Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Final Environmental Impact Statement

US Army Corps of Engineers®
Portland District

Executive Summary

The Need for a Management Plan

In this Final Environmental Impact Statement, the U.S. Army Corps of Engineers (Corps) has evaluated several alternatives to reduce predation-related losses of juvenile salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) from double-crested cormorants (*Phalacrocorax auritus*) nesting on East Sand Island in the Columbia River Estuary. Many of these juvenile salmon and steelhead (referred to collectively hereafter as salmonids; Figure ES-1) are listed as threatened or endangered under the Endangered Species Act. Development and implementation of a management plan to reduce avian predation is a requirement from the Corps' consultation under the Endangered Species Act with the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA Fisheries) for the operation of the hydropower dams that make up the Federal Columbia River Power System. The proposed management plan in this Final Environmental Impact Statement was developed to comply with reasonable and prudent alternative action 46 in the 2008 and associated 2010 and 2014 Supplements to the Federal Columbia River Power System Biological Opinion issued by NOAA Fisheries.

Management of double-crested cormorants is necessary to increase survival of juvenile salmonids by reducing predation-related losses. Over the past 15 years, double-crested cormorants on East Sand Island consumed approximately 11 million juvenile salmonids per year, although total consumption varies each year and by salmonid population. When compared to other known mortality factors, this level of predation is considered a substantial source of mortality. Predation-related losses of juvenile steelhead are of particular concern for resource managers, as data to date indicate they are most impacted by double-crested cormorant predation (NOAA Fisheries 2014). Average annual double-crested cormorant predation rates of juvenile steelhead originating upstream of the Bonneville Dam have ranged from 2 to 17 percent over the past 15 years (depending on the run, or distinct population segment, and year).

FIGURE ES-1. Juvenile salmonids.

Double-crested cormorants are native to the Columbia River Estuary. Approximately 98 percent of double-crested cormorants breeding in the Columbia River Estuary nest on East Sand Island. The colony on East Sand Island near the mouth of the Columbia River has increased from 100 breeding pairs in 1989 to approximately 15,000 breeding pairs in 2013, likely due to changes regarding habitat, nesting, and foraging conditions near the mouth of the Columbia River that are favorable for the species. The colony accounts for approximately 40 percent of the western population of double-crested cormorants, which includes the breeding colonies from British Columbia to California and east to the Continental Divide.

Based on the western population abundance estimates ca. 1990 and ca. 2009, the entire western population of double-crested cormorants has increased approximately 2 percent per year. This growth has been primarily associated with the growth of the East Sand Island colony. The estimated annual sums of breeding individuals across other western colonies, not including East Sand Island, are similar or higher when comparing population data from ca. 1990 to current, even when accounting for losses in portions of the range. Thus, a re-distribution has taken place; some locations have declined while others have increased. The number of active colonies has also increased. In about 1990, Carter et al. (1995) noted 99 active colonies in British Columbia, Washington, Oregon, and California. That number increased to 160 active colonies (2008-2012) for the same states and province (Pacific Flyway Council 2013).

With a typical foraging range of approximately 15 miles (25 kilometers; Figure ES-2), the diet of double-crested cormorants on East Sand Island is made up mostly of marine forage fish. However, as juvenile salmonids migrate through the Lower Columbia River Estuary and past East Sand Island on their out-migration to the ocean, they are susceptible to and consumed by double-crested cormorants; consumption is highest in early May, which coincides with the peak nesting season.

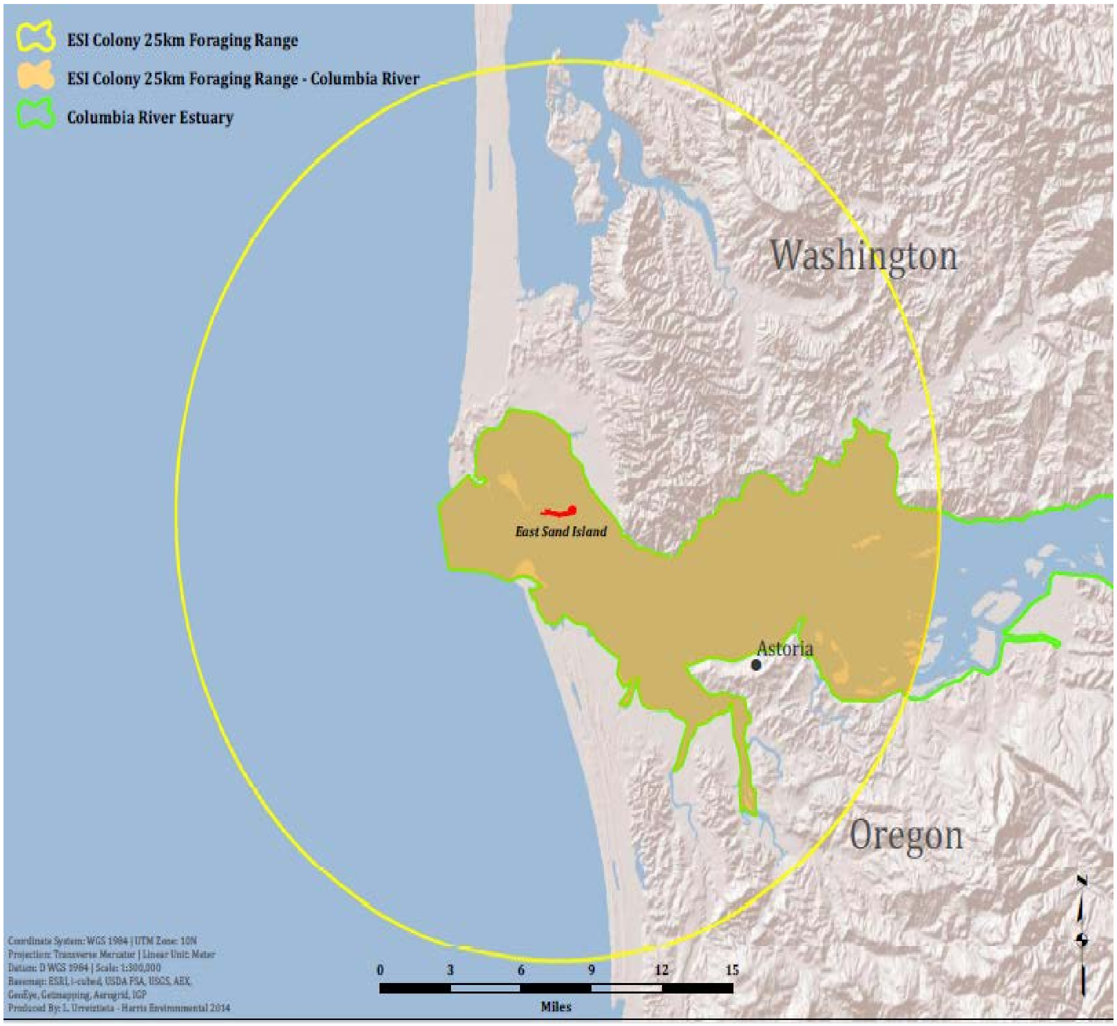

FIGURE ES-2. East Sand Island and the typical foraging range of nesting double-crested cormorants.

Management Goals

Management of the double-crested cormorant colony on East Sand Island was identified as reasonable and prudent alternative action 46 in the 2008 and associated 2010 and 2014 Supplements to the Federal Columbia River Power System Biological Opinion issued by NOAA Fisheries. In the 2014 Supplemental, NOAA Fisheries presented a “survival gap” analysis, which evaluated the difference in double-crested cormorant predation on juvenile steelhead between the “base period” of 1983–2002 and the “current period” of 2003–2009. Because steelhead are more susceptible to double-crested cormorant predation (compared to other salmonid species and in the context of the Biological Opinion), they were used to describe survival improvements that could be achieved through management of the double-crested cormorant colony on East Sand

Island. NOAA Fisheries analysis determined that mortality of juvenile steelhead from double-crested cormorant predation was approximately 3.5 percent higher in the "current period" than the "base period."

NOAA Fisheries then determined that a reduced double-crested cormorant breeding population of 5,380 to 5,939 breeding pairs on East Sand Island would restore juvenile steelhead survival to the environmental baseline or "base period" levels. Thus, reasonable and prudent alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion called for the Corps to "…*develop a cormorant management plan (including necessary monitoring and research) and implement warranted actions to reduce cormorant predation in the estuary to Base Period levels (no more than 5,380 to 5,939 nesting pairs on East Sand Island).*"

Developing the Plan

The Corps is the lead agency of the Final Environmental Impact Statement under the National Environmental Policy Act. The U.S. Fish and Wildlife Service, U.S. Department of Agriculture's Animal and Plant Health Inspection Service – Wildlife Services, Oregon Department of Fish and Wildlife, and Washington Department of Fish and Wildlife are cooperating agencies. The analyses in this Final Environmental Impact Statement will support decision-making within the cooperating agencies and other agencies, which have connected actions as a result of the Corps' proposed action. Four action alternatives are considered in detail in the Final Environmental Impact Statement. Each alternative contains a set of actions, monitoring efforts, and potential adaptive responses that comprise an implementable management plan. Each alternative integrates non-lethal and lethal methods to manage the double-crested colony on East Sand Island, with focus on one method as the primary management strategy.

The reasonable and prudent alternative action 46 specified the primary management goals (i.e., a reduced colony size of approximately 5,600 nesting pairs of double-crested cormorants on East Sand Island to achieve a 3.5 percent survival increase for juvenile steelhead) and was adopted into the statement of purpose and need. In meeting this purpose, impacts to species not targeted for management would be minimized to the extent possible. The time period associated for implementation and achievement of management objectives is also connected to the Biological Opinion, which identifies actions to begin by spring of 2015 and overall objectives to be achieved by the end of 2018.

Management Feasibility Studies

The Corps has conducted research to understand the dynamics of the double-crested cormorant colony on East Sand Island and test the feasibility of potential management techniques for reducing predation-related losses of juvenile salmonids. Social attraction techniques (setting up decoys and broadcasting audio playback of bird calls to encourage nesting) were tested within and outside the Columbia River Estuary for several years as a possible method to redistribute the East Sand Island double-crested cormorant colony. During 2004–2008, social attraction techniques were employed on various islands within the Columbia River Estuary with some success at promoting double-crested cormorants to nest at alternative sites, primarily on Miller Sands Spit. However, nesting was very dependent upon continued management efforts, and the locations where nesting occurred were further upriver from East Sand Island, where double-crested cormorant predation impacts to salmonids have been documented to be higher. During 2007–2012, social attraction techniques were used outside of the Columbia River Estuary at five known roosting sites in Oregon, but there were no nesting attempts made by double-crested cormorants at any site.

In 2007 the Corps began to investigate the effectiveness of certain non-lethal methods to dissuade double-crested cormorants from nesting in specific locations on East Sand Island (Figure ES-3). The objective of these investigations was to determine feasibility of various management actions and gather necessary information that would be needed to adequately inform a future management strategy (i.e., this Management Plan). Human hazing and use of visual deterrents was determined to be the most effective method to reduce the amount of available nesting habitat. Available nesting habitat was incrementally reduced during 2011 to 2013 but, by design, not to such a degree to actively reduce colony size. In 2013, double-crested cormorants were restricted to just 4.4 acres of habitat, which was a 75 percent reduction of their preferred nesting area.

FIGURE ES-3. Cormorant colony on East Sand Island during dissuasion research.

Knowing where double-crested cormorants might relocate if dissuaded from nesting on East Sand Island was a high priority of the past management feasibility studies. As part of the studies, breeding adult double-crested cormorants were marked with radio or satellite transmitters. After some off-colony dispersal immediately following tagging, most returned to roost or nest on or near East Sand Island in the same year they were tagged and dissuaded from nesting. Double-crested cormorant use of areas during the breeding season was highest in the Lower Columbia River Basin, followed by the Washington Coast and Salish Sea (Table ES-1). Of all satellite-tagged cormorants hazed from East Sand Island prior to the 2012-2013 nesting seasons, 98 percent remained in the Columbia River Estuary for the nesting season. The level of habitat reduction and hazing during the management feasibility studies did not affect the size of the double-crested cormorant colony or nesting success, nor promote double-crested cormorant long-term dispersal or permanent emigration. These studies provided relevant information about double-crested cormorant commitment to East Sand Island and the Columbia River Estuary, likely dispersal locations, and the feasibility of various actions that would achieve the purpose and need of this Final Environmental Impact Statement.

TABLE ES-1. Nighttime Detections during April 1–May 30 (Years 2012 and 2013) by Double-crested Cormorants Satellite-tagged on East Sand Island within the Affected Environment.

Region	# of Birds that Visited	% of Birds that Visited	# of Detections	% of Detections	Active Colonies	Active + Historical Colonies
Oregon Coast	0	0.0 %	0	0.0 %	22	40
Lower Columbia River Basin (excludes East Sand Island)	93	97.9 %	976	59.7 %	4	8
Washington Coast	61	64.2 %	460	28.1 %	4	32
Salish Sea	20	21.1 %	144	8.8 %	12	44
Vancouver Island Coast	4	4.2 %	55	3.4 %	0	0

Putting Predation Impacts in Context

Although there are many causes of mortality to juvenile salmonids as they move through the Columbia River Basin to the Pacific Ocean, in the context of other identified point-sources of mortality such as hydropower dams, the mortality from predation by double-crested cormorants for some salmonid groups in the Columbia River Estuary is substantial. For example, dam passage survival of juvenile steelhead and yearling Chinook salmon is required to be 96 percent. The required survival passage at a dam (i.e., 4 percent) is less than the average annual 6.7 percent mortality for juvenile steelhead from 2003-2009 resulting from double-crested cormorant predation, as estimated in the NOAA Fisheries' analysis.

Even higher predation rates have been documented for some Columbia River salmonid groups in a given year (e.g., 11-17 percent; see Chapter 1, Section 1.2). Thus, average double-crested cormorant predation impacts can be similar to or exceed the mortality experienced at a hydropower dam in the Federal Columbia River Power System, and in some years (e.g., 2011) can be three to four times higher. Furthermore, recent research indicates juvenile salmonid mortality is highest in the lower 31 miles of the Columbia River (Harnish et al. 2012), which overlaps geographically with the known foraging range of the double-crested cormorant colony on East Sand Island (Figure ES-2).

Reducing predation of juvenile salmonids from double-crested cormorants is an objective of several Columbia River Basin recovery plans. Direct mortality from avian predation (i.e., double-crested cormorants and Caspian terns) is identified as a key limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead; one of the secondary factors limiting viability for all Lower Columbia River coho and late fall and spring Chinook salmon and steelhead populations; and a threat to Upper Columbia River spring Chinook and steelhead populations.

Double-crested cormorant predation can differ dramatically within a given nesting season and between years. During 2003–2013, when the colony size was relatively stable, estimates of total annual juvenile salmonid consumption ranged between 2.9 and 20.9 million. Factors that likely affect double-crested cormorant predation include environmental conditions that affect the timing, abundance, and availability of forage fish in the estuary (e.g., river discharge, tidal volume, sea surface temperature, upwelling timing and strength), differences in double-crested cormorant abundance, nesting chronology, and nesting success, and large-scale climatic factors that influence both the prey and predator (e.g., El Niño Southern Oscillation, Pacific Decadal Oscillation, North Pacific Gyre Oscillation, and Pacific Northwest Index). These factors would be considered when predicting and interpreting the success of management actions on East Sand Island within a given year and over the long-term.

The potential benefits to juvenile salmonids, presented in the Final Environmental Impact Statement analyses, do not factor in any degree of compensatory mortality. Compensatory mortality is one type of mortality largely replacing or “compensating” for another kind of mortality, but where the total mortality rate of the population remains constant. This is in contrast to additive mortality, where one source of mortality is added to another for a combined total effect. The degree to which a source of mortality is compensatory or additive is likely not a static condition but changes within the context of dynamically changing environmental conditions, population abundances, and complex food webs.

Currently, the degree to which double-crested cormorant predation of juvenile salmonids is compensatory versus additive is unknown (Lyons et al. 2014). Therefore, the benefits to juvenile salmonids from reducing the double-crested cormorant colony are potential maximum benefits that could occur. These potential benefits would ultimately depend upon the degree of compensation actually occurring and other factors that could result in the management goals for reduced predation not being achieved throughout the entire Columbia River Estuary, such as double-crested cormorant dispersal and the effectiveness at precluding double-crested cormorants from the Columbia River Estuary.

A Complex Issue

Wildlife management is fundamentally a human concept that aims to manage the needs or goals of humans with the needs of wildlife. Thus, there is a large “human dimension” component to wildlife management, as individuals with an interest in the outcome of the management plan do not all share common values, nor would any one management action or alternative appease all stakeholders. The issues presented in this Final Environmental Impact Statement pose a complex problem that spans a diverse range of stakeholders, and the importance of the “human dimension” in making a decision cannot be overstated.

The differences in values held by the various stakeholders interested in the Corps’ double-crested cormorant management plan were identified during public scoping and in comments received during the public comment period for the Draft Environmental Impact Statement. Many fisheries groups expressed concern that the problem has been left unaddressed for too long, that double-crested cormorant predation will only continue to increase, and the loss of personal income due to reduced fishing opportunities is unacceptable. Alternately, many wildlife groups commented that double-crested cormorants are being made scapegoats and suggested the Corps look at the true causes endangering salmonid runs, which these groups stated as overfishing, an excess of hatchery fish being released, and fish passage barriers such as the hydropower dams. Acknowledging the extremes in viewpoints, the Corps has sought to develop a balanced solution with its cooperating agencies that addresses competing needs and interests and achieves management objectives within established timeframes while minimizing environmental impacts.

Key Considerations in Developing Alternatives

Both double-crested cormorants and juvenile salmonids are natural components of the ecosystem and are protected under federal laws. Proposed management actions of double-crested cormorants must comply with the regulations implementing the Migratory Bird Treaty Act. In developing the range of alternatives, this and many other factors were considered in determining how best to achieve management goals while minimizing effects from the action.

Early in project planning and scoping, concerns were raised regarding adverse impacts to the western population of double-crested cormorants and other nesting waterbirds on East Sand Island. Short- and long-term effects of the proposed action on the western population of double-crested cormorants are described and considered for each alternative. The alternatives proposing lethal take include annual monitoring of the western population of double crested cormorants. This information will be used to evaluate and adjust future actions through an adaptive management strategy (Chapter 2, Section 2.1.2), which will reduce the potential risk of negatively affecting the long-term sustainability of the western population of double-crested cormorants. A sustainable population was defined for this Final Environmental Impact Statement as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered. Based on the past population trend (described previously) and the current number of active colonies, it appears the western population is sustainable around 41,660 breeding individuals (ca. 1990 abundance).

Concerns were also raised regarding redistribution of a large number of double-crested cormorants and how other species and resources, as well as states, local agencies, and the public, might be affected should impacts be transferred to other areas. Dispersal of double-crested cormorants has the potential to cause greater impact to juvenile salmonids if they move to upriver locations in the Columbia River Estuary where juvenile salmonids compose a higher proportion of their diet. In response to these concerns, the Corps included extensive monitoring and adaptive management approaches into the alternatives to minimize dispersal.

Prior research and the scientific literature from double-crested cormorant and great cormorant management programs were reviewed to determine technically feasible methods. The results of past Corps-funded double-crested cormorant research, particularly the smaller scale management feasibility studies during 2011–2013, were assessed when selecting methods that would be technically feasible at the larger scale of management. As the purpose and need is to reduce double-crested cormorant predation over a large geographic area – 172 river miles of the Columbia River Estuary – special consideration was given to methods that would practically achieve this, both from a technically feasible and economic standpoint. Thus, only alternatives that were considered feasible in meeting the need to reduce double-crested cormorant depredation of juvenile salmonids throughout the Columbia River Estuary were carried forward for detailed study.

Public Comments on the Draft Environmental Impact Statement

On June 12, 2014, the Draft Environmental Impact Statement was announced via a public notice issued by the Corps and made available on the project website. On June 20, 2014, a Notice of Availability was published in the Federal Register, with an initial comment period of 45 days. A request to extend the comment period was granted and the comment period was extended 15 days and ended August 19, 2014. Numerous local and national media organizations published stories on the Corps' proposed action.

The Draft Environmental Impact Statement elicited a substantial number of public comments, with over 152,000 comments received. More than 98 percent (over 149,000) of all comments were submitted from two online petitions (CARE2 and National Audubon Society). The majority of comments expressed opinions about the range of alternatives and other issues regarding salmon recovery methods. Many suggested the Corps consider other methods, such as altering flow management, removal of dams, habitat restoration, etc., rather than managing native wildlife to improve salmonid populations. Comments were organized into two general categories: 1) opinion-based comments and 2) comments that challenged the methodologies, alternatives, and assumptions of effects made in the Draft Environmental Impact Statement, to which the Corps would respond with adding clarifying information, additional analysis, or changes to the alternatives in preparing a Final Environmental Impact Statement.

The majority of substantive comments challenged the science supporting the need for double-crested cormorant management; criticized the range of alternatives considered; challenged the adequacy of the cumulative impacts analysis for the western population of double-crested cormorants, citing drought, human disturbance, and other threats; challenged the proposed management plan's lethal focus for consistency with Migratory Bird Treaty Act depredation permit regulations; and claimed the Corps misrepresented the scope and scale of research to justify selecting lethal methods for the preferred alternative.

In response to public and agency comments, the Final Environmental Impact Statement was updated to address the comments and make factual corrections. Important changes resulting from comments about the science supporting the need to manage double-crested cormorants include revisions to NOAA Fisheries' "survival gap" analysis as presented in the purpose and need, and an explanation of methods, limits, assumptions, and uncertainty in the bioenergetics modeling that was used in the "survival gap" analysis. Contextual information was added with an expanded discussion on the rationale for not evaluating other alternatives (such as dam removal, hatchery or flow management, etc.) that would not involve managing double-crested cormorants.

In response to comments regarding the cumulative impacts to the western population of double-crested cormorants, the Final Environmental Impact Statement includes Alternative C-1, which is the preferred alternative. Alternative C-1 is a modification to Alternative C that includes both nest oiling and culling as the lethal management strategy. Alternative C-1 reduces the total amount of take of individual double-crested cormorants by approximately 40 percent compared to Alternative C, leaving more breeding adults in the population. Additionally, changes were made to the double-crested cormorant population model parameters to incorporate a future reduced carrying capacity scenario to account for potential long-term threats and risks to the western population of double-crested cormorants. Furthermore, the adaptive management strategy was revised for alternatives considering lethal take to adjust take levels dependent upon information received from annual monitoring of the western population of double-crested cormorants, per the Pacific Flyway Council Monitoring Strategy. This revision further mitigates the potential for adverse effects to the western population of double-crested cormorants.

In response to comments regarding the Migratory Bird Treaty Act and the mischaracterization of the scope and scale of past research, the Corps, in cooperation with the U.S. Fish and Wildlife Service, reorganized the Appendices and developed Appendix G to include the full summary of non-lethal methods attempted to date by the Corps and the results of those methods. This information was considered when evaluating the feasibility of those methods to be applied at the scale necessary to achieve management objectives. No comments were received that challenged the results from other cited studies attempting non-lethal management on similar geographic scales, nor compelling evidence provided or cited to suggest that non-lethal management could be effectively implemented to reduce double-crested cormorant predation on a geographic area as large as the Columbia River Estuary.

Summary of Alternatives

In coordination with its cooperating agencies, the Corps further refined the alternatives based on public comments from scoping and those received on the Draft Environmental Impact Statement. Four action alternatives (including the preferred) and a no-action alternative are considered in detail (Table ES-2). All action alternatives employ an "integrated" approach (using a combination of non-lethal and lethal methods, but with a focus on one or the other as a primary method) and a two-phased approach. Phase I involves efforts to directly reduce the size of the colony on East Sand Island to the management goal set in reasonable and prudent alternative action 46 (i.e., no more than 5,380 to 5,939 breeding pairs).

Phase II includes non-lethal efforts to ensure management goals for the colony size are retained and to evaluate the success of management. Phase II also includes modifying the terrain on the western portion of East Sand Island, which would allow for more frequent inundation of the island and reduce double-crested cormorant nesting habitat. Evaluation of the proposed action includes monitoring double-crested cormorants and other species that use East Sand Island and the recovery of salmonid passive integrated transponder tags deposited by double-crested cormorants on the East Sand Island colony. Passive integrated transponder tags are inserted into fish and their recovery allows for the assessment of juvenile salmonid mortality resulting from the East Sand Island double-crested cormorant colony.

Table ES-2. Comparison of Alternatives.

Alternative	Summary of Actions*	Monitoring	Adaptive Management
Alternative A *No Action*	No actions would occur to manage the colony on East Sand Island. Compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need would not be met. Comparative survival improvements for juvenile salmonids would need to be achieved by other actions.	n/a	n/a
Alternative B *Non-Lethal Management Focus with Limited Egg Take*	Phase I - Use primarily non-lethal methods to achieve colony size of ~5,600 double-crested cormorant breeding pairs by dispersing >7,250 breeding pairs off East Sand Island over a 4-year period. Incremental dispersal (approximately 2,000-3,000 breeding pairs per year) would occur by reducing available acreage incrementally and hazing elsewhere on the island to preclude nesting. An application for a depredation permit for limited egg take on East Sand Island (500 eggs) and on Corps dredge material islands in the Columbia River Estuary (250 eggs) would be submitted to USFWS annually to support the effectiveness of hazing efforts after the beginning of the breeding season. Extensive off-island land- and boat-based hazing would occur throughout the Columbia River Estuary where accessible to preclude double-crested cormorants from nesting, roosting, and foraging. Phase II - Terrain modification to inundate the western portion of East Sand Island and preclude nesting, combined with continued monitoring and hazing efforts, supported with limited egg take, as needed. No management actions would be taken to ensure a minimum colony size.	Phase I - Surveys to measure peak colony size on East Sand Island and detect movement of double-crested cormorants in the Columbia River Estuary. Monitoring response of other birds. Recovery of passive integrated transponder tags after the breeding season to assess fish mortality. Outside the Columbia River Estuary, abundance surveys in the Columbia Basin above the Bonneville Dam and in coastal areas in Washington and Oregon at least once per year during the peak breeding season. Phase II - Monitoring would decrease in frequency depending on information needs. Outside of the Columbia River Estuary, monitoring would match or supplement the Pacific Flyway Monitoring Strategy, which calls for monitoring at select sites every three years.	Corps would convene Adaptive Management Team, consisting of the cooperating agencies, NOAA Fisheries, and tribal entities, to meet as needed during implementation. Monitoring results would be used to determine need for adjustments in field techniques. If aerial surveys are not sufficient in assessing dispersal, individual marking techniques (i.e., primarily satellite tags, but also VHF radios and bands) could be used.

Alternative	Summary of Actions*	Monitoring	Adaptive Management
Alternative C *Culling with Integrated Non-Lethal Methods*	Phase I - Culling of individuals to achieve colony size of ~5,600 breeding pairs. Culling would occur over 4 years with 24.0 percent of the colony culled per year. In total, 18,185 double-crested cormorants would be taken in all years (6,202, 4,887, 3,881, and 3,214 double-crested cormorants in years 1 to 4, respectively). The Corps would submit an annual depredation permit application to the USFWS for the proposed individual take levels and associated nest loss from take of those individuals. Take would occur on-island and over water within the foraging range (25km) of the East Sand Island colony. Concurrent with culling, hazing supported with limited egg take would occur to prevent colony expansion on East Sand Island. Take levels would be reported annually. Hazing in the Columbia River Estuary would occur at Corps dredge material islands under the Corps' Channels and Harbors program. Phase II - Same as Alternative B.	Phase I – Same monitoring on East Sand Island as Alternative B with the addition of monitoring and reporting take. Monitoring the western population annually per Pacific Flyway Council Monitoring Strategy. Monitoring in the Columbia River Estuary would occur 2 to 3 days after a culling session and be used to assess potential dispersal to areas in the Columbia River Estuary, particularly upstream of the typical double-crested cormorant foraging range (25km) of East Sand Island. Phase II - Same as Alternative B.	Same Adaptive Management Team as described in Alternative B, but no individual marking would occur. Take levels could increase or decrease depending upon information gained from monitoring when comparing predicted and observed abundances. Monitoring locations in the Columbia River Estuary could change and the need for hazing could increase or decrease based upon monitoring results.
Alternative C-1 *Culling with Egg Oiling and Integrated Non-Lethal Methods*	Phase I – Same as Alternative C, except both culling of individuals and egg oiling would be used as the primary lethal strategy. Annual individual take of 13.5 percent in years 1 to 4 and associated nest loss and nest oiling rates of 72.5 percent in years 1 to 3 and 13.5 percent in year 4. In total, 10,912 individuals and 26,096 total nests is proposed to be taken in all years (3,489, 3,114, 2,408, and 1,902 individuals taken in years 1-4; 9,368, 8,361, 6,466, and 1,902 nests lost in years 1-4). Phase II - Same as Alternative B.	Phase I – Same as Alternative C. Phase II - Same as Alternative B.	Same as Alternative C.

Alternative	Summary of Actions*	Monitoring	Adaptive Management
Alternative D *Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II*	Phase I - Same as Alternative C-1. Phase II - The same primarily non-lethal methods described in Phase II of Alternatives B, C, and C-1 (terrain modification supplemented with hazing, supported with limited egg take, as necessary) would be used to disperse all remaining double-crested cormorants (~5,600 breeding pairs) from East Sand Island and exclude future double-crested cormorant nesting. Hazing efforts in the Columbia River Estuary would be the same as Phase I of Alternative B.	Phase I - Same as Alternative C-1. Phase II - Same as Phase I of Alternative B initially, but would transition to Phase II of Alternatives B and C.	Same as Phase I of Alternative B initially, but would transition to Phase II of Alternatives B and C.

* Sum of annual take totals may not equal overall take total due to rounding.

Summary of Resources in the Affected Environment

Because double-crested cormorants are migratory birds and use a large area and action alternatives proposed in the Final Environmental Impact Statement are expected to cause some dispersal, the affected environment encompasses a large geographic area. This area includes the coastal and interior areas from northern California (San Francisco Bay) to southern British Columbia (Vancouver Island Coast) and the entire states of Oregon and Washington. Nearly all of the documented post-breeding and wintering locations of double-crested cormorants marked on East Sand Island as part of past monitoring efforts were found within this area. Additionally, sub-regions within the affected environment were identified where double-crested cormorant dispersal and usage may be more likely and the potential for resources to be affected is greater. The effects analysis for double-crested cormorants included the entire western population of double-crested cormorants, which spans from southern British Columbia to California and from the Pacific coast to the Continental Divide. The affected environment is summarized below (Table ES-3):

TABLE ES-3. Affected Environment.

Affected Resource	Summary
Vegetation and Soils of East Sand Island	A mix of native and non-native plant species is found on the island. Several tidal and non-tidal wetlands and forested areas are present. Guano from double-crested cormorants on the western portion of the island has adversely affected vegetation establishment. Soils are generally sandy to sandy silt.
Double-crested Cormorants	The double-crested cormorant colony on East Sand Island has increased from approximately 100 breeding pairs in 1989 to approximately 15,000 breeding pairs in 2013. Approximately 98 percent of double-crested cormorants breeding in the Columbia River Estuary nest on East Sand Island. The colony accounts for approximately 40 percent of the western population of double-crested cormorants, which includes the breeding colonies from British Columbia to California and east to the Continental Divide. Although the western population of double-crested cormorants composes a small percentage of the continental population, the breeding colony on East Sand Island is the largest in North America. The coastal states and provinces account for greater than 90 percent of the western population, with approximately 70 percent of the breeding population along the coast. From approximately 1987 to 2009, the number of double-crested cormorant breeding pairs estimated within coastal states and provinces increased by approximately 72 percent (i.e., 3 percent per year), or 12,000 breeding pairs, with most growth occurring at the East Sand Island colony. Based on abundance estimates ca. 1990 and ca. 2009, the entire western population of double-crested cormorants has increased approximately 2 percent per year. Since the 1990s, large-scale distributional changes occurred, largely as a result of growth at East Sand Island.

Affected Resource	Summary
Other Birds on East Sand Island	Gulls, Caspian terns, and Brandt's cormorants nest on the island. Large numbers of California brown pelicans use the island for roosting and limited past instances of nesting have been observed. Several raptors (eagles, owls, and falcons) are also present on the island, foraging on eggs, chicks, and adult birds. Waterfowl and shorebirds frequent the island to roost and forage, although in far fewer numbers than nesting colonial waterbirds. Shorebirds are observed in the tidal flats and beaches, and a variety of songbirds are present in the more vegetated areas on the central portion of the island.
Other Birds	Streaked horned larks, listed as threatened under the Endangered Species Act, occupy designated critical habitat on nearby islands (Rice, Miller, and Pillar Rock) where double-crested cormorants are likely to prospect for new habitat. American white pelicans and pelagic cormorants nest in the Columbia River Estuary. Along the Pacific Coast and Salish Sea, a number of other birds may overlap with double-crested cormorants, including auklets, petrels, puffins, oystercatchers, herons, and pigeon guillemot.
ESA-Listed Fish in the Lower Columbia River Basin	Five salmonid species, representing thirteen different Evolutionary Significant Units or Distinct Population Segments listed under the Endangered Species Act, occur in the Lower Columbia River Basin and are potential prey to double-crested cormorants. Direct mortality from avian predation, including double-crested cormorant predation, is identified in certain Endangered Species Act recovery plans as a secondary factor limiting viability for all Lower Columbia River coho, late fall and spring Chinook salmon, and steelhead populations; a key limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead; and a threat to Upper Columbia River spring Chinook and steelhead populations. On average, double-crested cormorants have consumed approximately 11 million Columbia River Basin juvenile salmonids per year during the past 15 years. Green sturgeon and Pacific eulachon are also Endangered Species Act species present in the Columbia River Estuary. Pacific eulachon are a potential prey species for double-crested cormorants but green sturgeon are not.
Other ESA-Listed Fish	Oregon Coast coho and Southern Oregon and Northern California coho are found along the Oregon Coast. Puget Sound steelhead and Chinook, Hood Canal chum, Ozette Lake sockeye, and three species of rockfish (bocaccio, canary, and yelloweye) are found along the Washington Coast and Salish Sea areas. Bull trout and Pacific eulachon are widely distributed throughout the affected environment. All of these species are listed under the Endangered Species Act and are potentially vulnerable to double-crested cormorant predation.
Public Resources and Social Values	Public resources identified as having potential impacts from management actions include: public health and human safety (as is related to possible exposure to concentrations of double-crested cormorant guano, and the use of firearms under lethal take strategies); transportation facilities (particularly the Astoria-Megler Bridge); and dams and hatcheries (where double-crested cormorants congregate and depredate juvenile salmonids). Social values were identified as individual existence and aesthetic values of double-crested cormorants or salmonid populations, and depend upon an individual's value system and perspective.

Affected Resource	Summary
Columbia River Basin Salmon Fisheries	Columbia River commercial, tribal, and recreational fisheries are important regional economic contributors. Equally important is the cultural importance of salmon as a "first food" for Columbia River tribes. The value of tribal ceremonial and subsistence harvests cannot be measured in terms of dollars and are culturally significant beyond economic gain. Columbia River tribes contribute greatly to the production of hatchery fish. An estimated $49.7 million in personal income (2012 dollars) was generated by Columbia River in-river fisheries from hatchery surpluses (1 percent), tribal commercial (15 percent), non-Indian commercial (14 percent), and freshwater sport recreational (70 percent) fisheries.
Historic Properties	Four historic properties have been recorded on the island; two are associated with stabilization efforts (a basalt rock armored shoreline and an associated equipment bone-yard), and two are associated with the Harbor Defense System of World War II. Prior to a 1930s stabilization effort the island was a shifting sandbar and did not exist in its current configuration.

Summary of Environmental Consequences

Alternative A: No Action

If no actions are taken to manage the double-crested cormorant colony, compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need of the Final Environmental Impact Statement would not be met. This would require re-initiation of consultation with NOAA Fisheries. Predation rates on juvenile salmonids would likely remain higher than rates estimated during the environmental baseline of the 2008 Federal Columbia River Power System Biological Opinion and would continue to be a significant source of mortality. Additional measures would need to be identified to fill the gap in juvenile salmonid survival. These measures are unspecified at this time but would need to demonstrate an increase in juvenile salmonid survival equivalent to NOAA Fisheries' "survival gap" analysis. These actions could have potentially significant environmental and economic impacts given the required survival improvement. Since these actions are unknown at this time, it would be speculative to evaluate the potential environmental and social effects. Therefore, the no action alternative in this document describes effects that could continue to occur if no efforts were taken to manage the double-crested cormorant colony on East Sand Island.

Double-crested cormorant predation would continue to be a substantial cause of juvenile salmonid mortality, with 11 million juvenile salmonids being consumed on average annually and potential predation rates as high as 17 percent on particular salmonid groups within a given year. Direct or indirect effects to threatened or endangered fish outside of the Lower Columbia River Basin would be similar to past conditions.

The average size of the double-crested cormorant colony on East Sand Island is expected to remain similar to current estimates in the near-term (approximately 26,000 breeding individuals). The abundance of the western population of double-crested cormorants is expected to remain similar to current estimates in the near-term (approximately 62,400 breeding individuals) but may decline in the future due to potential loss of habitat from cumulative adverse effects, such as drought caused by climate change, increasing depredation by an expanding bald eagle population, and other regional impacts. Based on modeled results of long-term trend, a gradual decrease from current levels is predicted, with abundance stabilizing at approximately 53,000 breeding individuals in 20 years, approximately 11,300 breeding individuals more than observed in ca. 1990. The East Sand Island colony would continue to account for approximately 40 to 50 percent of the breeding western population.

Vegetation and soils within the 16 acres of the double-crested cormorant colony would continue to be impacted by guano, resulting in the western end of the island largely denuded from vegetation and species diversity reduced. With the exception of the Caspian tern colony, which is currently subject to management and hazing, the colony size and abundance of other bird species on and off East Sand Island would remain similar to current estimates, and spatial distribution of other nesting species would likely be similar.

The annual economic value of in-river Columbia River fisheries would likely remain similar to current levels in the near-term ($41.9 million direct financial value [i.e., revenue received by harvesters and expenditures made by anglers]; $49.7 million regional economic impact [i.e., expenditures as related to personal income and jobs]). When compared to Alternative D, which proposes to exclude all nesting by double-crested cormorants on East Sand Island, current levels of juvenile salmonid predation by double-crested cormorants on East Sand Island would likely continue to result in potential annual losses of $2.6 million to Columbia River in-river fisheries (i.e., for both direct financial value and regional economic impact) and $6.4 million in hatchery production investment costs.

Direct or indirect adverse effects to public resources would be similar to past conditions before the management feasibility studies and dissuasion research, which potentially increased dispersal of double-crested cormorants. This alternative could have the greatest beneficial effects regarding existence and aesthetic value to individuals with positive perceptions of double-crested cormorants and the greatest adverse effects to individuals with negative perceptions of double-crested cormorants or high existence values of juvenile salmonids. There would be no adverse effects to historic properties, since there would be no ground disturbance on the island.

Alternative B: Non-Lethal Management Focus with Limited Egg Take

Movement data from research indicates double-crested cormorants are strongly committed to nesting on East Sand Island and roosting in the Lower Columbia River Basin when hazing has prevented that nesting. Substantial and continued efforts would likely be needed to deter and disperse double-crested cormorants from this area under Alternative B. Similar impacts to salmonids would continue to occur if double-crested cormorant abundance near East Sand Island remains similar to current levels, and impacts could be higher if double-crested cormorants disperse upriver, where salmonids compose a higher proportion of their diet. With high double-crested cormorant dispersal outside of the Columbia River Estuary under Alternative B, there is a greater potential for adverse effects to other ESA-listed fish species outside of the Columbia River Estuary located in double-crested cormorant high use areas, particularly along the Washington coast and Salish Sea. When compared to Alternative A (no action) and Alternatives C-D, which propose lethal removal, predation rates of juvenile salmonids could increase in Phase I in these areas.

Reduction of the double-crested cormorant colony size to approximately 5,600 pairs is expected to reduce the rate of predation necessary to eliminate the survival gap identified by NOAA Fisheries, resulting in average annual juvenile salmonid survival increases of 1 to 4 percent, depending on Evolutionarily Significant Unit and Distinct Population Segment. However, these benefits represent maximum values (as previously described) and there would be less certainty in achieving these benefits because hazing is unlikely to be effective in keeping double-crested cormorants out of the Columbia River Estuary and thus reducing their predation impacts on salmonids.

Even if hazing were effective at preventing double-crested cormorants from foraging and/or nesting in the Columbia River Estuary, there is the potential that the impacts of double-crested cormorant predation of ESA-listed juvenile salmonids could be shifted to other areas outside of the Columbia River Estuary. Bull trout susceptibility to double-crested cormorant predation may be greater for migratory fish compared with resident fish, especially for bull trout that utilize estuaries. Extended use of estuaries and nearshore marine environments by juvenile Puget Sound Chinook and juvenile Hood Canal chum suggests they would be more vulnerable to double-crested cormorant predation if double-crested cormorants disperse to coastal estuaries in Washington. Puget Sound steelhead smolts may move offshore more quickly, as compared with Puget Sound Chinook and Hood Canal chum salmon, and this would likely lessen their susceptibility to double-crested cormorant predation. Impacts to Ozette Lake sockeye are unknown but the potential for conflict exists, especially if sockeye use estuary or nearshore habitats for extended periods of time.

Because this alternative proposes to utilize primarily non-lethal methods to achieve the colony size reduction on East Sand Island, the abundance of the western population of double-crested cormorants is expected to remain similar to current levels in the near term (62,400 breeding individuals) but may decline to a greater extent than Alternative A due to the factors described plus additional loss of habitat at East Sand Island from the Phase II terrain modification and future limitation of the colony. Based on modeled results of long-term trend, a gradual decrease is predicted, with abundance stabilizing at approximately 46,000 breeding individuals in years 13-20 after implementation, approximately 4,300 breeding individuals more than observed in ca. 1990. There may be a depression in recruitment prior to the successful breeding of individuals at new sites or if productivity at new sites is lower than at East Sand Island. Approximately 24 percent (11,200/46,000) of the western population of breeding double-crested cormorants could nest at East Sand Island.

With a reduced double-crested cormorant colony on East Sand Island, vegetation and soils may experience passive restoration in the short-term, although dissuasion activities could adversely impact soils and vegetation while managing the colony. Later modification of the terrain would likely cause conversion of current bare sand to tidal mudflat or marsh areas, which may increase diversity of vegetation and soil complexity and provide beneficial effects to shorebirds and long-term benefits to juvenile salmonids, but could have short-term adverse effects from localized increases of turbidity and sedimentation from ground-disturbing work.

Non-target species common to the island have the greatest potential for experiencing adverse effects from human disturbance (human hazing, etc.), which could flush adults or young birds and increase exposure time of eggs and juveniles to predators. Depending on the proximity, frequency, and duration of these activities, this disturbance could result in reduced survival for individuals. There is high potential for a significant reduction in abundance or the exclusion of nesting of Brandt's cormorants on East Sand Island as a consequence of management because they nest in close association with double-crested cormorants. There is a moderate to high potential for a significant reduction in colony size or abundance of other waterbird species (gulls, pelicans, and terns) on East Sand Island. There is a possibility other species may completely abandon East Sand Island after repeated hazing, as well as a potential for increased inter-specific competition.

The potential for adverse effects off of East Sand Island is dependent upon and commensurate with dispersal levels to new areas and subsequent site-specific interactions. Within the Columbia River Estuary, there is potential for hazing to occur in new areas or to intensify in existing areas where hazing already occurs (i.e., upland dredged disposal areas on estuary islands). The greatest potential for adverse effects to other birds off of East Sand Island is the potential for double-crested cormorant dispersal and hazing to affect streaked horned larks, which were recently listed as threatened under the Endangered Species Act and occupy designated critical habitat on nearby islands in the Columbia River Estuary. The entire population of streaked horned larks in the world is estimated to be less than 1,700 individuals, with approximately 45 to 60 breeding pairs nesting in the Columbia River Estuary. Pelagic cormorants and American white pelicans also overlap with double-crested cormorants in the Columbia River Estuary and could be affected by hazing activities.

The proposed reduction in the colony size and the associated reduction of in-river Columbia River salmonid predation could result in increases of annual direct financial value and regional economic impacts of 3.4 percent ($1.4 million) and 3.0 percent ($1.5 million), respectively, and $3.6 million savings in direct financial investment in hatchery production. Similar to juvenile salmonid survival benefits, economic benefits are not expected to be fully realized and are less certain, at least in the short-term, because hazing is not expected to be successful in keeping double-crested cormorants out of the Columbia River Estuary.

Persistent use of the Astoria-Megler Bridge by double-crested cormorants throughout the breeding season is expected, and there could be high potential for adverse effects from associated guano corrosion. Effects to other transportation structures, dams, and hatcheries would be commensurate with dispersal levels to new areas. No adverse effects to human health and safety are expected, as little direct contact between humans and double-crested cormorants would be expected and disease transmission is unlikely to occur. Terrain modification may adversely affect two recorded historic properties on the island: the basalt rock armor, as the result of the removal of rock; and the World War II observation tower, as a result of increased tidal inundation. Compared to no management (Alternative A), Alternative B may have adverse effects to individuals who have high existence and aesthetic value for double-crested cormorants and believe that humans should not manage nature or ecosystems. There could be adverse effects to individuals who have high existence or aesthetic value for salmonids or other species if they become affected, or are perceived to be affected, by double-crested cormorant dispersal or redistribution.

Alternative C: Culling with Integrated Non-Lethal Methods

The expectation for double-crested cormorant dispersal is low under this alternative. Because the end colony size is the same as Alternative B, the potential range of survival benefits for juvenile salmonids and economic benefits could be the same. However, because the potential for dispersal is lower, these benefits would likely be fully realized and predation rates would be substantially reduced when compared to Alternative B. Additionally, because Alternative C does not propose to redistribute double-crested cormorants, the potential for adverse effects to listed fish in other areas would be low.

Culling would adversely impact the abundance and future growth rate of the western population of double-crested cormorants, which is expected to decline due to regional cumulative factors, plus the proposed cull and additional loss of habitat at East Sand Island from the Phase II terrain modification. Based on modeled results of long-term trend, the abundance of the western population of double-crested cormorants is projected to be approximately 35,000 breeding individuals at the end of four years of management, which is approximately 6,700 breeding individuals less than observed abundance in ca. 1990. The projected abundance falls below ca. 1990 population level for 9 years after implementation of Phase I actions and increases to a long-term 20-year projected size of approximately 44,500 breeding individuals, approximately 2,800 breeding individuals greater than observed abundance in ca. 1990. Approximately 25 percent (11,200/44,500) of the western population of breeding double-crested cormorants could nest at East Sand Island.

Other birds nesting on East Sand Island would likely be affected (i.e., flushing, loss of eggs, etc.) from human disturbance. This effect would likely be less than or similar to that of Alternative B. There is a low potential for overall double-crested cormorant use and hazing outside the area where nesting occurs on East Sand Island because habitat would not be restricted on the western portion of the island.

Due to the potential for misidentification, there is a potential for take of up to 0.1 to 0.3 percent of the regional population of Brandt's cormorants per year under the proposed 4-year strategy, or up to 3 to 6 percent of the colony on East Sand Island (i.e., colony is approximately 1,600 breeding pairs) per year. Because Brandt's cormorants nest in close association with double-crested cormorants, adverse effects could occur to Brandt's cormorants that overlap in areas where culling activities occur, although this would be minimized to the extent possible. There is a high potential for a substantial reduction in the size of the Brandt's cormorant colony when available nesting habitat would be reduced on East Sand Island during Phase II.

There is also a potential for take of up to 0.03 to 0.06 percent per year of the regional population of pelagic cormorants, or up to 6 to 12 percent of the colony that nest on the Astoria-Megler Bridge (i.e., colony is approximately 75 to 100 breeding pairs). Take levels would vary depending on the field techniques used and location (i.e., shooting over water has a greater potential for take of Brandt's and pelagic cormorants due to misidentification). The potential for take would be reduced by the implementation of the best management practices and adaptive management strategies described in Chapter 2.

There is a much lower potential to realize adverse effects to other species or public resources off of East Sand Island, as compared to Alternative B. Streaked horned larks are the primary species of concern for reasons previously stated; however, additional hazing, beyond what is currently planned by the Corps' Channels and Harbors Program, is not expected.

The proposed reduction in the colony size and the associated reduction of in-river Columbia River salmonid predation could result in increases of annual direct financial value and regional economic impacts as described for Alternative B. Effects to public resources and other transportation structures, dams, and hatcheries would be commensurate with dispersal levels to new areas. No adverse effects to human health and safety are expected, as shooters would employ safety protocols. This alternative could have adverse or beneficial effects (depending on the individual's values and perspective) regarding existence and aesthetic values and effects would likely be greater than the other alternatives because culling adults is the primary lethal strategy. Effects to historic properties would be the same as Alternative B.

Alternative C-1: Culling with Egg Oiling and Integrated Non-Lethal Methods (*Preferred Management Alternative)*

Alternative C-1 is a modification to the primary lethal strategy proposed in Phase I for Alternative C and would combine egg oiling with culling on East Sand Island. The expectation for double-crested cormorant dispersal is similar to Alternative C, but there is a potential for an increased number of disturbance events on East Sand Island when combining culling and egg oiling. Depending upon double-crested cormorant response and the effectiveness of boat-based culling, the number of disturbance events could be similar to Alternative C. Overall, benefits to juvenile salmonids, economic benefits, and adverse effects to other resources would be the same as or similar to Alternative C; however, if there is more dispersal in-season or between years, these benefits could be reduced. Effects to existence and aesthetic values would be similar to Alternative C, but the reduction in culling by 40 percent and the inclusion of egg oiling into the alternative could lessen the effects to individuals who have a high existence value for double-crested cormorants and who perceive egg oiling as a more humane method compared to culling adults.

The number of individual double-crested cormorants culled would be reduced by approximately 40 percent when compared to Alternative C (i.e., total take of approximately 11,000 versus 18,000 breeding individuals). The abundance of the western population of double-crested cormorants is projected to be approximately 38,500 breeding individuals at the end of four years of management, which is approximately 3,200 breeding individuals less than observed abundance in ca. 1990. The projected abundance falls below ca. 1990 population level for 4 years after implementation of Phase I actions and increases to a long-term 20-year projected size of approximately 44,500 breeding individuals, approximately 3,300 breeding individuals greater than observed abundance in ca. 1990. In total, 72.5 percent of nests (including both associated nest loss and nests destroyed from egg oiling) would be lost in years 1–3 on East Sand Island.

Because fewer individual double-crested cormorants would be culled, there is less potential for take of Brandt’s and pelagic cormorants. However, under Alternative C-1, a greater proportion of individuals could be culled over water compared to Alternative C to reduce the number of disturbances to the colony, which may reduce the difference in potential take levels of Brandt's and pelagic cormorants between the two alternatives. Implementation of Alternative C-1 would likely occur later into the breeding season compared to Alternative C, and this could have additional impacts to non-target nesting birds on East Sand Island due to egg oiling activities.

Alternative D: Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II

Alternative D is identical to Alternative C-1 in Phase I, and the effects described under Alternative C-1, both on and off of East Sand Island, would be the same for Alternative D in the short-term. The key difference in Alternative D is that non-lethal management would be used to exclude double-crested cormorants from nesting on East Sand Island. Loss of the East Sand Island colony would result in a substantial effect to the distribution of the western population of double-crested cormorants and potentially greater effects to those described in Phase I of Alternative B, where redistribution of the colony is proposed. In the long-term, Alternative D has the greatest overall adverse impact to the western population of double-crested cormorants, as abundance is projected to decrease to a low of approximately 33,000 breeding individuals and slightly increase to a long-term 20-year projected size of approximately 37,500 breeding individuals, approximately 4,200 breeding individuals less than observed abundance in ca. 1990.

There could be greater benefits for juvenile salmonid survival increases as well as the expected economic benefits in the long-term. These benefits may be substantially higher in the long-term than other alternatives should double-crested cormorants be completely excluded from the Columbia River Estuary (resulting in potentially no predation impacts), although this may not be realized for many years after Phase II. With no double-crested cormorant nesting on East Sand Island, average annual juvenile salmonid survival increases of 2 to 8 percent (depending on Evolutionarily Significant Unit and Distinct Population Segment) and economic increases to in-river Columbia River fisheries of 6.1 percent ($2.6 million; annual direct financial value) and 5.3 percent ($2.6 million; regional economic impact) and savings of $6.4 million in direct financial investment in hatchery production may be realized.

Double-crested cormorant dispersal and non-lethal management and hazing efforts on East Sand Island and in the Columbia River Estuary would be similar to Phase I of Alternative B. Thus, the expected benefits from additional double-crested cormorant abundance reduction would be less certain and the potential adverse effects to resources potentially affected by double-crested cormorant dispersal and hazing (e.g., streaked horned lark, Astoria-Megler bridge, ESA-listed fish within and outside the Columbia River Estuary) would similar to Phase I of Alternative B and greater than the other alternatives during Phase II.

Effects to individuals with high existence and aesthetic values for double-crested cormorants would be similar to those described in Alternative C-1 in Phase I. In Phase II, although the overall regional abundance would still be large, loss of the species from the local geographic area could have greater adverse or beneficial effects (depending on the individual's values and perspective) than just a reduction in colony size abundance. There is potential for greater beneficial effects to individuals who have high existence or aesthetic value for Columbia River salmonids as there is potential that double-crested cormorant predation could be reduced to greater levels and even eliminated in Phase II.

The Preferred Alternative/Management Plan

The Council on Environmental Quality defines the agency's preferred alternative as "the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors." Alternative C-1 was identified as the preferred alternative after evaluating the environmental consequences of each alternative when compared to the technical and logistical feasibility of achieving the Final Environmental Impact Statement purpose and need. In fulfilling the Corps' statutory responsibilities, adoption and implementation of the double-crested cormorant management plan described in Alternative C-1 meets the consultation requirements under the Endangered Species Act as identified by the 2014 Federal Columbia River Power System Supplemental Biological Opinion. Additionally, Alternative C-1 addresses many of the substantive comments received on the Draft Environmental Impact Statement during the public review period.

Because Alternative C-1 proposes a reduction in colony size through culling and egg oiling, there is more certainty this alternative would meet the need of reducing double-crested cormorant predation throughout the Columbia River Estuary than Alternatives B and D, which propose abundance reduction through dispersal. Compared to Alternative C, Alternative C-1 would lessen the potential effects to the short- and long-term population trend of the western population of double-crested cormorants by decreasing the number of adults lethally removed annually. Risk to the long-term sustainability of the western population is further reduced given that take on East Sand Island would occur within a well-monitored and adaptive management framework (see Chapter 2, Section 2.1), and proposed take levels would be reviewed annually under a depredation permit application. Monitoring of the western population would occur annually and this information would be used to evaluate and adjust future management activities. This allows time for annual evaluation and adaptive management changes and increases the ability for the western population to respond from a potential catastrophic event.

Minimal double-crested cormorant dispersal is expected under Alternative C-1 given proposed field techniques, adaptive management protocols, and knowledge from other similar programs. Dispersal levels would likely be similar to Alternative C and lower than Alternatives B and D. Given the proposed adaptive management techniques to minimize dispersal, this alternative would likely have few direct and indirect adverse effects to non-target species and resources off East Sand Island.

Alternative C-1 would have similar costs compared to Alternative C and lower associated dollar costs for implementation than Alternatives B and D. Alternative C-1 is expected to have greater direct adverse effects to individual double-crested cormorants and the colony on East Sand Island than Alternative B, but less than Alternatives C and D. Additionally, a reduction in culling by 40 percent and the inclusion of egg oiling into the alternative could lessen the effects to individuals who have a high existence value for double-crested cormorants and who perceive egg oiling as a more humane method compared to culling adults.

Public Review and Agency Decisions

The Corps is making the Final Environmental Impact Statement available for public review. The Corps has responded to comments received on the Draft Environmental Impact Statement. The Final Environmental Impact Statement includes a discussion of opposing views which were not adequately discussed in the Draft Environmental Impact Statement and indicates the Corps' response to the issues raised during the public comment period.

The Corps will make a decision on the proposed action that will be described in a record of decision thirty days after publication of the notice of availability of the Final Environmental Impact Statement in the Federal Register. The Corps will make the record of decision available to the public and it will identify all of the alternatives considered, state what the Corps' decision regarding a double-crested cormorant management plan is, identify all of the alternatives considered, and state whether all practicable means to avoid or minimize environmental harm have been adopted. If the Corps makes a decision to implement an action alternative, the Corps will submit a depredation permit application to the U.S. Fish and Wildlife Service after making the record of decision available and will request assistance from the U.S. Department of Agriculture's Wildlife Services to directly assist the Corps in implementing the management plan.

The Final Environmental Impact Statement will be available for public review for 30 days after publication of the notice of availability in the Federal Register by the U.S. Environmental Protection Agency. This period is anticipated to begin February 13, 2015. For more information on the schedule of this review, please visit the project webpage at http://www.nwp.usace.army.mil/Missions/Current/CormorantEIS.aspx.

Written comments may be sent electronically or by traditional mail to:

Mr. Robert Winters
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant Final EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Send electronic comments to **cormorant-eis@usace.army.mil**

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List of Acronyms

AM	Adaptive Management
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BRNW	Bird Research Northwest
Corps	United States Army Corps of Engineers
CRCIP	Columbia River Channel Improvement Project
CRFM	Columbia River Fish Mitigation
CRITFC	Columbia River Inter-Tribal Fish Commission
DCCO	Double-crested Cormorant
DEIS	Draft Environmental Impact Statement
DPS	Distinct Population Segment
DDT	Dichlorodiphenyltrichloroethane
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FCRPS BiOp	Federal Columbia River Power System Biological Opinion
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
GIS	Geographic Information Systems
LiDAR	Light Detection and Ranging
MBTA	Migratory Bird Treaty Act
MSA	Magnuson–Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA's National Marine Fisheries Service
NWR	National Wildlife Refuge
O & M Program	Corps' Columbia River Channel Operation and Maintenance Program
ODFW	Oregon Department of Fish and Wildlife
PRDO	Public Resource Depredation Order

RM	River Mile
RPA	Reasonable and Prudent Alternative
USACE	United States Army Corps of Engineers
USDA-WS	United States Department of Agriculture - Wildlife Services
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WRDA	Water Resources Development Act

Glossary of Terms

Affected Environment. Geographic scope of analysis for EIS includes coastal areas from northern California (37°24’00”) to southern British Columbia (51°00’00”) and the states of Washington and Oregon

Anadromous. Fish that migrate from the ocean to fresh water to spawn (breed)

Base Period. The time period (1983–2002) used to establish a baseline of survival for salmon and steelhead for RPA action 46 of the FCRPS Biological Opinion

Clutch. The complete set of eggs produced or incubated at one time

Columbia River Estuary. The region on the Columbia River influenced by ocean tides, extending upriver to Bonneville Dam at River Mile 146 and to the Willamette Falls, south of Portland, at River Mile 26 on the Willamette River (a major tributary to the Columbia River)

Colony. A group of birds nesting or roosting in the same area

Current Period. The time period (2003–2009) used to establish current survival for salmon and steelhead for RPA action 46 of the FCRPS Biological Opinion

Designated Colony Area. For DCCOs on East Sand Island, the area which would not be hazed or modified. In-season and prior year observation of DCCO nesting locations and density would be used as a guide to determine the amount of area

Direct Financial Value. Revenue received by harvesters and expenditures made by anglers, which are linked with the availability of Columbia River Basin production returning adults

Dissuade. To discourage from nesting

Dredged material. Any excavated material from waterways

Effigies. A likeness of a natural predator

Estuary. The wide part of a river where it nears the sea; fresh and salt water mix

Federal Columbia River Power System. Hydro-electric dams that are owned and operated by the federal government on the Columbia River

Foraging habitat. The area where an animal searches for food and provisions

Fry. The young of any fish

Habitat. The type of environment in which an organism or group normally lives or occurs

Habitat Modification. Any measure taken to change the way habitat can be used by DCCOs in order to make it unsuitable for that use

Hazing. Any non-lethal activity that discourages nesting, roosting, and foraging behavior, such as using visual and noise deterrents, habitat modification, boats or other similar equipment, or any other dispersal technique

Inter-specific Competition. Competition between different species over the same resources, such as food, water, and habitat

Marsh. Wetlands frequently inundated with water, which are principally composed of emergent soft-stemmed plants adapted to saturated soils; may also include small amounts of shrub or tree cover

Out-migrating. Juvenile fish migrating out of their native rivers or streams toward ocean waters

Pacific Flyway. Major north-south flight path for migratory birds, extending from the North Slope of Alaska to Central and South America

Pacific Region. Refers to the regional population of the Seabird Conservation Plan; includes Washington, Oregon, and California

Pelagic. Of or pertaining to the ocean; applied especially to animals that live at the surface of the ocean, away from the coast

Pile dike. Dike with pilings

Piscivorous. Fish-eating

PIT tag. Passive Integrated Transponder tag; very small (12 mm by 2.1 mm) glass encapsulated tube containing a microchip inserted into a fish's body cavity. PIT tags remain inactive until activated by an electrometric field to transfer data

Prospecting. To search for nesting habitat

Regional Economic Impact. An estimate of the level of economic activity being generated within a specified geographic region, stemming from changes being made to expenditures within that region

River Mile. A measure, in miles, of distance along a river, from its mouth

Salmonid. Of, belonging to, or characteristic of the family Salmonidae, which includes salmon, trout, char, whitefish, and other coldwater fishes

Smolts. Juvenile salmonids migrating to the sea for the first time

Sub-regions of Affected Environment. The area within the affected environment that is most likely to be affected by management actions; includes the Lower Columbia River Basin and Estuary, and the coasts of Oregon, Washington, and British Columbia

Sub-yearling. A juvenile fish, less than 1 year old

Sustainable Population. A sustainable population was defined for this Final Environmental Impact Statement as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered

Spawner. A fish that has produced fry

Take (MBTA regulatory definition). To pursue, hunt, shoot, wound, kill, trap, capture, or collect, or the attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect

Waterbirds. Birds that obtain all or most of their food from the water

Western Population. The breeding population of DCCOs within British Columbia, Washington, Oregon, Idaho, California, Nevada, Utah, Arizona, and portions of Montana, Wyoming, Colorado, and New Mexico that lie west of the Continental Divide; a management population within the Pacific Flyway; the affected environment (see above) lies within the boundary of the western population

Yearling. A fish that is one year old or has not completed its second year

Chapter 1 Purpose of and Need for Action

1.1 Introduction

This Final Environmental Impact Statement (FEIS) describes and evaluates several alternatives the U.S. Army Corps of Engineers (Corps), lead agency under the National Environmental Policy Act (NEPA), is considering for increasing survival of Endangered Species Act (ESA)-listed juvenile salmonids, by reducing double-crested cormorant (*Phalacrocorax auritus;* DCCO) predation of juvenile salmonids in the Columbia River Estuary. Each alternative contains a set of actions, monitoring efforts, and adaptive responses that comprise a management plan. This chapter provides a brief introduction, establishes the geographic scope for analysis, defines the purpose and need, identifies the lead and cooperating agencies and their roles in developing this document, and presents issues that arose during scoping and public comments from the Draft Environmental Impact Statement (DEIS).

1.1.1 East Sand Island

East Sand Island is in the state of Oregon (Clatsop County), near the mouth of the Columbia River (River Mile 5) approximately 1 mile west of Chinook, Washington and 10 miles northwest of Astoria, Oregon (Figure 1-1). The island is approximately 60 acres in size, for the area above the high tide mark. The Corps is the federal land manager of East Sand Island and 36 Code of Federal Regulations (C.F.R.) Part 327 applies to its use as public land.

Historically, East Sand Island was connected to the larger Sand Island in Baker Bay. In 1863, the United States Army obtained Sand Island for military purposes. In the early 1940s, the island separated into eastern and western portions, due to erosion. The island's present configuration was established during the 1940s and 1950s in an attempt to stabilize the island and prevent further erosion. Stabilization was achieved through the implementation of a pile dike system, installation of rip-rap, and targeted placement of dredged material. In 1954, 1,249 acres were transferred to the Corps for the Sand Island Channel Improvement Project.

Two dredged material placement events occurred on East Sand Island in the late 1970s and early 1980s. The material was dredged during maintenance on the Chinook Channel. Over 650,000 cubic yards of material was placed on the eastern portion of the island during these events (NOAA 2012). The island is no longer used as a disposal site for dredged material, and the island was stabilized with rip-rap on the south beach to prevent additional erosion. East Sand Island continues to play an important role in maintaining the stability of the Columbia River federal navigation channel and port access to the Chinook Channel and Baker Bay.

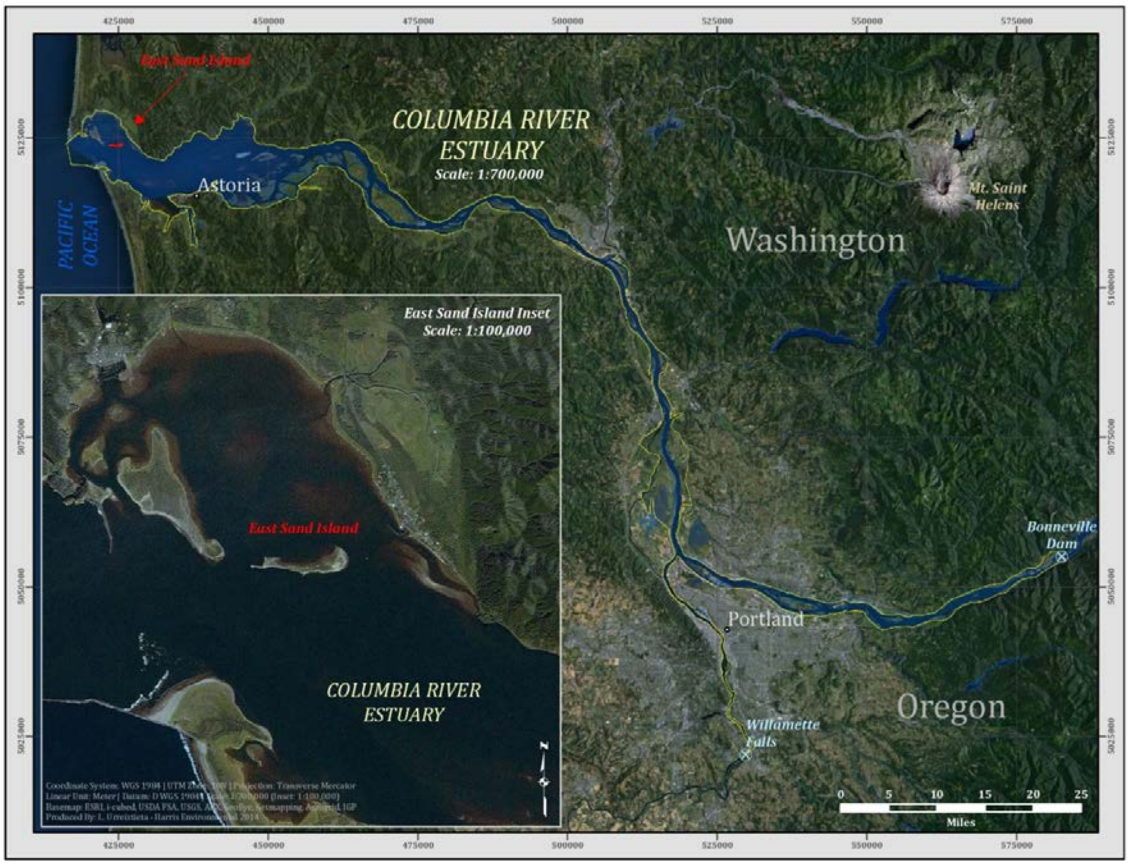

FIGURE 1-1. Map of the Columbia River Estuary, including East Sand Island.

The largest breeding colony of DCCOs in North America resides on East Sand Island (Roby et al. 2014). The DCCO peak breeding season (April-July) overlaps with the out-migration of millions of juvenile salmonid smolts, which are a prey source for DCCOs. DCCO nesting on East Sand Island was first documented in 1989, with fewer than 100 breeding pairs. Since then, the size of the colony has increased significantly; the highest count recorded was 14,900 breeding pairs in 2013 (Roby et al. 2014). During the last decade (2004-2013) the average breeding colony size has been 12,917 breeding pairs

(Figure 1-2). The increase in colony size is likely due to changes regarding habitat, nesting, and foraging conditions near the mouth of the Columbia River that are favorable for the species, such as stable, rather undisturbed, largely mammalian predator-free nesting habitat on East Sand Island and consistent forage base. Approximately 98 percent of DCCOs breeding in the Columbia River Estuary nest on East Sand Island.

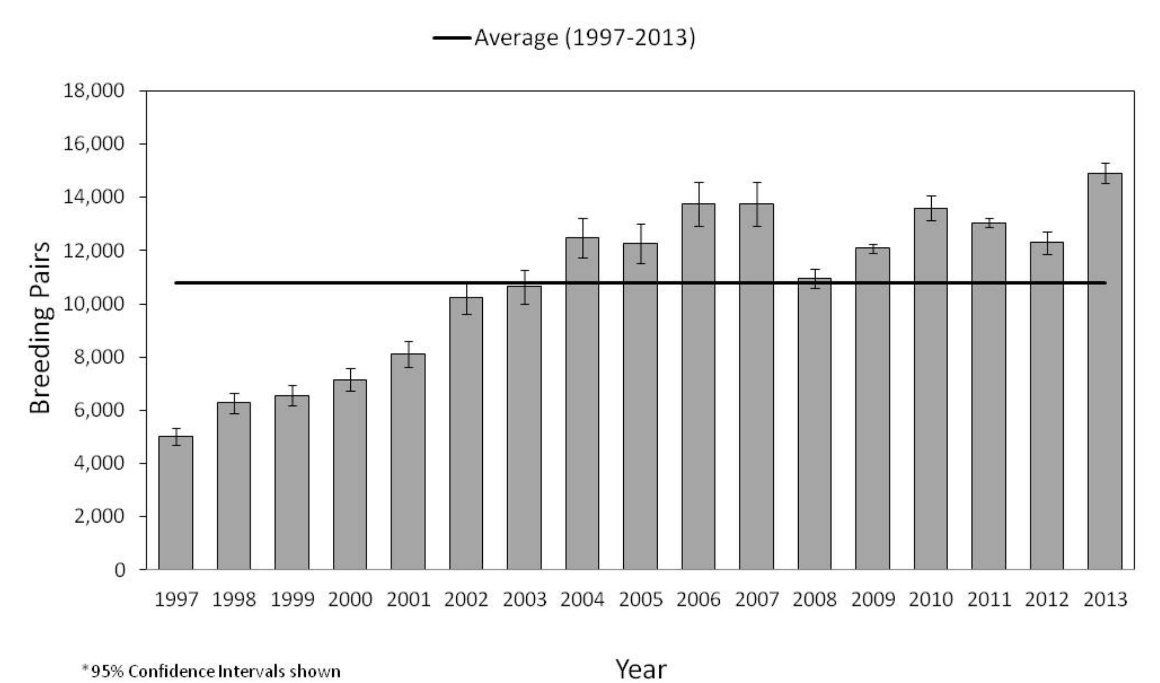

FIGURE 1-2. East Sand Island DCCO colony sizes, 1997-2013.

In addition to DCCOs, a variety of waterbirds use East Sand Island for roosting and nesting. The largest known breeding colony of Caspian terns (*Hydroprogne caspia*) in the world is on the eastern portion of the island. Glaucous-winged/western gulls (*Larus glaucescens/occidentalis*) are present throughout the island. A small colony of ring-billed gulls (*L. delawarensis*) nests near the tern colony on the eastern shoreline. Brandt's cormorants (*P. penicillatus*) nest within the DCCO colony. East Sand Island is also the largest known post-breeding roost site in the region for California brown pelicans (*Pelecanus occidentalis)*. The island provides an important foraging and roosting site for shorebirds in the winter and during migration (see Chapter 3 for more information).

Because of the large numbers and diversity of other birds using East Sand Island, the island is recognized as an Important Bird Area by the American Bird Conservancy and the National Audubon Society (see Appendix G for a list of birds observed during 2013 nesting season). These designations are important to conservation planning efforts, but they do not afford additional legal protection to East Sand Island. With the exception of Caspian terns (USFWS 2005a), the Corps does not actively manage or maintain East Sand Island to support various bird species, including DCCOs.

1.1.2 Columbia River Estuary

For the purposes of this document, the Columbia River Estuary is defined as the region on the Columbia River influenced by ocean tides. It extends upriver to Bonneville Dam on the Columbia River at River Mile (RM) 146 and to the Willamette Falls, south of Portland, at RM 26 on the Willamette River, a major tributary to the Columbia River. In total, the Columbia River Estuary is 172 miles. The Columbia River Estuary varies between 3 to 5 miles in width in the main channel of the Columbia River and forms the border between Washington and Oregon.

The Columbia River Estuary is critical to the development of juvenile salmonids, providing essential rearing habitat and a migratory corridor for the various salmonid species and life history stages (Fresh et al. 2005). The Columbia River Estuary, from the mouth to RM 60, is also designated as a site of regional importance to shorebirds by the Western Hemispheric Shorebird Reserve Network. The U.S. Fish and Wildlife Service (USFWS) Pacific Region Seabird Conservation Plan (USFWS 2005b) identifies the Columbia River Estuary as an important nesting and foraging area for terns, cormorants, and gulls (see Chapter 2, Section 2.6 for more information on consistency with regional plans).

1.1.3 Double-crested Cormorants and the Migratory Bird Treaty Act

DCCOs are native to North America, and their range extends across much of the continent (USFWS 2003). There are five recognized DCCO subspecies in North America (Wires et al. 2001; USFWS 2003). The western population of DCCOs includes all breeding colonies within British Columbia, Washington, Oregon, Idaho, California, Nevada, Utah, Arizona, and the portions of Montana, Wyoming, Colorado, and New Mexico west of the Continental Divide (Adkins et al. 2014). The western population of DCCOs is a management population within the Pacific Flyway (Pacific Flyway Council 2012).

The estimated size of the western population of DCCOs ca. 2009 is approximately 31,200 breeding pairs (Adkins et al. 2014). From approximately 1987 to 2009, the number of DCCO breeding pairs estimated within British Columbia, Washington, Oregon, and California increased by approximately 72 percent (i.e., 3 percent per year), or 12,000 breeding pairs, and large-scale distributional changes occurred (Adkins et al. 2014; Pacific Flyway Council 2012). The coastal states and provinces account for greater than 90 percent of the western population of DCCOs, with the majority of DCCOs breeding along the Pacific Coast (67 percent coastal vs. 33 percent inland; Adkins et al. 2014). Growth of the western population of DCCOs is largely attributed to the increase in size of the DCCO breeding colony at East Sand Island, which accounted for 39 percent of the western population of DCCOs during 2008–2010 (Adkins et al. 2014). The DCCO increase at East Sand Island likely initially resulted from immigration from other breeding colonies, as colony declines were documented in southern Alaska, British Columbia, Washington, and California (Carter et al. 1995; Hatch and Weseloh 1999; Moul and Gebauer 2002; Wires et al. 2001; Anderson et al. 2004b; Wires and Cuthbert 2006; Pacific Flyway Council 2012). Outside of East Sand Island, growth of the western population of DCCOs in other areas has been relatively static over the past two decades, with some isolated areas of limited DCCO increase (e.g., Idaho, Montana, Arizona) and areas of decline or concern for continued decline (e.g., Salton Sea, California; Pacific Flyway Council 2012, T. Anderson, USFWS, personal communication. 2014, 2015).

The Migratory Bird Treaty Act (MBTA) is the implementing legislation for treaties between the U.S. and four neighboring countries (Canada, Mexico, Russia, and Japan) for the protection of migratory birds. In 1972, DCCOs were added to the list of bird species afforded protection under the MBTA. The USFWS has statutory authority and responsibility for enforcing the MBTA. Relevant regulations are found at 50 C.F.R. Parts 10, 20, and 21. In 50 C.F.R. 21.11, it states "[n]o person may take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit issued pursuant to the provisions of [these regulations]." Take is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or the attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (50 C.F.R. § 10.12). 50 C.F.R. § 21.41-21.54 allow for take of migratory birds through permits or other means of authorization under certain conditions to minimize depredation.

1.1.4 Columbia River Basin Salmonids and the Endangered Species Act

Pacific salmon and steelhead are *salmonids*, of the scientific family *Salmonidae*. They are anadromous fish, which means they migrate up rivers from the ocean to breed in fresh water. They are in the scientific genus *Oncorhynchus*, which includes sockeye, chum, Chinook and coho salmon, and steelhead trout. These are the five species, referred to in this document as the Columbia River Basin salmonids, which use the Columbia River and its tributaries in their life cycles. They are listed under the Endangered Species Act (ESA) and migrate through the Columbia River Estuary to the Pacific Ocean.

Within the five species, there are thirteen different groupings, referred to as Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs), specifically listed under the ESA. ESU designations are used for the four species of Pacific salmon and DPS designations are used for steelhead in the Columbia River Basin. The definition of an ESU and DPS is essentially the same: a population that is substantially reproductively isolated from other units within the species and represents an important component of the evolutionary legacy of the species. The USFWS and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) issued a joint policy describing DPSs in Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act (61 FR 4722 [1996]).

Under the ESA, a species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become endangered in the future. The listing of a species under the ESA as endangered or threatened makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things). NOAA Fisheries manages marine and anadromous species, such as salmon and steelhead. The Columbia River Basin salmonids were first ESA-listed in the 1990s (Table 1-1).

TABLE 1-1. ESA-listed Columbia River Basin Salmonids.

Species, Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS)*	Status
CHINOOK	
Lower Columbia River	Threatened
Upper Columbia River Spring-run	Endangered
Upper Willamette River	Threatened
Snake River Spring/Summer-run	Threatened
Snake River Fall-run	Threatened
COHO	
Lower Columbia River	Threatened
CHUM	
Columbia River	Threatened
SOCKEYE	
Snake River	Endangered
STEELHEAD	
Upper Columbia River	Threatened
Middle Columbia River	Threatened
Lower Columbia River	Threatened
Snake River	Threatened
Upper Willamette River	Threatened

Endangered Species Act Listing Policy for Hatchery-raised Fish

NOAA Fisheries 1993 interim policy on hatchery-raised Columbia River Basin salmonids stated that hatchery-origin fish should be listed only if they are essential to the conservation of the species. In 2001, however, the U.S. District Court in Oregon ruled any hatchery-origin component part of a listed ESU must also be listed under the ESA (*Alsea Valley Alliance v. National Marine Fisheries Service*, 161 F. Supp. 2d 1154). NOAA Fisheries subsequently modified its hatchery policy to conform to this ruling, and the revised hatchery listing policy provides for the listing of a population found to be part of the ESU, regardless of whether it is of natural origin or hatchery-raised. The revised policy was upheld in 2009 by the 9th Circuit in *Trout Unlimited v. Lohn*, 559 F3d 946 (NOAA 2010). There are more than fifty hatchery facilities for Columbia River Basin salmonids operated by federal and state agencies, tribes, and private interests. These hatchery facilities support over 100 hatchery programs, which help increase harvest and conserve populations of the Columbia River Basin salmonids (NOAA 2010). Throughout this document, all references to Columbia River Basin salmonids include both hatchery-raised and natural-origin (wild) fish.

1.1.5 Federal Columbia River Power System Biological Opinion

The Corps operates and maintains several hydropower dams on the Columbia and Snake Rivers, referred to together as the Federal Columbia River Power System (FCRPS). Because the dams adversely affect salmonids and their habitat, the Corps, along with Bonneville Power Administration and the Bureau of Reclamation, formally consults with NOAA Fisheries to ensure their actions are not likely to jeopardize the continued existence of ESA-listed Columbia River Basin salmonids or adversely modify their critical habitat.

In May 2008, NOAA Fisheries issued a 10-year Biological Opinion, which considered how a number of factors, in addition to the operation of the FCRPS, are affecting the productivity (i.e., recruits per spawner) and risk of extinction of dozens of ESA-listed salmon and steelhead populations throughout the Columbia River Basin over the past 20 or more years, for which population-specific productivity estimates are available (NOAA 2008, 2008a, 2008b). This analysis specifically considered how variations in ocean conditions, seasonal runoff and water withdrawals, harvest actions, habitat modification, predators, and structural and operational hydropower modifications have affected ESA-listed salmon and steelhead populations in the past and how implementation of required Reasonable and Prudent Alternative (RPA) actions would likely affect them through the period of the Biological Opinion and beyond.

The 2008 Biological Opinion contains 73 RPA actions and monitoring efforts to be implemented by the Action Agencies. These include improving fish passage at dams, managing river flow, improving tributary and estuary habitat, reforming hatchery practices, and controlling predators that prey on juvenile salmonids. Comprehensively, the FCRPS Biological Opinion addresses mortality factors at all salmonid life stages through the multiple RPA actions. No one RPA action singly results in salmonid recovery or works independently or in isolation from other RPA actions, but, collectively, all RPA actions work together to improve salmonid populations. The 2008 Biological Opinion concluded, after considering the status of the species and the effects of past and ongoing human and natural factors on the current status of the species (the environmental baseline), that, through implementation of the RPA (encompassing all the discrete RPA actions), the operation of the FCRPS would not likely jeopardize the federally-listed Columbia River Basin salmonids affected by the system (NOAA 2008).

In 2008 and subsequent years, the Federal Action Agencies to the 2008 FCRPS Biological Opinion reached agreements with several Columbia Basin tribes and states. Each Columbia Basin Fish Accords Memorandum of Agreement secured funding to implement a variety of projects throughout the Columbia River Basin, including restoration of salmon and steelhead habitat. These agreements established a partnership among the Federal Action Agencies, six Northwest tribes, one inter-tribal organization, and three states. The agreements secured federal funding of over $900 million to implement many of the Biological Opinion's RPA actions through the 2018 expiration of the Biological Opinion. The Corps manages the Columbia River Fish Mitigation Program with yearly expenditures of over $100 million for research and general construction projects to improve habitat, passage, and survival of Columbia River Basin salmonids.

On May 20, 2010, NOAA Fisheries completed a 2010 Supplemental Biological Opinion, incorporating an Adaptive Management Implementation Plan into the 2008 Biological Opinion (NOAA 2010). Two RPA actions from the 2008 FCRPS Biological Opinion specifically address management of DCCOs in the Columbia River Estuary:

- ***RPA action 46*** requires the development of a management plan for DCCOs in the Columbia River Estuary and implementation of warranted actions in the Estuary.
- ***RPA action 67*** requires the DCCO population in the Columbia River Estuary and the population's impact on out-migrating juvenile salmonids be monitored. RPA action 67 also calls for the implementation of a management plan to decrease predation rates, if warranted.

In accordance with the August 2, 2011 U.S. District Court for the District of Oregon Order, the 2010 FCRPS Supplemental Biological Opinion was remanded to NOAA Fisheries. In response, NOAA Fisheries prepared a Supplemental Biological Opinion, which was finalized in January 2014 (NOAA 2014). RPA action 46 was modified to read:

Modified RPA action 46 Double-Crested Cormorant Predation Reduction

"The FCRPS Action Agencies will develop a cormorant management plan (including necessary monitoring and research) and implement warranted actions to reduce cormorant predation in the estuary to Base Period levels (no more than 5,380 to 5,939 nesting pairs on East Sand Island)" (NOAA 2014).

1.1.6 Research on Double-crested Cormorants in the Columbia River Estuary

The Corps has funded research to determine the potential effects of DCCO predation on juvenile salmonids and as a means to determine effective field methods that could be applied on East Sand Island for future management as well as to track movement of DCCOs to better quantify effects (see Appendix G, Table G-1).

Colony Monitoring and Smolt Consumption and Predation Rates

In 1997, the Corps began funding studies to monitor the size, productivity, and diet of DCCO colonies in the Columbia River Estuary. DCCOs were found to nest at several locations in the Columbia River Estuary during the course of this research (1997-2013), including the largest colony on East Sand Island and smaller colonies on a dredge material island (i.e., Rice Island at RM 21) and structures (i.e., Astoria-Megler Bridge and channel markers) located further upriver.

Two diet estimation approaches and have been developed over the past decades and used concurrently to estimate and document impacts of DCCO predation on juvenile salmonids in the Columbia River Estuary. Bioenergetic-based smolt consumption estimates have been developed since 1998 and used to derive annual total smolt consumption at the species level. Passive integrated transponder (PIT) tags have been collected on the DCCO colony since 1999 and are used to determine a rate of predation at the ESU/DPS level. Each approach has various pros, cons, and limitations and relies upon different assumptions for interpretation of results. Implications of using the different analytical approaches are generally positive, as they offer independent analysis, answer different questions, and corroborate predation impacts. A brief synopsis of each approach and primary findings are included below (see Appendix C for a more complete description).

Bioenergetic-based consumption estimates — Smolt consumption estimates by DCCOs nesting on East Sand Island were derived using a bioenergetics model, which considers DCCO energy requirements, diet composition, and the energetic content of their various prey. Bioenergetics techniques have been used to estimate prey consumption by a variety of predators, including many of the known avian predators on juvenile salmonids in the Columbia River basin (Roby et al. 2003; Antolos et al. 2005; Wiese et al. 2008; Lyons 2010; Maranto et al. 2010). Diet composition data and genetic identification allow for consumption estimates to be resolved to the species level (and age-class for Chinook salmon), providing a large-scale assessment of DCCO impacts on Columbia River salmonids. Consumption estimates do not distinguish between rearing type, migration history, or population, and require diet sampling and DCCO abundance monitoring; however, no representative tagging of smolts is needed. Calculations are performed using a statistical (Monte Carlo) sampling technique to produce median estimates and corresponding 95 percent confidence intervals (after Furness 1978) and follow techniques first developed in Roby et al. (2003) and Lyons (2010).

Bioenergetics-based estimates of smolt consumption are derived from the following input parameters: 1) abundance of DCCO breeding adults, adults, and chicks throughout the breeding season, 2) diet composition obtained from stomach contents of collected DCCOs, 3) DCCO adult and chick energy expenditure, and 4) prey energy content.

Key assumptions of the bioenergetics approach include:

- There are relatively few non-breeding DCCOs associated with East Sand Island during the peak breeding period (mid-May to early July).
- Chick abundance is well estimated by assuming complete hatching synchrony in early June.
- The seasonal pattern in salmonid breakdown in the DCCO diet is consistent across years.
- The energy expenditure of adult DCCOs is consistent across years.
- Energy requirements of independent (post-fledging) DCCO chicks is equivalent to post-breeding adults.
- Annual differences in prey energy content are adequately represented by differences in prey mass. Energy density is assumed to be similar across seasons and years. Prey mass is assumed to be constant across seasons.

Efforts to validate these assumptions were made whenever possible, and these and other assumptions, caveats, discussion points, and sample sizes are presented in more detail in Appendix C and in Roby et al. (2003) and Lyons (2010).

Results from the bioenergetic-based approach show that estimates of total annual smolt consumption by the East Sand Island DCCO colony have varied between 2.9 and 20.9 million smolts (mean = 11.9 million) during 2003–2013 (Figure 1-3). Salmonid consumption by the East Sand Island DCCO colony peaks in early May, which coincides with the peak nesting season (Figure 1-4).

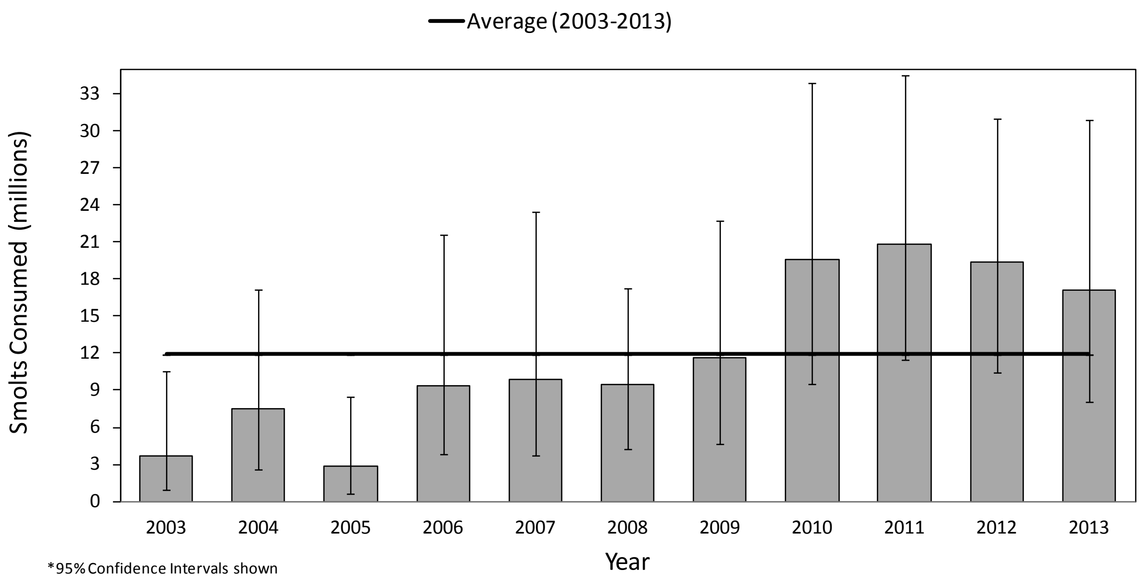

FIGURE 1-3. Estimated total annual consumption of juvenile salmonids by DCCOs on East Sand Island during the 2003–2013 breeding seasons.

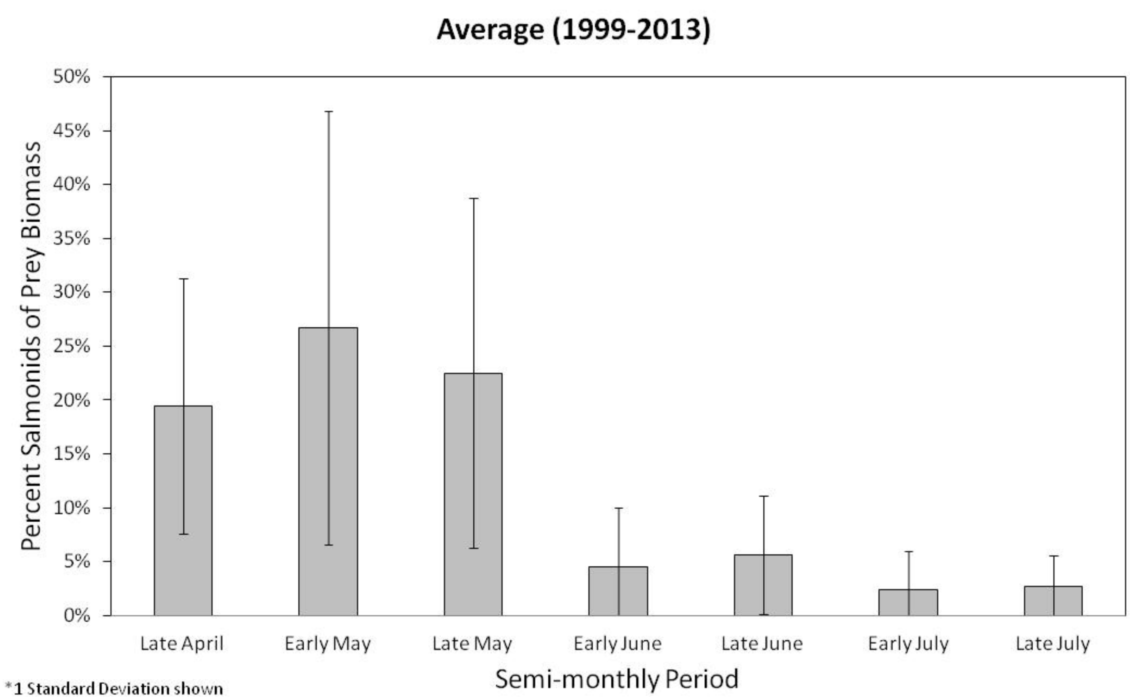

FIGURE 1-4. Seasonal proportion of juvenile salmonids in the diet of DCCOs nesting on East Sand Island during 1999-2013.

PIT tag-based predation rates — Since 1987, PIT tags have been placed in juvenile salmonids and other fishes from the Columbia River basin to study their behavior and survival following release. PIT tags provide specific information on each individual fish, including the species, rear-type (hatchery, wild), migration timing (based on detections of live fish passing hydroelectric dams), size, and other unique individual information. A proportion of these PIT-tagged fish are consumed by avian predators. The probability of recovering a PIT tag on an avian nesting colony is the combined probability that the PIT-tagged fish was consumed, it was deposited (regurgitated or defecated) on the nesting colony, and was later detected. Recoveries of PIT tags on avian nesting colonies have been used to estimate predation rates (percent of the total number of PIT-tagged fish consumed) and to compare the relative vulnerability of different fish species and fish populations to avian predators in the Columbia River basin since 1999 (Collis et al. 2001; Ryan et al. 2003; Antolos et al. 2005; Maranto et al. 2010; Evans et al. 2012; Hostetter et al. 2012; Sebring et al. 2013).

PIT tag predation rates are derived from the following input parameters: 1) number of PIT-tagged salmonid smolts available to DCCOs nesting on East Sand Island and 2) number of PIT-tags recovered on the DCCO colony post-deposition. The latter incorporates two processes: 1) deposition probability of PIT-tags on the colony and 2) detection probability of PIT-tags if deposited on the colony. Statistical models have been developed and applied to address each of these key input parameters (Evans et al. 2012; Osterback et al. 2013; Hostetter et al. in-press).

Key assumptions of the PIT tag approach include:

- PIT tag salmonid release and interrogation information obtained from Bonneville and Sullivan dams were complete and accurate.
- PIT-tagged smolts last detected passing Bonneville and Sullivan dams were available to DCCOs nesting on East Sand Island.
- The detection probabilities of PIT tags sown on-colony as part of research studies were equal to that of PIT tags naturally deposited by DCCOs.
- The deposition probabilities of PIT tags (those used in deposition studies during 2012-2013) were equal to that of fish consumed and deposited by DCCOs in all years where estimates were generated.
- PIT tags from consumed fish were deposited on a bird colony within a short time period (weeks) of the fish being detected passing Bonneville or Sullivan dams.
- PIT-tagged fish, by species, ESU/DPS, rear-type, and detection site (dam), were representative of non-tagged fish.

Efforts to validate these assumptions were made whenever possible, and these and other assumptions, caveats, discussion points, and sample sizes are presented in more detail in Appendix C and in Evans et al. (2012), Lyons et al. (2014), and Hostetter et al. (in-press). Sample sizes of PIT-tagged fish available for use in these models vary by ESU/DPS and year but were generally in the thousands, minimizing the potential risk for bias or spurious results that could emerge with small numbers of tagged fish.

Results from the PIT tag approach showed average East Sand Island DCCO predation rates during 1999–2013 of ESA-listed ESUs/DPS originating upstream from Bonneville Dam and Sullivan Dam were 5.4 to 6.5 percent [annual range = 1.0 percent to 16.6 percent) for the three steelhead DPSs, 1.7 to 3.6 percent [annual range = 0.4 percent to 6.8 percent) for the four Chinook ESUs, and 4.0 percent [annual range = 2.6 percent to 5.7 percent) for the Snake River Sockeye ESU (see Appendix C). Similar to smolt consumption estimates, DPS/ESU-specific predation rate estimates were highly variable among years and differed by salmonid population.

Factors Influencing Predation

Diet composition studies revealed that DCCOs nesting in the upper estuary (on Rice Island and channel markers) were far more reliant on freshwater fish species, including salmonids, than DCCOs nesting closer to the river mouth on East Sand Island, which consumed a greater proportion of marine forage fish (Collis et al. 2002). Juvenile salmonids were three times more prevalent in the diet of DCCOs nesting in the upper estuary (45 percent of the identifiable biomass) as compared to DCCOs nesting on East Sand Island (15 percent; Collis et al. 2002). This study, along with data from subsequent diet studies at East Sand Island, revealed that the percentage of the diet composed of salmonids varies both spatially and temporally (Roby et al. 2014; Appendix C), suggesting the relative abundance and availability of forage fish in the Columbia River Estuary varies considerably both within and among years.

In 2014, the Corps funded an analysis to evaluate the relationship of multiple annual measures of DCCO predation to colony size and environmental covariates (see Appendix C). Factors thought to drive the large inter-annual variation in predation impacts (consumption estimates and predation rates) include, but are not limited to: large-scale climate indices (Pacific Decadal Oscillation, El Nino/Southern Oscillation Index, North Pacific Gyre Oscillation, Pacific Northwest Index), regional climate measures (sea surface temperature, upwelling strength, upwelling timing), variables describing conditions during freshwater and estuarine out-migration (river discharge, spill at hydroelectric dams, measures of salmonid smolt survival to the estuary), and differences in DCCO abundance, nesting chronology, and nesting success. Results showed that colony size was an important explanatory factor in most regression analyses, and, of the environmental covariates considered, river discharge and the North Pacific Gyre Oscillation were prominent environmental explanatory factors for many of the DCCO predation measures (Appendix C). These factors will be considered when predicting and interpreting the success of DCCO management actions on East Sand Island within a given year and over the long-term.

Habitat Enhancement and Social Attraction

Social attraction techniques consist of setting up decoys and broadcasting audio playback of bird calls to encourage nesting. These techniques have been tested within and outside the Columbia River Estuary during 2004–2012 as a possible method to redistribute the East Sand Island DCCO colony (Suzuki 2012).

Social attraction within the Estuary — Within the Columbia River Estuary, social attraction methods have been used and tested at East Sand Island (2004–2007; i.e., on portions of the island where no DCCOs previously nested), Miller Sand Spit (2004–2009), Trestle Bay (2005), and Rice Island (2006–2007; see Appendix G, Table G-1 for a complete description). Social attraction techniques showed success at promoting DCCOs to nest in new areas on East Sand Island and at Miller Sands Spit and Rice Island, but not at Trestle Bay. At Miller Sands Spit successful production of fledglings occurred in 2 of 4 years DCCO nesting was attempted. Without continued implementation of social attraction techniques (i.e., annual management), continued DCCO nesting at both Miller Sands Spit and Rice Island did not persist.

Social attraction outside the Estuary — Outside of the Columbia River Estuary, social attraction methods have been used and tested at Foundation Island on the Columbia River near Kennewick, Washington (2007–2009), Fern Ridge in northwestern Oregon (2007–2009), Summer Lake Wildlife Area in central Oregon (2010–2011), Tule Lake National Wildlife Refuge in northeastern California (2011–2012), and Malheur National Wildlife Refuge in southeastern Oregon (2012; see Appendix G, Table G-1 for a complete description). At these 5 locations (i.e., 11 annual trials in total), no DCCO nesting was recorded at any site during any year from these efforts (see Appendix G, Table G-1).

Non-lethal Dissuasion Studies and Breeding Season Dispersal

In 2007, the Corps initiated studies to investigate certain non-lethal methods to dissuade DCCOs from nesting in specific locations on East Sand Island. Methods tested to date include human disturbance (2008–2009 and 2011–2013), removal of nest structures prior to egg-laying (2011–2013), pond-liner material placed over nesting substrate (2009–2010), hazing using lasers (2008–2009), erection of potential perches for bald eagles (2007), placement of low (1.2m tall) silt fencing (2007), and reflective tape placed in nesting trees (BRNW 2013a). During the 2011–2013 nesting seasons, studies were conducted to test the use of privacy fences and targeted human disturbance prior to egg-laying to reduce the amount of available nesting habitat for DCCOs on East Sand Island, which consists of approximately 16 acres on the western half of the island (Figure 1-5). By design, available DCCO habitat on East Sand Island was not reduced or hazing increased to such a level to intentionally reduce overall DCCO colony size, as research objectives were designed at an appropriate scope and scale so as to inform future management decisions on the feasibility of techniques when applied to a larger scale (see Appendix G).

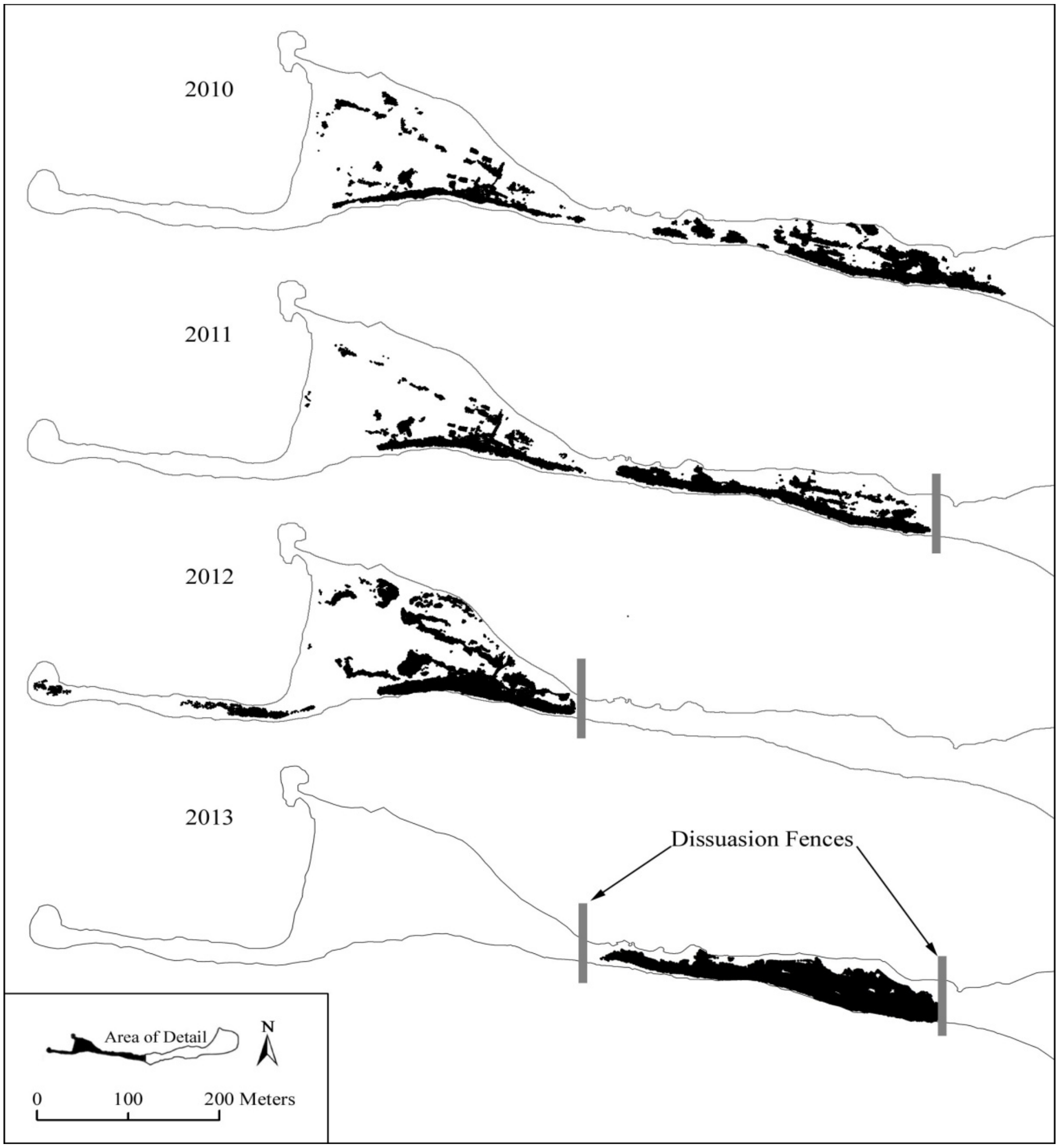

FIGURE 1-5. Distribution of DCCO nests on the west end of East Sand Island during 2010–2013 and placement of dissuasion fence.

The use of privacy fences and human disturbance in 2011-2013 was shown to be feasible and effective in deterring DCCOs from breeding within the designated nest dissuasion areas (Figure 1-6) and had minimal impacts to the nesting colony of DCCOs and other species present on East Sand Island. These techniques reduced the available nesting habitat during the breeding season by approximately 6 percent in 2011, 31 percent in 2012, and 75 percent in 2013 (see Appendix G) (Roby et al. 2014). As part of these studies, breeding adult DCCOs were marked with VHF radios (n=60 [2011]; n=126 [2012]) or satellite transmitters (n=12 [2012]; n=83 [2013]) to provide information about DCCO usage of areas during the dissuasion efforts in the early breeding season as well as throughout the entire breeding season.

FIGURE 1-6. Photo of East Sand Island showing past DCCO dissuasion methods, July 2012.

At the scope and scale of habitat modification and hazing conducted during the management feasibility studies (i.e., up to 75 percent of available nesting habitat on East Sand Island precluded and up to 11 weeks of active hazing with, on average, 4 [range = 0 to 21] hazing events per day), overall DCCO colony size was not reduced. Greater levels of habitat restriction and hazing would be needed to substantially reduce colony size at East Sand Island (see Chapter 2). After some off-colony dispersal immediately following tagging, most radio- and satellite-tagged DCCOs returned to roost or nest on or near East Sand Island within weeks from when they were tagged and dissuaded from nesting. DCCO usage of areas during the early nesting season, when habitat reduction and hazing efforts were conducted, confirms that the Lower Columbia River Basin is the area most used by DCCOs if dispersed from East Sand Island. There was no evidence of permanent emigration from the Columbia River Estuary associated with nest dissuasion experiments during the 2011-2013 breeding seasons (see Appendix G) (Roby et al. 2014), suggesting that DCCOs are rather committed to East Sand Island and the Columbia River Estuary.

Although permanent emigration did not occur, initial, or near-term dispersal was considered indicative of where DCCOs may likely prospect or relocate if habitat was not available on East Sand Island during the early breeding season (i.e., April–May). During April and May of the 2012 and 2013 management feasibility studies, the majority of DCCO satellite tag detections at nighttime roost locations away from East Sand Island were in the lower Columbia River. Night roosting locations better indicate secure roosting habitat and more commitment to a given location than daytime locations, which may just be foraging or short-term prospecting areas. Overall, radio- and satellite-tagged DCCOs that dispersed from East Sand Island during the early breeding season were found to use sites within the Lower Columbia River Basin and Estuary most frequently, followed by the outer Washington coast and the Salish Sea (see Chapter 3, Section 3.1 and Appendix G). There were no confirmed detections of radio- or satellite-tagged DCCOs at inland sites east of the Dalles Dam or along the Oregon coast. Over the entire breeding season (April–September), locations of radio- and satellite-tagged DCCOs marked on East Sand Island during the 2011–2013 breeding seasons consisted of four main areas: 1) Columbia River Estuary; 2) outer Washington coast (Willapa Bay and Grays Harbor); 3) Puget Sound; and 4) northern Salish Sea (San Juan Islands, Strait of Georgia, Vancouver, British Columbia) (Roby et al. 2014; see Chapter 3, Section 3.1). Use of historical and currently active DCCO colonies was common within each of these areas.

Post-Breeding Season Dispersal Studies

During 2008–2009, 51 DCCOs on East Sand Island were marked with satellite tags to determine their movement after the nesting season (post-breeding dispersal) and the connectivity of birds breeding at East Sand Island to other areas. DCCOs satellite-tagged on East Sand Island had the greatest connectivity with three estuarine and inner coastal regions to the north (i.e., Willapa Bay, Grays Harbor, and the Salish Sea) and the Western Columbia Basin (Courtot et al. 2012). Although DCCOs were detected from southern British Columbia to the Colorado River delta in northern Mexico, and as far east as western Nevada, frequency of DCCO use within this range decreased with distance from East Sand Island. There was little connectivity to colonies east of the Cascade-Sierra Nevada Mountains or along the coasts of Oregon, southern California, or Mexico (Courtot et al. 2012).

DCCO band re-sighting data from birds banded at East Sand Island and elsewhere in the Columbia River Estuary support the radio- and satellite-tagging results of minimal DCCO movement east of the Cascade-Sierra Nevada Mountains and primary connectivity to northern coastal areas in Washington and British Columbia (Clark et al. 2006; Roby et al. 2014). During 1995–2000, 3,635 DCCO fledglings from East Sand Island and Rice Island were banded; less than 4 percent of all band recoveries were east of the Cascade-Sierra Nevada Mountains, and 63 percent of band recoveries were from coastal Washington and British Columbia (Clark et al. 2006). During 2008–2013, 1,961 DCCOs (816 adults and 1,145 juveniles) were marked with field-readable color bands (Roby et al. 2014). As of February 2014, approximately 55 percent of re-sighting records and dead recoveries

(36 of 65) were in coastal Washington and British Columbia (Roby et al. 2013, 2014). The remaining re-sighting records and dead recoveries were in coastal Oregon (6 percent), interior Washington and the Lower Columbia and Willamette Rivers (17 percent), and California (the entire state; 22 percent; Roby et al. 2013, 2014).

1.2 Purpose of and Need for Action

The purpose of the proposed action is to reduce DCCO predation of juvenile salmonids in the Columbia River Estuary to levels identified in the environmental baseline (base period) of the 2008/2010 FCRPS Biological Opinion (NOAA 2008, 2010). To meet this purpose, the management objectives identified in the revised RPA action 46 for juvenile salmonid survival and associated DCCO colony size (5,380 to 5,939 breeding pairs on East Sand Island) based on NOAA Fisheries analysis are being used for management objectives (NOAA 2014). In meeting this purpose, impacts to species not targeted for management would be minimized to the extent possible.

Need

The 2008/2010 FCRPS Biological Opinion did not completely address the full impact of the rapidly increasing DCCO population in the Columbia River Estuary on salmonid survival. To address this, NOAA Fisheries conducted a "survival gap" analysis, which evaluated the difference in DCCO predation on steelhead, yearling Chinook, and sockeye between the "base period" of 1983-2002 and the "current period" of 2003–2009 (see Appendix D). This analysis was included in the 2014 Supplemental FCRPS Biological Opinion. It was developed as a management-focused analysis for comparing base period (baseline conditions) to current period (current conditions), as determined at the time of the 2008 FCRPS Section 7 consultation. These time periods were determined by NOAA Fisheries Science Center.

For the RPA action 46 "survival gap" analysis, annual bioenergetics-based DCCO consumption estimates and NOAA Fisheries annual estimates of available smolts in the Columbia River Estuary were used to calculate an annual per capita DCCO consumption rate. These rates were then used to calculate average DCCO consumption within the two periods respectively and the resulting relative difference in survival for the various salmonid species considered. Results from NOAA Fisheries' "survival gap" analysis show that during 1998–2012 DCCO consumption rates of juvenile steelhead, yearling Chinook, and juvenile sockeye were estimated to be 6.7 percent, 2.8 percent, and 1.3 percent, respectively (Appendix D). This and other data suggest steelhead are more susceptible to DCCO predation (compared to other salmonid species in the context of the FCRPS Biological Opinion), so steelhead were used to describe survival improvement objectives that could be achieved through DCCO management. Actions taken to improve juvenile steelhead survival would additionally benefit other juvenile salmonids. NOAA Fisheries estimated a 97.1 percent survival rate (i.e., 2.9 percent DCCO consumption rate) for juvenile steelhead during the "base period" compared to 93.5 percent (i.e., 6.5 percent

DCCO consumption rate) in the "current period," a base-to-current gap of 3.6 percent (Appendix D). NOAA Fisheries then determined that a reduced DCCO breeding population of 5,380 to 5,939 breeding pairs on East Sand Island would eliminate the gap and restore juvenile steelhead survival to the environmental baseline or "base period" levels. The analysis was updated based upon comments received on the DEIS using updated bioenergetic estimates (see Appendix D, final memos; Figure 1-7). These changes increased variance of the estimates but had essentially no effect on the point estimates, or conclusions drawn from the original analyses, including the management goal for a reduced DCCO colony size. For steelhead, updated "base period" survival was 2.8 percent and "current period" survival was 6.3 percent, a base to current gap of 3.54 percent (Figure 1-7).

While NOAA Fisheries' "survival gap" analysis forms the basis of the management objective, per the RPA action 46, and presents the relative average increase of DCCO predation on steelhead, Chinook, and sockeye from the "base period" to the "current period" for ESA consultation purposes, the impacts of DCCO predation on specific ESU/DPS can be substantially higher within a given year. Predation rate data from steelhead DPSs (those originating entirely upstream of Bonneville Dam) indicate that juvenile steelhead are susceptible to DCCO predation in the Columbia River Estuary, with average annual predation rates ranging from 2 to 17 percent (depending on the DPS and year; Appendix C). During 2007–2010, Lyons et al. (2014) documented an average annual predation rate of 26 percent by DCCOs nesting on East Sand Island for PIT-tagged lower Columbia River hatchery Chinook salmon. Zamon et al. (2013) documented an annual predation rate of 19 percent on an experimental tagged group of Lower Columbia River ESU subyearling fall Chinook salmon released below Bonneville dam.

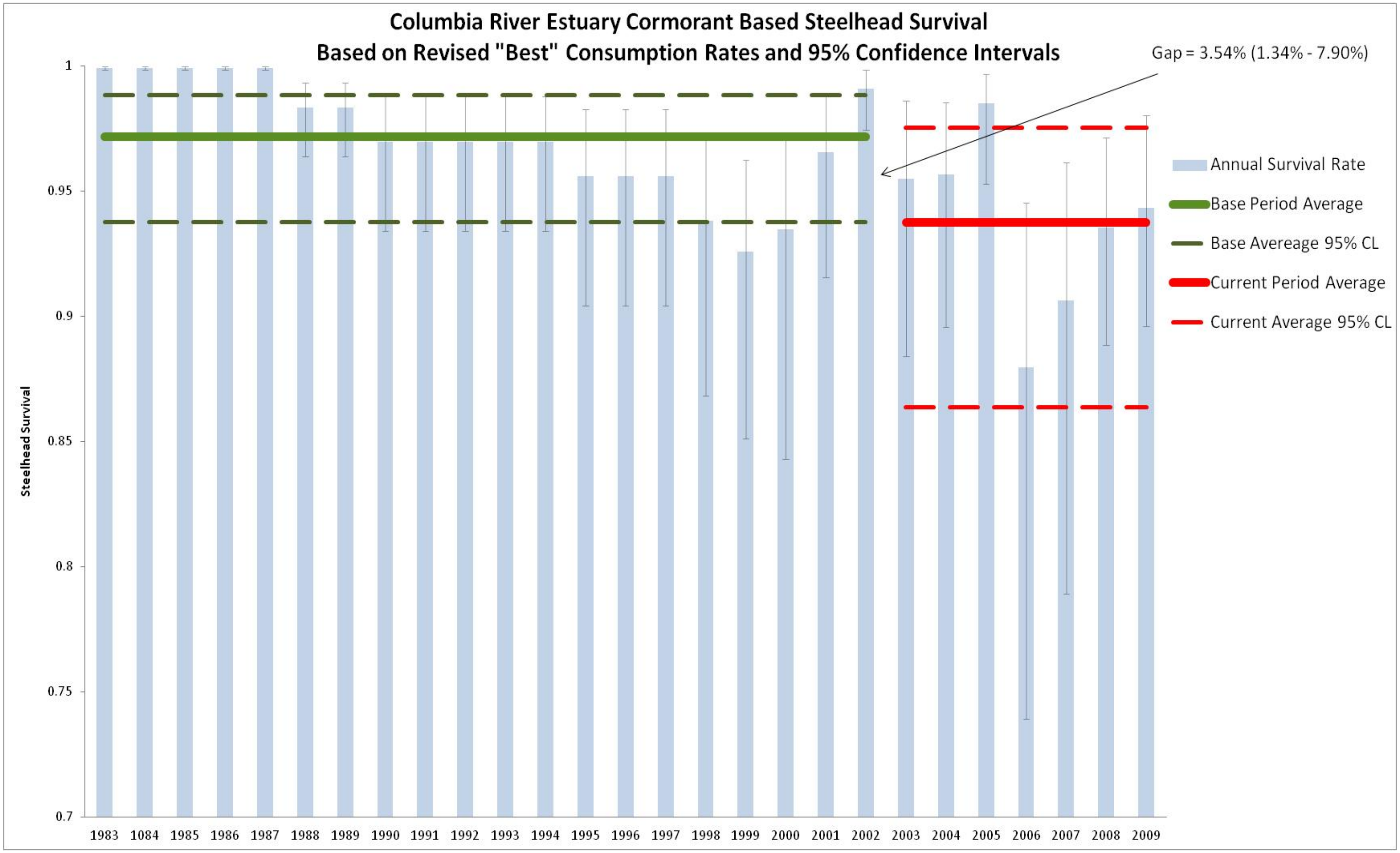

FIGURE 1-7. Estimated annual juvenile steelhead survival and average survival estimates during the “base period” (1983-2002) and “current period” (2003-2009). Annual survival estimates were derived from DCCO consumption data and estimated numbers of available juvenile salmonids and DCCOs in the Columbia River Estuary.

In the context of other FCRPS efforts and survival requirements, DCCO predation can be a substantial source of mortality for some Columbia River ESU or DPS salmonid groups. For example, dam passage survival of steelhead and yearling Chinook salmon is required to be 96 percent (no more than 4 percent mortality). In 2011, estimated juvenile steelhead survival was higher than this threshold, at 97.5 percent or2.5 percent mortality (Skalski et al. 2012). This level of mortality is approximately 2.7 times less than mortality from East Sand Island DCCO predation as determined by NOAA Fisheries' "survival gap" analysis (6.7 percent; NOAA 2014). Thus, for some ESU or DPS salmonid groups, DCCO predation impacts, on average, can be similar to or exceed the mortality experienced at a hydro-system facility in the FCRPS, and, in some years, can be 3 to 4 times higher or more. Furthermore, McMichael et al. (2010) found the highest rates of juvenile salmonid mortality occurred in the downstream-most 31 miles of the Columbia River Estuary. Harnish et al. (2012) also concluded mortality was highest for juvenile steelhead and Chinook salmon between RM 22 and RM 4, suggesting this was due to the proximity of large nesting colonies of piscivorous birds on East Sand Island. Based on the documented adverse impacts of DCCO predation of juvenile salmonids in the Columbia River Estuary, there is a need to reduce DCCO predation to the levels specified in the 2014 FCRPS Supplemental Biological Opinion.

There is also a need to develop a management strategy that achieves reduction in predation throughout the Columbia River Estuary and minimizes impacts where feasible to other species. As previously stated, East Sand Island and the Columbia River Estuary are important bird areas due to the large number of birds using the island and estuary for nesting, roosting, and foraging. Dispersal of DCCOs from East Sand Island also has the potential to cause greater impact to ESA-listed juvenile salmonids if they move to upriver sites along the lower Columbia and Snake Rivers (Collis et al. 2002) or to other areas in the affected environment where ESA-listed fish exist.

1.3 Lead and Cooperating Agencies

In response to the 2008 FCRPS Biological Opinion (NOAA 2008), an interagency working group formed in 2010 to address the effects of DCCO predation on the recovery of ESA-listed Columbia River Basin salmonids. The working group developed conceptual alternatives (based on percent reduction of colony sizes) and prepared a status assessment of DCCO, which was used in the development of the DEIS. A Notice of Intent announcing the Corps' preparation of an EIS was published in the Federal Register on July 19, 2012 (Fed. Reg., Volume 77, No 139, p. 42487). All of the agencies and tribes involved in the working group received written requests by the Corps to participate as cooperating agencies. These requests were sent August 1, 2012. The following is a list of the agencies who accepted the invitation and a description of their roles in the development of the EIS.

U.S. Army Corps of Engineers (Corps)

The Corps' Civil Works programs provide engineering and construction services for water resource development and management, flood risk management, emergency response, navigation, recreation, infrastructure (such as multiple-purpose hydroelectric power projects), and environmental restoration and stewardship. The Water Resources Development Acts (WRDA) are passed by Congress to provide for the conservation and development of water and related resources, to authorize the Secretary of the Army to construct various projects for improvements to rivers and harbors of the United States, and for other purposes related to Corps missions.

The Corps is the lead agency under NEPA, the federal land manager of East Sand Island, and an action agency with responsibility under the ESA for FCRPS consultation. Authority for the Corps to implement actions to manage DCCOs comes from the WRDA 1996 Subsection "511(c) which authorized management of avian predators on Corps' dredged material islands to reduce predation of endangered salmonids." Funding comes from the Columbia River Fish Mitigation appropriations.

U.S. Fish and Wildlife Service (USFWS)

The mission of the USFWS is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The USFWS has statutory authority and responsibility for enforcing the MBTA (16 U.S.C. 703–711). Under the MBTA, the USFWS implements conventions between the United States and four neighboring countries (Canada, Mexico, Russia, and Japan) for the protection of our shared migratory birds, and maintains the list of species protected under the MBTA (50 C.F.R. § 10.13). USFWS responsibilities include the conservation and management of DCCOs, which are included on the list of protected migratory birds.

The role of USFWS in this EIS is to provide technical assistance in developing alternatives to minimize impacts to DCCO and other migratory birds. The USFWS developed the population model (Appendix E-1) to assess the effects of different levels of individual and egg take on the East Sand Island DCCO colony and the western population of DCCOs. The USFWS will use the FEIS to support their permit decision-making upon receipt of an application for a federal Migratory Bird Permit (50 C.F.R. § 21) from the Corps for the take of migratory bird adults, eggs, or both, depending on which alternative the Corps selects.

U.S. Department of Agriculture - Wildlife Services (USDA-WS)

The mission of the USDA-WS program is "to provide Federal leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist." The USDA-WS is authorized by law to protect American agriculture and other resources from damage associated with wildlife. They provide assistance to agencies, organizations, and individuals in resolving wildlife damage problems on both public and private lands. When responding to requests for assistance, USDA-WS may provide technical assistance (e.g., advice, information, or equipment), direct control assistance, and research assistance. Technical and direct control assistance may involve the use of either non-lethal, lethal, or a combination of the two methods. The primary statutory authority for the USDA-WS program is the Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 426-426b) as amended in December 22, 1987 (101 Stat. 1329-331; 7 U.S.C. 426c).

The role of USDA-WS in this EIS process is to provide their subject matter expertise in developing alternatives and identifying methods appropriate to proposed DCCO management. The Corps would request technical assistance from USDA-WS to implement non-lethal and/or lethal components of the preferred alternative, and as a federal agency, they would need to ensure the action is compliant with NEPA and other applicable federal and state laws. This FEIS will be used to support NEPA compliance efforts for USDA-WS to directly assist the Corps in implementation of the preferred alternative.

Oregon Department of Fish and Wildlife (ODFW)

ODFW's mission is to protect and enhance Oregon's fish and wildlife and their habitats for the use and enjoyment of present and future generations. ODFW regulates fishing in the state and operates hatcheries to improve salmonid runs in the Columbia River and its tributaries. The role of ODFW in this EIS process is to ensure protected resources, such as sensitive fish and wildlife populations, are considered when alternatives are being evaluated. ODFW identified areas of specific management concern (see Figure 3-14) and provided information on current DCCO hazing efforts in coastal estuaries.

Washington Department of Fish and Wildlife (WDFW)

The WDFW mission is to preserve, protect, and perpetuate fish, wildlife, and ecosystems, while providing sustainable fish and wildlife recreational and commercial opportunities. WDFW regulates fishing in the state and operates hatcheries to improve salmonid runs in the Columbia River and its tributaries. The role of WDFW in this EIS process is to ensure protected resources, such as sensitive fish and wildlife populations, are considered when alternatives are being evaluated. WDFW identified areas of specific management concern (see Figure 3-14).

1.4 Public Involvement

Scoping is a process intended to inform the public early on when a federal agency is considering taking an action likely to have significant impacts on the environment. This process is also used to inform the federal agency, through stakeholder and public involvement, of important issues to consider in making their decision. Public review of a DEIS is a requirement of 40 C.F.R. §1503.1, and the federal agency is required to respond to comments received per 40 C.F.R. § 1503.4. Below is an overview of the scoping process which helped determine the scope of the issues to be analyzed in the DEIS, followed by an overview of the public outreach efforts and comments received on the DEIS, which were used to revise, update or otherwise inform the development of the FEIS. For more complete information on the responses to public comments see Appendix J.

1.4.1 Scoping

A Notice of Intent announcing the Corps' preparation of an EIS was published in the Federal Register on July 19, 2012. A public notice announcing the scoping process, public meetings, and website for the EIS was sent on October 25, 2012. Over 150 interested parties, non-governmental organizations, other federal, state, and local agencies, and other individuals who had previously contacted the Corps about past research efforts on East Sand Island were notified. The notice announced that lethal and non-lethal methods were being considered to reduce the DCCO colony size on East Sand Island. A press release to the local media was issued on October 29, 2012, announcing the scoping process and public meetings.

Three open house public meetings were held during scoping. The meeting locations were Olympia, Washington (November 8, 2012), Portland, Oregon (November 13, 2012), and Astoria, Oregon (November 15, 2012). The meetings in Olympia and Portland were poorly attended. The meeting in Astoria had approximately thirty people, mostly commercial fishermen, in attendance. General themes, reflecting concerns of the public, emerged from verbal comments made during public meetings and from twenty-two written comments received. This information was included in a newsletter sent to the DCCO EIS email distribution list (nearly 200 contacts) and was posted on the project website.

The following Table 1-2 identifies the general comments from scoping which helped identify the issues to address in the DEIS. Many of the themes that emerged during scoping were identified again in public comments on the DEIS.

TABLE 1-2. Comments received from Scoping.

Theme	General Comments	Where addressed
Scope of EIS	Focus more on birds, focus more on fish (ESA-listed and non-listed); have a balanced scientific approach; expand the geographic scope beyond Bonneville Dam; approach management more cautiously, approach it more aggressively; disclose the relationship of the EIS to other management plans.	*Sections 1.2 and 2.6*
Root Causes	Address the root causes (dams, flow management, hatchery management, etc.) that affect juvenile survival and do not just react to a symptom caused by an artificially created environment.	*Section 2.3*
Dispersal	Consider and mitigate the potential impacts DCCOs may have on other public resources (bridges, rooftops, other protected fish species, etc.) if they are displaced from East Sand Island. There were also some concerns about health and safety from DCCO guano.	*Sections 4.2 and 4.3*
Commercial and Recreational Fishing	Address the loss of income and jobs in fisheries due to the predation impacts.	*Section 4.3*
Economics	Consider the massive investment of millions of public dollars spent over the years and throughout the Columbia Basin to recover salmon, and how that may be offset from DCCO predation impacts.	*Sections 1.2 and 4.3*
Tribal Treaty Rights	Address the need for the federal government to honor and protect Columbia River tribal treaty and fishing rights. Harvests of non-listed salmonid runs are critical to ensure federally-protected fishing rights are preserved.	*Sections 3.3 and 4.3*
Management Standards	Address the perception that there are different standards for management of DCCOs throughout the country, and provide a rationale for the requirement to implement non-lethal methods before lethal take is considered; incorporate an analysis of the ethics of using lethal take, if it is proposed.	*Sections 2.4, 2.7 and 4.6*
Wildlife on East Sand Island	Consider how actions to manage DCCOs would impact their regional population and other wildlife on the island, such as California brown pelicans and Brandt's cormorants.	*Section 4.2.3*
Climate Change	Consider the effects climate change may have on Columbia River flows and the possibility that higher springtime flows may affect availability of other prey sources for DCCOs, thereby influencing predation rates on juvenile salmonids.	*Chapter 4*
Compensatory Mortality	Address the uncertainty over whether juvenile salmonids would die from other sources of mortality, specifically in the ocean, if they are not consumed by DCCOs.	*Section 4.6*
Scientific Methodology	Questions came up about the quality of the bioenergetics and consumption studies as they relate to the findings of the annual predation impacts. There is perception that management of DCCO and lethal take may not be warranted by the research findings.	*Sections 1.2 and 4.2.5*

1.4.2 Public Involvement on the Draft EIS

On June 12th, 2014, the DEIS was announced via a public notice issued by the Corps and made available on the project website. The public notice announced the availability of the DEIS for public review, dates of public meetings and webinars/conference calls, described the process for submitting public comments, and provided summary information on the alternatives under consideration. The document was distributed to an electronic mailing list of over 200 individuals, governmental, and non-governmental groups. On June 20th, 2014, a notice of availability was published in the Federal Register for the DEIS (79 FR 35346), with an initial comment period of 45 days. A request to extend the comment period was granted and the comment period was extended 15 days and ended August 19th, 2014. Numerous local and national media organizations published stories on the proposal.

Two open house public meetings were held; meeting locations were Portland, Oregon (July 10, 2014) and Astoria, Oregon (July 24, 2014). The meetings included informational exhibits with maps and graphics intended to highlight important aspects of the DEIS. Subject matter experts from participating agencies were available to answer questions and discuss the proposed actions in the DEIS with the public. Facilitators and note-takers were also on-hand at each meeting. The meeting in Portland, Oregon was held late afternoon and was attended by 66 people. The meeting in Astoria, Oregon was held early evening and was attended by 60 people. A significant portion of attendees wore visible logos or slogans on their persons demonstrating their position on a particular issue.

Three webinar/conference call meetings were held during July and August 2014. These meetings were designed to give those unable to attend the public meetings an opportunity to ask questions and voice their comments in an interactive environment with agency representatives. Members of the public had the option of logging into the live webinars online or to call in via telephone. Two webinar/conference calls were originally scheduled, but, during the public review period, a third webinar/conference call was added and specifically held during evening hours to accommodate those unable to attend meetings during the afternoon or daytime. A total of 17 people attended the webinars. Comments and questions received in public open house meetings and webinars are summarized in Table 1-3.

TABLE 1-3. Comments and Questions Received During Public Open House Meetings and Webinars.

Theme	General Comments
Decision Making Process	Perception that decisions are being made too rapidly/in a rushed manner; conversely, perception that too much time has already passed and action must be taken right away to save salmonids. • Who makes the final decision on which action alternative is chosen? • What is the depredation permit process and egg take process for MBTA? • Is there a single oversight group for all the efforts proposed in the EIS? • Consequences if Corps fails to meet RPA action 46 requirement. • MBTA rules regarding lethal take of protected birds. • The origin of the BiOp and RPA action 46. • Ethical concerns over lethal take of 16,000 birds; how will public comments about ethics be factored into decision-making process?
Public Involvement	Confusion/belief that attendees would be able to present public testimony at meetings. • Timeframe and process for public comment submittal? • Complaints about the small size and acoustic properties of the rooms; made it very difficult to hear. • Complaints that the public meeting format was not conducive to hearing people's opinions; desire for at least a short period for public speaking. • Complaints that the public comment system was flawed, that comments are received by the Corps but not taken into serious consideration. • Extending the public comment period. • Whether raw data for DCCO stomach content and diet could be made available to the public. • Comment that the first public meeting was too restrictive in its format, and the option for public hearings would allow attendees to be exposed to broader public opinion.
Scientific Methodology	Methods used for determining DCCO consumption of salmonids? • Accuracy and validity of research studies cited and analyses in DEIS. • How density dependence and compensatory mortality information has been incorporated into relevant analyses in the DEIS? • How baseline periods were determined?
Purpose and Need	Who directed Corps to follow the proposed action? • Perception that dams, hatcheries, artificial environments (dredged material islands), and overfishing are the true threats to salmon recovery; belief that money should be spent on reducing mortality at dams instead of culling DCCO population; DCCO being unfairly scapegoated. • Argument that tax dollars are being wasted on lethal measures when there are many non-lethal alternatives that have not been properly explored. • How was the desired East Sand Island DCCO population number determined? • What other actions are proposed /conducted under other RPA actions; what is the likelihood of achieving goals and/or RPA action 46 through other actions?
Alternatives and Monitoring	Perception that dispersal techniques have not been properly studied; over-reliance on lethal solutions. • Type of ammunition and firearms to be used during lethal take? • Details of proposed habitat modification on East Sand Island. • Whether lethal take of DCCOs in other areas of the U.S. has been considered in relation to this EIS? • How will effectiveness of this action be measured? • How will increases of salmonid abundance be measured?
Environmental Effects	Concerns over effects to non-target species from lethal take and habitat modification. • How/when shooting will occur during lethal take, and associated public safety concerns? • What the concerns might be if DCCOs from East Sand Island were relocated to coastal colonies? • If lethal take occurs, how to ensure population doesn't increase again thereafter. • Impacts of habitat modification to other species on island? • Whether juvenile salmonids consumed by DCCOs are healthy or more vulnerable to predation? • Impact of ocean conditions on adult salmonid returns? • How to explain the need for EIS actions with recent high salmonid returns? • History of lethal take on this scale. • How lethal take of DCCOs relates to lethal take of sea lions and overall long-term plan for management of predators within the Columbia River ecosystem.

1.4.3 Public Comments and Summary of Changes to the Final EIS

The Corps received over 152,000 comments during the comment period. Nearly all comments (over 149,000) were submitted from online petitions, stating personal preference or opinions on the proposed action. The majority of comments expressed opinions about the range of alternatives and other issues regarding salmon recovery methods. Many suggested other actions the Corps should consider, such as altering flow management, removal of dams, habitat restoration, etc., rather than managing native wildlife to improve salmonid populations. Comments were organized into two general categories: 1) general, opinion-based comments and 2) substantive comments, meaning comments that challenged the methodologies, alternatives, and assumptions of effects made in the DEIS in which the Corps would respond with adding clarifying information, additional analysis, or changes to the alternatives in preparing the FEIS.

All comments received were read and considered for revisions to the FEIS. All substantive comments were addressed either in modifying the text for the FEIS or via responses (see Appendix J) explaining why changes were or were not made. Based on public comments received the Corps and cooperating agencies made changes to the FEIS. Table 1-4 is a summary of the changes made from the DEIS to FEIS, representing the most important changes relative to the decisions to be made. Minor, grammatical, or typographical changes were made but not noted in Table 1-4.

TABLE 1-4. Summary of changes from DEIS to FEIS.

Section of EIS	What Changed
Figures and Tables	Variance measures, confidence intervals, and clarifying text about these measures added to figures, tables, and legends where appropriate.
Executive Summary	Expanded discussion on the rationale for development of Alternative C-1 and its selection as the preferred alternative; expanded discussion to address comments related to requirement of non-lethal management, concerns about compensatory mortality, adult returns of salmonids, and clarifying language for defining a sustainable population of DCCO.
Section 1.1.6	Text added about methods used for assessing DCCO predation (i.e., bioenergetic consumption estimates and PIT-tag predation rates) and assumptions with each technique; clarifying text added about management feasibility studies on East Sand Island and non-lethal methods used to date and effectiveness of methods and applicability of these studies to larger scale management.
Section 1.2	Text added about NOAA's "survival gap" analysis; replaced Figure 1-7 with revised graph.
Section 1.3	Expanded discussion of USDA Wildlife Service's role as a cooperating agency.
Section 1.4	Sections added to describe public involvement on the DEIS, comments from meetings and webinars and summary of changes to the FEIS based on public and agency comments.
Section 2.1.1	Text added about rationale for development of Alternative C-1; incorporation of public comments; clarification of management and monitoring actions and timeframes.
Section 2.1.3	Expanded to include information about Pacific Flyway Council Monitoring Strategy for the western population of DCCOs, Adaptive Management Framework, and applicability to action alternatives C-D.
Section 2.2	Additional detail added about terrain modification actions.
Section 2.2.2	Clarification of language regarding current efforts to haze Caspian terns and DCCO in the Columbia River Estuary of Corps' Channels and Harbors Program. Incorporation of impact minimization measures on islands that provide habitat for endangered streaked horned larks. Changes to adaptive management strategy in adjusting take levels to be based on status and trends of the western population of DCCOs.
Section 2.2.3	Alternative C - More detail added on proposed management actions, timing, scale, effort, etc.; take numbers updated with revised estimates from Appendix E. Inclusion of Alternative C-1 in response to comments.
Section 2.3	Expanded discussion on alternatives considered but dismissed.
Section 2.5	Inclusion of consistency with additional plans referenced in comments.
Section 3.1	Additional information about DCCO dispersal and usage of different geographic areas during the early breeding season when the majority of proposed actions would likely occur. Addition of Table 3-2 showing nighttime usage of DCCO during dissuasion research.
Section 3.2.2	Updates and expanded discussion about regional status, threats, and trends of the western population of DCCOs.
Section 3.2.3	Expanded discussion of streaked horned larks in Columbia River.

Section of EIS	What Changed
Sections 3.3.1-3.3.3	Revisions to economics sections clarifying terminology, scope, and contribution of tribal fisheries.
Section 4.2.2	Figures added to show abundance trajectories for the East Sand Island colony and western population of all alternatives. Take levels and commensurate percentages of colony and population take revised to account for reduced carrying capacity model parameters.
Section 4.2.5	Additional information included about abiotic and biotic effects from Phase II terrain modification; included effects to green sturgeon; expanded discussion about interpretation of analysis results as potential maximum benefits.
Section 4.4.2	Expanded discussion and analysis of ODFW hazing in coastal estuaries and DCCO management within the western population; expanded discussion and analysis of avian predation management within the Columbia River; expanded discussion and analysis of cumulative impacts to Columbia River salmonids; clarified the Corps' Operation and Maintenance (O&M) dredging of the Columbia River Federal Navigation Channel and expanded the discussion to explain rationale for adverse effects to streaked horned larks from human disturbance associated with requirement to haze piscivorous waterbirds.
Section 4.4.3	Expanded description and analysis regarding cumulative effects to DCCO western population from loss of Salton Sea DCCO colony, increases in bald eagle disturbances, and potential loss of coastal habitat from climate change.
Section 4.5.2	Climate change literature references and summaries of expected effects updated.
Section 4.6.5	Additional text and citations about compensatory mortality and uncertainty relative to DCCO predation.
Chapter 5	Plan updated per changes to Chapter 2, revised to include Alternative C-1 as preferred management plan.
Appendix C	Includes a "Retrospective Analysis" to quantify influence of environmental factors on predation rates.
Appendix D	Includes technical memos from NOAA Fisheries with rationale for using bioenergetics data and supplemental information and updates to the analysis since the DEIS.
Appendix E	DCCO population model revised to include updated estimates, variances, and distributions of model input parameters; changed method for estimating recruitment; explicit 2-age structure in model; elimination of reduced carrying capacity scenario for East Sand Island and taking mid-point between high and low carrying capacity scenarios for deriving take levels for East Sand Island; inclusion of reduced carrying capacity scenario for modeling future effects of the western population of DCCOs; Appendix E-3 added, which shows abundance trajectories of all alternatives.
Appendix G	Appendix G of DEIS combined with Appendix H of DEIS/FEIS. Appendix G in FEIS becomes DCCO Management Feasibility Research Methods and Results.
Appendix I	Economic report included in full; revised to include clarity of methods, models, and estimates used; expanded calculation for direct invest losses, and predation rates updated in model.

The Corps has determined that changes to the proposed action (i.e., Alternative C in the DEIS now Alternative C-1 in the FEIS) are not so substantial as to require a supplemental EIS. As noted in Table 1-4, one of the changes from the DEIS to the FEIS was the development of a modification to Alternative C to the new preferred alternative, Alternative C-1. As described in the DEIS, under Alternative C, the Corps would implement primarily lethal methods (culling) to reduce the colony size on East Sand Island integrated with non-lethal methods (see DEIS Chapter 2.2.3). Though not specifically proposed in Alternative C, one of the lethal methods discussed and considered in the DEIS was egg oiling (see DEIS Chapters and Sections 2.1.2, 2.2.3, 4.2.2, 5, and Appendix E-1). Specifically, egg oiling was considered a potential adaptive response in the description of Alternative C (see DEIS Chapter 2.2.3). As described in the FEIS, under Alternative C-1, the Corps would still implement primarily lethal methods integrated with non-lethal methods (see FEIS Chapter 2.2.4). However, under Alternative C-1, the number of individual DCCOs culled would be reduced and egg oiling would be an additional lethal method used to reduce the colony size on East Sand Island. Chapter 2, Section 2.1.1 of the FEIS describes the rationale for the development of this modified alternative. As described in Chapter 4, Section 4.2.2 of the FEIS, Alternative C-1 is expected to reduce the effects to the western population of DCCOs compared to Alternative C. Alternative C-1 is made of substantially the same elements that were analyzed in Alternative C in the DEIS. Specifically, Alternative C-1 in the FEIS includes, just as Alternative C in the DEIS included, the following elements: the proposed abundance reduction for the East Sand Island colony; abundance reduction is occurring primarily from the culling of adults, use of integrated non-lethal methods (e.g., hazing and habitat modification) augmented with limited direct egg take; use of best management practices and adaptive management thresholds and strategies to minimize effects to non-target species; and a two-phased approach, with Phase I to achieve the target size and Phase II involving terrain modification and primarily non-lethal methods to ensure that colony size is not exceeded. In other words, Alternative C-1 in the FEIS is identical to Alternative C in the DEIS with the exception of greater egg take. Though egg oiling was not specifically proposed in Alternative C, it was considered a potential adaptive response measure under Alternative C in the DEIS and as noted above, discussed in various sections of the DEIS. Given the foregoing and that Alternative C-1 is a minor variation of Alternative C and is qualitatively within the spectrum of alternatives discussed in the DEIS, a supplemental draft EIS is not necessary for this change.

The Corps has also determined that new circumstances or information made available after publishing the DEIS, specifically the status of the western population of DCCOs, is not of such significance as to require a supplemental draft EIS. Generally, in order to require a supplemental EIS, the new circumstances or information must show that the proposed action will affect the environment in a significant manner or to a significant extent not already considered. As described below, the Corps has determined that the status of the western population of DCCOs does not show that the proposed action, Alternative C-1 in the FEIS, will affect the environment in a significant manner or to a significant extent not already considered in the DEIS.

Regarding the effects analyzed, whereas certain factors were qualitatively analyzed in the DEIS, these factors were quantitatively analyzed in the FEIS. For example, the DEIS qualitatively analyzed: choice of carrying capacity, Appendix E-1; uncertainty about carrying capacity and how that would influence future trajectories, Appendix E-2; changes to physical processes associated with climate change, Chapter 4, Section 4.5.3; areas in which the western population of DCCOs was declining, including the Salton Sea, California, Chapter 1, Section 1.1.3; and the variability of DCCO abundance at specific sites based on environmental and water conditions and levels of disturbance, Chapter 3, Section 3.2.2. In contrast, the FEIS quantitatively analyzed these factors in modeling the western population of DCCOs and estimating future carrying capacity. Such explicit incorporation of these same factors in modeling more accurately predicts effects to the western population of DCCOs.

Regarding the status of the western population of DCCOs, populations vary year to year based on annual environmental conditions or human-induced factors. Long-term population monitoring is critical for assessing population trends and species status—long-term datasets better illustrate stable, positive, or negative trends in a population. Short- and long-term effects of the proposed action on the western population of DCCOs are described in the DEIS and, again, in the FEIS at Chapter 4, Sections 4.2.2 (effects to DCCOs) and 4.4.3 (cumulative effects), and in Appendix E-2 (modeling effects). Annual monitoring data will also be used to inform adaptive management so management does not negatively affect the long-term sustainability of the western population. A sustainable population is defined for this analysis as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered. This emphasis on the long-term population trend of the western population of DCCOs comports with the MBTA. Pursuant to the USFWS regulations implementing the MBTA, the USFWS must first issue a depredation permit to the Corps before the Corps is authorized to carry out the proposed action. Under the MBTA, the Secretary of the Interior has discretion to consider the long-term sustainability of a protected species when analyzing abundance, before allowing take. Based on the past population trend and current number of active colonies, it appears that the western population of DCCOs is sustainable around 41,660 breeding individuals (ca. 1990 abundance).

Within the coastal states and provinces, which account for approximately 90 percent of the western population of DCCOs, DCCO abundance increased 71 percent (approximately 3 percent per year) during the last two decades, but nearly all of the growth of the western population of DCCOs was attributed to abundance increase at the East Sand Island colony (Adkins et. al 2014; see Figure 4-8). With nesting habitat reduced and growth on East Sand Island limited and previous and new threats as likely limiting factors of the western population (e.g. predation, human disturbance, and climate), the western population of DCCOs would likely decrease in the future. However, the western population would likely rebound to some extent if abundance levels were to temporarily drop below the ca. 1990 level, given: 1) that mortality factors known to limit DCCO populations prior to the 1970s (i.e., environmental contaminants and hunting–DCCOs were protected under the MBTA in 1972) have been reduced or eliminated, 2) since the ca. 1990 time period the western population has exhibited growth on the whole, and 3) the sum of the breeding colony counts of the western population (excluding East Sand Island) ca. 2009 is similar to that observed in ca. 1990.

Risk to the long-term sustainability of the western population (i.e., 20 years) is further reduced given that take on East Sand Island would occur within a well-monitored and adaptive management framework (see Chapter 2, Section 2.1 and Appendix E-2), monitoring of the western population will occur annually and this information will be used to evaluate and adjust future management activities, and an annual depredation permit application would need to be approved and issued prior to take. Additionally, there are extensive examples throughout the United States and Europe of DCCO and Great cormorant (*P. carbo*) populations increasing concurrent with and after lethal management.

Based on model simulations presented in Appendix E-2, the DEIS and FEIS in Chapter 4, Sections 4.2.2 and 4.4.3, each analyzed the potential effects to, and long-term trends of, the western population of DCCOs for each alternative. With the exception of Alternative D in the FEIS, the long-term trends predict various rates of decline for the western population of DCCOs followed by a gradual increase to a projected abundance above that observed in ca. 1990. In analyzing Alternative C in the DEIS and Alternative C-1 in the FEIS, both EISs show the long-term population trends of the western population of DCCOs ultimately rising above that observed in ca. 1990. As such, the Corps has taken a hard look at the long-term population trends of the western population for each alternative in the DEIS and FEIS. For these reasons, the Corps has determined that new circumstances or information regarding the status of the western population of DCCOs do not show that the proposed action, Alternative C-1 in the FEIS, will affect the environment in a significant manner or extent not already considered in the DEIS so as to require a supplemental draft EIS.

Chapter 2 Alternatives

2.1 Introduction

This chapter describes the range of alternatives that were developed to meet the stated purpose and need. Each alternative, with the exception of the no-action alternative, contains a set of actions, monitoring efforts, and potential adaptive responses that comprise an implementable management plan. A description of each alternative is provided as well as a summary table for comparing alternatives that are carried forward for further study. Finally, this chapter explains why other alternatives were dismissed from detailed study and identifies mitigation measures, required permits or other approvals, and the relationship of the proposed action to relevant policies and plans.

2.1.1 How Alternatives Were Developed

The 2008 Federal Columbia River Power System Biological Opinion included a reasonable and prudent alternative to develop a DCCO management plan, but did not specify management objectives. In 2010, an interagency working group was formed to develop a management plan, which included general alternatives to reduce DCCO predation, based on percent reductions (i.e., 25 percent, 50 percent, 75 percent, etc.). In July 2012 the Corps published its Notice of Intent which identified these various alternatives. Subsequently, the 2014 Supplemental Federal Columbia River Power System Biological Opinion identified management objectives for the colony size on East Sand Island, which the Corps adopted as the purpose and need for the proposed management plan.

The draft management plan developed by the working group provided the basis for public scoping meetings. Several alternatives were suggested during public scoping and in public comments received on the DEIS. Some of these alternatives, or recommended changes to alternatives, were considered and incorporated into the alternatives, while others were not considered for further evaluation because they would not meet the purpose and need. The specific management objective for reducing predation impacts (i.e., reduction in colony size) was identified in the 2014 Supplemental FCRPS Biological Opinion (NOAA 2014) and adopted as the purpose and need statement. The action alternatives were then further developed to meet this purpose and need. During development of the DEIS, cooperating agencies identified priority issues and identified areas of specific management concern that were also integrated into the proposed alternatives; specifically, ODFW and WDFW raised concerns over dispersal of DCCOs and possible conflicts with fish of conservation concern in their respective states.

The Corps released the DEIS in June 2014 and identified Alternative C (i.e., Culling with Integrated Nonlethal Methods including Limited Egg Take) as the preferred alternative. Based on, and in response to, substantive comments received during the public review period (see Appendix J) and input from the USFWS and USDA-WS, the FEIS includes an additional alternative, Alternative C-1, Culling and Egg Oiling with Integrated Nonlethal Methods. This is the Corps' preferred alternative for the FEIS. This alternative is a modification of Alternative C and proposes culling and egg oiling to reduce the colony size. This modification to the primary lethal strategy reduces the number of culled individuals and increases egg oiling as a means of nest destruction. This alternative would achieve the purpose and need and lessen the potential effects to the short- and long-term population trend of the western population of DCCOs by decreasing the number of adults lethally removed annually. Alternative C-1 is described below in more detail and carried forward throughout the relevant sections of the FEIS. Alternative D is now based on Alternative C-1 in Phase I (instead of Alternative C).

In addition to the inclusion of Alternative C-1 and as a response to comments, the adaptive management strategy for implementing annual take was revised for all the alternatives proposing lethal methods as a primary strategy to include annual monitoring of the western population of DCCOs. Each year, the Corps, in cooperation with USFWS and the state wildlife agencies within the Pacific Flyway, would implement the *Monitoring Strategy for the Western Population of Double-crested Cormorants within the Pacific Flyway* (herein Pacific Flyway Council Monitoring Strategy; Pacific Flyway Council 2013). This annual monitoring data will be used to obtain status and trends information on the western population to determine how management actions are affecting the western population compared to predictions. Additionally, information obtained from the annual monitoring will be used to evaluate take requests for subsequent years after implementation of management. This allows time for annual evaluation and adaptive management changes and increases the ability for the western population to respond from any potential catastrophic event.

The adjusted 3- and 2-year adaptive management strategy of Alternative C presented in the DEIS was revised to the updated adaptive management strategy for all the alternatives presented in the FEIS in order to reduce potential adverse effects to the western population.

2.1.2 Description of Wildlife Management Techniques Considered in this EIS

There are two general categories of DCCO management techniques: non-lethal and lethal. Non-lethal actions do not constitute "take" as defined by the MBTA, whereas lethal actions do. However, implementation of non-lethal techniques in certain circumstances, which would result in loss of eggs or chicks, can result in "take." Available non-lethal and lethal techniques are described below. The primary techniques proposed for use in the alternatives are noted in Chapter 2. Techniques were taken from relevant literature (USDA-WS 1997; USFWS 2003; Pacific Flyway Council 2012) and developed in coordination with the cooperating agencies and input from public scoping.

Non-lethal Methods

Hazing — any activity to discourage nesting, roosting, and foraging behavior, such as: using visual and noise deterrents, modifying habitat, using boats or other similar equipment, or any other dispersal techniques.

Visual deterrents — human or animal (e.g., dog) disturbance, any moving or stationary object, or any object that emits deterring stimuli, such as: mylar or reflective tape, rope, other material between or on objects, hand-held or positioned lasers or lights, water cannons, eagle kites or other kites, effigies, scarecrows, or decoys of predators or humans.

Noise deterrents — any noise or noise producing object, such as: pyrotechnics, screamer shells, bird bombs, 12 gauge cracker shells, propane cannons, live ammunition, whistling projectiles, exploding projectiles, bird bangers, flash and detonation cartridges, sirens, or distress calls.

Habitat modification — any measure taken to change the way habitat could be used to make it unsuitable for that use, such as: creating temporary or permanent obstruction or exclusion devices and barriers (e.g., nets, cones, fences, wire devices, floating rope, line, screen, tarps, pond liners, etc.), or causing temporary or permanent physical changes to the topography or landscape (e.g., creating berms, increasing vegetative cover, removing trees, flooding areas, etc.). Habitat modification also includes removing, tearing down, or scattering nest materials or constructed nests that do not contain eggs.

Lethal Methods

Egg addling/destruction/oiling — destroying the embryo in an egg prior to hatching by shaking or other methods, breaking eggs by physical means, spraying eggs with food grade oil to suppress embryo development, or doing any other action, such as shooting an individual incubating an active nest, that would prevent an egg from hatching.

Shooting adults, sub-adults, and young — shooting with firearms, typically shotguns or rifles. Shooting must adhere to local regulations and restrictions but could occur over water or land, during daylight or night with the aid of night vision, spotlights, firearm suppressors, or other modifications to reduce the noise or disturbance associated with shooting.

Traps/nets/capture by hand/euthanasia — capturing DCCOs alive by hand or with traps, nets, or other means. Euthanasia techniques would follow American Veterinary Medical Association approved methods, such as cervical dislocation or carbon dioxide asphyxia.

Any lethal method implemented under an FEIS action alternative would be a humane euthanasia technique. Shooting, egg oiling or destruction, nest destruction, cervical dislocation, and CO_2 asphyxiation are all classified as humane euthanasia techniques for birds by the American Veterinary Medical Association.

2.1.3 Monitoring and Adaptive Management Framework

For this FEIS, adaptive management is defined as evaluating the accuracy of the predicted environmental impacts, assessing the effectiveness of management actions, and modifying them as needed to ensure the purpose and need is met and predicted levels of environmental effects predicted in the FEIS are not exceeded. The approaches taken in the alternatives follow the process described in the 2003 NEPA Task Force Report to the Council on Environmental Quality (CEQ) on Modernizing NEPA Implementation:

Predict → Mitigate → Implement → Monitor → Adapt

Results from prior dissuasion research, other avian predation management efforts, NOAA Fisheries' "survival gap" analysis, the fish and economic analyses, and the DCCO population model were used to *predict* potential outcomes. The management plan outlines various measures to *mitigate* impacts to non-target species and reduce potential for DCCO dispersal and identifies actions the Corps could *implement* to achieve management objectives. The Pacific Flyway Council *monitoring* strategy and other monitoring would be implemented annually to assist in the annual evaluation of management actions and in determining *adaptive* responses to proposed management. PIT tags would be recovered on the DCCO colony after the breeding season to assess predation rates. The Corps would convene an Adaptive Management Team, consisting of the cooperating agencies to the FEIS, NOAA Fisheries, and tribal entities, to meet as needed to assess the effectiveness of, and guide future management actions. The Corps would be the decision making body for the Adaptive Management Team but would consider input and recommendations from the team.

The primary goals of adaptive management would be to ensure that actions:

- Achieve baseline levels of predation as described in the FCRPS Biological Opinion (NOAA 2014)
- Reduce DCCO depredation of juvenile salmonids throughout the Columbia River Estuary
- Reduce the potential for shifting DCCO depredation impacts to areas outside the Columbia River Estuary
- Minimize adverse impacts to the western population of DCCO
- Minimize adverse impacts to non-target species during implementation
- Implement passive methods that are cost effective and require less human presence in the long-term

Adaptive management would allow for in-season and between-year adjustments in application of management techniques based on knowledge gained during implementation and in annual monitoring of the western population of DCCOs. This includes adjusting field methods, such as technique, timing of activities, and duration of actions, and monitoring frequency. When implementing non-lethal and lethal techniques and monitoring, impact avoidance measures (timing of activities to minimize impacts, use of field techniques that have least impacts to non-targets as identified in the alternatives), as identified in the action alternatives, would be used to reduce the potential for dispersal, colony abandonment, and impacts to non-target DCCOs and other species (see USDA-WS 1997; Steinkamp et al. 2003; USFWS 2003, 2008; Pacific Flyway Council 2013).

PIT Tag Recovery

PIT tag recoveries on East Sand Island would occur after the breeding season. The average annual percentage of available PIT tags that are recovered in the DCCO nesting area would be evaluated in context of relevant factors to assess DCCO predation rates of juvenile salmonids. PIT tag data will be used to evaluate the effectiveness of management and in reporting per the Corps' FCRPS consultation requirements and to supplement information needed for a depredation permit application. PIT tag data would be used to inform future management actions and objectives if proposed actions do not achieve juvenile survival improvements as stated in the purpose and need. Due to annual variability in predation impacts, monitoring would likely need to occur over a longer period of time (5-10 years) to assess overall trends and effects accounting for yearly fluctuations.

Pacific Flyway Monitoring Strategy

For the action alternatives primarily considering lethal take (i.e., Alternatives C, C-1, and D), the Corps, in coordination with the USFWS and states, would implement the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013) annually. Each year, the Corps would monitor all specified locations of the monitoring strategy, where and when there are not already established monitoring efforts and secure funding sources, supplement data processing of aerial photography, and assist in preparing an annual summary report of the Pacific Flyway Council and other collected monitoring data. During implementation this monitoring would occur annually for Phase I (expected to occur over a 4 year timeframe). The objective of this monitoring strategy is to detect a 5 percent annual change in the number of breeding pairs in the western population of DCCOs. Beginning in 2014, the strategy was designed to monitor all large colonies and randomly selected historic and active colony locations every 3 years for at least 10 years (see Appendix F-2 for partial data from this monitoring). The full plan is available at: http://pacificflyway.gov/Documents/Dcc_strategy.pdf.

Adaptive Management

An adaptive management approach is needed due to uncertainties in predicting future outcomes. Adaptive management would be used to adjust proposed take levels in future years for alternatives considering lethal methods as a primary strategy in Phase I, if needed (Table 2-1, for greater detail see Table E-2 3). The predictions of effects on the DCCOs on East Sand Island and the western population were developed from the DCCO western population model. Four fundamental sources of uncertainty may cause observations to not match the predictions (Nichols et al. 1995a, Johnson et al. 1996, Williams et al. 1996): environmental variation, partial controllability of culling/egg oiling, partial observability of estimating population attributes, and structural uncertainty with an incomplete understanding of underlying biological processes.

For the action alternatives primarily considering lethal take (i.e., Alternatives C, C-1, and D), adjusting the amount of take would be determined based on observed DCCO abundances on East Sand Island and within the western population and behavioral responses of DCCO and non-target species after implementation. Observed abundance on East Sand Island is the peak number of nesting DCCO pairs on the island after culling has taken place in a given year; the observed abundance of the western population will be the estimate of the nesting population following the annual population-wide monitoring, using methods described in the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013). The adjustments to take levels will be based upon the thresholds and descriptions in Table 2-1 (see Appendix E-2 for specific examples) and include a two-step evaluation process with regard to whether observed abundance is less than, greater than, or within one standard deviation of predicted abundances from the population models for both the western population of DCCOs and the DCCO colony on East Sand Island.

Take could increase if, for both the East Sand Island colony and the western population, the observed abundance is greater than one standard deviation of the predicted abundance. This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and thus, the predicted decline in the western population may not occur.

Increased take could also be considered in years 3–4 above what is stated in the proposed take levels described in the alternatives if authorized take the previous year was not fulfilled and if the observed abundance East Sand island is within one standard deviation above predicted while the observed abundance for the western population is within one standard deviation above predicted for that year. As described above, if this scenario occurs, it may indicate that the population model used to develop predictions may also be more conservative than actual conditions. However, if the observed abundance for the western population continues to decline, it would move evaluation and adaptive management into the next scenario described in Table 2-1.

Take could decrease or cease if observed abundance of the western population is lower than one standard deviation below predicted abundance, as this could be an indication that the East Sand Island colony is acting as an immigration sink, with DCCOs immigrating from other colonies within the western population. It could also be possible that the model could not adequately incorporate all the sources of fundamental uncertainty (as stated above; see Table 2-1 for additional adaptive management scenarios).

TABLE 2-1. Adaptive Management General Framework.

East Sand Island Colony Abundance	Western Population Abundance	Potential Adaptive Decision
Observed colony size is within one standard deviation above predicted.	Observed population is within one standard deviation above predicted.	For years 1 and 2, stay with proposed take levels; for years 3 and 4, if take levels were not achieved, and observed population on East Sand Island is above predicted, then consider increasing take in following year to include numbers not taken the previous year. The maximum increase would be the difference between the observed and predicted East Sand Island colony size.
Observed colony size is greater than one standard deviation above predicted.	Observed population is greater than one standard deviation above predicted.	Consider increasing take on East Sand Island, or consider increasing take to authorize numbers not collected the previous year. The maximum increase would be equal to one standard deviation. This would potentially bring the next year's observations closer to the predicted median colony size on East Sand Island. This scenario may indicate the population model is conservative.
Observed colony size is greater than one standard deviation above predicted.	Observed population is within one standard deviation above predicted.	Consider increasing take on East Sand Island by a maximum of the difference between observed colony size and one standard deviation above predicted colony size on East Sand Island, or consider increasing take to authorize numbers not collected the previous year. Consider increasing non-lethal methods to limit colony size. The maximum increase would be equal to one standard deviation. This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and/or this may indicate some immigration to East Sand Island from other colonies is occurring.
Observed colony size is greater than one standard deviation above predicted.	Observed population is lower than one standard deviation below predicted.	Consider cessation of culling and cessation/reduction of egg oiling and increasing non-lethal methods to limit colony size. This scenario may indicate immigration to East Sand Island from other colonies is occurring.
Observed colony size is lower than one standard deviation below predicted.	Observed population is greater than one standard deviation above predicted.	Stay with proposed take levels, but stop take when East Sand Island management objective for colony size is achieved. Potentially speed up timeline for Phase II habitat modification or implement dissuasion to maintain lower colony size; will likely reach colony size sooner than predicted. This scenario may indicate dispersal is taking place.
Observed colony size is lower than one standard deviation below predicted.	Observed population is within one standard deviation above predicted.	Stay with proposed take levels, but stop when East Sand Island management objective for colony size is achieved. Implement non-lethal methods to limit colony size; will likely reach management objective for colony size sooner than predicted. This scenario would indicate that the population model used to develop predictions may be more liberal than actual conditions and/or this may indicate some dispersal is taking place.
Observed colony size is lower than one standard deviation below predicted.	Observed population is lower than one standard deviation below predicted.	Consider cessation of take. Implement non-lethal methods to limit colony size; will likely reach management objective for colony size sooner than predicted. This scenario may indicate the model is liberal.

2.2 Detailed Description of Alternatives

Overview of Alternatives

Each action alternative includes a suite of actions that make up a management plan to achieve the stated purpose and need. As defined by RPA action 46, non-lethal and lethal actions by the Corps related to DCCO management are restricted to the Columbia River Estuary, with primary focus on the breeding colony on East Sand Island.

The alternatives are presented in a nested structure (e.g., methods in Alternative B apply to C, C-1, and D; and methods in Alternative C apply to C-1 and D). When methods are identical between alternatives, this is noted with a short statement (e.g., same as Alternative B). The term "integrated" is used in Alternatives B–D, which means combining non-lethal and lethal methods during implementation. A depredation permit application would need to be submitted to the USFWS and approved prior to implementation of any of the alternatives that result in take.

The alternatives describe a "phased" approach. Phase I (up to 4 years after the onset of management, or once the reduction in DCCO predation is reached) includes actions to reduce the number of DCCOs on East Sand Island to 5,380–5,939 breeding pairs. This is a reduction of approximately 7,300 breeding pairs (56 percent reduction in colony size) from the average breeding colony size during 2004-2013 (12,917 breeding pairs). Phase II of Alternatives B, C, and C-1 (5 to 10 years after the onset of management) include actions to ensure the number of DCCOs on East Sand Island does not exceed 5,380–5,939 breeding pairs. In Phase II of Alternatives B, C, and C-1 no efforts would be made to maintain a minimum DCCO colony size on East Sand Island or to reduce the DCCO abundance below 5,380 breeding pairs. In Phase II of Alternative D, primarily non-lethal methods supported with limited egg take (same as Phase II of Alternative B, C, and C-1) would be used to remove all remaining DCCOs from East Sand Island and redistribute them outside the Columbia River Estuary. Each alternative includes associated adaptive management and monitoring strategies. In addition to monitoring on East Sand Island and the Columbia River Estuary, for alternatives considering lethal take, the Corps, in coordination with the USFWS and states, would annually monitor DCCOs at all specified locations of the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013).

2.2.1 Alternative A – No Action

Under Alternative A, no action would be taken to reduce predation-related losses by managing the DCCO colony on East Sand Island. Compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need of the FEIS would not be met requiring re-initiation of consultation with NOAA Fisheries. Efforts to improve juvenile salmonid survival to FCRPS baseline levels would need to be accomplished through other RPA actions (e.g., habitat improvement, increased fish passage at dams, management of other avian and mammalian predators). Hazing, habitat reduction experiments, and DCCO monitoring, management, and research efforts conducted by the Corps on East Sand Island and in the Columbia River Estuary would cease.

If no actions are taken to manage the DCCO colony, predation rates on juvenile salmonids would likely remain higher than rates estimated during the environmental baseline of the FCRPS Biological Opinion and would continue to be a significant source of mortality. Additional measures would need to be identified to fill the gap in survival. These measures are unspecified at this time but would need to demonstrate an increase in juvenile salmonid survival equivalent to NOAA Fisheries' "survival gap" analysis per the purpose and need. These actions could have potentially significant or localized adverse environmental and socio-economic impacts, given the required survival improvement. Since these actions are unknown at this time, it would be speculative to evaluate the environmental and social effects. Therefore, the no action alternative in this document describes effects that could continue to occur if no efforts were taken to manage the DCCO colony on East Sand Island.

2.2.2 Alternative B – Non-Lethal Management Focus with Limited Egg Take

Summary — Under Alternative B, primarily non-lethal methods (i.e., temporary habitat modification and hazing) supported with limited egg take (500 eggs) would be used to reduce the DCCO colony on East Sand Island to 5,380–5,939 breeding pairs (Phase I). Egg take includes eggs intentionally removed and/or physically destroyed by personnel. Large-scale terrain modification on the west end of East Sand Island, supplemented with the non-lethal methods described above as necessary, would be used to ensure this level is not exceeded (Phase II). Alternative B would disperse approximately 7,300 breeding pairs from East Sand Island. Non-lethal methods, particularly boat- and land-based hazing supported with limited egg take on Corps' dredge material islands (250 eggs), would be used to discourage dissuaded DCCOs from nesting and foraging throughout the 172 mile long Columbia River Estuary. Significant economic and labor resources for adequate hazing and monitoring efforts would be required to ensure DCCOs redistribute outside of the Columbia River Estuary. In Phase II, hazing efforts throughout the Columbia River Estuary would occur, as needed, but efforts are expected to be less than Phase I, assuming DCCOs emigrate from the estuary. Management would be considered successful once the DCCO management objective for colony size is achieved and maintained, and the Corps would continue to implement primarily non-lethal methods supported with limited egg take, as necessary, to maintain the management objectives. To ensure hazing can continue once active nests are laid, up to 750 eggs per year (i.e., 500 on East Sand Island and 250 elsewhere in the Columbia River Estuary) would be requested in a depredation permit.

Feasibility — Based on past DCCO habitat modification and dissuasion research on East Sand Island (Roby et al. 2012, 2013, 2014), it is likely the reduction in DCCO colony size could be achieved using the techniques described in Alternative B. It is also very likely DCCOs would continue to stay and prospect for nesting sites within the Columbia River Estuary (Roby et al. 2012, 2013, 2014; Appendix G). No prior studies or research was found that described using non-lethal techniques to permanently redistribute such a large number of DCCOs from as large of an open water system as the Columbia River Estuary (approx. 83,000 ha). Based on past DCCO research, hazing efforts in the Columbia River Estuary could likely be effective at precluding other large DCCO breeding colonies from forming and have measurable success at reducing nesting, roosting, or foraging at specific areas of the Columbia River Estuary. This could be limited due to legal/landowner issues or environmental concerns and would likely require a long-term commitment of resources, with an estimated need of five to eight boat crews surveying and hazing DCCOs throughout the Columbia River Estuary. Even with this presence and level of hazing, based upon past research (see below), it would likely not be effective in completely precluding DCCO foraging throughout the entire Columbia River Estuary.

Smaller-scale efforts than what are proposed under Alternative B have been successful in precluding DCCOs and other waterbirds from establishing nesting colonies on many of the Corps' dredge material islands over the past decades (see Roby et al. annual reports). However, precluding nesting colonies from forming throughout the entire Columbia River Estuary would depend on land access issues and the ability to locate and respond to DCCO nesting quickly.

Prior research has shown that coordinated and continued hazing can reduce or preclude DCCO foraging in particular areas within a large geographic context (see Mott et al. 1998, Wires et al. 2001, Dorr et al. 2010, Russell et al. 2012). Dorr et al. (2010) found that coordinated hazing methods supplemented with less than 6 percent lethal take reduced DCCO foraging attempts by 90 percent at Brevoort Lake and Durmmond Island, Michigan. These areas encompassed approximately 2,050 ha. The average hazing intensity to achieve a 90 percent reduction in foraging, measured as the average hours of active harassment effort per hectare per day of hazing, was 0.03 h/ha/d (Dorr et al. 2010). In comparison, the entire Columbia River Estuary encompasses approximately 83,000 ha, although DCCOs would likely nest, roost, and forage within a smaller geographic area rather than uniformly use the entire Columbia River Estuary. To achieve half the level of hazing intensity as Dorr et al. (2010) in an area one-fourth the size of the Columbia River Estuary (20,750 ha) would require approximately 300 active hours of hazing per day of hazing, or approximately 30 people working 10 hour days (i.e., approximately 7-10 crews if 3-4 people per crew). If hazing were focused on more limited areas within the Columbia River Estuary, less personnel and hazing intensity would be needed.

Other large-scale dissuasion efforts have shown limited success in completely excluding DCCO foraging throughout large geographic areas (see King 1996, Mott et al. 1998, Tobin et al. 2002). Large-scale, coordinated night roosting harassment efforts have been conducted to disperse wintering DCCOs from the eastern portion of the Mississippi Delta, an area greater than 40,000 ha, to reduce impacts to catfish aquaculture (King 1996; Mott et al. 1998; Tobin et al. 2002). For example, Mott et al. (1998) harassed all known active roost sites in the eastern delta of Mississippi an average of 22 and 35 times during two consecutive years. During these harassment programs, DCCO abundance was reduced at some site-specific locations and DCCOs were found to change night roost more frequently; however, DCCOs typically moved to alternative non-harassed sites and continued to forage on catfish farms in the eastern delta (King 1996; Mott et al. 1998; Tobin et al. 2002).

Phase I - Management Actions to Reduce Colony Size on East Sand Island and Deter Nesting and Foraging in Columbia River Estuary

Mobilization and Field Preparation

Field crew personnel would arrive on East Sand Island prior to the breeding season (Feb-Mar) to transport supplies and equipment and make any necessary preparations for management that year. Temporary housing (i.e., tents or weatherports) would be constructed and maintained, as personnel may be present 24 hours a day during the period of active hazing. Individuals would follow designated travel routes to minimize potential impacts on other wildlife. These paths are located along the northern beaches and through vegetation to colony sites. Travel by all-terrain vehicles (ATVs) would occur along compacted sand along the shore or on previously established ATV paths. Boat landing and loading points would be chosen to reduce potential disturbance. Protective fences would be used to conceal hazing activities from designated nesting areas. Established trails would be used to minimize human impacts on vegetation.

Reducing Habitat and Hazing on East Sand Island

Similar to dissuasion research methods, habitat modification combined with human hazing would be used to restrict DCCOs to a designated nesting area (see Figures 1-5 and 4-6). Privacy fences would be constructed to designate this area prior to nesting birds arriving on the island (Feb-Mar). Based on prior estimated maximum DCCO nesting density on East Sand Island (1.28 nests per square meter; BRNW unpublished data), the amount of available nesting habitat may ultimately need to be reduced to 1.04–1.15 acres or less in order to achieve the management objective for colony size. There is little evidence from past dissuasion research on East Sand Island or other DCCO colonies that density would greatly exceed prior estimates, as DCCOs maintain the relative spacing necessary to avoid bill strikes and stealing of nesting materials from neighboring nesting DCCOs. Therefore, available nesting habitat would be reduced per Table 2-2 unless densities increase and further reduction is needed.

TABLE 2-2. Proposed Reduction in DCCO Nesting Area.

Year	Available Nesting Habitat*	Estimated # of Pairs (based on nesting density of 1.28 nests per square meter)
Year 1	2 acres	10,360 pairs
Year 2	1.5 acres	7,770 pairs
Year 3	1.1 acres	5,698 pairs
Year 4	Reduce further or maintain	5,380–5,939 breeding pairs

*If nesting density exceeds prior estimates, greater habitat reductions would be needed to achieve the management objective for colony size.

Reducing acreage over a period of 3 years would allow for incremental dispersal among years (approximately 2,000-3,000 breeding pairs per year), rather than all dispersal in one year. Incremental dispersal would be preferred because there is more risk that management efforts would be insufficient to effectively limit 14,500 DCCOs from the Columbia River Estuary, compared to 2,000-3,000 breeding pairs per year. Additionally, incremental dispersal would better allow for evaluation of DCCO response to management and to prepare for effective and proactive, not reactive, management in future years. Hazing and habitat modification would occur on the western portion of East Sand Island, where DCCOs have previously nested or attempted to nest (an area of approximately 16 acres; Figure 2-1), but could be used in other areas on the island if DCCOs move into those areas. To the extent possible, ground-disturbing work would be focused outside of the breeding season and during time periods and in locations where impacts to target and non-target species would be less. Any temporary habitat modification techniques would be removed, when appropriate, to reduce potential impacts to non-target species and to ensure materials are not damaged or lost over winter.

FIGURE 2-1. DCCO nesting area on East Sand Island. DCCO use and nesting areas are based on distribution of nesting and roosting in 2010, prior to dissuasion experiments. The yellow boundary on land is the area where the majority of management actions would occur.

Personnel would observe DCCOs from blinds or similar structures, and the following observations or behaviors outside of the designated nesting area would trigger a hazing event: 1) DCCO breeding behavior (i.e., courtship, nest building, or copulation); 2) more than 50 DCCOs loafing in an area; and 3) DCCOs present at twilight (i.e., preparing to roost overnight). Hazing triggers would be adapted if they are ineffective at producing desired results. Other visual and noise deterrents (i.e., those described in Chapter 2, Section 2.1.2) could be used during hazing events as needed depending on effectiveness of human hazers and knowledge gained during implementation. Given the magnitude of the colony size and presence of other nesting birds, some level of egg take would likely be necessary to ensure hazing can continue after the beginning of the breeding season and the alternative is feasible to implement. Take of 200 DCCO eggs was authorized for past dissuasion research on East Sand Island, although actual take was minimal (e.g., 1 egg in 2012; BRNW 2013a). Because proposed actions are greater than prior research efforts, take of 500 DCCO eggs would be requested in a depredation permit application the first year and adjusted accordingly thereafter.

Hazing in the dissuasion area on East Sand Island would be implemented frequently and repeatedly during the nest initiation period. During 2012 dissuasion research, hazing in the dissuasion area was conducted from April 20–June 12 (approximately 8 weeks), with an average of five (range = 1-19) hazing events per day (Roby et al. 2013). Efforts and date range were slightly greater in 2013 (i.e., April 13–June 30, approximately 11 weeks in western dissuasion area; April 26–June 13, approximately 7 weeks in eastern dissuasion area; four [range = 0-21] hazing events per day on average [see Appendix G]). Since a larger area for hazing would be included and more DCCOs dissuaded under Alternative B than prior research, a greater hazing effort would likely be needed. Management-related activities would likely extend greater than 11 weeks and into the late chick or early fledgling stage of the breeding season.

Impact Avoidance Measures

On East Sand Island, preference would be given to visual deterrents first and noise deterrents second as a means to minimize impacts to non-target species. Monitoring to determine when hazing events are needed would be done via field crew observations from ground positions. DCCOs and other birds would be monitored from concealed areas or distances sufficient not to induce flushing. If monitoring or management within the colony is necessary, it would be kept to as short a time duration as possible and would be minimized during severe weather conditions or when higher than normal levels of predation might be expected. To effectively implement the alternative, a limited amount of direct egg take outside the designated DCCO nesting area is proposed. Direct egg take would occur through intentionally and physically removing or destroying eggs to keep DCCOs from nesting in particular areas. Otherwise (not including direct egg take), egg take would be minimized to the extent possible by: 1) implementing actions frequently enough so nest destruction and hazing occur before egg laying; 2) reducing or ceasing hazing and habitat modification techniques within a sufficient distance of an active nest (i.e., once an egg is laid); 3) removing nesting materials or destroying nests only if the nest does not have egg(s) in it; and 4) reducing or ceasing hazing if higher than normal levels of subsequent predation might be expected. Nests with provisioning chicks would be avoided to the extent possible and actions would occur outside the breeding season to the extent possible to reduce effects to nesting birds and chicks. The Adaptive Management Team would convene to evaluate the feasibility of continuing certain actions during the nesting season once chicks are observed. Table 2-3 provides a summary of non-lethal methods and adaptive responses for Alternative B. Methods and intensity of implementation would be increased to achieve desired objectives if necessary and reduced or curtailed if greater levels of dispersal and colony reduction occur than anticipated, particularly if observed abundance is 70 percent or less than the expected abundance one week after implementation of non-lethal management. Management actions could be changed or scaled back until abundance returns to at least 90 percent of the expected abundance. This dispersal threshold was chosen based upon interagency coordination and input and was determined to be a level that would take into account variation in colony size and not create a management situation over- or under-reactive to natural changes in DCCO abundance. This threshold would be assessed based upon all relevant monitoring data available at the time of the assessment, including data from ground, aerial, and other surveys on East Sand Island and within and outside the Columbia River Estuary (see Table 2-5).

TABLE 2-3. Non-Lethal Methods and Adaptive Response.

Action	When Used	Adaptive Response*
Designate Nesting Area	Prepared prior to nesting season (Feb-Mar). Habitat reduction is based on known nesting densities (1.28 nests per square meter) and reduced to allow for incremental dispersal of 2,000-3,000 breeding pairs.	Based on peak colony size estimates and density; change available nesting area as needed to allow for incremental dispersal or if densities increase greater than 1.28 nests per square meter. If management objective for colony size is not achieved with 1.1 acres, apply further habitat reduction to 0.25-0.5 acres in the following years.
Human Hazing	Outside designated nesting area if breeding behavior observed, >50 DCCO observed loafing, or DCCOs observed at twilight about to roost.	Reduce threshold to 25 (or fewer) DCCOs loafing if greater hazing intensity needed. If DCCO habituate to human hazing, apply visual deterrents to increase effectiveness in hazing. Dogs could be used selectively if human hazing is not effective.
Visual Deterrent**	If DCCO habituate to human hazing.	If DCCO habituate to visual deterrents, apply noise deterrents.
Noise Deterrent**	If DCCO habituate to human hazing and visual deterrents.	If DCCO habituate to noise deterrents, combine additional methods.
Temporary Habitat Modification	Concurrent with hazing. Apply temporary habitat modification prior to or during nesting season.	Increase amount and area.
Egg Collection	Concurrent with hazing. The Corps would submit a depredation permit application for take of up to 500 DCCO eggs.	Take numbers adjusted in subsequent years based on take during the prior year.

*Methods and intensity would be reduced if greater levels of dispersal and colony reduction occur than anticipated, particularly if observed abundance is 70 percent or less than the expected abundance one week after implementation of non-lethal management.

**Visual and noise deterrents refer to those described in Chapter 2, Section 2.1.2.

Monitoring and Hazing DCCOs in the Columbia River Estuary

Boat- and land-based hazing in the Columbia River Estuary to deter DCCO nesting, roosting, and foraging would begin concurrent with monitoring (see below) and management actions on East Sand Island. Based on other large scale programs, an estimated need of five to eight boat crews surveying and hazing DCCOs throughout the Columbia River Estuary is anticipated. Primary hazing locations were selected from past DCCO usage and methods of detecting DCCOs were adapted from current efforts to monitor and haze Caspian terns in the lower Columbia River Estuary and are identified in Table 2-4. Boat-based hazing would be used to deter DCCO foraging, particularly at up-river locations where predation impacts are known to be greater (Collis et al. 2002). If necessary, noise deterrents (e.g., pyrotechnics, cracker shells, etc.) would be used to aid hazing efforts over open water. The Corps would submit a depredation permit application to the USFWS for take of up to 250 DCCO eggs on the Corps' dredged material sites so hazing can continue after the beginning of the breeding season. It may not be possible to entirely limit DCCO expansion into new areas in the estuary, given the geographic scope, difficulty in accessing some sites due to logistics (e.g., Astoria-Megler Bridge; Figure 2-2) or landowner permission, and potential overlap with ESA-listed species (i.e., streaked horned lark) or other species of conservation concern. Potential DCCO dispersal locations within Columbia River Estuary may be in areas the Corps does not own or have the right to access. Any potential actions in these areas would need to be coordinated with the appropriate landowner(s) or interested parties, prior to implementation.

TABLE 2-4. Locations and Protocols for Monitoring and Hazing DCCO in the Columbia River Estuary.

Key Estuary Monitoring/Hazing Locations*	**Monitoring and Hazing Protocols**
Astoria-Megler Bridge Tongue Point Piers Trestle Bay Rice Island Miller Sands Spit Pillar Rock Island Lewis and Clark Bridge Troutdale Transmission Tower Willamette Falls/Oregon City	1) Begin surveys in April, in areas where suitable nesting habitat is present, to detect incipient nesting attempts before eggs are laid. Continue surveys through mid-June or until nest initiation has stopped. 2) Once DCCOs are detected on suitable nesting habitat, use binoculars and/or spotting scope to count the number of individuals and determine whether the birds are roosting or initiating nesting. 3) Coordinate with the landowner/state and federal resource agencies for access and regarding management activities where species of concern occur, such as occupied streaked horned lark critical habitat. 4) Use non-lethal methods to deter nesting, primarily by human hazing. 5) Collect eggs only under approved USFWS permit. Record and report any eggs collected.

*Additional locations for hazing would be determined from the results of surveys and monitoring.

Impact Avoidance Measures

On dredged material islands, hazing could occur early in the nesting season and would be coordinated with the USFWS to occur at a distance sufficient to minimize impacts to non-target species, especially streaked horned larks. These efforts would be integrated with on-going avian predation management requirements of dredged materials sites under the Corps' Channel and Harbors program, which monitors dredged material sites for DCCO and Caspian terns and implements hazing as needed to prevent these species from nesting (see Chapter 4, Sections 4.2.4 and 4.4 for more information on this program). The Corps would coordinate with the USFWS prior to implementing any actions during the nesting season for other avian species. To minimize impacts to streaked horned larks, the Corps would not use all-terrain vehicles, dogs, or other visual or noise deterrents on islands designated as critical habitat for, or occupied by streaked horned larks, relying on human hazing and disturbance to deter DCCOs from nesting.

FIGURE 2-2. DCCOs using Astoria-Megler Bridge in 2012.

Monitoring and Adaptive Management

Monthly aerial surveys and high resolution aerial photographs would be taken over East Sand Island and other locations in the Columbia River Estuary during the breeding season to estimate peak colony size. Effectiveness in achieving colony size goals would be based upon the peak breeding season abundance count (i.e., typically late incubation). The amount of egg take and any other specifications of a depredation permit would be monitored and reported. PIT tag recoveries on the East Sand Island DCCO colony would occur after the breeding season. Areas where Brandt's cormorants are nesting would be delineated to ensure PIT tag recoveries are specific to DCCO consumption. The average annual percentage of available PIT tags recovered in the DCCO nesting area would be evaluated in context of relevant factors to assess DCCO predation rates. DCCO counts and behavior and response of non-target species would be monitored and recorded.

Aerial, boat, and land-based surveys would be conducted in the Columbia River Estuary to determine if DCCOs dispersed from East Sand Island are relocating within the estuary. DCCO abundance surveys would occur from the onset of management actions on East Sand Island until July 31 each year. Boat- and land-based surveys would initially be conducted at least every other day on the primary monitoring locations identified in Table 2-4. Approximately five to eight monitoring crews would be deployed throughout the Columbia River Estuary. Each crew would be responsible for monitoring approximately 30–40 RM of the Columbia River Estuary (172 RM in total). The number of DCCOs roosting, resting, or attempting to nest at specific locations would be counted and recorded. Additionally, monitoring crews would conduct short-interval point counts (i.e., 15 minute) from set, stationary positions within their monitoring areas multiple times per day (i.e., morning, mid-day, and evening) to monitor abundance of foraging and flying DCCOs.

Priority areas of management concern, where there are fish predation concerns and the potential for DCCO increases, were identified through input from cooperating agencies and utilizing past results from dissuasion experiments. In Oregon, these areas are the coastal estuaries and lakes. In Washington, these areas are Willapa Bay National Wildlife Refuge, Gray's Harbor, Puget Sound, and the San Juan Islands. The Columbia River Basin above the Bonneville Dam was also identified as a priority area. Annual aerial surveys of these areas to monitor abundance would occur at least once during the peak breeding season, ideally in June/July and after management activities for the year on East Sand Island are completed. Additional surveys could occur throughout the breeding season (i.e., April 1–July 31 or later). Surveys in the Columbia River Basin above Bonneville Dam would occur under/or in coordination with the Corps' Walla Walla District.

If monitoring efforts show DCCO increases in these areas, the Corps would notify and coordinate with ODFW, WDFW, or other appropriate land managers. The agency or entity that would lead any potential management actions and the extent of management techniques could vary, depending upon the location and DCCO impacts. The mere presence of DCCOs may not indicate there is a depredation problem that needs to be addressed. If conflicts result, the best management strategy for addressing any potential DCCO conflicts at these locations would be determined in the future and should follow existing and appropriate processes for resolving DCCO conflicts within the Pacific Flyway (Pacific Flyway Council 2012; Chapter 2, Section 2.5). Data collected from the proposed monitoring efforts would augment the Pacific Flyway Council Monitoring Strategy for the western population of DCCOs (Pacific Flyway Council 2013; Section 2.1.3). The Corps would follow the prescribed monitoring protocols, coordinate efforts, and share monitoring data to the greatest extent possible with these monitoring efforts.

Dispersal levels would be estimated from colony counts on East Sand Island and abundance surveys previously described. The initial survey frequency and areas could be adjusted based upon DCCO response and knowledge gained during implementation under a multiple-level adaptive approach, with increasing monitoring frequency based on particular thresholds (Table 2-5). Individual marking techniques (i.e., primarily satellite tags, but also VHF radios and bands) could be used to supplement abundance surveys to determine dispersal and redistribution of DCCOs from East Sand Island if abundance surveys are determined to be inadequate. Capture and marking of DCCOs, if determined necessary, would occur early in the breeding season prior to any subsequent hazing activities. Survey frequency and the amount of individual marking could change based upon information needs and knowledge gained during implementation.

Primary non-lethal techniques could be changed or adjusted based on knowledge gained during implementation and the most effective and least impactful measures would be selected. Adjustments in techniques would be coordinated through the Adaptive Management Team and specified in depredation permit applications. The amount of egg take requested in an annual depredation application could be adjusted based on the prior year's results.

TABLE 2-5. Monitoring and Adaptive Response Phase I.

Management Need	Proposed Monitoring and Frequency	Adaptive Response
Detect Reduction of Colony Size on East Sand Island	Monthly surveys and high resolution photographs, visual observations from field crews.	Increase frequency of aerial surveys to weekly if observed abundance is 70 percent or less than the expected abundance one week after implementation of non-lethal management.
Monitor and Haze DCCOs in Columbia River Estuary at Priority Areas	Boat- and land-based surveys and hazing every other day per week during peak nesting, surveys every three days outside of peak nesting in foraging area of East Sand Island. Bi-weekly surveys in upriver locations. Monthly aerial surveys.	Increase frequency of boat- and land-based surveys and hazing to daily if surveys in the estuary detect >4,000 DCCOs and DCCOs demonstrating breeding behavior at locations other than East Sand Island. At particular locations, decrease frequency of surveys and hazing to weekly or daily if no DCCOs present at location in three consecutive surveys. Aerial surveys same threshold as East Sand Island.
Detect DCCOs Outside of Columbia River Estuary - Monitor Western Population of DCCOs	Aerial surveys Level I - Annual Level II - Bi-annual Level III - Tri-Annual	Increase frequency of survey to next level if observed abundance is 70 percent or less than the expected abundance one week after implementation of non-lethal management and this number of DCCOs is not detected in the Columbia River Estuary. Surveys coordinated with USFWS seabird surveys and Pacific Flyway Council Monitoring Strategy. Individual marking if observed abundance is 70 percent or less than the expected abundance one week after implementation of non-lethal management, this number of DCCOs is not detected in Columbia River Estuary, and tri-annual surveys are ineffective in determining abundance changes.
Minimize Impacts to Non-Target Species	Daily observations of field crews, DCCO daily responses, nesting attempts and productivity, presence of bald eagles, and response of non-targets.	If monitoring indicates effects to non-target species greater than anticipated management actions would be scaled back or techniques changed to more passive measures in-season and in future years. Management strategies could change to more habitat modification prior to nesting season (April-May) in the following year. Boat-based or aerial monitoring would occur at a distance that does not induce flushing. Coordinate surveys and hazing with USFWS.
Assess Predation Rates	PIT tag recoveries post-breeding season	No adaptive response in Phase I. Use is for evaluation of overall multi-year effectiveness of management and to supplement information needed for a depredation permit application.

Phase II - Management to Ensure Colony Size Goals are Retained

The goal of Phase II is to transition to lower maintenance non-lethal techniques and reduce the amount of human presence needed on the island while still ensuring the colony size does not exceed 5,939 breeding pairs. This would be accomplished through proposed terrain modification or similar techniques to preclude nesting and supplemented with temporary habitat modification and hazing on East Sand Island as necessary. Hazing techniques would be the same as described in Phase I, and the extent of hazing would depend upon DCCO response to management and the capacity of the colony to increase in size after Phase I objectives are reached. Based on knowledge gained during Phase I, a limited amount of egg take on East Sand Island (up to 500 eggs) would most likely be requested in a depredation permit application to ensure hazing or habitat modification could continue during the nesting season.

Modification of the existing terrain (Figure 2-3) would occur through the excavation of sand (approximately 300,000 cubic yards on the western portion of the island) in order to inundate the DCCO nesting area. Sand would be excavated to an elevation that would be inundated at least once per week during April 1-July 15, and to a water depth of 6 inches to 1 foot to preclude nesting attempts. The shoreline would be armored with added rock (approximately 30,000 cubic yards of rip-rap) or other bio-engineering solutions on the northern shore to reinforce the island and maintain stability of the Columbia River Federal Navigation Channel. The Corps would perform soil testing to determine potential contamination and nutrient load and final disposal locations will be identified upon results. Soft or bio-engineering techniques and other impact avoidance measures would be implemented where feasible. A re-vegetation and invasive species plan would be developed prior to implementation of the action.

Disposal locations of excavated sand could be located on the designated Caspian tern colony to improve nesting habitat and/or in other upland areas on the eastern portion of the island and in upland areas where feasible. Disposal of sand could also be used for beach nourishment on the southern and eastern portions of the island and/or placed between the pile dikes on the southern shoreline. Disposal locations would be selected to avoid and minimize impacts to delineated wetlands on the central portion of the island. Two delineated tidal estuarine wetlands (approximately 0.6 acre) on the eastern portion of the island could be filled during disposal. Construction activities for terrain modification and associated work would take place within the in-water work window (November 15-February 15) to the extent possible but work below ordinary high could take place earlier in the fall, potentially September or October, and would be determined in consultation with NOAA Fisheries and USFWS.

Excavation of sand would occur to create two “lagoon” type areas located on the western portion of the island (darker shaded green, Figure 2-4), designed with an elevation range of 1.7–2.2 m (NAVD88) and generally sloping downward from south to north. These lagoon areas would be open to tidal fluctuations via five channels on the north side of the island. Terrain modification was designed to encourage the establishment of mud flats, marshes, and other low-elevation herbaceous vegetation, and to be resilient to sea level rise over a 50-year planning horizon (see Chapter 4, Section 4.5.3 for sea level rise analysis).

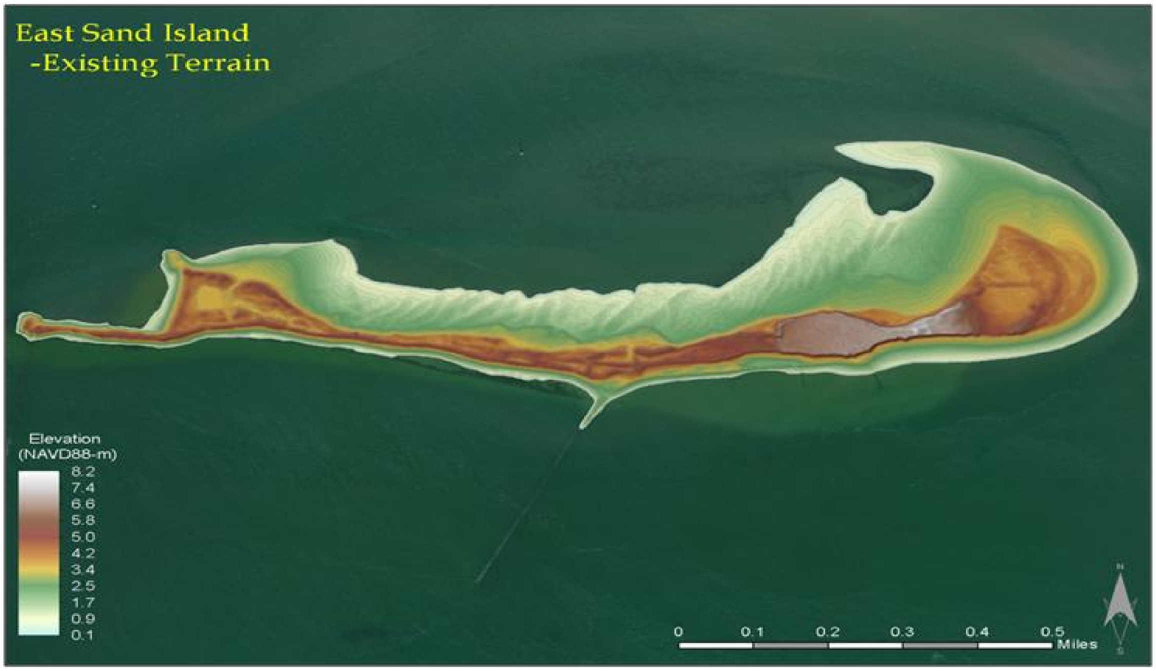

FIGURE 2-3. Existing terrain of East Sand Island based on 2009 LiDAR data.

FIGURE 2-4. Proposed terrain modification, creating "lagoon" type areas in the DCCO nesting area on the western portion of East Sand Island.

Monitoring and Adaptive Management

Annual monitoring to estimate DCCO abundance, nesting density, and PIT tag recoveries on East Sand Island would continue as necessary. Peak breeding season abundance would be determined from counts during late incubation. A three-year average estimate of peak breeding season colony size would be used for evaluating actual colony size to management objectives. If personnel are on the island conducting hazing activities, DCCO counts and behavior and response of non-target species would be monitored and recorded. PIT tag recoveries would be used to evaluate overall effectiveness of management actions in reducing predation of juvenile salmonids. Due to annual variability in predation impacts, monitoring would likely need to occur over a longer period of time (5-10 years) to assess overall trends and effects accounting for yearly fluctuations.

Abundance surveys would continue, as needed, to determine DCCO abundance at other locations within the Columbia River Estuary. Monitoring would likely be less than during Phase I and would concentrate on known areas of concern or interest. Monitoring efforts would match or supplement those of the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013), which calls for monitoring at selected locations every three years.

Management actions would be adjusted accordingly to ensure the colony size and associated base period DCCO predation conditions are not exceeded. A long-term hazing program would likely be needed to deter DCCOs from breeding at other locations throughout the Columbia River Estuary. Once management goals are attained, boat-based hazing to deter DCCO foraging would decrease or cease, unless DCCO foraging occurs in areas of predation concern, such as below dams or at other upriver locations. Based on knowledge gained during Phase I, a limited amount of egg take (up to 250 eggs) on the Corps' dredged material sites could be requested in a depredation permit application in order to ensure the alternative can be implemented effectively.

Continued non-lethal management on East Sand Island is expected to be necessary to slow or stop abundance increase of the colony. These actions would be conducted as necessary and would continually transition to methods that are most effective, least impactful to non-target species, and require least management effort and cost. Actions would be considered successful when the average 3-year peak colony size estimate does not exceed the objective for colony size while no management actions are conducted. The Adaptive Management Team would develop actions and appropriate monitoring based on Phase I and II results for long-term DCCO management in the Columbia River

Estuary. Continuance of long-term monitoring and management would depend upon available appropriations and future management needs. Additional environmental review may be needed at that time.

2.2.3 Alternative C – Culling with Integrated Non-Lethal Methods

Summary — Under Alternative C, the Corps would implement primarily lethal methods (i.e., culling on-island and over-water within the foraging range) during Phase I to reduce the DCCO colony on East Sand Island to between 5,380 and 5,939 breeding pairs. The Corps would implement Phase I in 4 years under an adaptive approach to achieve the management objective for colony size (by the end of 2018 if implementation began in 2015). Under Alternative C, 24 percent of the DCCO colony would be culled each year, resulting in a total take of 18,185 (6,202, 4,887, 3,881, and 3,214 DCCOs in years 1 to 4, respectively). The Corps would submit an annual depredation permit application to the USFWS for the proposed individual take levels and associated nest loss from take of those individuals.

The Corps, in coordination with the USFWS and states, would collaborate in the monitoring of the western population by implementing the Pacific Flyway Council Monitoring Strategy annually, and take levels could be adjusted depending upon information gained from annual monitoring of the western population of DCCO (see Adaptive Management Framework [Section 2.1.3]). Any adjustment to take levels would occur in coordination with the Adaptive Management Team. The same non-lethal methods supported with limited direct egg take (up to 750 eggs total; 500 on East Sand Island and 250 for Corps dredge material islands in the Columbia River Estuary) described in Phase I of Alternative B would be used to prevent expansion of the DCCOs to other areas on East Sand Island. Similar hazing and egg collection efforts would be implemented to deter nesting on Corps dredge material islands in the Columbia River Estuary. Phase II would be the same as Alternative B. Since lethal take of individuals would primarily be used to achieve the management objective for colony size, habitat reduction and hazing efforts would likely be less than those described in Alternative B.

Feasibility — Prior large-scale culling efforts at other DCCO breeding colonies have been documented (Bedard et al. 1997; Ontario Parks 2008). At Presqu'ile Provincial Park, approximately 11,000 adult DCCOs were culled in 3 years using multiple (five or fewer) shooters working within DCCO colonies during the day. The time duration to conduct culling was short and also included greater levels of concurrent nest destruction (6,030

DCCOs culled in 13 days in 2004; 1,867 DCCOs culled in 5 days in 2005; and 2,927 DCCOs culled in 5 days in 2006; Ontario Parks 2008). During 1989–1992 (i.e., 4 years), approximately 8,000 adult DCCOs were culled within a complex of breeding colonies in the St. Lawrence River Estuary. Rates of less than or equal to 75 DCCOs culled per shooter, per hour, were reported (Bedard et al. 1997).

The field techniques proposed for Alternative C would likely be as or more effective in lethally taking DCCOs than the studies cited (due to timing of activities, night shooting, use of firearm suppressors, etc.); thus, feasibility of achieving potential take levels and doing so within a relatively short time period on-island is high. Given the magnitude of take, regulatory prohibition on use of decoys, and general habituation of DCCO to being hazed over water, lethal removal of DCCO over water is expected to be relatively low and the majority of culling would likely occur on-island.

Phase I - Management Actions to Reduce Colony Size on East Sand Island and Deter Nesting and Foraging in Columbia River Estuary

This alternative proposes to cull individual DCCOs on and in the vicinity of East Sand Island for 4 years following the proposed annual take levels in Table 2-6 (see Adaptive Management section below for how take levels could be adjusted in future years).

TABLE 2-6. Proposed Take Levels under Alternative C.

Year	# individuals taken[1]	Associated active nests lost[2]
1	6,202	6,202
2	4,887	4,887
3	3,881	3,881
4	3,214	3,214
Total	18,185	18,185

[1] Increased take could also be considered above the proposed take levels (per Table 2-8 and Section 2.1.3).

[2] "Active nests lost" values represent the upper bound of potential egg loss that could occur indirectly from taking individuals. The period of nest initiation typically begins March 27. For associated active nests lost, actual numbers would be recorded and reported when determination in the field can be made. If determination cannot be made in the field, associated nests will be accounted for after nest initiation is observed each year or March 27, if unknown.

Culling on East Sand Island

Culling on-island would initially be attempted as early in the year as possible and before active nests are present to determine the feasibility of lethally removing individuals without causing excessive DCCO dispersal and to minimize actions during the chick rearing phase. DCCOs are present on the island beginning late March and active nests are present late April. The majority (approximately 70 percent) of DCCOs arrive on East Sand Island in mid- to late April (Roby et al. annual reports). Culling on-island could occur during the day or night using night-vision optics. Take of individuals would occur by use of firearms with non-toxic ammunition. Preferred shooting distance would be between 25-75 yards but could extend to 100 yards or more, depending on DCCO location and their response to shooting. The number of shooting events on-island per year is estimated to be 6-8, but could be higher or lower depending upon the response of DCCO and efficacy of boat-based shooting.

Management would be carried out in weekly intervals. Field personnel would initially conduct surveys for DCCO abundance and activity at various points on the Oregon and Washington side of the Columbia River. Personnel may be deployed to observe birds on East Sand Island from blinds or in a boat observing DCCOs foraging in the Columbia River Estuary, concentrating on areas downstream of the Astoria-Megler Bridge. On-island shooting would occur as personnel observe the colony from various blinds and identify optimal shooting locations based on suitable numbers of DCCOs and minimal presence of non-targets. A culling event would include multiple individuals shooting from observation points (ground or elevated) and existing structures on East Sand Island using rifles. Two shooters would likely operate from the same blind with an additional person assisting with observation and logistics. Personnel would monitor remaining DCCOs (likely from a different position opposite the direction of shooting) to determine responses and potential for dispersal or abandonment and would communicate via radio. During nighttime shooting, a thermal vision unit would be used to aid in observing DCCO response and to identify potential human activity in the vicinity of East Sand Island.

To facilitate management while minimizing impacts to non-target DCCOs and other nesting birds, additional silt fence installation and maintenance and modification of existing blinds would be conducted prior to birds nesting on the island (Figure 2-5), with similar field crew presence as described in Alternative B. Silt fence would be installed to break up dense groups of DCCOs into smaller areas where culling would occur, while minimizing disturbance to nesting birds in other nearby areas. Silt fence could connect the tunnels on the east side of the colony to the tunnels near the west tower to minimize human disturbance. Personnel would attempt to walk behind and stay below the top of the silt fence when moving across the island. The east privacy fence would be reinstalled to create a visual barrier when accessing the east tower.

FIGURE 2-5. Example of additional silt fence and existing structures that would be used to delineate lethal removal areas, and reduce disturbance to non-target birds on the DCCO breeding colony on East Sand Island.

Carcasses would be retrieved and removed immediately or as soon as feasible after the conclusion of lethal take with the intention to minimize disturbance to non-target nesting DCCOs and other non-target nesting species. Lights would be used to aid in carcass recovery at night. If this is not feasible, carcasses would be recovered the following day when DCCOs have left the island to forage. Carcass recovery would involve gathering DCCOs by hand and moving them to the north side of the tunnels. Wounded birds would be dispatched immediately using humane euthanasia techniques (see Chapter 2, Section 2.1.2) to minimize suffering of those individuals. Utility carts, small inflatable boats, and all-terrain vehicles (using established trails along the northern shoreline) would be used to transport carcasses off island to nearby disposal locations. When possible, lethally removed birds or eggs would be donated to a public educational or scientific institution, Non-Eagle Feather Repositories, or other entities authorized to possess birds. Carcasses not donated for these purposes would be disposed of following standard conditions of 50 C.F.R. 21.41, which include burial and incineration, and any special conditions specified in a depredation permit.

Culling Over Water within Foraging Range of the DCCO Colony on East Sand Island

Boat-based culling could begin in early April and end when post-breeding dispersal is underway. Boat-based culling would be conducted a sufficient distance from East Sand Island so birds on the colony are not disturbed. Personnel would avoid shooting at large flocks to minimize sensitization to shooting. If DCCOs become wary to boat-based shooting from associated disturbance and noise, locations of culling could change within the foraging area (25km) to increase effectiveness.

Personnel would use shotguns and directly approach DCCOs with boats and shoot once in effective range or situate boats and individuals in the flight path of DCCOs. Pursuant to depredation regulations (50 C.F.R. § 21.41), shotguns would not be larger than 10-gauge and decoys and concealment would not be used to entice birds into gun range. Noise associated from boat-based shooting would also be used to deter DCCO foraging.

Culled birds would be retrieved soon after being shot and wounded birds would be dispatched immediately using humane euthanasia techniques (see Chapter 2, Section 2.1.2) and recovered. As with on-island shooting, carcasses would be collected and taken in the boat to a nearby disposal facility and off-loaded. For boat-based culling, where culled individuals would fall in open water, take activities would cease frequently enough in order to retrieve culled individuals while they are in the proximal area, or other boats and personnel would monitor or be positioned away from the site of culling to retrieve carcasses (i.e., downriver, along shorelines).

Minimizing the Potential for DCCO Dispersal or Colony Abandonment

Short-term and short-distance dispersal from management activities (Roby et al. 2012, 2013, 2014) and daily movements for foraging (foraging range typically < 25 km; Anderson et al. 2004a) are expected. An increase in DCCO dispersal from East Sand Island is suggested by 1) a large disparity between the expected colony abundance and the observed colony abundance, 2) increased DCCO abundance in the Columbia River Estuary upstream of the typical known foraging range of DCCOs from East Sand Island (i.e., 25 km; Anderson et al. 2004a), or 3) an increase of DCCO abundance in other monitored areas outside the Columbia River Estuary.

Both day and night shooting would be attempted and if one timeframe results in less dispersal, that would be the primary time on-island shooting would occur throughout the project. Silencers and sub-sonic (i.e., slower than the speed of sound) shot would be used to minimize noise disturbance. To further minimize the potential for dispersal and colony abandonment, the island would be left undisturbed after a culling event until another culling session occurs (likely the following week).

Shooting would cease if excessive dispersal of DCCOs occurs. Excessive dispersal would be determined by a dispersal threshold, which is identified as an observed abundance that is 70 percent or less than the expected post-take abundance one week after the culling event.[3] For example, if observed abundance was 5,000 breeding individuals at the time of the culling event, and 500 breeding individuals were culled, expected abundance would be 4,500 breeding individuals. An abundance of 3,150 (0.7 x 4,500) breeding individuals would be the dispersal threshold. If observed abundance one week after the culling event is less than the dispersal threshold, culling on-island would temporarily cease until observed abundance returns to at least 90 percent of the expected post-take abundance. In the example provided, this would be 4,050 breeding individuals (0.9 x 4,500). Once observed abundance returns to at least 90 percent of the expected abundance, culling could resume.

Management actions (i.e., type, frequency, location, and duration) would be adjusted depending on effectiveness of technique and resulting dispersal levels in comparison to the dispersal threshold. Initially, culling would be attempted as early in the year as possible; but if the lower dispersal threshold is exceeded, culling would not occur until DCCO are observed building and attending active nests (late April). The same dispersal thresholds would be used for modifying the frequency of culling events on-island once active nests are present.

Preventing DCCOs from Nesting in New Areas on East Sand Island

Hazing would be conducted on the eastern portion of East Sand Island to prevent DCCOs from nesting in new areas. Personnel would observe DCCOs from blinds or similar

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[3] Dispersal threshold was chosen based upon cooperating agency input and was determined to be a level that would take into account variation in colony size and not create a management situation that is over- or under-reactive to natural changes in DCCO abundance. This threshold would be assessed based upon all relevant monitoring data available at the time of the assessment, including data from ground, aerial, and other surveys on East Sand Island and within and outside the Columbia River Estuary.

structures, and the following observations or behaviors on the eastern portion of the island would trigger a hazing event: 1) DCCO breeding behavior (i.e., courtship, nest building, or copulation); 2) more than 50 DCCOs loafing in an area; and 3) DCCOs present at twilight (i.e., preparing to roost overnight). Hazing triggers would be adapted if they are ineffective at producing desired results. Other visual and noise deterrents could be used during hazing events as needed depending on effectiveness of human hazers and knowledge gained during implementation. Human hazers would begin to restrict DCCOs from nesting in areas outside the designated colony area. Any temporary habitat modification techniques would be removed, when appropriate, to reduce potential impacts to non-target species and to ensure materials are not damaged or lost over winter. Nest removal (up to 500 nests) would occur on East Sand Island in areas outside of the DCCO use area (Figure 2-1) to limit DCCO colony expansion. Hazing on East Sand Island would occur separate from, or in conjunction with, shooting.

Impact Avoidance and Minimization Measures

Applicable impact avoidance and minimization measures described in Alternative B would be implemented for Alternative C in preventing DCCOs from nesting in new areas on East Sand Island. When implementing lethal measures, nests with provisioning chicks would be avoided to the extent practicable. The Adaptive Management Team would convene to evaluate the feasibility of continuing certain actions during the nesting season once chicks are observed. Boat-based shooting would be the preferred primary lethal strategy for take of individual DCCOs during the time of chick rearing until chicks have fledged.

In addition to minimizing DCCO dispersal, efforts would be taken to minimize take of non-target species during culling by developing and establishing a shooting protocol prior to implementation. Shooters would receive species identification training, and trained individual(s) or biologist(s) in species identification would be present when lethal take occurs to minimize take due to misidentification (i.e., Brandt’s and pelagic cormorants). Species would be identified prior to shooting. If there is a high concentration of non-target species in the area, these areas would be avoided. Techniques and methods would also be modified to minimize take of non-target species if it should occur. These actions include increasing the amount of training for personnel, increasing the number of individuals in the field adequately trained in species identification, removing personnel unable to adequately perform duties, ceasing that particular lethal technique, or avoiding mixed species areas.

Personnel would also adhere to all safety standards of firearm operation and training as described in the USDA-WS Policy Manual, Directive 2.615 (Firearm Use and Safety), and Firearms Safety Training Manual. The use of firearms would be conducted in accordance with all applicable local, state, and federal regulations. Personnel would implement precautionary measures to reduce risk to public safety, such as positive identification before shooting, ensuring a backstop should the bullet miss, using rifles that fire single projectiles per shot, and using only specially trained personnel. To the extent possible, areas and times of public usage would be avoided when implementing management actions on-island and over water. Monitoring would occur before shooting to ensure people are not present within the management area or shooting direction. East Sand Island would be closed to the public during implementation and any violations of the closure or interference to management activities would be enforced as specified in 18 U.S.C. 111.

Detecting DCCOs in the Columbia River Estuary

Surveys would be conducted in the Columbia River Estuary to determine if DCCOs dispersed from East Sand Island are relocating within the Estuary. Monitoring would focus on the key locations identified in Table 2-4 and in upriver locations greater than the expected foraging range of DCCOs. Surveys would closely coincide to when culling sessions occur on East Sand Island. Subsequent hazing efforts, if necessary, would be integrated with on-going avian predation management of dredge materials sites under the Corps' Channel and Harbors Program, which monitors dredged material placement sites for DCCOs and Caspian terns as needed to prevent their nesting. The Corps would include take of up to 250 DCCO eggs on dredged material sites in their depredation permit application to ensure hazing efforts can continue after the nesting season has begun. Hazing locations and efforts needed for Alternative C are expected to be less than Alternative B because fewer DCCOs are expected to be dispersed from East Sand Island given dispersal thresholds and proposed management techniques.

Reporting

All individuals taken (DCCOs and non-target species) and associated active nests lost would be recorded, and information would be submitted to USFWS for reporting requirements. Take of active nests is expected to occur indirectly from culling breeding adults that are actively nesting. Associated nests will be accounted for after nest initiation is observed. Active nesting typically occurs on East Sand Island beginning March 27 (see Figure 3-10 and Table 4-1). For associated active nests lost, actual numbers would be recorded and reported when determination in the field can be made. If determination cannot be made in the field, associated nests will be accounted for after nest initiation is observed each year or March 27, if unknown. Informal reporting of field conditions and events could occur more frequently. DCCO carcasses would be examined for leg bands or other markers and reported to the USGS Bird Banding Laboratory or other appropriate entity.

Monitoring and Adaptive Management

Monitoring on East Sand Island would be similar to Phase I of Alternative B, except individual marking is not proposed. The Corps, in coordination with the USFWS and states, would implement the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013) annually. Each year, the Corps would monitor all specified locations of the monitoring strategy, where and when there are not already established monitoring efforts and secure funding sources, supplement data processing of aerial photography, and assist in preparing an annual summary report of the Pacific Flyway Council and other collected monitoring data. Results from this monitoring and observations of peak colony abundance on East Sand Island after culling would be used to consider adjusting take levels in future years. The amount of increased take would be determined based on observed DCCO abundances on East Sand Island and within the western population and behavioral responses of DCCO and non-target species after implementation. The first year of management would follow the proposed take levels in Table 2-6.

The Adaptive Management strategy for adjusting take levels under lethal alternatives is described in Chapter 2, Section 2.1.3 and further described in detail in Appendix E-2. Adjustments to take levels in future years would be based upon the thresholds and descriptions in Table 2-1 and include a two-step evaluation process with regard to whether observed abundance after culling is less than, greater than, or equal to one standard deviation of predicted abundance for both the western population of DCCOs and the DCCO colony on East Sand Island (Table 2-7).

TABLE 2-7. Predicted abundance after culling and adaptive management thresholds for the East Sand Island colony and western population of DCCOs under Alternative C.

	East Sand Island Colony				Western Population			
Year	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD
1	19,640	1,559	18,081	21,199	55,262	5,545	49,717	60,807
2	15,477	1,322	14,155	16,799	46,589	4,739	41,850	51,328
3	12,290	1,321	10,969	13,611	39,113	5,250	33,863	44,363
4*	10,178	1,144	9,033	11,322	34,358	4,949	29,409	39,307

* Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood of achieving the reduction in colony size on East Sand Island and that the predicted abundance would be observed. Final evaluation of the management action would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population. For Alternative C in year 5, the predicted abundance before culling was 11,278 (+/- 1 SD = 10,034–12,522) for East Sand Island and 34,979 (+/- 1 SD = 29,899–40,058) for the western population.

Phase II - Management Actions to Ensure Colony Size Goals are Retained

The same non-lethal methods described in Phase II of Alternative B (i.e., terrain modification, human hazing with use of visual and noise deterrents, and other temporary habitat modifications, as necessary) supported with limited egg take (up to 750 eggs total; 500 on East Sand Island and 250 for Corps dredge material islands in the Columbia River Estuary) would be used to ensure the colony size does not exceed the management goal. Monitoring in the Columbia River Estuary and Adaptive Management would be similar to Phase II of Alternative B and revert to the Pacific Flyway Council Monitory Strategy every three years.

2.2.4 Alternative C-1 – Culling with Egg Oiling and Integrated Non-Lethal Methods *(Preferred Alternative/Management Plan)*

Summary — Under Alternative C-1, the Corps would implement primarily lethal methods (i.e., culling on-island and over water and egg oiling) during Phase I to reduce the DCCO colony on East Sand Island to between 5,380 and 5,939 breeding pairs. The Corps would implement Phase I in 4 years under an adaptive approach to achieve the management objective for colony size by the end of 2018 if implementation began in 2015. Under Alternative C-1, 13.5 percent of the DCCO colony would be culled each year, resulting in a total take of 10,912 DCCOs (3,489, 3,114, 2,408, and 1,902 DCCOs in years 1 to 4, respectively). In total, 72.5 percent of nests (including both associated nest loss and nests destroyed from egg oiling) would be lost in years 1–3 and 13.5 percent in year 4, resulting in 26,096 total nests lost (9,368, 8,361, 6,466, and 1,902 nests lost in years 1-4, respectively). The Corps would submit an annual depredation permit application to the USFWS for the proposed individual take levels and associated nest loss from take of those individuals and the proposed nest take through egg oiling or removal. In addition, the Corps, in coordination with the USFWS and states, would collaborate in monitoring the western population by implementing the Pacific Flyway Council Monitoring Strategy annually.

Through adaptive management, take levels could change based upon observed abundance as compared to the predicted abundance for the East Sand Island colony and the western population, DCCO colony and population response to lethal take, and knowledge gained during implementation concerning what levels of annual take can be effectively achieved. Any year-to-year adjustments to strategies or proposed take levels would occur in coordination with the Adaptive Management Team. The same non-lethal methods supported with direct egg take described in Phase I of Alternative B would be used to prevent expansion of DCCOs to other areas on East Sand Island and similar hazing and egg collection efforts would be implemented to deter nesting on Corps dredge material islands in the Columbia River Estuary. Phase II would be the same as Alternative B.

Feasibility — The feasibility under Alternative C-1 is similar to Alternative C, but the numbers of individual DCCOs to be culled is smaller and thus would be easier to achieve under C-1. Egg oiling in conjunction with culling is a technique often used in bird depredation conflicts (Bedard et al. 1997, Ontario Parks 2008, Guillaumet et al. 2014) and would likely be very effective on East Sand Island. The field techniques proposed for Alternative C-1 would likely be as or more effective in lethally taking DCCOs than has been reported in other studies (Bedard et al. 1997, Ontario Parks 2008) due to the timing of activities, use of night shooting, use of firearm suppressors, and other proposed improvements; thus, feasibility of achieving the proposed take levels is high.

Phase I - Management Actions to Reduce Colony Size on East Sand Island and Deter Nesting and Foraging in Columbia River Estuary

This alternative proposes to cull individual DCCOs on and in the vicinity of East Sand Island for 4 years and to take nests through egg oiling for 3 years using the proposed annual take levels in Table 2-8.

TABLE 2-8. Proposed Take Levels under Alternative C-1.

Year	# individuals taken[4]	Associated nests lost through culling individuals[5]	Nests lost through egg oiling	Total nests lost
1	3,489	3,489	5,879	9,368
2	3,114	3,114	5,247	8,361
3	2,408	2,408	4,058	6,466
4	1,902	1,902	0	1,902
Total	10,912	10,912	15,184	26,096

Culling and Egg Oiling on East Sand Island

Culling individuals on-island would be the same as described in Alternative C, in that culling would be attempted early in the year prior to active nesting, but DCCO response and dispersal would determine the feasibility of this approach. On-island culling and egg oiling would occur in separate managed areas to reduce disruption to birds nesting in unmanaged areas to the extent possible (Figure 2-5). Take of nests through egg oiling or removal would occur during the day or night on East Sand Island. Field personnel would initially conduct surveys for DCCO and non-target species to determine the distribution of their nests. This would continue through the breeding season to determine species' use within areas designated for egg oiling. Personnel would identify DCCO and non-target nests from blinds prior to egg oiling. Egg oiling would occur in the area DCCOs have used in the past and likely on the western half of the DCCO nesting area (Figure 2-1). The egg oiling areas would be selected where the densities of non-target species is low and in areas not already identified as areas for culling individuals. Overlap could occur near the end of the breeding season if necessary to achieve the planned number of individuals culled.

Egg oiling could occur from approximately May through July, from peak incubation through peak fledging, and would likely be carried out in 2-3 week intervals. The number of egg oiling events is estimated to be 4-6 per year, but could be higher depending upon response of DCCOs. Personnel would use backpack sprayers with food-grade corn oil. During active egg oiling activities, personnel would walk through the managed area and thoroughly coat each egg in a nest with oil and mark each nest with

[4] Increased take could also be considered above what is stated in the proposed take levels described in the alternatives (per Table 2-11 and Section 2.1.3).

[5] "Active nests lost" values represent the upper bound of potential egg loss that could occur indirectly from taking individuals. The period of nest initiation typically begins March 27. For associated active nests lost, actual numbers would be recorded and reported when determination in the field can be made. If determination cannot be made in the field, associated nests will be accounted for after nest initiation is observed each year or March 27, if unknown.

marking paint to ensure efficiency (reduce duplication) and accurate recording of number of nests oiled. Time on the colony and number of incursions would be minimized by using up to four people for each egg oiling event and by close observation of the nesting synchronicity. Fewer egg oiling events would be needed if the DCCOs nesting within an area have synchronized nesting. Movement through the colony and in the tunnel, privacy fence, and silt fence areas for retrieval of carcasses of culled birds would be as described in Alternative C.

Culling Over Water within Foraging Range of the DCCO Colony on East Sand Island

Same as described in Alternative C.

Preventing DCCOs from Nesting in New Areas on East Sand Island

The same methods as Alternatives B and C would be used to prevent DCCOs from nesting in new areas on East Sand Island. Boat-based hazing, human hazing, habitat modification, and culling of individuals would be conducted as described in Alternative C. Any nest take from hazing and nest removal activities to limit DCCO colony expansion would count toward the total proposed take levels in Table 2-8.

Minimizing the Potential for DCCO Dispersal or Colony Abandonment

Similar methods as Alternative C would be used to minimize the potential for DCCO dispersal. If observed abundance is 70 percent or less than the expected abundance one week after culling or an egg oiling event, management actions could be changed or scaled back until abundance returns to at least 90 percent of the expected abundance. Changes in management actions to reduce dispersal from egg oiling so as not to exceed the lower dispersal threshold include: changing the number of personnel conducting egg oiling to decrease time on colony site, or changing the number of disturbance points; changing locations in colony that may be less susceptible to dispersal; and/or decreasing the frequency and intensity of egg oiling.

Impact Avoidance and Minimization Measures

The same measures to minimize impacts to non-target species when hazing to prevent DCCOs from nesting in new areas on East Sand Island and when culling as described in Alternative C would be used. Culling would be attempted as early in the breeding season as possible to minimize loss of associated eggs and chicks. The same measures to minimize impacts to non-target species when culling would also be applied for egg oiling events. Nests would be identified to species prior to egg oiling, and areas with a high concentration of non-target species that could be misidentified would be noted and avoided. If non-target take occurs, techniques and methods would be modified to minimize the probability of it reoccurring. These actions include increasing the amount of training for personnel, increasing the number of individuals in the field adequately trained in species and nest identification, removing personnel unable to adequately perform duties, ceasing that particular activity, or avoiding mixed species areas.

Detecting DCCOs in the Columbia River Estuary

The same methods as Alternative C would be used to detect DCCO dispersal off East Sand Island and determine if they are nesting in the Columbia River Estuary. Alternative C-1 also incorporates limited direct egg take of up to 250 eggs from nests on other Corps dredge material islands in the Columbia River Estuary (as described in Alternatives B and C).

Reporting

Similar to Alternative C, all individuals taken (DCCO and non-target species) and associated active nests lost and number of nests taken via egg oiling would be recorded, and information would be submitted to USFWS for reporting requirements. Informal reporting of field conditions and events could occur more frequently. DCCO carcasses would be examined for leg bands or other markers and reported to the USGS Bird Banding Laboratory or other appropriate entity.

Monitoring and Adaptive Management

Monitoring and adaptive management for Phase I expand upon those described in Alternatives B and C to include changes in culling and egg oiling management. Similar to Alternative C, the Pacific Flyway Council Monitoring Strategy would be implemented annually (see Chapter 2, Section 2.1.3 for monitoring protocols) for Phase I; this would assist in the annual evaluation of the proposed action and in determining adaptive management needs (see Tables 2-1 and 2-9). Adjustments to take levels in future years would be based upon the thresholds and descriptions in Table 2-1 and Appendix E-2 and include a two-step evaluation process with regard to whether observed abundance after culling is less than, greater than, or equal to one standard deviation of predicted abundance for both the western population of DCCOs and the DCCO colony on East Sand Island (Table 2-9).

TABLE 2-9. Predicted abundance after culling and adaptive management thresholds for the East Sand Island colony and western population of DCCOs under Alternative C-1.

	East Sand Island Colony				Western Population			
Year	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD
1	22,353	1,775	20,579	24,128	57,975	5,817	52,158	63,792
2	19,950	1,644	18,306	21,594	51,081	5,154	45,927	56,235
3	15,428	1,492	13,936	16,920	43,980	5,504	38,476	49,484
4*	12,185	1,293	10,891	13,478	39,034	5,312	33,722	44,345

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood of achieving the reduction in colony size on East Sand Island and that the predicted abundance would be observed. Final evaluation of the management action would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population. For Alternative C-1 in year 5, the predicted abundance before culling was 11,259 (+/- 1 SD = 10,013–12,504) for East Sand Island and 38,365 (+/- 1 SD = 32,984–43,746) for the western population.

Phase II - Management Actions to Ensure Colony Size Goals are Retained

The same non-lethal methods described in Phase II of Alternative B (i.e., terrain modification, human hazing with use of visual and noise deterrents, and other temporary habitat modifications, as necessary) supported with limited egg take (up to 750 eggs total; 500 on East Sand Island and 250 for Corps dredge material islands in the Columbia River Estuary) would be used to ensure the colony size does not exceed management goals.

2.2.5 Alternative D – Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II

Phase I - Management Actions to Reduce Colony Size on East Sand Island and Deter Nesting and Foraging in Columbia River Estuary

Under Alternative D, the same methods described in Alternative C-1 would be used to reduce the DCCO colony on East Sand Island to 5,380–5,939 breeding pairs during Phase I.

Phase II - Management Actions to Exclude all DCCO Nesting on East Sand Island

The same non-lethal methods supported with limited egg take (up to 750 eggs; 500 on East Sand Island and 250 for Corps dredge material islands in the Columbia River Estuary) as described in Phase II of Alternatives B and C would be used to remove all DCCO nesting on East Sand Island and to disperse the remaining approximate 5,600 breeding pairs away from the Columbia River Estuary. Since a large number of DCCOs would be dispersed from East Sand Island in Phase II, monitoring efforts and hazing efforts in the Columbia River Estuary would be similar to those described in Phase I of Alternative B. Costs and efforts could be higher in the short-term because greater effort could be needed to completely exclude DCCOs from nesting on East Sand Island and redistribute them outside the Columbia River Estuary, compared to just ensuring Phase I management goals are maintained. Cost and effort would be low or negligible thereafter in the long-term if few or no DCCOs would be present on East Sand Island and in the Columbia River Estuary.

Monitoring and Adaptive Management

Monitoring and adaptive management would initially be the same as Phase I of Alternative B. Monitoring and adaptive management would transition to Phase II of Alternatives B, C, and C-1 until all DCCOs are excluded from East Sand Island and the Columbia River Estuary.

2.3 Alternatives Considered but Eliminated from Detailed Study

Placing DCCO management in context of the other efforts undertaken by the Corps and other Action Agencies to the FCRPS Biological Opinion is important to understanding how many of the alternative methods proposed during scoping and public comment are currently addressed. In May 2008, NOAA Fisheries issued a 10-year Biological Opinion, which considered how a number of factors, in addition to the operation of the FCRPS, are affecting the productivity (e.g., recruits per spawner) and risk of extinction of dozens of ESA-listed salmon and steelhead populations throughout the Columbia River Basin over the past 20 or more years, for which population-specific productivity estimates are available (NOAA 2008). This analysis specifically considered how variations in ocean conditions, seasonal runoff and water withdrawals, harvest actions, habitat modification, predators, and structural and operational hydropower modifications have affected ESA-listed salmon and steelhead populations in the past, and how implementation of required RPA actions would likely affect them through the period of the Biological Opinion and beyond. The 2008 Biological Opinion contains 73 RPA actions, including research and monitoring efforts to be implemented by the Action Agencies. These include improving fish passage at dams, managing river flow, improving tributary and estuary habitat, reforming hatchery practices, and controlling predators that prey on juvenile salmonids.

Many of the other methods suggested by the public during scoping and public comment on the DEIS are more relevantly addressed in other RPA actions, such as those specific to dam operations, habitat, harvest, and hatcheries. The alternatives described below were considered but eliminated from detailed study because they do not meet the stated purpose and need (i.e., to reduce DCCO predation of juvenile salmonids in the Columbia River Estuary to levels identified in the environmental baseline [base period] of the 2014 FCRPS Biological Opinion [NOAA 2014]).

1) Employ Social Attraction Techniques Outside of the Columbia River Estuary to Redistribute DCCOs

As stated in Section 1.1.6 (and in further detail in Appendix G, Table G-1), social attraction techniques have been tested within and outside the Columbia River Estuary for several years as a possible method to redistribute the DCCO colony on East Sand Island. Social attraction research showed success at promoting DCCOs to nest in new areas on East Sand Island. In the Columbia River Estuary, social attraction techniques were successful at promoting nesting at Miller Sands Spit and Rice Island, but not at Trestle Bay. At Miller Sands Spit, successful production of fledglings occurred in two of four years DCCO nesting was attempted. However, without continued implementation of social attraction techniques (i.e., annual management), continued DCCO nesting at both Miller Sands Spit and Rice Island did not persist.

Excluding East Sand Island, locations where DCCO social attraction has shown some success in the Columbia River Estuary (Miller Sands Spit and Rice Island) would actually increase predation of ESA-listed juvenile salmonids. Diet composition studies revealed that DCCOs nesting in the upper estuary (on Rice Island and channel markers) were far more reliant on freshwater fish species, including salmonids, than DCCOs nesting closer to the river mouth on East Sand Island, which consumed a greater proportion of marine forage fish (Collis et al. 2002).

Outside of the Columbia River Estuary, social attraction techniques were attempted at five independent sites (i.e., eleven annual trials in total during 2007–2012), and no DCCO nesting was recorded at any site during any year from these efforts. DCCO social attraction methods have also proved rather unsuccessful at relocating a DCCO colony on a new span of the Old Bay Bridge in San Francisco, including $709,000 spent on alternative nesting platforms (Matier and Ross 2014). Additionally, for social attraction to be a successful management tool, perceptions of DCCOs would need to change, as there is currently little to no social acceptability for DCCOs in Oregon and Washington (see Figure 3-14). An additional consideration concerning overall feasibility of this approach is the need for continuous annual funding for management (e.g., managing water levels, habitat), colony monitoring, predator management, and human presence.

The Corps does have experience employing large-scale hazing and social attraction as a method to resolve depredation damage from the largest colony of Caspian terns, also located on East Sand Island (see Chapter 4, Section 4.4.2; USFWS 2005; Roby et al. 2013). Beginning in 2008, the Corps has spent millions of dollars constructing islands in Fern Ridge, Summer Lake, Klamath Basin, and Malheur for alternative Caspian tern nesting habitat. These sites, due to their location in areas susceptible to drought, have shown limited or no success in maintaining viable breeding Caspian tern colonies, particularly without continued annual predator management and/or need of water control management in interior sites. Based on the annual consumption data from East Sand Island (Roby et al 2013), there has been little to no measurable resolution of the depredation damage to juvenile salmonids from Caspian terns.

Based on DCCO research results and experience implementing the Caspian tern management plan, even less success would be expected from trying these techniques on DCCOs, as DCCOs are documented as being less receptive to social attraction than Caspian Terns (Roby et al. 2007). Because social attraction was not shown to be a successful method for relocating DCCOs outside of the Columbia River Estuary, and because there are concerns over dispersal and redistribution of DCCOs, this method was considered but was eliminated from detailed study because it would not be effective at meeting the purpose and need.

2) Altering Flow Management Practices

Several alternative suggestions to change flow management practices were made during scoping and in public comments received on the DEIS. One suggestion was to alter flows by increasing the amount of spill at Columbia River dams as a means to inundate East Sand Island. That level of inundation at East Sand Island is not possible with changes in spill at dams. Additionally, potential river increases of this magnitude would likely have other adverse environmental effects within the floodplain; therefore, this alternative is not feasible and would not meet the purpose and need. However, the concept of inundating East Sand Island is reflected in the proposed terrain modification described in Section 2.2.

Another suggestion would be to hold more water in storage as a means to decrease river flows, allowing for more marine forage fish to be present in the Lower Columbia River Estuary, and, therefore, available as prey for DCCOs. This method was considered, but was eliminated from detailed study because altering river flow to this extent is not possible as described above and would not meet the stated purpose and need.

Increasing spill was often suggested as a way to meet the Corps' management goals to improve juvenile salmonid survival. However, altering flow at one or multiple dams of the FCRPS to increase salmonid passage would not directly address the RPA action 46, which is specific to reducing DCCO predation of juvenile salmonids from the colony on East Sand Island. Managing flow to increase spill over the dams is currently addressed under other RPA actions.

3) Altering Fishery Management Practices

This alternative would change or stagger the timing of releases of juvenile salmon to prevent large concentrations of juvenile salmonids migrating through the Lower Columbia River Estuary in April and May, which coincides with the arrival and nest initiation of DCCOs on East Sand Island. This suggestion was proposed during scoping and identified as a method in the Pacific Flyway Council DCCO Management Plan (Pacific Flyway Council 2012).

The Corps and cooperating agencies worked with ODFW Fish Propagation Program personnel and with USFWS Regional Fisheries Resources Program personnel to determine the feasibility of this approach. While there was interest in this alternative from the respective agencies, several issues were identified that indicated this method would not be feasible on a scale large enough to substantially reduce DCCO predation of juvenile salmonids. The primary concern was in the operational constraints of individual hatcheries in holding fish for longer periods or releasing them earlier or later in the year (S. Patterson, ODFW; M. Bagdovitz, USFWS, personal communication 2013). Releasing fish later would require pulling more flow from nearby rivers to maintain adequate water quality and temperatures. In some instances, the required flow necessary to maintain adequate fish rearing conditions would likely exceed the expected flow (e.g., at Big Creek). Releasing fish earlier may not be feasible because the juvenile fish may not be of a sufficient age, size, or physiological condition for successful out-migration. Further, spill-over FCRPS dams would likely be required for an early release of juvenile fish for hatcheries upriver of the dams. Currently, for example at Spring Creek National Fish Hatchery, juvenile fish are not released until the onset of voluntary spill for downstream fish passage at Bonneville Dam on or about April 10. Due to operational constraints of the hatcheries and the lack of feasibility in changing hatchery release times on a scale that would effect a measurable change, this alternative method was considered but eliminated from further analysis.

4) Barging Juvenile Salmonids

This alternative, proposed during scoping, suggested barging and releasing salmonids to the Lower Columbia River Estuary in lieu of managing DCCOs and summarized a three-year study titled *Alternative Barging Strategies to Improve Survival of Transported Juvenile Salmonids* (McMichael et al. 2006; also see Marsh et al. 2012), which analyzed recovery rates of PIT tags from wild and hatchery released steelhead and Chinook from two barge release sites: one at Skamania Landing near Bonneville Dam and the other near Astoria, Oregon.

Barging of juvenile salmonids around the FCRPS has been used as a management strategy to reduce dam and reservoir mortality rates in the Columbia River Basin for decades. Data from Marsh et al. (2012) indicates that extending the release site of barged fish from RM 139 in the tailrace of Bonneville Dam to RM 6 in the Lower Columbia River Estuary can reduce smolt predation by Caspian terns and DCCOs nesting on East Sand Island by approximately 60 to 80 percent in some years, compared with smolts released from barges below Bonneville Dam.

However, the barge strategy applies only to the proportion of each salmonid population that can be collected at upstream hydroelectric dams, which are predominately dams on the lower Snake River (FPC 2013). Of the fifteen ESA-listed fish populations that utilize the Columbia River Estuary and are susceptible to DCCO predation, extended barging could potentially only benefit up to seven ESUs and DPSs. Of these seven, under current mandated spill and river operational strategies, roughly 5 to 50 percent (depending on the ESU or DPS and year) are annually loaded into barges and transported to RM 139 (FPC 2013). Numerically, barged fish make up the minority (typically less than 10 percent) of all smolts that pass through the Columbia River Estuary (Dey 2012). Barging only benefits a very small fraction of juvenile salmonids and increasing capacity to achieve RPA action 46 for all ESA-listed salmonids from this approach is not feasible, nor cost-effective. Thus, this alternative was considered but eliminated from detailed study because it does not meet the purpose and need.

5) Implement a Hunting Season

This alternative, proposed during scoping, suggested a hunting season be established for DCCOs. While the MBTA (16 U.S.C. 703-712) grants the authority to establish hunting seasons for migratory game bird species, only species defined as "game birds" may be considered for hunting. The migratory bird conventions with Canada and Mexico define "game birds" as those species belonging to the following families: Anatidae (swans, geese, and ducks), Rallidae (rails, gallinules, and coots), Gruidae (cranes), Charadriidae (plovers and lapwings), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Scolopacidae (sandpipers, phalaropes, and allies), and Columbidae (pigeons and doves). DCCOs belong to the family Phalacrocoracidae and are not considered “game birds.” This alternative was considered but eliminated from further analysis because it is inconsistent with the conventions governing the MBTA.

6) Introducing Predators on East Sand Island

Several comments from scoping suggested introducing predators on East Sand Island to manage the DCCO colony. This method was also identified as a method in the Pacific Flyway Council DCCO Management Plan (Pacific Flyway Council 2012). This method was considered but eliminated from detailed study due to the potential to affect non-target species on East Sand Island, and because there are other more efficient and humane methods for take. Also, there are concerns about dispersal if mammalian predators make the area unsuitable for nesting.

7) A Non-Lethal-Only Management Program

Given the magnitude of the colony size reduction and realities of field logistics, it is not feasible to advance an alternative that relies solely on non-lethal methods. Some limited level of egg take would likely have to occur under every alternative for effective implementation, even when utilizing impact avoidance measures. This is based on prior field experience during the management feasibility studies on East Sand Island. Given this, a non-lethal-only management program was considered but dismissed from detailed study because it would not feasibly meet the purpose and need.

8) A Lethal-Only Management Program

An alternative that considered lethal-only management was not considered for detailed study because a lethal-only management program would not be feasible because the species is protected under the MBTA and take requires authorization under a depredation permit, which typically specifies use and integration of non-lethal techniques. Since 2008, the Corps has conducted research on East Sand Island, which has focused on use and assessment of non-lethal techniques. Use and effectiveness of some of these non-lethal techniques to haze DCCO have been demonstrated and documented, while others have not been effective. Effective non-lethal techniques have been incorporated into the alternatives.

Phase II proposes methods that transition to non-lethal techniques that reduce the amount of human presence needed on the island, which would not be feasible under a lethal-only management program. Additionally, hazing is inherent to some lethal take methods (e.g., shooting from boats can scare more birds away from a location than can be lethally removed) and a non-lethal hazing management component would be necessary to deter DCCOs from nesting in the Columbia River Estuary, as lethal take would likely not be permissible in as many areas as non-lethal methods. Lastly, Federal Migratory Bird Depredation permit standard conditions state: "To minimize the lethal take of migratory birds, you are required to continually apply non-lethal methods of harassment in conjunction with lethal control."

9) A Take-of-Individuals as Primary Method Alternative

An alternative was considered that included take of individuals as the primary method, with limited (up to 250) eggs collected during the nesting season. This alternative was dismissed from detailed study because it does not meet the purpose and need due to feasibility concerns over timing of activities during the breeding season, given the magnitude of the colony reduction being considered. This alternative would require essentially all take of individuals to be completed prior to DCCOs attending active nests.

This timing constraint could effectively eliminate the ability to implement the scale of reduction necessary to achieve the management objective for colony size. Given the regulatory definition of take under the MBTA, any activity that leads to take of a breeding bird attending an active nest effectively takes the eggs and nest of that breeding bird. The lethal take strategy described in Alternatives C, C-1, and D, in which take of individuals is the primary method but indirect or direct take of eggs and nests are included into the proposed take levels, was determined to be more feasible in meeting the objectives of the purpose and need.

10) Egg-Take-Only to Reduce the Colony Size

This alternative would utilize nest destruction via egg oiling as the sole lethal method to reduce the East Sand Island colony and meet the purpose and need. Conceptually, this alternative was considered as a means to reduce overall DCCO salmonid consumption because there would be reduced energetic demands (i.e., no chicks being fed), thus resulting in an improvement in juvenile salmonid survival and eventual reduction in the colony through decreased recruitment. However, this alternative was eliminated from detailed study because it would not meet the purpose and need for the following reasons. One, compared to integrated culling in Alternative C-1, an egg-take-only alternative would not likely achieve the proposed reduction in colony size in the specified time frame because DCCOs typically breed in their third year (Hatch and Weseloh 1999) and there would be a multiple year delay before decreased recruitment begins to affect the colony size (see Appendix E). Two, the general conclusion is that even intensive egg oiling over several years can have only a limited effect on colony size if there is abundant food in the area, as DCCOs are long-lived birds (i.e., lifespan can be greater than 15 years) and prime foraging areas would likely continue to result in DCCO immigrating to the area; additionally, egg oiling integrated with culling has shown to be more effective at reducing DCCO abundance than egg oiling alone (see examples below). Third, the peak consumption of juvenile salmonids by DCCO nesting on East Sand Island occurs in early May, which is before the time period when the majority of DCCO are feeding chicks on East Sand Island. However, observed data show that smolt consumption by DCCOs peaks in early May and drops by June (see Chapter 1, Section 1.1.6; Figure 1-4), whereas DCCO chicks are typically not present until June and July (see Chapter 3, Section 3.2.2; Figure 3-10); thus, the peak in salmonid consumption occurs prior to the presence of chicks and fledglings.

<u>Lake Huron –</u> A large-scale egg oiling effort was conducted in the North Channel and Georgian Bay of Lake Huron for 5 years (2000-2005; Ridgeway et al. 2012). An experimental design was used to oil eggs at randomly selected colonies from

approximately 80 colonies in total. The study found decreases in DCCO colony abundance in one part of the study area from egg oiling, but other areas saw abundance increases or no effect likely because DCCO fidelity and immigration to these particular areas were high since prey base was abundant there due to escapement of fish from pen rearing facilities (Ridgway et al. 2012). Also, the researchers did not observe colony abundance effects late in the season after the fledgling stage. Conclusions about the research stated: "Regional approaches for cormorant management cannot rest solely on egg oiling but may have to include culling to be effective" (Ridgeway et al. 2012).

Great Lakes – Guillaumet et al. (2014) attempted the first comprehensive assessment of the cumulative effects of DCCO control at various spatio-temporal scales, focusing on 199 colonies of DCCOs monitored in the Great Lakes during a 29-year period. Overall, Guillaumet et al. (2014) detected a cumulative effect of management, whereby the reduction in population growth rate was generally stronger when different control activities such as culling or egg oiling were combined.

Denmark – During the past decades an extensive egg oiling program was undertaken in Denmark in accompaniment to other means of lethal take. Total number of great cormorant nests to which intervention measures were applied with the result that the nests or their contents were lost rose from a total of 7,500 nests in 1994–2001 to a total of 39,700 nests in 2002–2008. The highest number of nests subject to regulation by the Danish Forest and Nature Agency in a single year was approximately 7,200 nests in 2008, which is equivalent to a fifth of all cormorant nests in Denmark (Bregnballe and Eskildsen 2009). Overall, intervention measures applied in new colonies were believed to have reduced the general "risk" of colonies with growth potential from becoming medium-sized or large-sized and contributed to the decline in the total Danish breeding population (Bregnballe and Eskildsen 2009). However, this method rarely led to cormorants leaving a site the subsequent year. In most cases where all eggs were oiled annually, cormorants continued to attempt breeding for 2-6 years before giving up for at least a few years (N. Jepsen, DTU-Aqua, personal communication 2014). Additionally, it was revealed to be difficult to predict the effects of oiling on future colony nest numbers due to prey conditions and a high degree of unpredictability in exchange of individuals among colonies (i.e., immigration) (Bregnballe and Eskildsen 2009). For example, in the Rønland Sandø and Ringkøbing Fjord colonies, which are two of the larger colonies in the country, 80–93 percent of all nests were exposed to egg oiling from 2003 to 2008 with no appreciable change in colony size (Russell et al. 2012).

11) A Lesser Degree of Lethal Take (Individual or Egg Take)

Alternatives proposing a lesser amount of take were not considered for detailed study because they would not meet the purpose and need within the timeframe of the 2014 FCRPS Biological Opinion (NOAA 2014).

12) A Greater Degree of Lethal Take (Individual or Egg Take)

Alternatives proposing a greater amount of take were not considered for detailed study because additional lethal take would be in excess of specified objectives identified in RPA action 46 of the 2014 FCRPS Biological Opinion. Additionally, greater levels of take could increase the risk of affecting the long-term sustainability of the western population of DCCOs.

2.4 Comparison of Actions and Costs for each Alternative

The following summary tables provide a comparison of the methods proposed for each action alternative carried forward for detailed study (Alternatives B-D). Table 2-10 outlines specific actions occurring under each alternative. Table 2-11 presents an estimate of dollar costs to implement the proposed alternatives. See Chapter 4, Section 4.7 for a comparison of the environmental consequences of each alternative and a comparison of the feasibility of each alternative in meeting the purpose and need.

TABLE 2-10. Comparison of Actions Proposed in Alternatives B-D.

		Alternative B	Alternative C	Alternative C-1 *(Preferred Alternative/ Management Plan)*	Alternative D
Location and Action		**Non-Lethal Management Focus with Limited Egg Take**	**Culling with Integrated Non-Lethal Methods**	**Culling with Egg Oiling and Integrated Non-Lethal Methods**	**Culling with Exclusion of DCCO Nesting on East Sand Island in Phase II**
East Sand Island	Hazing	Yes - Human presence, visual and noise deterrents used to dissuade DCCO from nesting outside of designated area. Extensive in Phase I. Supplementary in Phase II to maintain management objective for colony size.	Yes - Same methods, but less intensive than Alternative B in Phase I. No designated nesting area but hazing used to keep DCCO from nesting on the east side of the island and other particular areas. Identical to Alternative B in Phase II.	Yes - Same methods as Alternative C.	Yes - Same methods as Alternative C-1. Greater effort than Alternative B in Phase II in order to dissuade 100 percent of DCCOs from East Sand Island.
	Habitat Modification	Yes - Temporary techniques (fences, barriers, etc.) used during Phase I. Phase II more permanent methods (terrain modification) but supplemented with temporary techniques if needed.	Yes - Same methods, but less intensive than Alternative B in Phase I. Same as Alternative B in Phase II.	Yes - Same methods as Alternative C.	Yes - Same methods as Alternative C-1. Greater effort than Alternative B in Phase II.
	Take of Individuals	No	Yes – Culling individuals (up to 24 percent of colony per year) under a 4-year lethal take strategy. In total up to 18,195 individuals could be removed. Proposed individual take levels would include associated amount of indirect nest loss that could occur from taking individuals. In Phase II, take of individuals would not occur. Through adaptive management, take levels could change based upon observed abundance as compared to the predicted.	Yes - Similar to Alternative C, culling individuals (up to 13.5 percent of colony per year) under a 4-year lethal take strategy. In total up to 10,912 individuals could be removed.	Yes - Same as Alternative C-1.
	Take of Eggs/Nests	Yes - Limited amount of egg take to allow hazing during nesting season in Phase I and Phase II. Take of 500 eggs would be requested in a depredation permit application the first year and adjusted accordingly thereafter.	Yes - In Phase I, egg take could occur in support of non-lethal techniques (up to 500 eggs) and indirectly from loss of associated nests when individuals are taken. In Phase II, egg take could occur in support of non-lethal techniques (up to 500 eggs).	Yes - In Phase I, up to 72.5 percent of nests taken in years 1–3 and 13.5 percent in year 4, resulting in 26,096 total nests taken in all years.	Yes - Same as Alternative C-1.

Location and Action		Alternative B	Alternative C	Alternative C-1 *(Preferred Alternative/ Management Plan)*	Alternative D
		Non-Lethal Management Focus with Limited Egg Take	**Culling with Integrated Non-Lethal Methods**	**Culling with Egg Oiling and Integrated Non-Lethal Methods**	**Culling with Exclusion of DCCO Nesting on East Sand Island in Phase II**
	Monitoring	Yes - In Phase I, aerial counts and counts by field crews to determine DCCO colony abundance, take, and to assess dispersal, behavior, and response of non-target species. PIT tag recoveries after the breeding season to assess predation. Phase II, same monitoring as necessary. An average 3-year peak breeding season colony size estimate would be used to evaluate observed colony size to management objective.	Yes - Same as Alternative B in Phase I, except no individual marking in adaptive management. Same as Alternative B in Phase II.	Yes - Same methods as Alternative C.	Yes - Same as Alternative C-1 in Phase I. In Phase II, same as Phase I of Alternative B. Monitoring would cease in Phase II once DCCOs are no longer present on East Sand Island.
Columbia River Estuary	Monitoring	Yes - In Phase I, extensive aerial, boat, and land surveys to monitor DCCO abundance throughout the entire Columbia River Estuary during the breeding season; 5-8 boat crews monitoring some areas daily or weekly. In Phase II, DCCO abundance surveys conducted as needed, depending on future information needs, but extensive effort still likely required.	Yes - In Phase I, same methods as Alternative B but much less effort required. Surveys conducted to monitor DCCO abundance at priority areas from aerial surveys and in conjunction with the Corps' Channels and Harbors program. In Phase II, same as Alternative B, but less effort likely needed.	Yes - Same methods as Alternative C.	Yes - Same as Alternative C-1 for Phase I. In Phase II, same as Phase I of Alternative B.
Columbia River Estuary	Hazing	Yes - In Phase I, adaptive hazing plan and non-lethal techniques would be used to deter DCCOs from nesting in new areas. Extensive boat-based hazing would be used to prevent DCCO foraging. Take of 250 eggs on Corps' dredged material sites would be requested in a depredation permit application the first year and adjusted accordingly thereafter. In Phase II, a long-term, extensive effort would likely be needed to keep DCCOs from nesting at other areas.	Yes – Similar to Alternative B but hazing would occur only on Corps' dredged material islands under the Corps' Channels and Harbors program with collection of eggs per Alternative B; much less effort required due to reduction in abundance levels of DCCOs in the Columbia River Estuary. Hazing locations and intensity could change in the future based upon DCCO usage and access.	Yes - Same methods as Alternative C.	Yes - Same as Alternative C-1 in Phase I. In Phase II, same as Phase I of Alternative B.

		Alternative B	Alternative C	Alternative C-1 *(Preferred Alternative/ Management Plan)*	Alternative D
Location and Action		**Non-Lethal Management Focus with Limited Egg Take**	**Culling with Integrated Non-Lethal Methods**	**Culling with Egg Oiling and Integrated Non-Lethal Methods**	**Culling with Exclusion of DCCO Nesting on East Sand Island in Phase II**
Outside Columbia River Estuary	Monitoring	Yes - In Phase I, priority coastal areas in Washington, Oregon, and Columbia River Basin above the Bonneville Dam would be monitored for DCCO abundance at least once during the peak breeding season, ideally in June/July post-management. In Phase II, monitoring would match or supplement the Pacific Flyway Council Monitoring Strategy for the western population of DCCOs, which calls for surveys at a sample of historic and current colonies every three years.	Yes - In Phase I implement Pacific Flyway Council Monitoring Strategy annually to determine difference between the predicted abundance of DCCOs on East Sand Island and in the western population (Appendix E) and what is observed. Each year, the Corps would monitor all specified locations of the monitoring strategy, where and when there are not already established monitoring efforts and secure funding sources, supplement data processing of aerial photography, and assist in preparing an annual summary report of the Pacific Flyway Council and other collected monitoring data. In Phase II revert to Pacific Flyway Council Monitoring Strategy implemented every 3 years.	Yes - Same methods as Alternative C.	Yes - Same methods as Alternative C-1 in Phase I. In Phase II, same as Phase I of Alternative B.

TABLE 2-11. Annual Cost Comparison of Action Alternatives.

PHASE I	Alternative B	Alternative C	Alternative C-1 *(Preferred Alternative)*	Alternative D
Ground Efforts to Reduce Habitat and Colony Size	$200,000 to $300,000	$250,000 to $300,000	Same as Alternative C	Same as Alternative C-1
Monitoring East Sand Island and Columbia River Estuary	$200,000 to $300,000	$100,000 to $125,000	Same as Alternative C	Same as Alternative C-1
Hazing DCCOs in Columbia River Estuary	$400,000 to $500,000	$10,000 to $20,000	Same as Alternative C	Same as Alternative C-1
Monitoring outside of Columbia River Estuary	$100,000 to $125,000	$50,000 to $75,000	Same as Alternative C	Same as Alternative C-1
Monitoring Western Population	$75,000 to $85,000	Same as Alternative B	Same as Alternative B	Same as Alternative B
PIT tag Recovery	$200,000 to $300,000	Same as Alternative B	Same as Alternative B	Same as Alternative B
Total Annual Costs[6]	**$1,175,000-$1,610,000**	**$685,000-$905,000**	**Same as Alternative C**	**Same as Alternative C**
PHASE II				
Terrain Modification	$5,000,000 to $7,000,000	Same as Alternative B	Same as Alternative B	Same as Alternative B
Efforts to Retain Colony Size Goals on East Sand Island	$200,000 to $300,000	$75,000 to $100,000	Same as Alternative C	Same as Alternative B
Monitoring and Hazing in Columbia River Estuary	$100,000 to $125,000	$100,000 to $125,000	Same as Alternative C	$400,000 to $500,000
PIT tag Recovery	$200,000 to $300,000	Same as Alternative B	Same as Alternative B	Same as Alternative B
Total Annual Costs (without terrain modification)	**$500,000-$725,000**	**$375,000-$525,000**	**Same as Alternative C**	**$800,000-$1,100,000**

[6] Costs are approximate and could increase or decrease dependent upon DCCO dispersal and the subsequent need for monitoring and/or hazing. For "Monitoring Western Population," annual costs are shown and equal among all alternatives, but annual monitoring is proposed for Alternative C, C-1, and D, whereas monitoring every 3 years is proposed for Alternative B.

2.5 Relationships to Federal, State, and Local Policies and Plans

This section describes regional plans relevant to DCCOs and salmon conservation efforts and addresses consistency with waterbird conservation efforts. Several plans were identified in public comments and those are included here. The intent of this section is to identify possible conflicts between the proposed alternatives and the objectives of federal, regional, state, and local land use plans in the area concerned (40 C.F.R. § 1502.16(c)). Many salmon recovery efforts are identified in regional (i.e., Pacific Fisheries Management Council's Pacific Coast Salmon Fishery Management Plan), tribal (Columbia River Inter-Tribal Fish Commission's Wy-Kan-Ush-Mi Wa-Kish-Wit), and state agency plans. The proposed actions in the alternatives described in Section 2.2 are consistent with the objectives of improving salmon and steelhead runs in the Columbia River Basin.

Pacific Flyway Council

The Pacific Flyway Council is an administrative body that forges cooperation among federal and Pacific Flyway state wildlife agencies for the purpose of managing and conserving migratory birds. In 2010, the Pacific Flyway Council began development of a DCCO management framework and monitoring strategy in anticipation of current and future management needs. In July 2012, the Pacific Flyway Council finalized *A Framework for the Management of Double-crested Cormorants Predation on Fish Resources in the Pacific Flyway.* This document provides a framework for management of the western population of DCCOs and guidelines to follow when addressing DCCO-fish conflicts in the Pacific Flyway. The plan is available at: http://pacificflyway.gov/Abstracts.asp#dcc.

To the extent practicable, the proposed alternatives are consistent with the Pacific Flyway Council plan in the following ways: there is empirical evidence documenting DCCO predation of juvenile salmonids; non-lethal measures were conducted as part of dissuasion research and are built into the alternatives; actions comply with federal, state, and local regulations; benefits to juvenile salmonids and effects to DCCOs and other non-target species and resources have been analyzed by the respective federal resource agencies and; expected outcomes of management are identified in the alternatives section and environmental consequences section (Chapter 4).

Waterbird Conservation Planning

Within the Pacific Region, there are several conservation plans related to waterbirds found in the Columbia River Estuary. The 2002 North American Waterbird Conservation Plan (Kushlan et al. 2002) provides an overarching plan and framework for conserving waterbirds. In that plan, species of conservation concern were identified. The 2005 USFWS Seabird Conservation Plan (USFWS 2005b) was developed to identify USFWS priorities for seabird conservation. The plan specifically identifies East Sand Island as being important for DCCOs. The Western Riverside County Multiple Species Habitat Conservation Plan is a conservation plan which covers 1.2 million acres in inland southern California to ensure the maintenance of biological diversity by protecting native species of plants and animals and preserving their habitat. DCCOs are included in this conservation plan because of their conservation status in southern California.

Many of the bird species mentioned in this document are included in the Seabird Conservation Plan, which identifies species-specific conservation recommendations. Conservation recommendations for DCCOs included: researching predation on fish resources, monitoring contaminants, protecting nest sites, and conducting a range-wide survey. DCCOs are considered “not currently at risk” on both the North American Waterbird Conservation Plan and the USFWS Seabird Conservation Plan for the Pacific Region (USFWS 2005b).

As a cooperating agency, the USFWS has input in developing the DEIS and FEIS, specifically the analysis of effects to birds under their jurisdiction, and to ensure the proposed alternatives and scope of analysis are sufficient and consistent with their regional plans. The 2005 Seabird Conservation Plan can be read in detail at: http://www.fws.gov/pacific/migratorybirds/PDF/Seabird%20Conservation%20Plan%20Complete.pdf

The 2002 North American Waterbird Conservation Plan is available at: http://www.waterbirdconservation.org/pdfs/plan_files/complete.pdf

The Western Riverside County Multiple Species Habitat Conservation Plan is available at: http://www.wrc-rca.org

Salmon and Steelhead Recovery Plans and Boards

Recovery plans describe necessary reasonable actions, based upon the best scientific and commercial data available, for the conservation and survival of listed species. For listed anadromous fish, these plans are published by NOAA Fisheries. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

NOAA Fisheries has adopted ten recovery plans for salmon and steelhead. Recovery plans for Snake River Basin species and several California salmon and steelhead species are under development at the time of the FEIS. Primary factors limiting recovery of salmonid ESUs/DPSs include the loss, damage, and modification of natural habitats, including decreased floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, and stream substrate amount, stream flow, and water quality (NOAA 2014a). Avian predation is generally acknowledged as a factor affecting certain listed ESUs/DPSs, though not necessarily identified as a factor contributing to their decline. However, direct mortality from avian predation (DCCO and Caspian terns) is identified as a key limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead, one of the secondary factors limiting viability for all Lower Columbia River coho and late fall and spring Chinook salmon and steelhead populations, and a threat to Upper Columbia River spring Chinook and steelhead populations.

As part of their recovery planning, NOAA Fisheries completed the Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (referred herein as Estuary Module; NMFS 2011). This module was intended to help answer questions about the degree to which the estuary and plume can contribute to salmonid recovery efforts throughout the Columbia River Basin. The goal of the module was to identify and prioritize management actions that, if implemented, would reduce the impacts of limiting factors, meaning the physical, biological, or chemical conditions that impede salmonid survival during their migration through and rearing in the estuary and plume ecosystems (NMFS 2011). The underlying causes of limiting factors are identified and prioritized based on the significance of the limiting factor and its contribution to one or more limiting factors (NMFS 2011). The Estuary Module identifies categories of limiting factors and prioritizes them from “top,” “high,” “medium,” “low,” and “lowest” (NMFS 2011). The top limiting factors are flow-related habitat and plume changes, water temperature changes, and reduced macrodetrital inputs (NMFS 2011). Limiting factors in the “high” category are sediment and nutrient-related estuary habitat changes, bankfull elevation changes, native birds (Caspian terns and DCCOs), native pinnipeds, and non-bioaccumulative toxicity (NMFS 2011). The Estuary Module identifies a range of actions to address the factors limiting recovery, emphasizing actions to address the top factors. Consistent with the objectives of the management objectives stated in the purpose and need, the Estuary Module identifies actions to "implement projects to reduce DCCO habitats and encourage dispersal to other locations" to achieve a lower predation rate (NMFS 2011).

NOAA Fisheries recovery plans and supporting documents are available at the following link:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/recovery_plans_supporting_documents.html

The Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead is available at the following link:
http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/estuary-mod.pdf

ESA Recovery Boards are composed of agencies and non-governmental organizations and develop sub-basin watershed plans to recover local salmon and steelhead populations. Many of the recovery boards and plans support immediate adoption of effective predator control programs, including lethal removal, when necessary, of avian predators that have the most significant negative impacts on ESA-listed salmonids. The Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, developed by the Lower Columbia River Fish Recovery Board, identify seven threat categories and calls for a reduction in the negative impact from each one of these threat categories. Ecological Interactions is one of those threat categories, and avian predation is a large part of that threat category. The management plan presented in the preferred alternative of the FEIS would reduce impacts from avian predation as called for by above mentioned Plans and Boards.

Oregon Coastal Management Program - Clatsop County Comprehensive Plan

Congress enacted the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 et seq.) to protect the coastal environment from growing demands associated with development. In accordance with Section 304(a) of the Act, all federal lands, owned, leased, held in trust, or whose use is otherwise subject solely to the discretion of the federal government, are excluded from the coastal zone. However, if the federal agency conducts the action on federal lands and the action does affect coastal uses or resources off of federal lands, then a state may review the action for consistency with the state's enforceable policies.

The state of Oregon has a federally approved coastal management program which defines, through its land use planning process, enforceable policies that apply to activities proposed in a coastal zone. These policies are generally found in the statewide planning goals and the approved city or county comprehensive plan and implementing land use regulations. Federal agencies must follow the federal consistency provisions as delineated in 15 C.F.R. Part 930. East Sand Island is considered federal land for the purposes of the CZMA. However, some management actions associated with Phase II would likely occur off the island (i.e. disposal of excavated material). The Corps will evaluate the proposed actions associated with off-federal land effects and prepare a consistency determination after reviewing the Clatsop County Comprehensive Plan and Oregon Statewide Planning Goals and submit this finding to the Oregon Coastal Management Program.

2.6 Permits and Approvals Needed

The following permits or approvals would be required prior to the implementation of proposed alternatives:

MIGRATORY BIRD DEPREDATION PERMITS (Migratory Bird Treaty Act, 50 C.F.R. § 21.41). A Federal Migratory Bird Depredation Permit would be required from the USFWS for any management action that involves take as defined by 50 C.F.R. § 10.12. No permit is required to implement non-lethal methods, if there is no potential for take.

SPECIAL USES AUTHORIZATION (Oregon Administrative Rules 141-125-0100). A special uses authorization from the Oregon Department of State Lands may be required prior to implementing actions on state-owned land. The Corps has easements with the states of Oregon and Washington to dispose of dredged material on many islands in the Columbia River Estuary and permits are not required for those actions under existing easements.

OREGON DEPARTMENT OF STATE LANDS PERMIT (Oregon Revised Statute 196.795-990). A permit from the Oregon Department of State Lands may be required for the terrain modification proposed for Phase II, primarily for wetlands that could be filled when disposing of excavated sand on the island. No permit would be required if these areas are avoided.

ENDANGERED SPECIES ACT- SECTION 7 CONSULTATIONS (50 C.F.R. Part 402). Consultation with NOAA Fisheries for species under its jurisdiction for Phase I of the proposed action was completed in the 2014 FCRPS Biological Opinion. Consultation would be completed for the terrain modification in Phase II prior to implementing that action. Coordination with USFWS is ongoing and consultation will be completed prior to implementation of Phase I.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT (50 C.F.R. Part 600). Consultation with NOAA Fisheries on the effects to essential fish habitat would be conducted concurrently with Section 7 consultation for Phase II.

NATIONAL HISTORIC PRESERVATION ACT- SECTION 106 (36 C.F.R. Part 800). Consultation with the Oregon State Historic Preservation Officer would be completed prior to conducting management activities that have the potential to affect historic properties.

Chapter 3 Affected Environment

3.1 Introduction

The “affected environment” section of an EIS should “succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced” (40 C.F.R. § 1502.15). Thus, only the biological and socioeconomic resources expected to be potentially impacted by the alternatives under consideration are discussed in this chapter. Biological resources in the affected environment include DCCOs, other bird species, and fish species. For other bird species, primary focus is on other birds that use East Sand Island for nesting or roosting, species that co-nest with DCCOs, and species of conservation concern that could be potentially impacted by DCCOs and actions under the alternatives. Other species, such as invertebrates, small mammals and rodents, and other aquatic organisms are present on or near East Sand Island, but these species are only briefly mentioned because anticipated effects from the proposed action would be negligible or adequately captured within the range of effects for those species described in more detail. For fish species, the primary focus is on ESA-listed fish that could be potentially predated by DCCOs. Socioeconomic resources include fisheries (tribal, commercial, and recreational), public resources (health and safety, structures, property), existence and aesthetic values, and historic properties that are present on East Sand Island.

All of the action alternatives proposed are expected to have some potential for dispersal of DCCOs. Because of this, the affected environment encompasses a large geographic area including the coastal and interior areas from northern California (37°24’00”) to southern British Columbia (51°00’00”) and the states of Oregon and Washington (Figure 3-1). This scope was developed by the DCCO Interagency Working Group and includes an area that DCCOs, if dissuaded from nesting on East Sand Island, can be expected to prospect for new breeding sites and thus potentially affect resources. Nearly all (greater than 94 percent) of the documented post-breeding and wintering locations of DCCOs marked on East Sand Island were within this area (BRNW unpublished data; also see Table 3-1 and Courtot et al. 2012). Because East Sand Island and the affected environment are within the recognized management population of the western population of DCCOs (Pacific Flyway Council 2012), the effects analysis for DCCOs included the entire western population, which spans from southern British Columbia to California and from the Pacific coast to the Continental Divide.

FIGURE 3-1. Map of the affected environment and sub-regions of management concern.

To better categorize and describe anticipated effects resulting from proposed management alternatives, sub-regions of the affected environment were identified that are more likely to experience use by DCCOs, if dissuaded from East Sand Island. Sub-regions of the affected environment are: 1) Lower Columbia River Basin (including the Columbia River Estuary and lower Willamette River); 2) Washington Coast; 3) Salish Sea (including the Strait of Juan de Fuca, Strait of Georgia, and Puget Sound); 4) Vancouver Island Coast; and 5) Oregon Coast. In Chapters 3 and 4, resources of the sub-regions of the affected environment are described in more detail and given a greater depth of analysis than resources of the affected environment outside of the sub-regions. These sub-regions were based upon knowledge of the species, past research findings, and areas where active and historic DCCO colonies overlap with where DCCO dispersal from East Sand Island has been documented.

During the breeding season, DCCOs marked on East Sand Island have been documented using areas that are within only a small portion of the post-breeding and wintering range (Roby et al. 2013, Roby et al. 2014). Areas within the breeding season dispersal range that were more distant from East Sand Island were used much less frequently. Over the entire breeding season (March–September) and not including locations at East Sand Island, DCCOs satellite-tagged on East Sand Island during 2012 and 2013 used areas in the Lower Columbia River Basin most commonly (59.7 percent of detections), followed by the Washington Coast (28.1 percent) and Salish Sea (8.8 percent); DCCO use of the outer Vancouver Island Coast (3.4 percent) and Oregon coast (0.0 percent) was minimal (Table 3-1). Use of historical and currently active DCCO colonies was common within each of these areas. Resight information during 2010–2013 from DCCOs banded on East Sand Island also shows highest connectivity to the Lower Columbia River Basin, Washington Coast, and Salish Sea (Figure 3-2).

TABLE 3-1. Nighttime Detections during March 1–September 30 (Years 2012 and 2013) by DCCOs Satellite-tagged on East Sand Island and the Number of Active and Historical DCCO Colonies (from Adkins and Roby 2010) within the Sub-regions of the Affected Environment.

Region	# of Birds that Visited	% of Birds that Visited	# of Detections*	% of Detections	Active Colonies	Active + Historical Colonies
Oregon Coast	0	0.0 %	0	0.0 %	22	40
Lower Columbia River Basin**	93	97.9 %	976	59.7 %	4	8
Washington Coast	61	64.2 %	460	28.1 %	4	32
Salish Sea	20	21.1 %	144	8.8 %	12	44
Vancouver Island Coast	4	4.2 %	55	3.4 %	0	0

*All detections summarized occurred at night; nighttime use of a site indicates secure roosting habitat and more commitment to a given location than daytime locations, which could just be foraging locations.
**"Lower Columbia River Basin" does not include detections on East Sand Island, which are not listed.

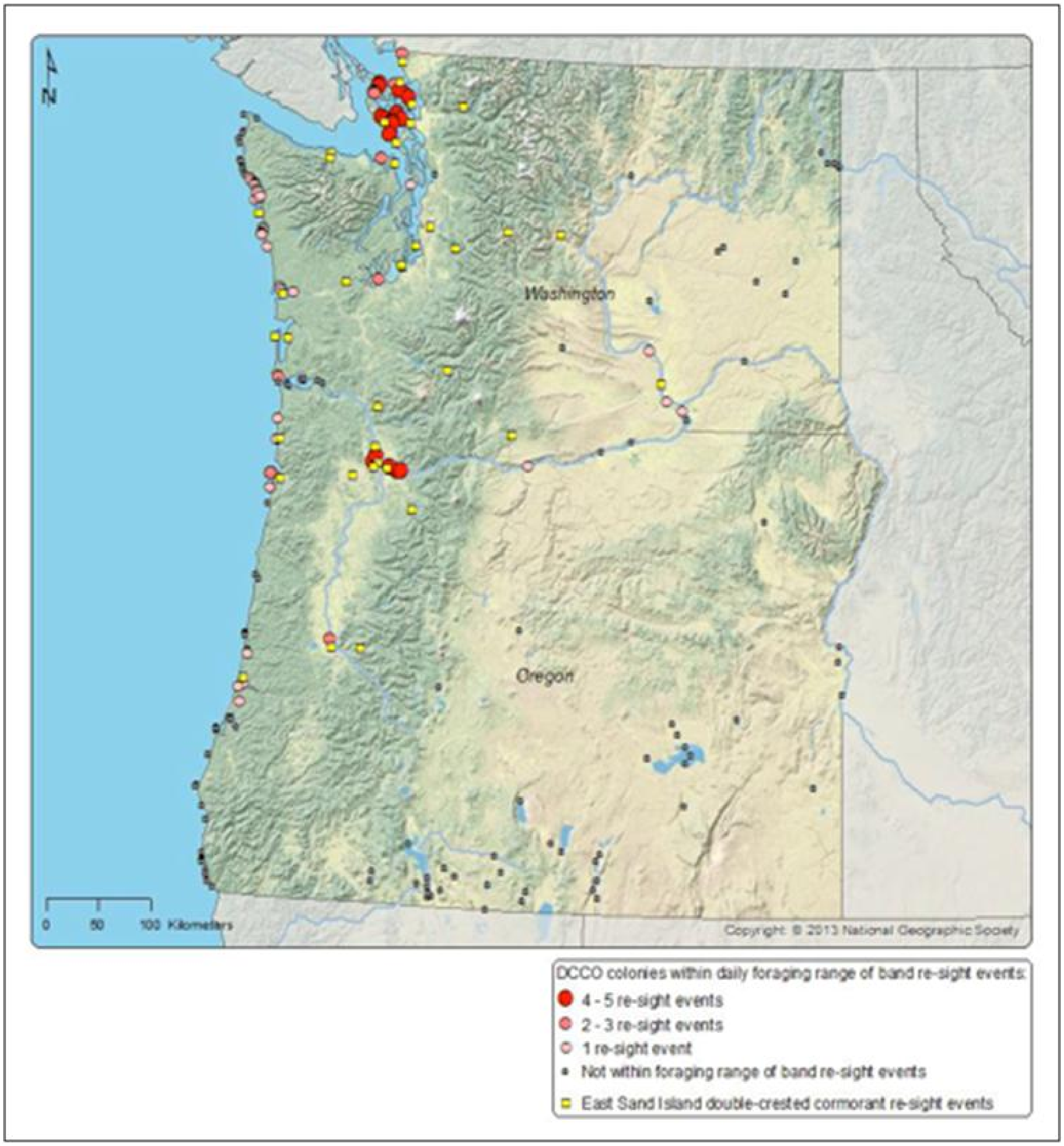


FIGURE 3-2. DCCO colonies in Oregon and Washington visited during 2010-2013 by DCCOs banded on East Sand Island.

Actions proposed in the alternatives would likely affect the biological and socioeconomic resources in the Columbia River Estuary and those on East Sand Island more than any other areas within the affected environment because there is high likelihood that DCCOs, if deterred from nesting on East Sand Island, would initially prospect for other nearby nesting sites within the Columbia River Estuary. During the management feasibility studies conducted on East Sand Island during the 2011–2013 breeding seasons (see Chapter 1, Section 1.1.6 and Appendix G), nearly all satellite-tagged DCCOs relocated to the Astoria-Megler Bridge or other nearby areas to East Sand Island immediately following hazing events (Roby et al. 2014). There was no evidence of permanent emigration from the Columbia River Estuary (see Appendix G, Roby et al. 2014), suggesting that DCCOs are rather committed to East Sand Island and the Columbia River Estuary. DCCO dispersal and usage was considered indicative of where DCCOs may likely prospect or relocate if habitat was not available on East Sand Island during the early breeding season (i.e., April–May). Satellite-tagged DCCOs that dispersed from East Sand Island during the early breeding season were found to use sites within the Lower Columbia River Basin most frequently (22.7 percent of detections away from East Sand Island), followed by the Washington coast (2.7 percent) and the Salish Sea (0.6 percent) (Table 3-2, also see Appendix G). There were no confirmed detections of satellite-tagged DCCOs along the Oregon coast and only three detections (0.1 percent) on the Vancouver Island Coast (Table 3-2).

TABLE 3-2. Nighttime Detections during April 1–May 30 (Years 2012 and 2013) by DCCOs Satellite-tagged on East Sand Island within the Sub-regions of the Affected Environment.

Region	# of Birds that Visited	% of Birds that Visited	# of Detections*	% of Detections
Oregon Coast	0	0.0%	0	0.0%
Lower Columbia River Basin**	86	90.5%	631	22.7%
Washington Coast	22	23.2%	74	2.7%
Salish Sea	3	3.2%	18	0.6%
Vancouver Island Coast	1	1.1%	3	0.1%
East Sand Island**	95	100.0%	2048	73.8%

*All detections summarized occurred at night; nighttime use of a site indicates secure roosting habitat and more commitment to a given location than daytime locations, which could just be foraging locations. Data from tags that failed or DCCOs that died at any point during this period were not excluded from the summary. No attempt was made to normalize the number of detections per bird for this analysis, so detections of individual DCCOs are not necessarily evenly weighted.

**"Lower Columbia River Basin" does not include detections on East Sand Island, which are listed separately.

3.2 Biological Environment

The affected environment provides significant habitat for both fish and wildlife, and East Sand Island is an important area for migratory birds. Section 3.2.1 describes existing conditions, vegetative communities, soils, and inundation patterns on East Sand Island. Section 3.2.2 describes the life history of DCCOs and gives specific information on DCCO colonies in the affected environment. Section 3.2.3 addresses other colonial waterbirds common to East Sand Island, as they are the most likely to be impacted by the proposed alternatives. Section 3.2.4 addresses other birds within the affected environment that co-nest with DCCOs and/or are of special conservation concern. Section 3.2.5 provides an overview of ESA-listed fish in the affected environment. Section 3.2.6 provides specific information on ESA-listed fish in the Lower Columbia River Basin and provides ESU-specific predation rates based on PIT tag recoveries on East Sand Island. Section 3.2.7 provides information on ESA-listed fish in the affected environment, specifically focusing on listed fish that would be vulnerable to predation by DCCO, should they relocate to other areas in the region.

3.2.1 Vegetation and Soils on East Sand Island

DCCO habitat requirements and usage are described in Chapter 3, Section 3.2.2. On East Sand Island, DCCOs nest and use vegetated and bare, open substrate. As DCCOs are known to impact vegetation and soils (see Chapter 3, Section 3.3.4), this section describes the general vegetative communities on East Sand Island, indicating which areas DCCOs have typically used on the island.

Vegetation Communities

East Sand Island can be divided into six main vegetation communities based on vegetation type and bird species impacts (Figure 3-3). The percent cover reported here is classified by life forms, including herbaceous plants, shrubs, and trees. Percent cover may total more than 100 percent due to an area being under the canopy of more than one life form. Only the three most dominant species are reported for each life form; thus, percent cover for all species is greater than what is presented.

FIGURE 3-3. Areas of vegetation communities (described below), based on vegetation communities and impacts by birds on East Sand Island.

The upland area on the western portion of the island, approximately 12 acres in size, was identified as Area 1. This area has been used by DCCOs predominantly for nesting and is mostly devoid of vegetation, with the exception of a few scattered willows and small shrubs. DCCOs were hazed from a portion of this area during the 2013 breeding season and some vegetation is returning to the area where DCCOs were excluded. The three most dominant herbaceous species accounted for approximately 92 percent of the herbaceous plant canopy cover in Area 1. These included common chickweed (*Stellaria media*) [50 percent], annual bluegrass (*Poa annua*) [40 percent], and bull thistle (*Circium vulgare*) [2 percent]. The three species with the greatest percent cover in the shrub life form were gorse (*Ulex europaeus*) [5 percent], elderberry (*Sambucus racemosa*) [3 percent], and Himalayan blackberry (*Rubus armeniacus*) [<1 percent]. The three dominant trees encountered were Sitka spruce (*Picea sitchensis*) [2 percent], red alder (*Alnus rubra*) [2 percent], and Oregon ash (*Fraxinus latifolia*) [<1 percent].

Adjacent to the primary nesting area, DCCOs have been excluded from Area 2 for the last three breeding seasons (2011-2013). This area is approximately 3 acres in size and represents an intermediary zone between the heavy DCCO nesting area and the more vegetated portion of the central island. Geese have utilized this area throughout the spring and summer of each year that the DCCOs were excluded. The three most dominant herbaceous plant species accounted for approximately 11 percent canopy cover in Area 2. These species included American dunegrass (*Leymus mollis*) [5 percent], common velvetgrass (*Holcus lanatus*) [5 percent], and annual bluegrass [1 percent]. The three shrubs with the greatest percent cover were salmonberry (*Rubus spectabilis*) [5 percent], elderberry [3 percent], and twinberry (*Lonicera involucrata*) [3 percent]. The three dominant trees encountered were Sitka spruce [1 percent], red alder (*Alnus rubra*) [2 percent], and bitter and domesticated cherries (*Prunus* spp.) [<1 percent].

The central portion of the island (Area 3), approximately 3 acres in size, contains silt loam and silty clay loam and has a dense understory of shrubs. The most dominant herbaceous plants and their percent cover in Area 3 are common velvetgrass (*Holcus lanatus*) [10 percent], slough sedge (*Carex obnupta*) [5 percent], and American dunegrass [2 percent]. Shrubs with the greatest percent cover were elderberry [55 percent], salmonberry [30 percent], and twinberry [15 percent]. Trees accounted for approximately 11 percent of the canopy cover of Area 3, and the dominant trees encountered were red alder [10 percent], Sitka spruce [<1 percent], and Pacific crabapple (*Malus fusca*) [<1 percent].

Area 4 is approximately 10 acres in size and is densely covered with a mix of shrub and tree species, including, but not limited to, willows (*Salix spp*.), elderberry, red alder *(Alnus rubra),* and Sitka spruce at the edge of the unit. These areas have not been used for nesting by any of the colonial waterbirds on the island. The most dominant herbaceous species and their percent cover were common velvetgrass (*Holcus lanatus*) [5 percent], common rush (*Juncus effusus*) [2 percent], and woodland buttercup (*Ranunculus uncinatus*) [1 percent]. Shrub cover was 100 percent, with the three dominant species being Hooker willow (*Salix hookeriana*) [55 percent], salmonberry [35 percent], and twinberry [10 percent]. The dominant trees encountered were red alder [2 percent], Sitka spruce [1 percent], and western hemlock (*Tsuga heterophylla*) [<1 percent].

The easternmost area of the island (Area 5) is approximately 17 acres in size and contains the primary nesting sites for the Caspian terns and ring-billed gulls in the upland area. The most dominant species were American dunegrass [40 percent], cheatgrass (*Bromus tectorum*) [10 percent], and common velvetgrass (*Holcus lanatus*) [15 percent]. Shrubs with the greatest percent cover were Hooker willow [5 percent], elderberry [2 percent], and gorse [2 percent]. The dominant trees encountered were red alder [<1 percent], black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) [<1 percent], and Oregon ash [<1 percent]. The managed Caspian tern colony (Area 6) is approximately 1.58 acres, as of February 2014, and has only sparse coverage, including American dunegrass shoots [<1 percent].

Invasive/Noxious Weeds

Observed invasive or noxious weed species are Japanese knotweed (*Polygonum cuspidatum*), gorse (*Ulex europaeus*), Scotch broom (*Cytisus scoparius*), yellow flag iris (*Iris pseudacorus*), Himalayan blackberry (*Rubus armeniacus*), stinking willie (*Senecio jacobaea*), and bull thistle (*Circium vulgare*).

Soils

Due to the history of disturbance and the dynamic nature of the fluvial system, soils on the island are very young and poorly developed. Soils on East Sand Island are mapped in the Clatsop County, Oregon (OR007) Soil Survey as Tropopsamments, 0 to 15 percent slopes (Soil Survey Staff, 2014). These soils have been built up by repeated alluvial deposition, evidenced by the thin contrasting layers in exposed profiles from the northwestern shore of the island. They are very deep, excessively drained, and very low in organic matter and fines (silts and clays). Poorly developed A-horizons are typically less than four inches thick on the island and relatively low in organics (mostly partially decomposed sticks, twigs, and recognizable plant material). Soils observable in some beach exposures on the northern and northeastern shore of East Sand Island are higher in silt (predominantly silt loam textures). This is likely the Coquille soil in Map Unit 11A (Fluvaquentic Edoaquepts) that is mapped along the northern and eastern shores of adjacent Sand Island. This soil profile has common redox features throughout, as a result of its proximity to the water table and its higher water holding capacity. This inclusion may be capped with sand and occur as a buried soil further inland, likely perching and retaining water.

Inundation at East Sand Island

The area-time inundation index model (Chapter 4, Section 4.5.3) was used to model inundation at East Sand Island. The expected inundation of the island at four water surface elevations is presented in Figure 3-4 to illustrate the range of inundation in the existing terrain condition. The lowest water surface elevation shown, 1.2 m (NAVD88), is equivalent to the current lower boundary of marsh elevation at reference sites in Baker Bay (Borde et al. 2011). The highest water surface elevation shown, 3.0 m, was the maximum water surface elevation reached for the modeled period, March-October 2009 (see Chapter 4, Section 4.5.3).

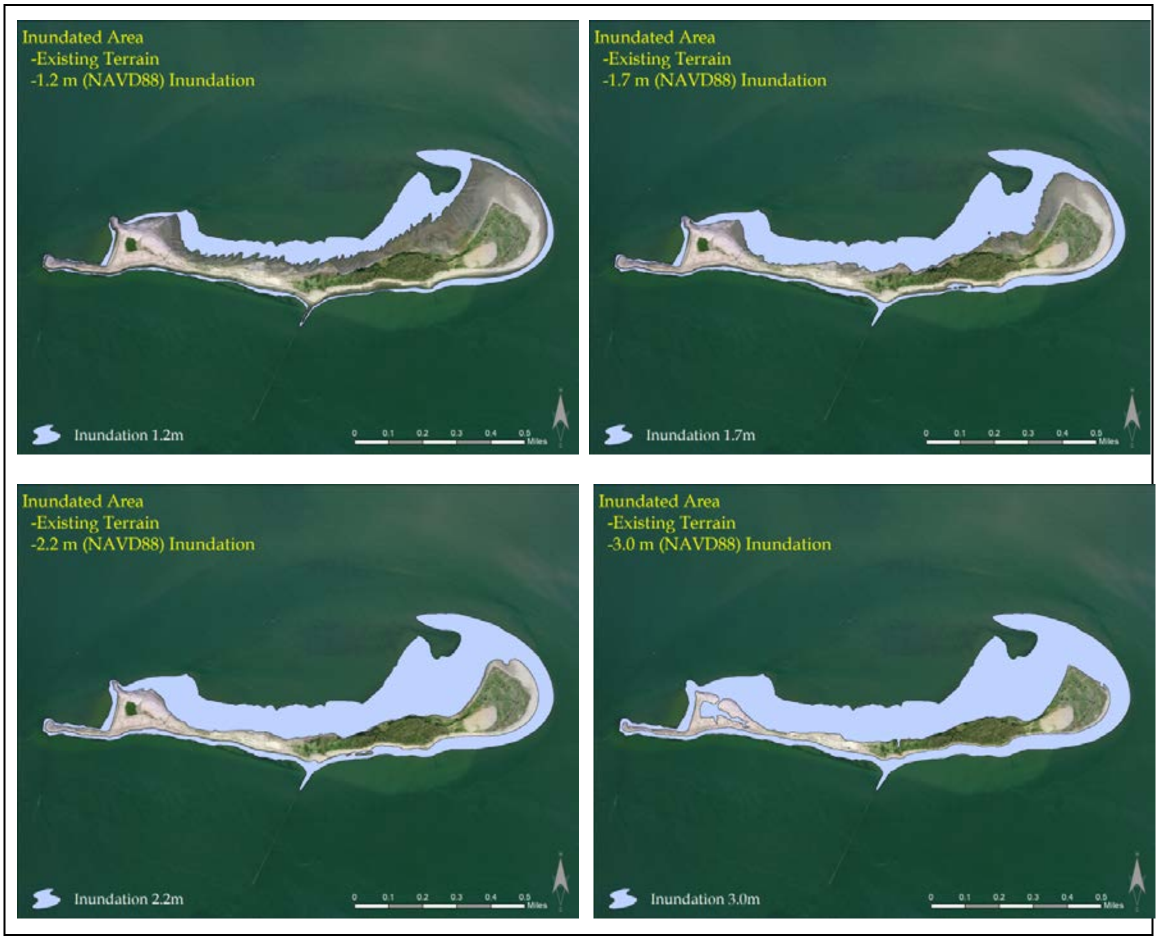


FIGURE 3-4. Water inundation outputs from the ATIIM for the existing terrain condition, representing four water surface elevations: 1.2, 1.7, 2.2, and 3.0 m (NAVD88).

Wetlands and Tidal Waters on East Sand Island

Wetlands and tidal waters were delineated on East Sand Island in February 2014 (Figure 3-5). A total of 7.135 acres (310,818 ft^2) of wetlands were delineated, including 6.026 acres (262,492 ft^2) of non-tidal freshwater wetlands and 1.109 acres (48,326 ft^2) of tidal wetlands (Green Banks 2014a,b). Forty-three data collection plots were established throughout the island to document the presence or absence of wetland vegetation, soils, and hydrology. The Cowardin (Cowardin et al. 1979) and Hydrogeomorphic classes (Adamus and Field 2001; Adamus 2006) of these wetlands were also determined. Functional analyses were conducted on representative non-tidal and tidal wetlands identified during the study, using the protocol of the Oregon Department of State Lands *2010 Manual for the Oregon Rapid Assessment Protocol (ORWAP), Version 2.0.2* (ODSL 2010). The wetlands have moderate to high scores for several of the ORWAP "Grouped Functions," indicating that they are relatively high functioning wetlands that provide valuable habitat support for certain species, as well as improve water quality and carbon sequestration (Green Banks 2014a,b).

FIGURE 3-5. East Sand Island wetlands and tidal waters.

Freshwater Non-Tidal Wetlands

The non-tidal wetlands contained a mix of palustrine scrub-shrub (PSS) and palustrine emergent (PEM) Cowardin classes. These wetlands generally have both Slopes and Flats Hydrogeomorphic (HGM) class components. The dominant plant species in these wetlands included: bentgrass (*Agrostis* species), black twinberry (*Lonicera involucrata*), Hooker willow, red elderberry (*Sambucus racemosa*), soft rush (*Juncus effusus*), and yellow-flag iris. Hydric soil textures consisted of sandy loam, silt loam, and silty clay loam. Wetland hydrology indicators, such as a high water table, soil saturation, and oxidized root-channels, were observed. The three highest scoring ORWAP Grouped Functions in the non-tidal wetlands were: Water Quality, Aquatic Support Group, and Terrestrial Support Group.

Estuarine Tidal Wetlands

The tidal wetlands were located below the calculated highest measured tide elevation for the island (11.34 feet [NAVD88]). The Cowardin class of these wetlands was estuarine emergent (EEM). Most of the tidal wetlands were “high marsh,” with an HGM class of marine-sourced high tidal fringe. One tidal wetland contained both “low marsh” (marine-sourced low tidal fringe) and high marsh components. The dominant plant species in these wetlands included: Baltic rush (*Juncus balticus*), bentgrass, common velvetgrass (*Holcus lanatus*), Hooker willow, Pacific silverweed (*Argentina anserina*), slough sedge (*Carex obnupta*), and soft rush. Hydric soil textures consisted of sand and loamy sand. Indicators of wetland hydrology, such as a high water table, soil saturation, and inundation, were observed. The highest scoring ORWAP Grouped Functions in the tidal wetlands were: terrestrial support group, carbon sequestration, and aquatic support group.

Tidal Waters

The "waters" boundary of the Columbia River was delineated using two methods (gauge-calculated and field indicator) and a merged boundary line was created to achieve the highest level of accuracy in areas where either method had observed error. The highest measured tide (HMT) elevation was determined based on a river gage near Hammond, Oregon, which calculated the HMT to be 11.34 feet (NAVD88) during the 1983-2001 tidal epoch. Light Detection and Ranging (LiDAR) data for the island was used to locate this elevation in the field and to map the HMT in Geographic Information Systems (GIS). The HMT elevation was ground-truthed using Global Positioning System (GPS) and appeared to be fairly accurate based on the observation of field indicators at the same approximate elevation, with the exception of some areas where recent erosion has occurred or where the LiDAR data may have been less accurate (e.g. areas with dense vegetation or wood debris).

3.2.2 Double-crested Cormorants

Description and Life History

DCCOs are large, black to dark-brown, colonial-nesting, mainly fish-eating birds, often found in close proximity to marine or freshwater foraging sites. Breeding DCCOs have a bright orange throat patch (gular pouch) and white plumes on either side of crown (i.e., double-crest). Average adult life expectancy is 6.1 years, and the oldest recorded banded DCCO was 17 years and 9 months (Van der Veen 1973; Hatch and Weseloh 1999). Mean age at first breeding is 2.74 years, with the majority of females breeding within their third year (van der Veen 1973). Mean clutch size is approximately 2.7 to 4.1 eggs; fledging success is approximately 1.2 to 2.4 young per nest (Hatch and Weseloh 1999). DCCOs commonly re-nest if clutches fail early in the year, but typically only raise one brood per breeding season.

Taxonomy, Distribution, and Management

DCCOs are native to North America, and their range extends across much of the continent. There are five recognized DCCO subspecies in North America (Figure 3-6) (Wires et al. 2001; USFWS 2003). Recent genetic analyses, however, supported the Alaska subspecies designation and presence of a divergent lineage associated with the southwestern portion of the species range (i.e., southern California and Baja California, Mexico), but found little support for recognition of subspecies within the conterminous U.S. and Canada (Mercer 2008, Mercer et al. 2013). The western population of DCCOs includes all breeding colonies within British Columbia, Washington, Oregon, Idaho, California, Nevada, Utah, Arizona, and the portions of Montana, Wyoming, Colorado, and New Mexico that lie west of the Continental Divide (Adkins et al. 2014). The western population of DCCOs is a management population within the Pacific Flyway (Pacific Flyway Council 2012). The geographic scope of analysis lies within the boundary of the western population of DCCOs. Separate management of the western population of DCCOs from the Alaskan subspecies and populations east of the Continental Divide has been supported because of geographic and demographic separation and differences in population status (Carter et al. 1995; Tyson et al. 1997; Wires et al. 2001; USFWS 2003; Mercer 2013; Adkins et al. 2014).

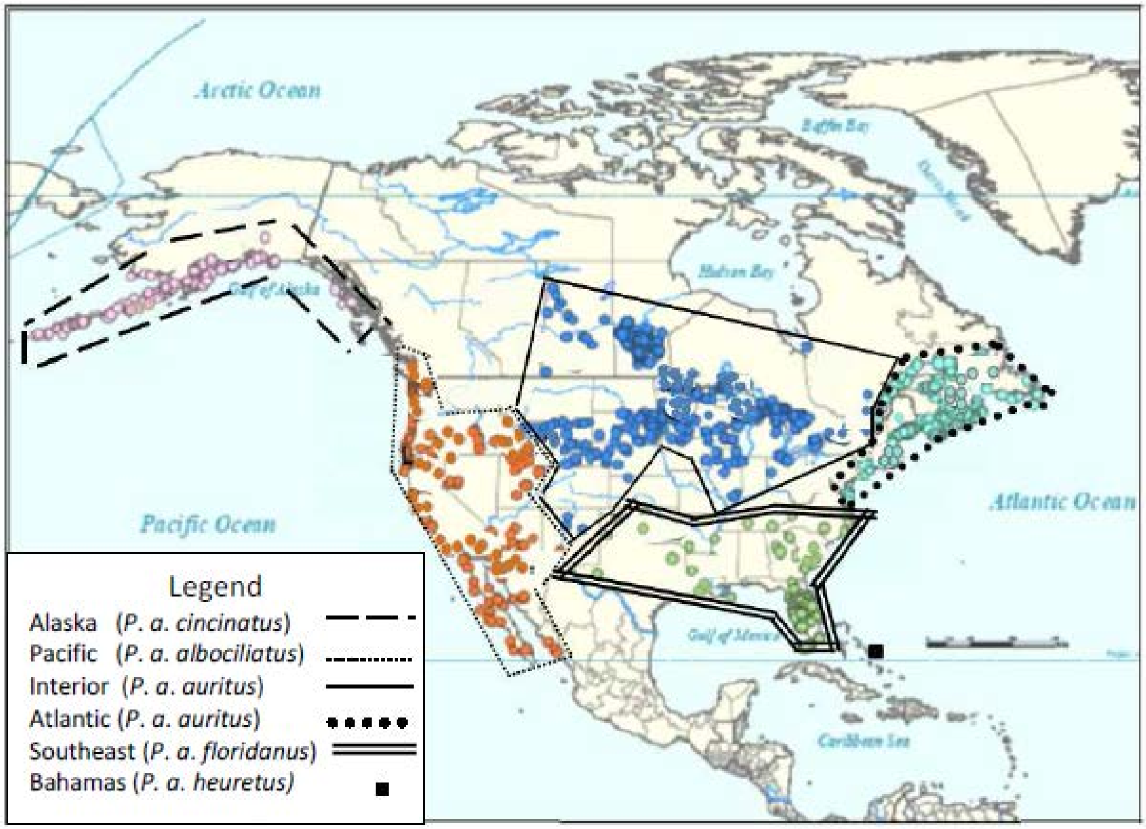


FIGURE 3-6. Breeding range of the five DCCO subspecies in North America (appended from Mercer 2008).

Habitat Requirements

DCCOs are habitat generalists and breed at lakes, marshes, rivers, bays, estuaries, coastlines, on rocky or sandy islands, offshore rocks, emergent vegetation, cliffs, trees, and human-made structures such as bridges, navigational aids, transmission towers, pilings, and jetties. DCCOs typically use breeding locations with protection from ground predators and within close proximity of foraging areas (typically less than 10 km; Hatch and Weseloh 1999). Ground-nesting may be the ancestral and preferred nesting habitat for DCCOs, whereas nesting in trees and other elevated structures could be a response to ground predators, human disturbance, and loss of natural breeding habitats (Lewis 1929; Carter et al. 1995; Hatch and Weseloh 1999).

DCCOs require similar habitat for foraging, loafing, and roosting during the non-breeding season as they do during the breeding season. Roosting and loafing sites are typically close to foraging areas and include exposed rocks, sandbars, shoals, coastal cliffs, offshore rocks, channel markers, pilings, wrecks, high-tension wires, utility poles, fishing piers, and trees. In the Columbia River Estuary, Lyons et al. (2007) documented high DCCO usage and foraging along the main channel where pile dikes were present. Non-breeders may roost at breeding colony sites or elsewhere during the night (Hatch and Weseloh 1999).

Diet

DCCOs are fish-eating, pursuit-diving birds that consume, on average, one pound of fish per day, usually comprised of small (<15 cm) fish (Hatch and Weseloh 1999; USFWS 2003). DCCOs are generalist feeders, preying on more than 250 species of freshwater and marine fish (Hatch and Weseloh 1999), but primarily on schooling forage fish (Lyons 2010). The composition of prey in the diet of DCCOs can vary considerably by location and throughout the year and is dependent on a number of factors, including the size, distribution, abundance, and behavior of fish (Collis et al. 2002; Lyons 2010; Hostetter et al. 2012; Roby et al. 2014). While their diet is almost entirely fish, DCCOs also feed on crustaceans, insects, and amphibians, although to a much lesser extent (Palmer 1962).

On East Sand Island, northern anchovy is the most prevalent DCCO prey type, followed by various marine and freshwater fishes, including clupeids, sculpins, and surf perch (Figure 3-7). Northern anchovy averaged approximately 30 percent of DCCO diet by biomass during 2001–2013 (Roby et al. 2014). On average, juvenile salmonids composed approximately 11.8 percent of DCCO diet by biomass during 1999–2013 (range 2 to 25 percent; Roby et al. 2014). Juvenile salmonid composition of DCCO diet by biomass was relatively stable at approximately 10 percent during 2006–2009, but was nearly double during 2010–2012. In 2013, diet composition was 10.7 percent juvenile salmonids. Osmerids (smelt) constituted 2 percent or less of DCCO diet on average during 2003–2010, but was atypically high in 2002 (8.7 percent). During 2002–2010, lamprey constituted 0.03 to 1.2 percent of DCCO diet each year (Roby et al. 2013).

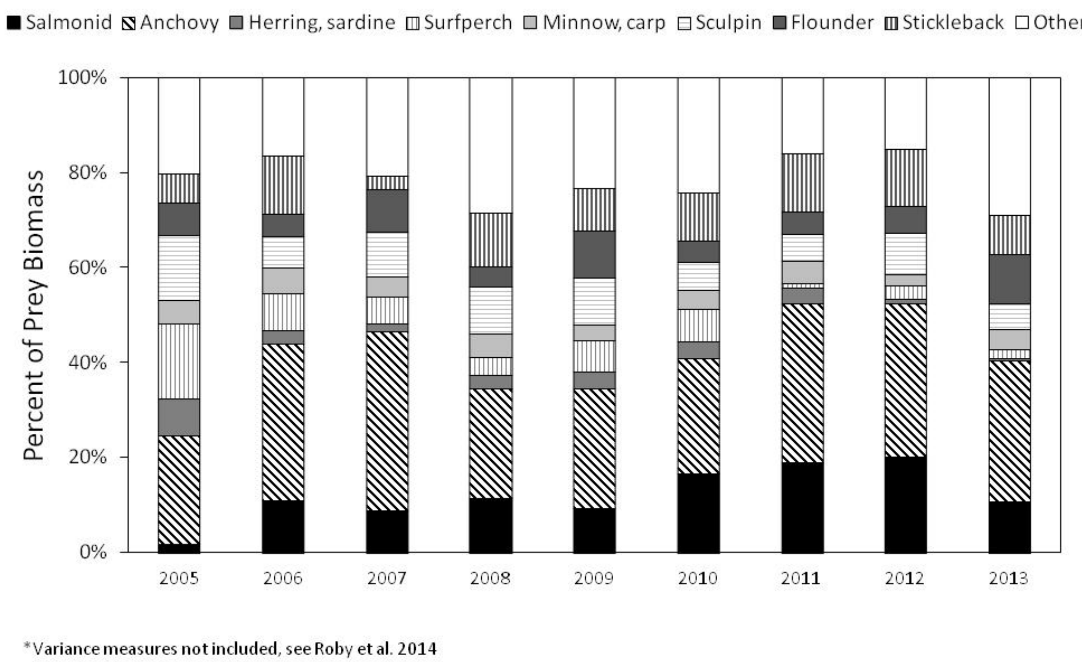


FIGURE 3-7. Annual diet composition (percent of prey biomass) of DCCOs nesting on East Sand Island during 2005–2013.

Colony Size

DCCOs are typically communal nesters, but the number of breeding pairs can vary widely (1 to >10,000) among locations and years (Wires et al. 2001; USFWS 2003; Adkins and Roby 2010). Colony sizes can change in response to environmental (e.g., drought, flooding), biological (e.g., increased predation, availability of prey), intra- or inter-colony dynamics (e.g., density dependence, proximity to other colonies), or anthropogenic factors (e.g., disturbance, management actions).

The East Sand Island DCCO colony, which has averaged approximately 12,917 breeding pairs during the past decade (2004-2013; see Figure 1-2), is an unusually large, stable colony, compared to others in the western population of DCCOs. The majority of breeding colonies within the western population of DCCOs average less than 250 breeding pairs, and colony size can fluctuate greatly among years (Adkins and Roby 2010; Pacific Flyway Council 2012). Stable, suitable nesting habitat, an abundance of forage fish nearby, and predator protection, provided by safety in numbers, have likely contributed to the unprecedented growth and size of the DCCO colony at East Sand Island (Adkins et al. 2014). These characteristics are not representative of DCCO habitat elsewhere in the affected environment.

Migration and Connectivity

DCCOs within the western population are thought to be less migratory compared to DCCOs within the interior and eastern U.S. (Hatch 1995; Wires et al. 2001). In many parts within the range of the western population, DCCOs are reported as year-round residents (Hatch 1995). DCCOs breeding in interior states west of the Continental Divide with harsh climates likely migrate to the Pacific Coast for the winter, but migration routes have not been concretely documented (Hatch 1995; Mercer 2008).

On East Sand Island, DCCOs are almost exclusively migratory, leaving East Sand Island after the breeding season (Courtot et al. 2012; Roby et al. 2013). DCCOs satellite-tagged on East Sand Island had the greatest connectivity with three estuarine and inner coastal regions to the north (Willapa Bay, Grays Harbor, and the Salish Sea) and the Western Columbia Basin (Courtot et al. 2012; BRNW unpublished data). These areas are likely better protected from winter weather extremes, compared to East Sand Island. Although satellite-tagged DCCOs were located from British Columbia to northern Mexico, there was little connectivity to colonies east of the Cascade-Sierra Nevada Mountains or along the coasts of Oregon, southern California, or Mexico (Courtot et al. 2012).

Population Status and Trend

Continental — DCCO abundance in North America has increased dramatically since the 1960s and 1970s, largely due to the growth of the Interior and Atlantic populations. Increases have largely been attributed to better environmental regulations, primarily restricting use of chlorinated hydrocarbons (e.g., DDT), protection under the MBTA in 1972, and decreases in hunting, compared to the early twentieth century (Hatch and Weseloh 1999). DCCOs have a status of “least concern,” the lowest designation under the International Union for Conservation of Nature (IUCN) ranking system (IUCN 2011). During 1989–1995, the total estimated DCCO continental population was 372,410 breeding pairs; 91 percent of all breeding DCCOs resided in the Atlantic and Interior regions, 4 percent in the Southeast, and 5 percent in the West Coast-Alaska region (Tyson et. al. 1997; USFWS 2003).

Western Population and Affected Environment — The western population of DCCOs is an order of magnitude smaller than the DCCO populations in the interior and eastern United States (Tyson et. al. 1997; USFWS 2003), and the Pacific Coast population is likely an order of magnitude smaller than it was historically (Wires and Cuthbert 2006). The estimated size of the western population of DCCOs is approximately 31,200 breeding pairs (Adkins et al. 2014; see Appendix F-1 for a list of historic and current breeding colonies). From approximately 1987 to 2009, the number of DCCO breeding pairs estimated within British Columbia, Washington, Oregon, and California increased by approximately 72 percent (i.e., 3 percent per year), or 12,000 breeding pairs, and large-scale distributional changes occurred (Adkins et al. 2014; Pacific Flyway Council 2012). The coastal states and provinces account for greater than 90 percent of the western population (Adkins et al. 2014). Based on the western population abundance estimates ca. 1990 (41,660 breeding individuals; Tyson et al. 1997) and ca. 2009 (62,400 breeding individuals; Adkins et al. 2014), the entire western population of DCCOs has increased approximately 2.04 percent per year over the last two decades. Based on Breeding Bird Survey (BBS) data, DCCOs within the Western BBS region (which closely aligns with the delineation of the western population of DCCOs) increased 2.9 percent per year (95 percent CI = -0.8 to 5.8 percent) during 1966–2009 and 7.5 percent per year (95 percent CI = -3.2 to 16.3 percent) during 1999–2009 (Sauer et al. 2011), which was greater than the central BBS region during the past decade. Growth of the western population of DCCOs is largely attributed to the increase in size of the DCCO breeding colony at East Sand Island, which accounted for 39 percent of the western population of DCCOs during 2008–2010 (Figure 3-8; Adkins et al. 2014).

The DCCO increase at East Sand Island likely initially resulted from immigration from other breeding colonies, as colony declines were documented over much of southern Alaska, British Columbia, Washington, and southern California during the same time period East Sand Island experienced growth (Carter et al. 1995; Hatch and Weseloh 1999; Moul and Gebauer 2002; Wires et al. 2001; Anderson et al. 2004b; Wires and Cuthbert 2006; Pacific Flyway Council 2012). Outside of East Sand Island, growth of the western population of DCCOs in other areas has been relatively static over the past two decades (see Figure 4-2), with some isolated areas of limited DCCO increase (e.g., Idaho, Montana, Arizona) and areas of decline or concern for continued decline (e.g., Salton Sea, California; Pacific Flyway Council 2012, T. Anderson, USFWS, personal communication. 2014, 2015).

Within the range of the western population of DCCOs, there are approximately 197 active breeding colonies, of which 124 (63 percent) are located within the affected environment (Pacific Flyway Council 2013). The majority of the western population of DCCOs breeds along the coast (67 percent coastal vs. 33 percent inland; Figures 3-8 and 3-9; Adkins and Roby 2010). Colony information for the western population of DCCOs and affected environment was taken primarily from two sources: 1) the Pacific Flyway Council Monitoring Strategy for the western population of DCCOs (Pacific Flyway Council 2013) and 2) the status assessment of the western population of DCCOs (Adkins and

Roby 2010). Pacific Flyway Council (2013) defined “active” as a breeding colony that contained five or more breeding pairs at least one time during 2008–2012. Adkins and Roby (2010) defined “active” as a breeding colony that contained one or more breeding pair at least one time during 1998–2009; thus, the two datasets are not exactly comparable. In total, within the affected environment, 94 colonies were identified as active in both Pacific Flyway Council (2013) and Adkins and Roby (2010); in addition, there were 30 active colonies exclusive to Pacific Flyway Council (2013) and 67 active colonies exclusive to Adkins and Roby (2010). Thus, Pacific Flyway Council (2013) and Adkins and Roby (2010) identified 124 and 161 active colonies, respectively, and there were 191 active colonies in total from both sources combined (see Appendix F-1 for list and map of colonies).

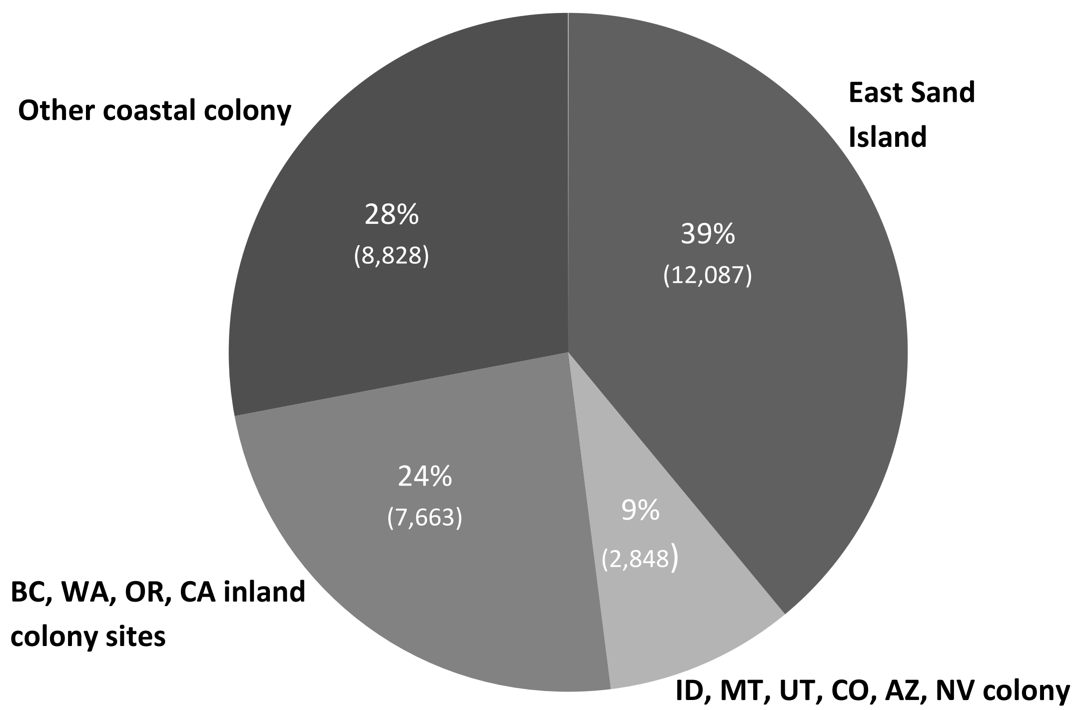


FIGURE 3-8. Percentage of DCCOs nesting at East Sand Island and other coastal and interior sites in the western population, using estimates through 2010 (from Adkins and Roby 2010).

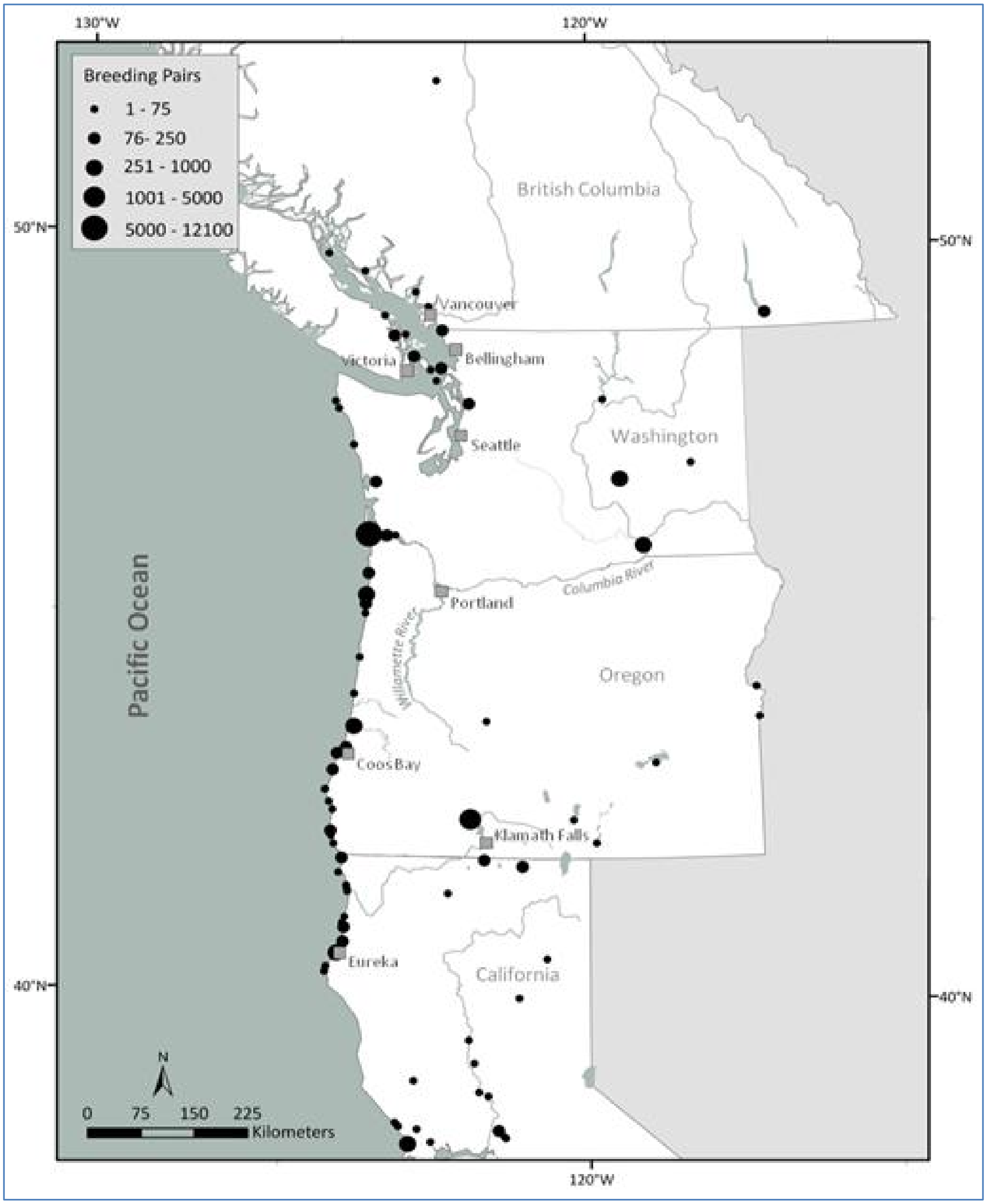


FIGURE 3-9. Distribution and relative size of DCCO breeding colonies in the Affected Environment during 1998-2009 (appended from Adkins and Roby 2010).

East Sand Island — DCCO nesting on East Sand Island was first documented in 1989, when less than 100 breeding pairs were reported (Naughton et al. 2007). By 1991, the estimated number of breeding pairs increased to 2,026 (Carter et al. 1995); this colony continued to grow and reached a peak estimate of 14,900 breeding pairs in 2013 (Roby et al. 2014). During the last decade (2004-2013) the average breeding colony size has been 12,917 breeding pairs (see Figure 1-2). The increase in colony size is likely due to changes regarding habitat, nesting, and foraging conditions near the mouth of the Columbia River that are favorable for the species, such as stable, rather undisturbed, largely mammalian predator-free nesting habitat on East Sand Island and consistent forage base.

DCCOs typically arrive on East Sand Island the last week of March, begin egg laying during the last week of April, and chicks hatch the last week of May (Figure 3-10). During 1997–2013, the average number of young raised per breeding pair was 1.83 (range = 1.2–2.8; Figure 3-11). The observed range on East Sand Island is slightly higher than the reported range for DCCOs (1.2–2.4 young raised per breeding pair; Hatch and Weseloh 1995).

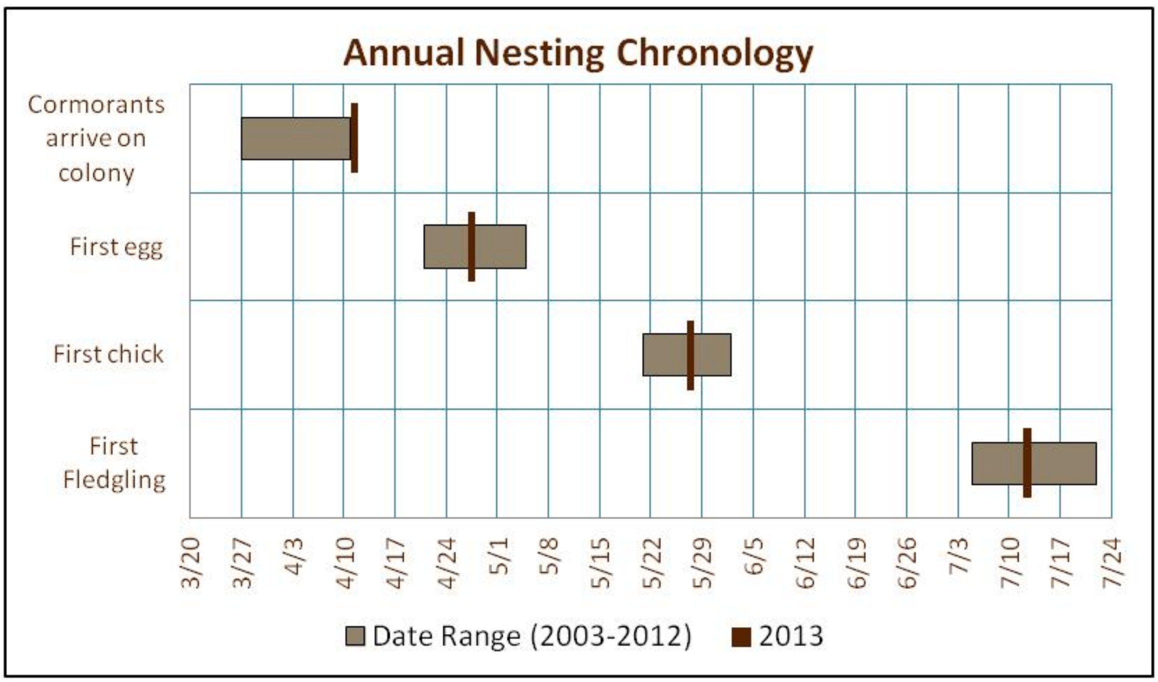


FIGURE 3-10. Nesting chronology of DCCOs on East Sand Island during 2003-2013.

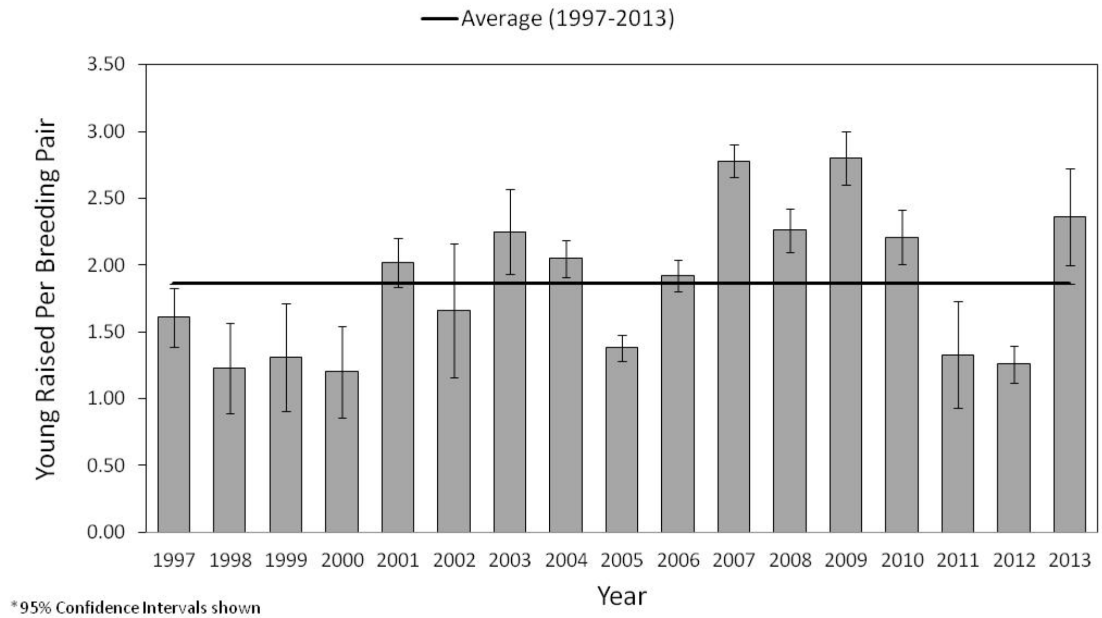


FIGURE 3-11. Young raised per breeding pair on East Sand Island during 1997–2013.

Columbia River Estuary — Within the Columbia River Estuary, DCCOs have nested at East Sand Island, Rice Island, Miller Sands Spit, Trestle Bay, Desdemona Sands pilings, Astoria-Megler Bridge, and on navigational aids around Miller Sands Spit and other nearby islands. Approximately 98 percent of DCCOs breeding in the Columbia River Estuary nest on East Sand Island. Without the use of social attraction techniques, DCCOs last nested on Rice Island in 2003 and on Miller Sands Spit in 2001 (BRNW data, see Roby et al. annual reports). DCCO nesting was last observed at Trestle Bay or on the Desdemona Sands pilings in 1992 and 2000, respectively (Adkins and Roby 2010). DCCOs have nested on the navigational aids around Miller Sands Spit and other nearby islands annually since 1997 and on portions of the Astoria-Megler Bridge since 2004 (BRNW data, see Roby et al. annual reports). In 2013, a maximum of 330 and 231 DCCO breeding pairs nested on 11 navigational aids and the Astoria-Megler Bridge, respectively (Roby et al. 2014). Thousands of DCCOs were observed roosting on the Astoria-Megler Bridge at various times while management feasibility studies and dissuasion research was conducted on East Sand Island (Roby et al. 2013, 2014).

Coastal Washington — It is difficult to establish a clear trend in the number of DCCOs breeding along coastal Washington (San Juan Islands, Eastern Strait of Juan de Fuca, Puget Sound, Olympic Peninsula Outer Coast, and Grays Harbor) during the last few decades. During 2009–2012, there were approximately 13 active breeding colonies in coastal Washington, which supported approximately 1,108 breeding pairs (Pacific

Flyway Council 2013). In 2009, there were an estimated 788 breeding pairs (Adkins et al. 2014), which was a 50 percent decrease from an estimated 1,564 breeding pairs in 1991–1992 (Carter et al. 1995, Adkins et al. 2014). The majority (approximately 75 to 80 percent) of DCCOs within coastal Washington breed in the San Juan Island and Eastern Strait of Juan de Fuca areas (Adkins et al. 2014; Pacific Flyway Council 2013). During 2009 aerial surveys, numerous bald eagles were observed in the vicinity of the seabird colonies along the coast, as well as two incidents of bald eagles actively disturbing colonies (Adkins and Roby 2010). Bald eagle disturbance and changes in prey availability may be limiting numbers of DCCOs nesting in coastal Washington (see Chapter 4, Section 4.4).

In the San Juan Islands*,* an estimated 697 DCCO breeding pairs nested at 8 active breeding colonies during 2009–2012 (Pacific Flyway Council 2013). In 2009, 595 DCCO breeding pairs nested at 4 sites compared to 718 breeding pairs at 5 sites in 2003 (Adkins and Roby 2010). The potential for the Snohomish River mouth colony, the largest breeding colony in the San Juan Islands, to continue to support 250 or more breeding pairs is uncertain, as this colony is located among old creosote pilings, some of which were removed in 2008 and replaced with fewer steel pilings intended for osprey nesting habitat (Adkins and Roby 2010). Other relatively large colonies, Bird Rocks and Drayton Harbor, each support approximately 100 to 150 DCCO breeding pairs (Adkins and Roby 2010; Pacific Flyway Council 2013).

In the Eastern Strait of Juan de Fuca, 53 breeding pairs nested at 2 active breeding colonies during 2009–2012 (Pacific Flyway Council 2013). Twenty-eight DCCO breeding pairs nested at Smith Island in 2009 (Adkins and Roby 2010). A second nearby site, Protection Island, has not been active since 2008, when 11 breeding pairs were documented (Adkins and Roby 2010). These two islands supported approximately 100 to 150 breeding pairs during the late 1990s and early 2000s and an estimated 528 breeding pairs in 1992; however, complete nest failure in 1992 and the preceding two years was attributed to human and bald eagle disturbances (Carter et al. 1995; Adkins and Roby 2010). During 2009 aerial surveys, 15 or more and 5 bald eagles were observed in the vicinity of Smith Island and Protection Island, respectively (Adkins and Roby 2010). DCCOs at Smith Island, which had nested on the ground in the past, have restricted their nesting to one to two navigation towers on the island during the last few years (Adkins and Roby 2010). Another nearby site, Minor Island, was active as recently as 2012, when 25 breeding pairs were documented (Pacific Flyway Council 2013).

In the Puget Sound, one active breeding colony in Woodard Bay, with approximately 150 breeding pairs in 2012, was identified (Pacific Flyway Council 2013). There is some uncertainty, though, as to whether DCCO breeding actually occurs at this location. Numerous DCCOs are frequently observed loafing and roosting in this area, sometimes on nests, but it is also the location of a heron rookery. DCCO chicks or fledglings have not been confirmed (WDFW unpublished data; D. Lyons, OSU, personal communication). DCCOs have been observed foraging and loafing in other areas throughout the Puget Sound during the summer, but nesting has not been documented elsewhere (WDFW unpublished data).

In the Olympic Peninsula Outer Coast, there was one active breeding colony, Little Hogsback Island, with approximately 71 breeding pairs in 2009 (Adkins and Roby 2010). This is less than the approximate 100 to 200 breeding pairs at 5 to 10 active breeding colonies in the late 1990s (Adkins and Roby 2010).

In Grays Harbor, 143 DCCO breeding pairs nested on channel markers in 2013 (Roby et al. 2014). Since 2000, all DCCOs breeding in Grays Harbor have nested on channel markers, but there is no clear trend in the number of breeding pairs during this period. Numbers peaked in 2004, with 185 DCCO breeding pairs (Adkins and Roby 2010). In 2008, 52 DCCO breeding pairs were estimated, the lowest number since 2000 (Adkins and Roby 2010). In the early 1990s, a greater number of DCCOs nested in Grays Harbor, compared to the present: 191 breeding pairs at Goose Island and 249 breeding pairs at Unnamed Sand Island in 1992 (Carter et al. 1995). Goose Island has since washed away, and Unnamed Sand Island has not supported DCCO nesting since 1999, when five breeding pairs were recorded (Adkins and Roby 2010).

Coastal Oregon — During 2012–2014, there were approximately 23 active breeding colonies in coastal Oregon (not including the Columbia River Estuary), which supported approximately 1,260, 1,937, 1,928 breeding pairs, respectively, during that time period (ODFW, unpublished data). In 2009, an estimated 2,384 DCCO breeding pairs nested at 22 sites along the Oregon coast (Adkins and Roby 2010). This is a modest increase from the 2003 and 2006 estimates of 2,216 and 1,903 breeding pairs at 24 and 21 sites, respectively (Naughton et al. 2007; Adkins and Roby 2010). Breeding pair numbers during 2003–2009 were 19 to 35 percent lower than the 1988–1992 estimate of 2,939 breeding pairs at 19 sites (Carter et al. 1995; Naughton et al. 2007). During this time period, DCCO nesting shifted from the Central Coast to the Southern Coast; 20 percent of all DCCO breeding pairs on the Oregon coast nested at Central Coast sites during 1988–1992, compared to 1 to 2 percent during 2003–2009 (Adkins and Roby 2010).

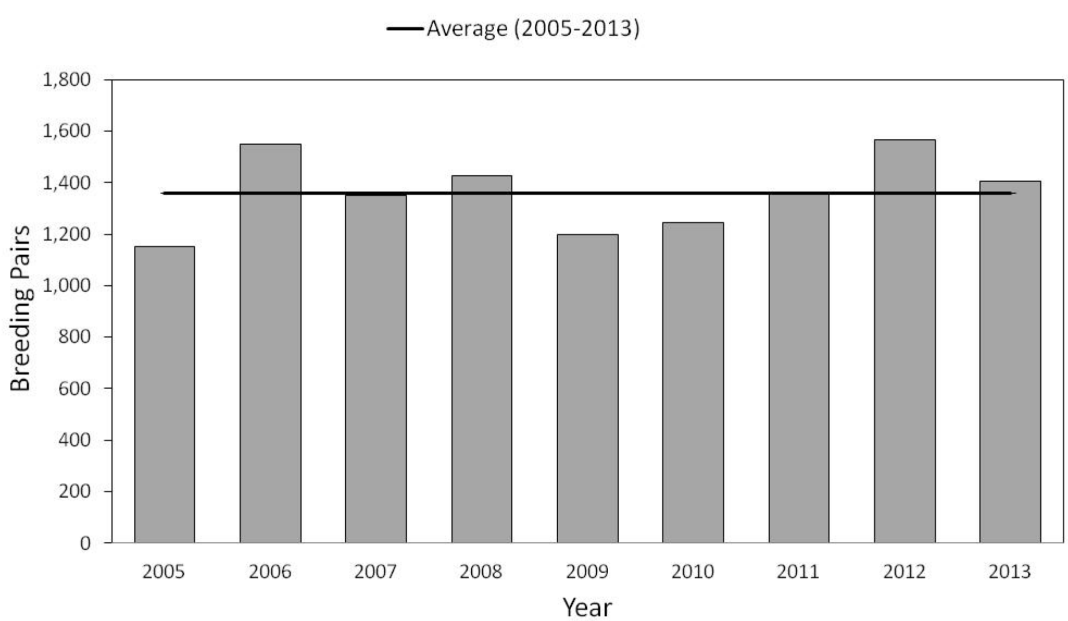
Complementary DCCO increases occurred at colonies in the southern coast during these same time periods. Three Arch Rocks on the northern coast and Bolon Island on the southern coast were two of the largest coastal Oregon colonies in some years, with 439 and 763 breeding pairs, respectively, in 2009 (Adkins and Roby 2010). However, only 13 DCCO nests on Three Arch Rocks and 647 nests on Bolon Island were observed in 2013 (USFWS 2014b).

Coastal Northern California — During 2008–2011, there were an estimated 3,415 breeding pairs at 35 active breeding colonies (Pacific Flyway Council 2013). Of all the coastal California areas considered in Adkins and Roby (2010), the Coastal Northern California sub-area had the greatest decline in estimated abundance between 2003 and 2008. During 2008, there were an estimated 1,625 breeding pairs at 18 sites in Coastal Northern California, compared to 2,437 breeding pairs at 19 sites during 2003, an approximate decrease of 33 percent or more (Adkins and Roby 2010). In 2008, this area supported approximately 33 percent of all DCCOs nesting on the California Coast, which was similar to the relative abundance in 2003 and 1989–1991 (Carter et al. 1995; Adkins and Roby 2010). Hog Island and Teal Island are two of the largest active breeding colonies in some years, supporting an estimated 548 (in 2011) and 485 (in 2008) breeding pairs, respectively (Adkins and Roby 2010; Pacific Flyway Council 2013). In 2003, 809 DCCO breeding pairs were documented at Arcata Bay Sand Island, but only 103 breeding pairs were observed in 2008 (Adkins and Roby 2010).

Coastal British Columbia — In British Columbia, DCCOs are a “blue-listed species” (i.e., species of special concern; B.C. Conservation Data Centre 2011). This designation results from low DCCO abundance in the province, as British Columbia is the northern extent of the range for the western population of DCCOs, and documented declines occurred at many breeding colonies during the 1980s and mid-1990s. In the Strait of Georgia (i.e., Vancouver Island and the lower coastal mainland), where the majority of DCCO colonies in British Columbia are located, there were an estimated 332 to 602 breeding pairs at 12 sites during 1999–2000, compared to 1,607–1,981 breeding pairs at 13 sites during 1983–1987, an approximate decrease of 66 percent or more (Moul and Gebauer 2002; Chatwin et al. 2002). Bald eagle disturbance, subsequent depredation by gulls and crows, and human disturbance were thought to be the most serious factors limiting DCCO growth (Moul and Gabauer 2002). Response to oceanic and climatic conditions (Wilson 1991) and potential immigration to other areas (i.e., East Sand Island; Anderson et al. 2004b) also likely contributed to observed colony declines. Since the late 1990s, DCCO abundance has remained relatively stable at approximately 350 to 600 breeding pairs (Moul and Gabauer 2002; Adkins and Roby 2010). DCCO abundance in coastal

British Columbia in the winter (i.e., non-breeding season) has increased during the past decade (Badzinski et al. 2008).

Interior Washington — There are approximately 7 active breeding colonies in interior Washington, and these sites supported approximately 1,544 breeding pairs in 2011 (Pacific Flyway Council 2013). Nearly all DCCOs in interior Washington breed on the Columbia River Plateau, with some small colonies near the Pend Orielle River and Spokane. Roby et al. (2014) documented 1,406 DCCO breeding pairs at 4 sites (Foundation Island, North Potholes Reservoir, Sprague Lake, and Okanogan River) on the Columbia River Plateau in 2013, which was slightly higher than the average of approximately 1,356 breeding pairs during 2005–2012. Long-term trends in interior Washington during the past decades are unclear, as comprehensive, systematic surveys of areas were not conducted until early to mid-2000s. Since 2005, DCCO abundance in the Columbia River Plateau has been relatively static, with a gradual increase in DCCO abundance during 2009–2012 and a slight decrease in 2013 (Figure 3-12). North Potholes Reservoir and Foundation Island are the largest active breeding colonies, averaging approximately 950 and 325 breeding pairs, respectively, during the past decade (Roby et al. 2014).



*Summation of point count estimates with no mesures of variance, see Roby et al. 2014

FIGURE 3-12. Estimated total number of DCCO breeding pairs in the Columbia Plateau region during 2005–2013.

Interior Oregon — During 2009–2011, there were approximately 18 active breeding colonies in interior Oregon (Pacific Flyway Council 2013). These sites supported approximately 1,040 and 800 DCCO breeding pairs in 2009 and 2011, respectively (Adkins and Roby 2010; Pacific Flyway Council 2013). Klamath Basin in southeastern Oregon has the greatest concentration of DCCOs in interior Oregon. DCCO abundance at specific sites often fluctuates greatly or exhibits cyclical increases and decreases depending on environmental and water conditions and levels of disturbance. Sites in close spatial proximity can function as a network of ephemeral sites; thus, there is likely less fluctuation in abundance at larger spatial scales. However, comprehensive, systematic survey efforts in interior Oregon have been lacking, and it is unclear if DCCO abundance in interior Oregon has changed in recent decades (Shuford 2010). Upper Klamath NWR and Malheur Lake and NWR are two of the largest active breeding colonies. Upper Klamath NWR supported 850 to 1,000 DCCO breeding pairs during 2003–2009 (Adkins and Roby 2010), but 250 breeding pairs were present in 2011 (Pacific Flyway Council 2011). Malheur Lake and NWR supported approximately 250 breeding pairs in the late 1990s and in 2011, but few to no breeding pairs were documented in the late 2000s (Adkins and Roby 2010; Pacific Flyway Council 2013).

Interior Northern California — During 2009–2011, there were approximately 16 active breeding colonies in interior Northern California, and these sites supported approximately 586 breeding pairs (Pacific Flyway Council 2013). The Klamath Basin in northeastern California has the greatest concentration of DCCOs in interior California. Smaller active breeding colonies also occur along the Sacramento River. As described above for interior Oregon, DCCO abundance at specific sites often fluctuates and comprehensive, systematic survey efforts have been lacking; thus, it is unclear if DCCO abundance in interior California has changed in recent decades (Shuford 2010). In 2009, an estimated 259 breeding pairs nested at five colonies in the Klamath Basin, which was much lower than the estimated 521 to 604 breeding pairs from partial surveys during 1992–2004 (Adkins and Roby 2010). Lower Klamath NWR and Clear Lake NWR are two of the largest active breeding colonies, and abundance at these sites has fluctuated greatly. The number of DCCO breeding pairs at Sheepy Lake in Lower Klamath NWR dropped from 978 in 1997 to 62 in 1999 because of water levels changes (Shuford 2010). In 2011, Sheepy Lake had an estimated 55 breeding pairs (Pacific Flyway Council 2013). At Clear Lake NWR, there were an estimated 97 to 200 breeding pairs during 1995–1999 and abundance peaked at 375 breeding pairs in 2000 (Shuford 2010). In 2011, Clear Lake had an estimated 148 breeding pairs. Tule Lake NWR supported approximately 150 breeding pairs in the late 1990s, but this site has not been active recently (Adkins and Roby 2010; Pacific Flyway Council 2013).

Interior British Columbia — There is one small DCCO breeding colony at the Creston Valley Wildlife Management Area (WMA). DCCO breeding pairs increased from relatively few to 98 or fewer breeding pairs during 1999–2008 (Adkins and Roby 2010).

3.2.3 Other Birds Common to East Sand Island

Other birds that could be affected by the proposed alternatives are other colonial waterbirds co-nesting or roosting on East Sand Island or other birds commonly found on the island during the nesting season when management actions are underway. Gulls, Caspian terns, and Brandt's cormorants nest on the island. Large numbers of California brown pelicans use the island for roosting and limited past instances of nesting have been observed (Table 3-3). Several raptors (e.g., eagles, owls, falcons) are also present on the island foraging on adults, eggs, and chicks. In 2012, up to 20 bald eagles were observed on the DCCO colony, killing adults and consuming eggs (BRNW unpublished data). Bald eagles also flush Caspian terns nesting in the designated tern colony, and subsequent gull predation of tern eggs has caused declines in tern productivity over the past several years.

Waterfowl nest on and use East Sand Island, although in far fewer numbers than nesting waterbirds. Areas most commonly used by waterfowl are the grassy areas on the eastern and central portions of the island. East Sand Island is within the Columbia River Estuary, which, from the mouth to RM 60, is designated as a site of regional importance to shorebirds by the Western Hemispheric Shorebird Reserve Network. Shorebirds frequent East Sand Island to roost and forage and are observed in the tidal flats and beaches. Additionally, a variety of songbirds are present in the more vegetated areas on the central portion of the island. Most, if not all of these birds, overlap with DCCOs throughout the affected environment.

A substantial amount of nesting and roosting habitat is available to birds on East Sand Island. There are approximately 60 acres of upland habitat (area above high tide) on East Sand Island, composed of vegetated (low lying grasses, shrubs, and trees), bare sand substrate, and rip-rap rock embankment (Figure 3-13). The amount of intertidal habitat, defined as the island area below the maximum high tide line, varies by tidal phase, with more area available to waterbirds and shorebirds during ebb and low tides. During low tide stages on East Sand Island, up to 90 acres of intertidal habitat can be available. This habitat is primarily used by roosting waterbirds, yet occasionally waterbirds nest in the upper intertidal zone, although nests are often inundated and destroyed during extreme high tide or storm events.

FIGURE 3-13. East Sand Island land cover classes.

A complete list of birds observed on East Sand Island during the 2013 nesting season is provided in Appendix H-2. All birds referenced in this document are protected under the MBTA and some have additional protections, which are noted. The primary co-nesting or roosting waterbird species on East Sand Island other than DCCOs are described below in more detail (Table 3-3; see Chapter 4, Section 4.2.2 for additional information concerning temporal and spatial usage of the island).

TABLE 3-3. Primary Co-nesting or Roosting Waterbirds on East Sand Island.

Species	Federal, State, Provincial, and Other Conservation Status*	Relationship to DCCO on East Sand Island	Estimated #'s on East Sand Island**	Estimated Regional Breeding Population (individuals)**
Brandt's Cormorants	RL (BC); SC (WA); HC	Co-nesting within DCCO colony on western portion	<1,600 nesting pairs	~74,000 (WA, OR, CA)
California Brown Pelicans	E (WA); E (OR); MC	Roost on East Sand Island; use inter-tidal zone and adjacent upland habitat	>10,000 roosting individuals	~100,000 (Western Region)
Caspian Terns	BL (BC); BCC; LC	Nest primarily on eastern portion but terns have attempted to nest near DCCO on western portion	~7,000 nesting pairs	~22,000 (Pacific Region)
Glaucous Winged/ Western Gull	LC/NCR	Predator of DCCO eggs and chicks; nests throughout the island and adults present throughout the island	~4,000 individuals	~73,000 (WA, OR)
Ring-Billed Gulls	NCR	Beach area near Caspian tern colony	~1,400 nesting pairs	~17,000 (Pacific Coast)

*Federal ESA Status (FED): NL= not listed, CS= candidate species, T= threatened, E= endangered; British Columbia status: BL=blue listed; RL= red listed; State-listed: C= sensitive-critical, SC= state candidate, SSC= species of special concern, V= sensitive-vulnerable, BCC= 2008 Birds of Conservation Concern; North American Waterbird Conservation Plan (2002): NCR= not currently at risk, LC= least concern, MC= moderate concern, HC= highest concern.
**Estimates for East Sand Island were from Roby et al. (2014) and BRNW (unpublished data); regional estimates were from the Pacific Region Seabird Conservation Plan (USFWS 2005b), except for Caspian terns (USFWS (unpublished data) and Collis et al. (2012))

Bald Eagles *(Haliaeetus leucocephalus)*

Bald eagles are protected under the Bald and Golden Eagle Protection Act and are common along the Washington and Oregon coast and freshwater rivers and streams at low elevations (Watson et al. 2002; Marshall et al. 2006). Bald eagles that breed along the lower Columbia River are primarily year-round residents and do not migrate. During the 1980s and early 1990s, bald eagles in this area experienced low reproductive success, characteristic of a declining population. High contaminant concentrations were thought to account for this population's low productivity (Anthony et al. 1994). The resident population has recently increased, likely as a result of recruitment of new adults from other areas (Watson et al. 2002). In addition to the resident population, migrant bald eagles from other regions overwinter on the lower Columbia River.

Breeding bald eagles are less common in eastern Washington, Oregon, and Idaho, although scattered pairs nest along lakes, reservoirs, and rivers (Stinson et al. 2007; Pacific Biodiversity Institute 2008). In winter, migrant bald eagles move into the region, focusing on salmon spawning streams and waterfowl wintering areas. In eastern Washington and Idaho, the reservoirs and major tributaries of the Columbia River and Snake River are important wintering habitats (Stinson et al. 2007). A nesting survey found 401 breeding pairs in Oregon and 40 on the Washington side of the Columbia River in 2002. Bald eagles were delisted from the ESA in 2007 and have exceeded recovery expectations. Recent increases in their numbers along the Pacific coast have been associated with substantial disturbance to nesting seabirds and waterbirds (Hipner et al. 2012).

Brandt's Cormorants *(Phalacrocorax penicillatus)*

Brandt's cormorants are similar in size and body color to DCCOs but have a bright blue gular pouch (throat patch) during the breeding season. Brandt's cormorants nest on East Sand Island within the DCCO colony (Roby et al. 2014). Brandt's cormorant temporal use of the island generally coincides with DCCOs (April–October), but their arrival and nesting stages are a few weeks later compared to DCCOs. An established breeding colony of Brandt's cormorants on East Sand Island was first documented in 2006, with 44 breeding pairs (BRNW data). Abundance steadily grew until 2012, when 1,684 breeding pairs were estimated; in 2013, 1,523 breeding pairs were estimated (Roby et al. 2014). The Brandt's cormorant regional population (WA, OR, and CA) is approximately 74,000 breeding individuals (USFWS 2005b).

California Brown Pelicans *(Pelecanus occidentalis)*

East Sand Island is the largest known post-breeding nighttime roost site for California brown pelicans in the region, supporting more than 10,000 individuals in some years, and the only known night roost for this species in the Columbia River Estuary (Wright 2005). California brown pelicans typically begin arriving to East Sand Island in very low numbers in April and peak usage is in August. They use the intertidal zone and adjacent upland habitat, and tend to avoid roosting on broad mud flats or densely vegetated interior portions of East Sand Island.

In 2013, the first California brown pelicans were observed roosting on East Sand Island in late April, and their numbers peaked in late August at about 3,850 roosting individuals, significantly less than the peak counts in 2011 (approximately 14,225 individuals; Roby et al. 2014; see Chapter 4, Section 4.2.2 for monthly counts during 2006–2013). California brown pelican breeding behavior has been observed on East

Sand Island (i.e., courtship displays, nest-building, etc.), and, in July 2013, three nests were documented on a grassy slope southeast of the Caspian tern colony, all of which contained eggs (one nest with 3 eggs and the other two nests with one egg each). These nesting attempts failed due to natural predation, and all three nests were abandoned by late July (Roby et al. 2014). This is the first documented egg-laying by California brown pelicans on East Sand Island or in Oregon; the nearest known colony is on the Channel Islands in Southern California. A northward distributional shift has been observed for California brown pelicans, as well as other seabirds, resulting from global climate change (Gremillet and Boulinier 2009).

California brown pelicans occur along the Pacific Northwest coast from June to October where they feed opportunistically in shallow marine waters, including bays and estuaries, and near offshore islands, spits, breakwaters, and open sand beaches (Seattle Audubon Society 2005). In Washington, their numbers are highest at communal roosts and on the coastline at Gray's Harbor, Ocean Shores, and Copalis, Washington (Opperman 2003; Seattle Audubon Society 2005). Their diet on the west coast consists primarily of schooling anchovies, eulachon, herring, Pacific mackerel, minnow, and sardines (Seattle Audubon Society 2005). Although available information does not indicate that California brown pelicans prey on salmon and steelhead, it is possible that the opportunistic foraging behavior would result in consumption of some salmon and steelhead. In 2005, the California brown pelican breeding population in the western region was estimated to be approximately 100,000 breeding individuals (USFWS 2005b). In 2009, California brown pelicans were removed from listing under the ESA. A draft California brown pelican monitoring plan was prepared by the USFWS and serves as the current monitoring plan.

Caspian Terns *(Hydroprogne caspia)*

The distribution of the regional population of Caspian terns in the Pacific Flyway dramatically changed during the 1980s and 1990s, likely as a result of immigration to the Lower Columbia River Estuary. Caspian tern breeding was first documented in the Columbia River Estuary in 1984 when approximately 1,000 terns were reported nesting on fresh dredged material disposed on East Sand Island. Prior to 1984, the species was a non-breeding summer resident of the lower Columbia River. In 1986, possibly because of vegetation development on East Sand Island, the colony moved to Rice Island where they nested until the Corps took actions to relocate the terns via social attraction to East Sand Island.

From the early 1980s estimate of approximately 6,000 breeding pairs (Gill and Mewaldt 1983), the Pacific Region Caspian tern population approximately doubled to 11,593 breeding pairs in 2011 (Collis et al. 2012). Abundance peaked in 2009 at approximately 19,000 breeding pairs and declined thereafter. This decline corresponded with a concurrent decrease in the East Sand Island colony (see below). The current estimate of the Pacific region population is approximately 11,000 breeding pairs (USFWS, unpublished data). The Caspian tern colony on East Sand Island is the largest in the world (Roby et al. 2014). Approximately 60 percent of the regional population currently resides on East Sand Island (USFWS, unpublished data). Caspian terns nest on the eastern end of the island, separated from the DCCO and Brandt's colonies by dense upland shrub habitat. The number of adult Caspian terns on the East Sand Island colony peaks in mid-May. A large number of Caspian terns use East Sand Island for nighttime roosting.

The number of breeding Caspian tern pairs on East Sand Island peaked in 2008 at 10,700 breeding pairs and declined incrementally through 2012 (i.e., 6,400 breeding pairs), as available habitat was gradually reduced. In 2013, abundance slightly increased to 7,400 breeding pairs, despite nesting acreage remaining constant from 2012 to 2013 (Roby et al. 2014). In 2013, approximately 0.20 young per breeding pair were produced, a significant increase, as production was zero or near zero during 2010–2012. In 2011, the colony did not produce any young; this is the first time that complete breeding failure was documented (Roby et al. 2012). Low productivity has been attributed to high levels of disturbance by bald eagles and associated gull predation on tern eggs and chicks.

Ring-billed Gulls (*Larus delawarensis*)

Ring-billed gulls nest in close association with the Caspian tern colony on the east end of the island, and their nesting chronology is similar to that of Caspian terns, with nesting ring-billed gulls present on the island from April through July. During 2013, an estimated 2,680 individuals nested on East Sand Island (Roby et al. 2014). During 2010–2012, estimated abundance was 1,417, 1,944, and 1,472 individuals, respectively (Roby et al. 2011, 2012, and 2013).

Within the Columbia River Estuary, ring-billed gulls have been observed nesting on Miller Sands Spit (Collis et al. 2002), and several hundred individuals were counted on a colony on the western portion of Rice Island. The numbers of ring-billed gulls in the Lower Columbia River Estuary have increased since 1998; 2,550 ring-billed gulls were counted on colonies in the Columbia River Estuary during a comprehensive survey in the 2009 nesting season, compared to less than 100 in 1998 (Collis et al. 2002). The continental ring-billed gull population has increased throughout the last century, and, in 2005, the estimated continental population size was approximately 1,700,000 individuals, with less than 1 percent breeding along the Pacific Coast; the current estimate of the Pacific Coast regional population is approximately 17,000 breeding individuals (USFWS 2005b).

Glaucous-winged/Western Gulls *(Larus glaucescens/occidentalis)*

Of all the colonial waterbirds that nest on East Sand Island, Glaucous-winged/western gulls are the only species that nest on both the eastern and western portions of the island. Glaucous-winged/western gulls are the first to arrive on the island (before March) and initiate nest territory defense (early March). The peak nesting period is in May and June, with some individuals remaining on the island as late as November. Glaucous-winged/western gulls are increasing throughout the Pacific Coast of North America, with an estimated regional population (WA and OR) of approximately 73,000 breeding individuals (USFWS 2005b).

In 2013, an estimated 4,580 Glaucous-winged/western gulls nested on East Sand Island and Rice Island. Glaucous-winged/western gulls typically breed on Miller Sands Spit, but breeding was not documented in 2013 (Roby et al. 2014). The number of Glaucous-winged/western gulls at these three colonies at the peak of nesting was 6,966, 6,776, and 3,369 individuals during 2010, 2011, and 2012, respectively. In 2012, estimated abundance on Rice Island and Miller Sands Spit was approximately 1,000 and 200 to 500 individuals, respectively (Roby et al. 2011, 2012, and 2013).

Waterfowl

Mallards (*Anas platyrhynchos*) and western Canada geese (*Branta canadensis moffitti)* are the most abundant breeding waterfowl on the islands in the Lower Columbia River Estuary (BRNW unpublished data). Non-breeding brant (*Branta bernicla*) are observed on East Sand Island during the summer. Nesting waterfowl mainly occur in vegetated areas on the east end of East Sand Island (BRNW unpublished data).

3.2.4 Other Birds

For other birds within the affected environment outside of East Sand Island, consideration is primarily limited to bird species that could potentially be impacted by the proposed alternatives. Focus is on species within the sub-regions of the affected environment, particularly the Columbia River Estuary, Washington Coast, and Salish Sea, and specifically to those species that co-nest or overlap in habitat use with DCCOs and are a conservation concern. DCCOs are colonial waterbirds and commonly nest with other waterbirds. All of the bird species co-nesting or roosting with DCCOs on East Sand Island also occur with DCCOs in other areas in the affected environment. These species were described in Chapter 3, Section 3.2.3, and are thus not included again in this chapter. Co-nesting species have the potential to be most impacted by large increases of DCCOs at a location through nest-site competition and possible displacement.

Bird species identified by the cooperating agencies for consideration are given in Table 3-4 and described below in more detail. Birds listed under the ESA within the affected environment, the sub-regions, and the Columbia River Estuary, are provided in Appendix H-1. Only one bird species of federal conservation concern, the streaked horned lark, which was recently designated as threatened, was identified on both lists. Within the Lower Columbia River Estuary, recent surveys have documented breeding streaked horned larks on Rice, Miller Sands Spit, Pillar Rock, Welch, Tenasillahe, Coffeepot, Whites/Browns, Wallace, Crims, and Sandy Islands in Wahkiakum and Cowlitz Counties in Washington, and Columbia and Clatsop Counties in Oregon (Pearson and Altman 2005). The Corps' Channels and Harbors Program has completed Section 7 consultation with the USFWS for the continued operations and maintenance dredging program for the Columbia River Federal Navigation Channel for placement and associated hazing of piscivorous waterbirds (Caspian terns and DCCOs).

American white pelicans and pelagic cormorants nest in the Columbia River Estuary. The other species identified in Table 3-4 primarily nest along coastal areas outside of the Columbia River Estuary. As stated in Chapter 3, Section 3.1, outside of the Columbia River Estuary, the Washington Coast and the Salish Sea areas likely have the greatest potential for immigration of DCCOs deterred from nesting on East Sand Island and the Columbia River Estuary. Waterbird declines have been documented in the Salish Sea area over the past decades (Bower 2009; Crewe et al. 2012). Increased numbers of DCCOs immigrating to this area have the potential to affect the other bird species present.

TABLE 3-4. Other Birds Found with DCCO in the Affected Environment.

Species	Federal, State, Provincial, and Other Conservation Status*	Where Found with DCCOs	Estimated Regional Breeding Population (individuals)**
American White Pelican	RL (BC); E (WA); V (OR); SSC (CA); MC	Columbia River Estuary, nests on Miller Sands Spit; breeding colonies in interior B.C., WA, and in the Klamath Basin of SE OR and NE CA.	~46,000 (Western Pop)
Pelagic Cormorant	RL (BC); BCC; HC	Columbia River Estuary, nests on Astoria-Megler Bridge and other in-water structures; coastal CA to B.C.	~29,000 (Pacific Region)
Streaked horned Lark	T (ESA); E (WA); C (OR); BCC	Columbia River Estuary, Rice Island, Brown Island; south Puget Sound and Washington Coast.	~150 (OR and WA)
Black Oystercatcher	V (OR); BCC	Coastal CA to B.C., concentrations in Salish Sea; nests on non-forested islands with gravel or shell beaches.	~10,000 (N. America)
Cassin's Auklet	BL (BC); SC (WA); V (OR); SSC (CA); BCC; MC	Coastal CA to B.C, with <1 percent in OR.	~180,000 (Pacific Region)
Rhinoceros Auklet	V (OR); LC	Coastal CA to B.C., primarily WA, B.C, and Salish Sea.	~1,000,000 (N. America)
Common Murre	RL (BC); SC (WA); MC	Coastal CA to B.C.; *U. a californica* primarily in OR and CA.	~1,000,000 (WA, OR, CA; *U. a californica*)
Fork-tailed Storm-Petrel	SSC (CA)	Coastal N CA to B.C, primarily WA.	~5,000 (WA, OR, CA)
Leach's Storm-Petrel	LC	Coastal CA to B.C, primarily OR.	~450,000 (WA, OR, CA)
Pigeon Guillemot	MC	Coastal CA to B.C., primarily WA and CA.	~38,000 (WA, OR, CA)
Tufted Puffin	BL (BC); SC (WA); V (OR); SSC (CA); LC	Coastal CA to B.C., primarily B.C. and WA and Three Arches NWR in OR.	~<15,000 (WA, OR, CA)
Pacific Great Blue Heron	BL (BC); NCR	Arboreal nester; coastal B.C. south to Puget Sound.	~10,000 (B.C. and WA)

*Federal ESA Status (ESA): NL= not listed, CS= candidate species, T= threatened, E= endangered; British Columbia status: BL=blue listed; RL= red listed; State-listed: C= sensitive-critical, SC= state candidate, SSC= species of special concern, V= sensitive-vulnerable; BCC= 2008 Birds of Conservation Concern; North American Waterbird Conservation Plan (2002): NCR= not currently at risk, LC= least concern, MC= moderate concern, HC= highest concern.

**Regional estimates were from the Pacific Region Seabird Conservation Plan (USFWS 2005b), except for American white pelican (Pacific Flyway Council 2012a), streaked-horned lark (Altman 2011), black oystercatcher (Tessler et al. 2010), and Pacific great blue heron (COSEWIC 2008).

American White Pelican (*Pelecanus erythrorhynchos*)

The first nesting record of American white pelicans in the Columbia River Estuary occurred at Miller Sands Spit during 2010. Since that time, the colony has averaged approximately 100 individuals each year. In 2013, a minimum of 104 individuals was estimated (Roby et al. 2014). While estimates of nesting success are unavailable, American white pelicans were successful in raising young at the Miller Sands Spit colony during 2010-2012 (data were unavailable for 2013; Roby et al. 2014). American white pelicans in the Columbia River Estuary compose a small portion of the western population of American white pelicans, which is estimated to be approximately 46,000 breeding individuals (Pacific Flyway Council 2012a).

Pelagic Cormorant *(Phalacrocorax pelagicus)*

Pelagic cormorants are similar in body color to DCCOs but smaller in size and have a very small red gular pouch (throat patch) during the breeding season. Pelagic cormorants typically nest on coastal mainland cliffs and offshore islands and occupy bridges and other in-water structures. Colony sizes are typically less than 100 individuals. In 2013, an estimated 72 breeding pairs nested on the Astoria-Megler Bridge, slightly lower than the 106 breeding pairs estimated in 2012 (Roby et al. 2014). This is the only known pelagic cormorant nesting site within the Columbia River Estuary. Pelagic cormorants have been observed nesting on the southern portion of the bridge since surveying began in 1999 (Roby et al. 2013). The number of pelagic cormorants in the Columbia River Estuary composes a small portion of the Pacific Region population; approximately 29,000 pelagic cormorants breed in the Pacific Region, with the majority (more than 40 percent) of the population breeding in California (USFWS 2005b). In the Salish Sea region, there has been increasing or no significant trend observed in pelagic cormorant wintering abundance, but declines of breeding abundance have been documented in this area (Bower 2009; Crewe et al. 2012).

Streaked horned Lark (*Eremophila aipestris strigata*)

The streaked horned lark was listed as threatened under the ESA October 3, 2013 (78 FR 61452). The current range and distribution of the streaked horned lark can be divided into three regions: (1) the south Puget Sound in Washington; (2) the Washington coast and lower Columbia River islands; and (3) the Willamette Valley in Oregon. Substantial declines have been documented across nearly the entire geographic range of the species. The current range-wide population is estimated to be about 1,170 to 1,610 individuals, with 150 to 170 breeding individuals at six sites in Oregon and Washington (Altman 2011, 78 FR 61452) and 45-60 breeding pairs in the Columbia River Estuary (Anderson 2013). Critical habitat has been designated on many islands within the

Columbia River Estuary (50 C.F.R. § 17.95(b)). A key attribute of habitat used by streaked horned larks is open landscape context. Streaked horned larks nest on the ground in sparsely vegetated sites dominated by grasses and forbs and are known to occupy dredged material islands typically after 1 to 3 years of a disposal event when vegetation emerges (Pearson and Altman 2005; Pearson et al. 2005). Within the Lower Columbia River Islands, recent surveys have documented breeding streaked horned larks on Rice, Miller Sands Spit, Pillar Rock, Welch, Tenasillahe, Coffeepot, Whites/Browns, Wallace, Crims, and Sandy Islands in Wahkiakum and Cowlitz Counties in Washington, and Columbia and Clatsop Counties in Oregon (Pearson and Altman 2005). The majority of breeding individuals in the Columbia River Estuary are found on Rice and Brown Island. In 2013, 22 breeding pairs were observed on Rice Island.

On Rice Island, streaked horned larks have been observed nesting on the plateau region of the Corps' dredged material at a higher elevation, several hundred feet above the beach area used by the few loafing Caspian terns and DCCOs that have occupied the island. Rice Island is a former major colony site for both DCCO and Caspian terns and a likely area for DCCO dissuaded from East Sand Island to attempt to nest. Miller Sands Spit and Pillar Rock Island were also designated critical habitat, and these areas were identified as potential DCCO dispersal locations and potential locations for hazing (see Table 2-4).

East Sand Island was not designated critical habitat for streaked horned larks. Since 2008, field crews have had presence on the island, typically February through September. During the field season, biologists walk the island daily, providing weekly monitoring reports. To date there have been no observations of streaked horned larks on East Sand Island during the nesting season. Rare observations of streaked horned lark have been made on East Sand Island (on the Caspian tern colony and eastern portion of the island) in late winter/early spring prior to Caspian terns and DCCOs arriving (D. Roby, USGS, personal communication 2014). One incidental observation of horned larks (not identified to subspecies) was made on April 17, 2013 (G. Smith, personal communication, 2014).

Black Oystercatcher *(Haematopus bachmani)*

Black Oystercatchers occur uncommonly along the North American Pacific coast from the Aleutian Islands to Baja California. Survey data are sparse, but the global population is approximately 10,000 individuals, making it one of the least abundant shorebird species in North America (Tessler et al. 2010). The majority (approximately 65 percent) of the global population resides in Alaska, and the species is most abundant from Alaska to southern British Columbia (Tessler et al. 1010). In the Salish Sea, an estimated 210 breeding pairs nested in 2005–2006 and breeding and wintering abundance has been either stable or increasing (Crewe et al. 2012). Black oystercatchers forage exclusively on intertidal macroinvertebrates (i.e., mussels and limpets predominantly) and nest in low densities. In Washington, black oystercatchers occasionally nest on gravel beaches on offshore islands, but there are few nests found on gravel in Oregon or California (Tessler et al. 2010).

Cassin's Auklet *(Ptychoramphus aleuticus)*

Cassin's auklets breed in natural crevices or burrows along the coast. The global population is estimated to be 3.6 million breeding individuals, with the core of the population breeding in British Columbia; the Pacific Region (Washington, Oregon, California) includes less than 5 percent of the global population (USFWS 2005b). In Washington, the breeding population is approximately 87,600 individuals, with the majority breeding on Alexander Island (approximately 54,600 individuals). In Oregon, there are an estimated 500 breeding individuals. The largest breeding colony (approximately 20,000 individuals) in California is on the Farallon Islands, which is the southernmost boundary of the affected environment. Population declines have been documented at many breeding colonies throughout the species' range (USFWS 2005b).

Rhinoceros Auklet *(Cerorhinca monocerata)*

There are approximately 1 million breeding individuals within the North American population of rhinoceros auklets, and distribution is primarily concentrated along the coasts of southeast Alaska, British Columbia, and northern Washington (USFWS 2005b). There are two major breeding colonies in Washington that support approximately 50,000 breeding individuals: Destruction Island along the coast and Protection Island in the Salish Sea; both are National Wildlife Refuges (USFWS 2005b). In Oregon, there are approximately 1,000 breeding individuals along the coast. Rhinoceros auklets have re-colonized areas in California where the breeding population is estimated to be approximately 2,000 individuals (USFWS 2005b). Breeding abundance declines at Protection Island and wintering abundance declines in the Salish Sea have been observed, although monitored breeding colonies elsewhere in British Columbia have been stable or increasing (USFWS 2005b; Crewe et al. 2012). Recent surveys documented 36,152, 1,546, and 6,494 occupied Rhinoceros Auklet burrows on Protection, Smith, and Destruction Islands, a 52 percent increase in abundance in the Salish Sea from the 1970s and 1980s, and a 60 percent decrease at Destruction Island since 1975 (Pearson et al. 2013).

Common Murre *(Uria aalge)*

U. a. californica is the recognized sub-species that breeds in California, Oregon, and Washington, and this population is estimated to be approximately 1 million breeding individuals (USFWS 2005b). The majority of the breeding population is in Oregon (approximately 712,000 individuals) and California (approximately 352,000 individuals), and abundance in these areas is stable or increasing (USFWS 2005b). Washington has approximately 7,000 breeding individuals (USFWS 2005b). Decreases in wintering abundance in the Salish Sea have been observed; there are no known breeding colonies in this area (Crewe et al. 2012).

Fork-tailed Storm-Petrel *(Oceanodroma frucata)*

Fork-tailed Storm-Petrels breed widely throughout the north Pacific, and the core of the breeding population resides in Alaska. Global populations and trends are unclear because of sparse data, due to nocturnal attendance at colonies and burrowing or crevice-nesting habits. There are an estimated 5,000 breeding individuals in Washington (approximately 3,900), Oregon (approximately 500), and California (approximately 400), which represents approximately less than 1 percent of the North American population (USFWS 2005b).

Leach's Storm-Petrel *(Oceanodroma leucorhoa)*

Leach's storm-petrels breed widely throughout the Pacific. The estimated global population is more than 16 million breeding individuals, although estimates and trends are unclear because of sparse data due to nocturnal attendance at colonies and burrowing or crevice-nesting habits (USFWS 2005b). There are an estimated 450,000 breeding individuals in Washington (approximately 36,000), Oregon (approximately 435,000), and California (approximately 12,500), which represents approximately 3 percent of the global population (USFWS 2005b).

Pigeon Guillemot *(Cepphus columba)*

Pigeon guillemots breed widely throughout the Pacific. The estimated global and North American populations are approximately 246,000 and 88,000 breeding individuals, respectively (USFWS 2005b). There are five recognized sub-species, two of which breed in the Pacific Region: *C. c. adianta* (British Columbia and Washington) and *C. c. eureka* (Oregon and California). There are an estimated 38,000 breeding individuals within Washington (approximately 18,000), Oregon (approximately 4,500), and California (approximately 15,500), which represents approximately 40 percent of the North American population (USFWS 2005b). Population trends are largely unknown due to sparse data. However, new breeding colonies have become established in the southern portion of the species' range (USFWS 2005b), and increases in winter abundance in the Salish Sea and coastal British Columbia have been documented (Bower 2009; Crewe et al. 2012).

Tufted Puffin (*Fratercula cirrhata)*

The estimated Tufted puffin global population is 3 million breeding individuals, of which less than 1 percent are located in Washington, Oregon, and California; the majority (approximately 95 percent) of the North American population resides in Alaska (USFWS 2005b). Estimates and trends are unclear because of sparse data due to burrowing or crevice-nesting habits, but breeding populations in the past decades appear to have increased in the Gulf of Alaska and westward and declined throughout southeast Alaska, British Columbia, Washington, Oregon, and California (USFWS 2005b).

In Washington, abundance decreased from approximately 23,000 breeding individuals in the 1980s to several thousands in recent years, and there was an estimated 60 percent decrease in occupancy of historic breeding sites during the past 25 years (approximately 50 percent in the Salish Sea; WDFW 2012). In Oregon, approximately 66 percent of tufted puffins bred at Three Arch Rocks NWR, which supported approximately 2,000 to 4,000 breeding individuals in the early 2000s. However, this colony is on the decline and only 200 breeding individuals were observed in 2013 (USFWS 2014b). The largest colony is now at Haystack Rock (USFWS 2014b). A few hundred individuals breed in California (Shuford and Gardali 2008). On February 11, 2014 the National Resources Defense Council petitioned the USFWS to list the tufted puffin under the ESA in California, Oregon and Washington, citing impacts from climate change, fish nets, oil spills, and declines in marine forage fish availability (NRDC 2014).

Great Blue Heron, Pacific sub-species *(Ardea herodias fannini)*

Great blue herons are a very common species with a wide distribution across most of North America. They are obligate tree nesters. Pacific great blue herons are a sub-species, distributed along the Pacific Coast from Prince William Sound, Alaska south to Puget Sound, Washington, and reside within this range year-round. Total population is approximately 9,500 to 11,000 breeding individuals, with approximately 4,000 to 5,000 breeding individuals in British Columbia (COSEWIC 2008). Population declines since the 1970s have been documented (COSEWIC 2008).

3.2.5 ESA-Listed Fish

ESA-listed listed fish species were chosen as the focus of analyses because they are the underlying focus of conservation efforts related to RPA actions in the FCRPS Biological Opinion. Due to their critical conservation status, ESA-listed species have the potential to be most seriously impacted by proposed alternatives. In many instances, data are often more readily available for ESA-listed species compared to other species, which provides a more robust and meaningful analysis. Additionally, the distribution of ESA-listed fish species and range of critical habitat overlaps areas where state-listed or other fish species are present. Thus, analyses of ESA-listed fish species adequately provide information for other species that could be impacted by DCCO predation in those areas.

This section is further narrowed down to address ESA-listed fish within sub-regions of the affected environment (i.e., the Lower Columbia River Basin, Oregon Coast, Washington Coast, Salish Sea, and Vancouver Island Coast). Several fish species protected by the ESA occur within the sub-regions identified in Chapter 3 and are potential prey for DCCOs if dispersed from East Sand Island (Table 3-5).

TABLE 3-5. ESA-listed Fish Species that Occur within the Sub-regions of the Affected Environment. ESA Status (Threatened [T], Endangered [E]) of Each Species or Distinct Population Segment (DPS) is provided.

Species - *ESU, DPS*	**ESA Status**	**Presence in Sub-Regions of Affected Environment**
Bocaccio rockfish	Endangered	Salish Sea
Bull trout	Threatened	Salish Sea/Washington Coast/Lower Columbia River
Canary rockfish		
Puget Sound/Georgia Basin	Threatened	Salish Sea
Chinook salmon		
Lower Columbia River	Threatened	Lower Columbia River
Snake River Fall-run	Threatened	Lower Columbia River
Snake River Spring/Summer-run	Threatened	Lower Columbia River
Upper Columbia River Spring-run	Endangered	Lower Columbia River
Upper Willamette River	Threatened	Lower Columbia River
Puget Sound	Threatened	Salish Sea
Chum salmon		
Columbia River	Threatened	Lower Columbia River
Hood Canal	Threatened	Salish Sea
Coho salmon		
Lower Columbia River	Threatened	Lower Columbia River
Oregon Coast	Threatened	Oregon Coast
Southern OR/Northern CA	Threatened	Oregon Coast
Green Sturgeon*	Threatened	Pacific Southern
Pacific eulachon	Threatened	Salish Sea/Washington Coast/Lower Columbia River /Oregon Coast
Sockeye salmon		
Ozette Lake	Threatened	Washington Coast
Snake River	Endangered	Lower Columbia River
Steelhead		
Lower Columbia River	Threatened	Lower Columbia River
Middle Columbia River	Threatened	Lower Columbia River
Snake River Basin	Threatened	Lower Columbia River
Upper Columbia River	Threatened	Lower Columbia River
Upper Willamette River	Threatened	Lower Columbia River
Puget Sound	Threatened	Salish Sea
Yelloweye rockfish	Threatened	Salish Sea

***** Only sub-adult and adult green sturgeon are present in the Columbia River Estuary and neither are a prey species of DCCOs; however, the species is included in the table because it and Pacific eulachon are non-salmonid ESA-listed species present in the Columbia River and affects could occur from Phase II terrain modification on East Sand Island.

Overview of Fish in the Affected Environment

The majority of ESA-listed fish species in the sub-regions of the affected environment belong to the salmon and trout family, *Salmonidae.* Pacific salmon and trout are an important biological, cultural, and economic resource in the Pacific Northwest. Many populations have been declining since the late nineteenth century, with documented losses to harvest, habitat degradation, hydropower development, and other anthropogenic causes (Gresh et al. 2000; Lichatowich 2001; NOAA 2014a). More recently, avian predation has been identified as a factor limiting the recovery of ESA-listed salmonid populations in the Columbia River Basin (see Chapter 2, Section 2.6). Before industrialized development occurred, numbers of adult salmon in the Columbia River Basin were estimated to be around 10 to 16 million adult fish per year (Gresh et al. 2000). Currently, less than two million adult salmon return to the Columbia River Basin annually (FPC 2014).

The maximum sized fish a DCCO can consume depends on the mass and shape of the fish, but is generally no greater than about 17 inches (Hatch and Weseloh 1999; BRNW unpublished data). Thus, predation concerns are primarily associated with the consumption of juvenile-sized fish, as most adult-size fish, particularly anadromous salmonids, exceed 17 inches in length (Groot and Margolis 1991). Anadromous salmonids generally exhibit two principal life history types: stream- and ocean-type. Stream-type salmonids typically rear in fresh water for a year or more (referred to as "yearlings") before beginning their downstream migration to the ocean. Ocean-type salmonids typically migrate downstream within days to months following hatching (referred to as "subyearlings"). Both life history types, stream and ocean, are susceptible to DCCO predation. The run-timing and abundance of fish that exhibit these life histories, however, can vary substantially by species, population, and location (Groot and Margolis 1991).

The southern DPS of Pacific eulachon (*Thaleichthys pacificus*), which ranges from the Mad River in California to the Elwha River in Washington, were ESA-listed in 2011. Similar to ocean-type salmonids, these anadromous fish migrate to the ocean shortly after hatching. Unlike most anadromous salmonids, however, both juvenile and adult Pacific eulachon are susceptible to DCCO predation due to the small size of adult eulachon (approximately 9 inches). Known threats to Pacific eulachon recovery include habitat loss and degradation, hydroelectric dams and dam operations, and adverse environmental conditions (NOAA 2014b).

The Pacific southern DPS of green sturgeon consists of populations originating from coastal watersheds south of the Eel River in Humboldt County, California, with the only known spawning population in the Sacramento River. When not spawning, the species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea (NOAA 2013a, 2014b). Critical habitat was designated in 2009, and the designation includes coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California to Cape Flattery, Washington, and various estuaries, including the Lower Columbia River Estuary (USDC 2009). Green sturgeon sub-adults and adults use the Columbia River Estuary for non-breeding, non-rearing purposes. Sampling suggests that green sturgeon occupy large estuaries during the summer and early fall (Moser and Lindley 2007) and primarily use deep waters of the mainstem Columbia River Estuary (NOAA 2013a).

Three species of rockfish (bocaccio [*Sebastes paucispinis*], canary rockfish [*Sebastes pinniger*], and yelloweye rockfish [*Sebastes ruberrimus*]) found in the Salish Sea sub-region were ESA-listed in 2010. These species are strictly found in marine waters. Adult rockfish are generally found in deep water (greater than 80 feet) and are often too large to be consumed by DCCOs. Juvenile rockfish, however, are known to inhabit shallower water near kelp beds, rocky tidal areas, and other structures where they could potentially be susceptible to DCCO predation. Known threats to bocaccio, canary, and yelloweye rockfish include direct harvest, by-catch in commercial fisheries, and adverse environmental conditions (NOAA 2014a). A more detailed description of the list history, distribution, and potential impact of DCCO predation on ESA-listed fish within the sub-regions of the affected environment is presented in Sections 3.2.6 and 3.2.7.

3.2.6 ESA-listed Fish in the Lower Columbia River Basin

Six fish species, representing fifteen different ESA-listed ESUs or DPSs, occur in the Lower Columbia River Basin and are potential prey to DCCOs within the sub-regions of the affected environment. Many of these fish populations originate upstream of the Lower Columbia River Basin but use the Lower Columbia River during the migratory portion of their life. Because DCCO predation primarily affects small fish, information presented in this section focuses on the juvenile life stage of each ESA-listed fish species or ESU or DPS.

Data regarding DCCO impacts to ESA-listed fish in the Lower Columbia River Basin are primarily based on studies conducted by Bird Research Northwest (BRNW) at the East Sand Island DCCO colony, including an analysis of juvenile salmonid consumption based on DCCO diet samples and bioenergetics modeling and ESU or DPS-specific predation rates based on recoveries of salmonid PIT tags. Empirical data, however, are not available for all ESA-listed ESU or DPS salmonid groups that occur in the Lower Columbia River Basin. Where data are available, it is provided. For those species lacking empirical data, potential impacts are primarily based on spatial or temporal overlap with the DCCO nesting season at East Sand Island and critical habitat designations for ESA-listed fish in the Lower Columbia River Basin.

Bull Trout (*Salvelinus confluentus*)

This DPS includes all bull trout within the contiguous United States (USFWS 2014a). Bull trout in the Columbia River Basin exhibit a resident, fluvial (migration between different streams or rivers), and adfluvial (migration between streams and lakes) life history. Use of the Columbia River Estuary by bull trout is believed to be minimal because bull trout from the Columbia River Basin are not anadromous (USFWS 2014a). Adult bull trout spawn in late summer to late fall (August to November) and reach maturity at 4 to 7 years of age (USFWS 2014a). Fish can live to be 12 years of age. Size at maturity varies by location and life history (migratory versus resident), but is generally between 12 and 20 inches, with fish greater than 30 inches and 30 lbs observed (USFWS 2014a). PIT tags implanted in juvenile and sub-adult bull trout have been detected on a DCCO colony located in the middle Columbia River (Roby et al. 2013); however, bull trout PIT tags have not been recovered on the East Sand Island DCCO colony, nor have bull trout been identified in DCCO diet samples. As such, there is no evidence that DCCOs nesting on East Sand Island have consumed bull trout in the Lower Columbia River Basin to date.

Lower Columbia River Chinook Salmon (*Oncorhynchus tshawytscha*)

This ESU includes all naturally spawned populations of Chinook salmon from the mouth upstream to the Hood River and the White Salmon River, including the Willamette River to Willamette Falls, Oregon (NOAA 2011a). Select hatchery stocks are also included in the ESU. Juveniles typically out-migrate to the ocean in the spring (April-June) as yearlings or in late spring to summer (June-August) as subyearlings. Numerically, hatchery-reared subyearlings dominate the juvenile population, with between 50 and 100 million subyearlings released annually into the Lower Columbia River Basin since the 1990s (NOAA 2011a). Based on a small number of PIT-tagged lower Columbia River hatchery Chinook, annual predation rates by DCCOs nesting on East Sand Island averaged 26 percent (range = 4-40 percent) of available fish during 2007-2010 (Lyons et al. 2014), representing some of the highest salmonid predation rates documented. Data indicate that hatchery stocks released in close proximity to East Sand Island and subyearling Chinook were the most vulnerable to DCCO predation in the Columbia River

Estuary (Sebring et al. 2013). Due to a lack of wild Chinook PIT-tagging for this ESU, especially below Bonneville Dam, and the disproportionate tagging of fish in close proximity to East Sand Island, however, it is unknown how representative these predation rate estimates are to all Chinook from the Lower Columbia River ESU (Lyons et al. 2014).

Diet composition data collected from DCCO nesting on East Sand Island also indicate that subyearling Chinook are particularly vulnerable to cormorant predation, with average annual consumption estimates of 7.8 million (range = 1.9-15.6) subyearling Chinook during 2004-2013. Although this estimate includes subyearling Chinook from all Columbia River Basin populations (Lower Columbia River, Snake River, Upper Columbia River, and others combined), genetic analysis indicates that the majority (ca. 70 percent) of subyearling Chinook consumed by DCCOs originate from the Lower Columbia River ESU (Roby et al. 2014).

Snake River Fall-run Chinook Salmon

This ESU includes all naturally spawned fall-run Chinook salmon in the lower Snake River and in lower reaches of the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River sub-basins (NOAA 2011a). Select hatchery stocks are also included in the ESU. Juveniles out-migrate during the spring as yearlings or in late spring to early fall (June–September) as subyearlings (Keefer and Peery 2008). Predation rates by DCCO nesting on East Sand Island indicate that an average of 3 percent (range = 2-5 percent) of available Snake River fall-run Chinook smolts were annually consumed by DCCOs during 2004-2013.

Snake River Spring/Summer-run Chinook Salmon

This ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River sub-basins (NOAA 2011a). Select hatchery stocks are also included in the ESU. Snake River spring/summer-run Chinook salmon out-migrate in the spring as yearlings. Predation rates by DCCO nesting on East Sand Island indicate that an average of 4 percent (range = 2-7 percent) of available Snake River spring/summer Chinook smolts were annually consumed by DCCOs during 2004-2013.

Upper Columbia River Spring-run Chinook Salmon

This ESU includes all naturally spawned populations of spring-run Chinook salmon in tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington State (NOAA 2011a). Select hatchery stocks are also included in the ESU.

Upper Columbia River spring-run Chinook are one of two ESA-listed Columbia River Basin salmonid populations designated as endangered (the other being Snake River sockeye), and they are considered to be at a high risk of extinction (NOAA 2011a). Upper Columbia River spring-run Chinook salmon out-migrate during the spring as yearlings. Predation rates by DCCO nesting on East Sand Island indicate that an average of 4 percent (range = 2-6 percent) of available Upper Columbia River spring-run Chinook smolts were annually consumed by DCCOs during 2004-2013.

Upper Willamette River Chinook Salmon

This ESU includes all naturally spawned spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries, above Willamette Falls, Oregon (NOAA 2011a). Select hatchery stocks are also included in the ESU. Upper Willamette River Chinook salmon out-migration times vary considerably compared to other ESA-listed salmonid populations in the Columbia River Basin, with fish out-migrating nearly year round (FPC 2014). Peak out-migration generally occurs in the spring as yearlings. Predation rates by DCCO nesting on East Sand Island indicate that an average of 2 percent (range = 1-4 percent) of available Upper Willamette River Chinook smolts were annually consumed by DCCOs in the Columbia River Estuary during 2007-2013.

Columbia River Chum Salmon *(O. keta)*

This ESU includes all naturally spawned chum salmon in the Columbia River and its tributaries in Oregon and Washington (NOAA 2011a). Select hatchery stocks are also included in the ESU. Although all naturally spawned chum salmon found in the Columbia River are included in the ESU, the vast majority of Columbia River chum originate in streams located downstream of Bonneville Dam (NOAA 2011a). Chum salmon fry out-migrate shortly after emergence in late winter to spring (March-May). Juvenile chum salmon may reside and feed in the Upper or Lower Columbia River Estuary before entering the open ocean (Groot and Margolis 1991). There are no PIT tag-based predation rate estimates available for Columbia River chum. Diet composition data from DCCO nesting on East Sand Island indicate that chum salmon are rarely consumed, however, with only one juvenile salmonid genetically identified as a chum salmon out of 451 samples tested (Lyons et al. 2014). Consequently, impacts to Columbia River chum salmon from DCCOs nesting on East Sand Island were likely minimal, although data regarding ESU-specific predation rates are lacking.

Lower Columbia River Coho Salmon *(O. kisutch)*

This ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries, from the mouth up to and including the Big White Salmon River and Hood River and up the Willamette River to Willamette Falls, Oregon (NOAA 2011a). Select hatchery stocks are also included in the ESU. Lower Columbia River coho out-migrate during the spring as yearlings. Similar to other ESA-listed salmonid populations that originate in the Lower Columbia River Basin, the majority of coho from this ESU are found in streams located downstream of Bonneville Dam. Based on the limited number of coho PIT-tagged downstream of Bonneville Dam, predation rates by DCCOs nesting on East Sand Island on juvenile coho averaged 28 percent (range = 10-30 percent) of the available fish during 2007-2010 (Lyons et al. 2014), representing some of the highest salmonid predation rates documented. Few wild coho, however, were PIT-tagged, and estimates were based predominately on select groups of hatchery fish released in close proximity to East Sand Island; thus, it is unknown how representative these predation rate estimates are to all coho from the Lower Columbia River ESU (Lyons et al. 2014). Diet composition data collected from DCCOs nesting on East Sand Island also indicate that juvenile coho are particularly vulnerable to DCCO predation in the Columbia River Estuary, with average annual consumption estimates of 2.4 million (range = 0.3-4.8) smolts during 2004-2013. Although this estimate includes coho from all populations or stocks combined, genetic analysis indicate that the majority (ca. 80 percent) of coho found in DCCO diet samples originated from the Lower Columbia River ESU (Roby et al. 2014).

Green Sturgeon (*Acipenser medirostris*)

This DPS includes green sturgeon originating from coastal watersheds south of the Eel River in Humboldt County, California, with the only known spawning population in the Sacramento River. When not spawning, the species is broadly distributed in nearshore marine areas from Mexico to the Bering Sea (NOAA 2013a, 2014b). Green sturgeon sub-adults and adults use the Columbia River Estuary for non-breeding, non-rearing purposes. Sampling suggests that green sturgeon occupy large estuaries during the summer and early fall (Moser and Lindley 2007) and primarily use deep waters of the mainstem Columbia River Estuary (NOAA 2013a). Sub-adult and adult green sturgeon in the Columbia River Estuary are not a prey species of DCCOs because of their size. However, because of their presence in the Columbia River Estuary, effects could occur to the species from Phase II terrain modification, although effects would likely be negligible.

Pacific Eulachon (*Thaleichthys pacificus*)

This DPS includes eulachon from the Mad River in northern California to the Elwha River in Washington, an area referred to as the southern DPS (NOAA 2014a). Pacific eulachon are small (maximum length approximately 9 inches), anadromous fish (NOAA 2014a).

The Columbia River and its tributaries are believed to support the largest eulachon runs in the southern DPS (NOAA 2011b). Although little is known about the movement of larvae and juvenile eulachon, they are believed to move quickly through the estuary (weeks), are widely distributed in the ocean, and are typically found in deep water (60 to 450 feet; NOAA 2011b). In the Columbia River, adult eulachon return to spawn in late winter to early spring (February to early April; NOAA 2011b). Due to their small size, eulachon are susceptible to DCCO predation throughout their entire life cycle. There is very little temporal overlap, however, between the DCCO nesting season (April to September) and the adult eulachon spawning run. Furthermore, eulachon (juveniles or adults) have not been identified in East Sand Island DCCO diet samples, so the impact of nesting DCCO on eulachon in the Lower Columbia River Basin is presumed to be minimal. The impact of non-breeding birds or breeding birds that arrive in the Columbia River Estuary before the nesting season, however, is unknown. There are no PIT tag-based predation rate estimates available for Pacific eulachon.

Snake River Sockeye Salmon *(O. nerka)*

This ESU includes all anadromous sockeye from the Snake River Basin, Idaho, as well anadromous and residual sockeye salmon (referred to as kokanee) from Redfish Lake, Idaho (NOAA 2011a). One hatchery stock, from the Redfish Lake Captive Program, is included in the ESU. Snake River sockeye are one of two Columbia River Basin salmonid populations designated as endangered (the other being Upper Columbia River spring-run Chinook), and although adult return numbers have recently improved, they are still considered to be at a high risk of extinction (NOAA 2011a). Anadromous juvenile Snake River sockeye out-migrate in the spring as yearlings. Predation rates by DCCO nesting on East Sand Island indicate that an average of 4 percent (range = 3-6 percent) of available anadromous Snake River sockeye smolts were annually consumed by DCCOs during 2009-2013.

Lower Columbia River Steelhead *(O. mykiss)*

This DPS includes all naturally spawned steelhead populations below impassable barriers in streams and tributaries of the Columbia River between the Cowlitz and Wind Rivers, Washington, the Willamette River to Willamette Falls, Oregon, and the Hood River, Oregon (NOAA 2011a). Select hatchery stocks are also included in the DPS. Juvenile Lower Columbia River steelhead out-migrate as yearlings in the spring. There are no PIT tag-based predation rate estimates available for this DPS. Smolt consumption estimates based on diet composition data are also lacking. Predation rate data from other steelhead DPSs (those originating entirely upstream of Bonneville Dam) indicate that juvenile steelhead are susceptible to DCCO predation in the Columbia River Estuary, with average annual predation rates ranging from 2 to 17 percent (depending on the DPS and year). Since data from other salmonid ESUs or DPSs indicate that fish that originate or are released in close proximity to East Sand Island may be particularly vulnerability to DCCO predation, it is possible that impacts to Lower Columbia River steelhead are greater than those implied by predation rate estimates on Middle Columbia River, Upper Columbia River, and Snake River steelhead (see below).

Middle Columbia River Steelhead

This DPS includes all naturally spawned steelhead populations from above the Wind River, Washington, and the Hood River, Oregon, upstream to, and including, the Yakima River, Washington (NOAA 2011a). Select hatchery stocks are also included in the DPS. Lower Columbia River steelhead out-migrate as yearlings in the spring. Predation rates by DCCOs nesting on East Sand Island indicate that an average of 8 percent (range = 2-15 percent) of available Middle Columbia River steelhead smolts were annually consumed by DCCOs during 2007-2013.

Snake River Steelhead

This DPS includes all naturally spawned steelhead populations in streams in the Snake River Basin in Washington, Oregon, and Idaho (NOAA 2011a). Select hatchery stocks are also included in the DPS. Snake River steelhead out-migrate as yearlings in spring. Predation rates by DCCOs nesting on East Sand Island indicate that an average of 8 percent (range = 3-17 percent) of available Snake River steelhead smolts were annually consumed by DCCOs during 2004-2013.

Upper Columbia River Steelhead

This DPS includes all naturally spawned steelhead populations below impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the United States-Canada border (NOAA 2011a). Select hatchery stocks are also included in the DPS. Upper Columbia River steelhead out-migrate as yearlings in the spring. Predation rates by DCCO nesting on East Sand Island indicate that an average of 6 percent (range = 3-11 percent) of available Upper Columbia River steelhead smolts were annually consumed by DCCOs during 2004-2013.

Upper Willamette River Steelhead

This DPS includes all naturally spawned winter-run steelhead populations in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River, Oregon (NOAA 2011a). Hatchery stocks are not included in the DPS. Upper Willamette River steelhead out-migrate as yearlings in the spring. There are no

PIT tag-based predation rate estimates or smolt consumption estimates available for this DPS, but it is reasonable to assume DCCO predation on Upper Willamette River steelhead is roughly comparable to that of other steelhead DPSs that originate upstream of the Lower Columbia River Basin (Middle Columbia River, Upper Columbia River, and Snake River basins), ranging from 2 to 17 percent of available fish per year.

3.2.7 Other ESA-listed Fish

Ten fish species, representing eleven different ESA-listed ESUs or DPSs, occur in regions other than the Lower Columbia River Basin and are potential prey to DCCOs within the sub-regions of the affected environment. Bull trout and Pacific eulachon were addressed in Section 3.2.6, but also occur in areas other than the Lower Columbia River Basin. A separate description for these two species is provided herein. It is important to note that many of the ESA-listed fish described are anadromous or marine species, and, as such, they may occur in several different regions during their life cycle.

Empirical data regarding DCCO predation on ESA-listed fish outside of the Lower Columbia River Basin are generally lacking. With the exception of a few temporally limited studies within a few Oregon Coast estuaries, little to no empirical data are available to estimate rates of DCCO predation on these fish species. Where data are available, it is provided. When it is not available, the potential for DCCO to impact ESA-listed fish is primarily based on the spatial and temporal overlap between DCCOs in each sub-region and critical habitat designations of ESA-listed fish within those sub-regions. Similar to Chapter 3, Section 3.2.6, discussion is focused on the juvenile life stage of each ESA-listed ESU or DPS (with the exception of Pacific eulachon) and assumes predation takes place within the sub-region of interest.

Bocaccio Rockfish

This DPS includes fish within the Puget Sound and Georgia Basin (NOAA 2013), the eastern section of the Salish Sea sub-region. Rockfish have internal fertilization and bear live young (viviparous). Following birth, larvae are found close to the surface in pelagic waters (NOAA 2013). Larvae and juveniles then temporarily settle in nearshore shallow water habitat before moving to deep water (50 to 750 feet; NOAA 2013), below the foraging depth reported for DCCOs (Hatch and Weseloh 1999). Based on their use of deep water habitat and large size at reproduction (typically more than 16 inches), interactions between bocaccio and DCCOs in the Salish Sea sub-region are likely minimal, although larvae and juveniles may be susceptible to DCCO predation.

Bull Trout

This DPS includes all bull trout within the contiguous United States (USFWS 2014a). Bull trout that occur in streams along the Washington Coast and Salish Sea sub-regions exhibit a resident, fluvial, adfluvial, and anadromous life history (USFWS 2014a). Migratory bull trout typically leave natal streams as juveniles or sub-adults. Bull trout reach maturity when they are 4 to 7 years of age and spawn in late summer to late fall (USFWS 2014a). Fish can live to be 12 years of age. Size and maturity varies by location and life history (migratory versus resident), but is generally between 12 and 20 inches, with fish greater than 30 inches and 30 lbs observed (USFWS 2014a). Bull trout susceptibility to DCCO predation may be greater for migratory fish compared with resident fish, especially for bull trout that utilize estuaries.

Canary Rockfish

This DPS includes fish within Puget Sound and Georgia Basin (NOAA 2013), the eastern section of the Salish Sea region. Similar to bocaccio, larvae canary rockfish are pelagic and then move to nearshore rocky areas to rear as juveniles (NOAA 2013). Juvenile canary rockfish are typically found in water 40 to 60 feet deep, but may use shallower water, particularly at night (NOAA 2013). Sub-adults and adults then move to deep water (more than 100 feet), outside the foraging depth reported for DCCOs (Hatch and Weseloh 1999). Based on their use of deep water habitats and the large size of fish at reproduction (more than 16 inches), interactions between canary rockfish and DCCOs in the Salish Sea sub-region are likely minimal, although larvae and juvenile canary rockfish may be susceptible to DCCO predation.

Puget Sound Chinook Salmon

This ESU includes all naturally spawned Chinook salmon from rivers and streams flowing into Puget Sound, including westward along the Strait of Juan de Fuca to the Elwha River and north along the Strait of Georgia in Washington (NOAA 2011a). Select hatchery stocks are also included in the ESU. Substantial variation occurs in the amount of time juvenile Chinook spend in freshwater and estuarine environments before entering the ocean. Most Puget Sound Chinook salmon out-migrate as subyearlings and may spend several months rearing in estuaries, including use of tidal marshes, dikes, and ditches. During their first ocean year, juvenile Puget Sound Chinook salmon can remain in nearshore marine habitats (NOAA 2011a). Extended use of estuaries and nearshore marine environments by juvenile Puget Sound Chinook suggests they could be vulnerable to DCCO predation.

Hood Canal Chum Salmon

This ESU includes all naturally spawned summer-run chum salmon in Hood Canal and its tributaries, as well as those in the Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington (NOAA 2011a). Select hatchery stocks are also included in the ESU. Hood Canal chum salmon out-migrate shortly after hatching as fry in late winter (February–March) and rear in deltas and estuaries, which support a diverse array of habitats (tidal channels, mudflats, marshes, and eelgrass meadows; NOAA 2011a). Juveniles remain in estuary and delta habitats for several weeks before entering the ocean. Similar to Puget Sound Chinook salmon, use of estuary and delta habitats by juvenile chum suggests they could be vulnerable to DCCO predation.

Oregon Coast Coho Salmon

This ESU includes all naturally spawned coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco, Oregon (NOAA 2011a). The hatchery stock from Cow Creek is included in the ESU. Juveniles out-migrate as yearlings in the spring. ODFW is concerned that DCCOs may be significantly impacting coastal salmonid populations and is partway through a 3-year study to assess the impacts of DCCO predation on salmonid populations along the Oregon coast. Based on current analyses, results to date indicate that juvenile salmonids in coastal estuaries are susceptible to DCCO predation.

Southern Oregon/Northern California Coast Coho Salmon

This ESU includes all naturally spawned coho salmon in coastal streams between Cape Blanco, Oregon and Punta Gorda, California (NOAA 2011a). Select hatchery stocks are also included in the ESU. Juveniles out-migrate as yearlings in the spring. No empirical data to evaluate Southern Oregon/Northern California Coast coho predation by DCCOs in the Oregon Coast sub-regions are currently available. Data from Adrean (2013) and Clements et al. (2012), however, suggest that coho smolts along the northern Oregon Coast may be vulnerable to DCCO predation in estuary environments, and estuaries with DCCO colonies exist in this sub-region (e.g., Rogue River Estuary, Oregon).

Pacific Eulachon

This DPS includes eulachon from the Mad River in northern California to the Elwha River in Washington; an area referred to as the southern eulachon DPS. Eulachon larvae out-migrate to the ocean shortly after hatching and spend the majority (more than 95 percent) of their lives in the ocean (NOAA 2011b). Although little is known about the movement of larvae and juvenile eulachon, they are believed to be widely distributed in the ocean and are typically found in deep water (60 to 450 feet; NOAA 2011b). Along the Oregon and Washington Coast, adult eulachon return to spawn in late winter to early spring (NOAA 2011b). No empirical data to evaluate eulachon predation by DCCOs in the Oregon Coast, Washington Coast, and Salish Sea sub-regions currently exist. Due to their small size, eulachon are susceptible to DCCO predation throughout their life cycle. There is little temporal overlap, however, between the DCCO nesting season (April to September) and the eulachon spawning run, and juvenile eulachon may be too dispersed in the open ocean and deep in the water column to be susceptible to DCCO predation.

Ozette Lake Sockeye Salmon

This ESU includes all naturally spawned sockeye salmon in Ozette Lake, Washington and streams and tributaries connected to Ozette Lake. Two hatchery stocks, Umbrella Creek and Big River, are also part of the ESU (NOAA 2011a). Juveniles rear in Ozette Lake and out-migrate via the Ozette River as yearlings in the spring (NOAA 2011a). No empirical data to evaluate Ozette Lake sockeye predation by DCCOs along the Washington Coast sub-region exist. The out-migration timing and size of Ozette Lake sockeye, however, suggest they could be susceptible to DCCO predation, especially if juvenile sockeye reside or congregate in or near the Ozette River estuary or other habitats where DCCO dispersed from East Sand Island forage.

Puget Sound Steelhead

This DPS includes all naturally spawned steelhead in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River and to the north by the Nooksack River and Dakota Creek. Hatchery winter-run steelhead stocks from the Green River and Hamma are included in the DPS. Puget Sound steelhead out-migrate as yearlings in the spring. Little is known about estuary and nearshore marine habitat use following out-migration, but steelhead smolts are believed to move offshore more quickly as compared with Puget Sound Chinook and Hood Canal chum salmon (NOAA 2011a).

Yelloweye Rockfish

This DPS includes fish within Puget Sound and Georgia Basin (NOAA 2013), the eastern section of the Salish Sea sub-region. Compared with bocaccio and canary rockfish, juvenile yelloweye rockfish are typically found in deep water (around 100 feet; NOAA 2013), outside the foraging depth reported for DCCOs (Hatch and Weseloh 1999). Yelloweye rockfish are also considered solitary and are rarely found in groups or aggregations (NOAA 2013). Based on their presence in deep water for the vast majority of their lives, including the juvenile life stage, and the large size of fish at reproduction, interactions between yelloweye rockfish and DCCOs in the Salish Sea sub-region are likely minimal, although larvae fish may be susceptible to DCCO predation.

Areas of Specific Management Concern for ODFW and WDFW

While this section focused on ESA-listed species, it is important to note that during interagency DCCO working group meetings WDFW and ODFW were asked to assess specific areas of management concern based on the occurrence and status of fish populations of conservation concern (Figure 3-14). Areas were classified according to the following criteria: 1) areas of significant management concern could not tolerate formation of new DCCO colonies or increases in active colonies; 2) areas of moderate management concern could tolerate some increase in DCCO numbers if closely monitored; 3) areas of low management concern could tolerate larger increases in DCCO numbers if monitored. During cooperating agency meetings, concerns from ODFW and WDFW over DCCO dispersal to areas of management concern were repeated (see Appendix J). ODFW and WDFW identified much of their respective states as areas of some concern (Figure 3-14). ODFW specifically identified and expressed concern for coastal estuaries and lakes (Nehalem Bay, Tillamook Bay, Nestucca Bay, Alsea Bay, Siuslaw River, Umpqua River, Coos Bay, Coquille River, Rogue River, and the coastal lakes of Siltcoos, Tahkenitch, and Tenmile).

WDFW identified much of the southern coast and interior as areas of significant concern (Figure 3-14). Areas of low management concern identified by WDFW were along the north coast, including the Copalis River between Pacific Beach and Ocean City, Moclips River south of Point Grenville, Raft River north of Cape Elizabeth, Kalaloch Creek south of Destruction Island, Mosquito and Goodman creeks, both north of Hoh Head, Quillayute River near James Island, and the Sooes and Waatch rivers between Cape Flattery and Point of the Arches.

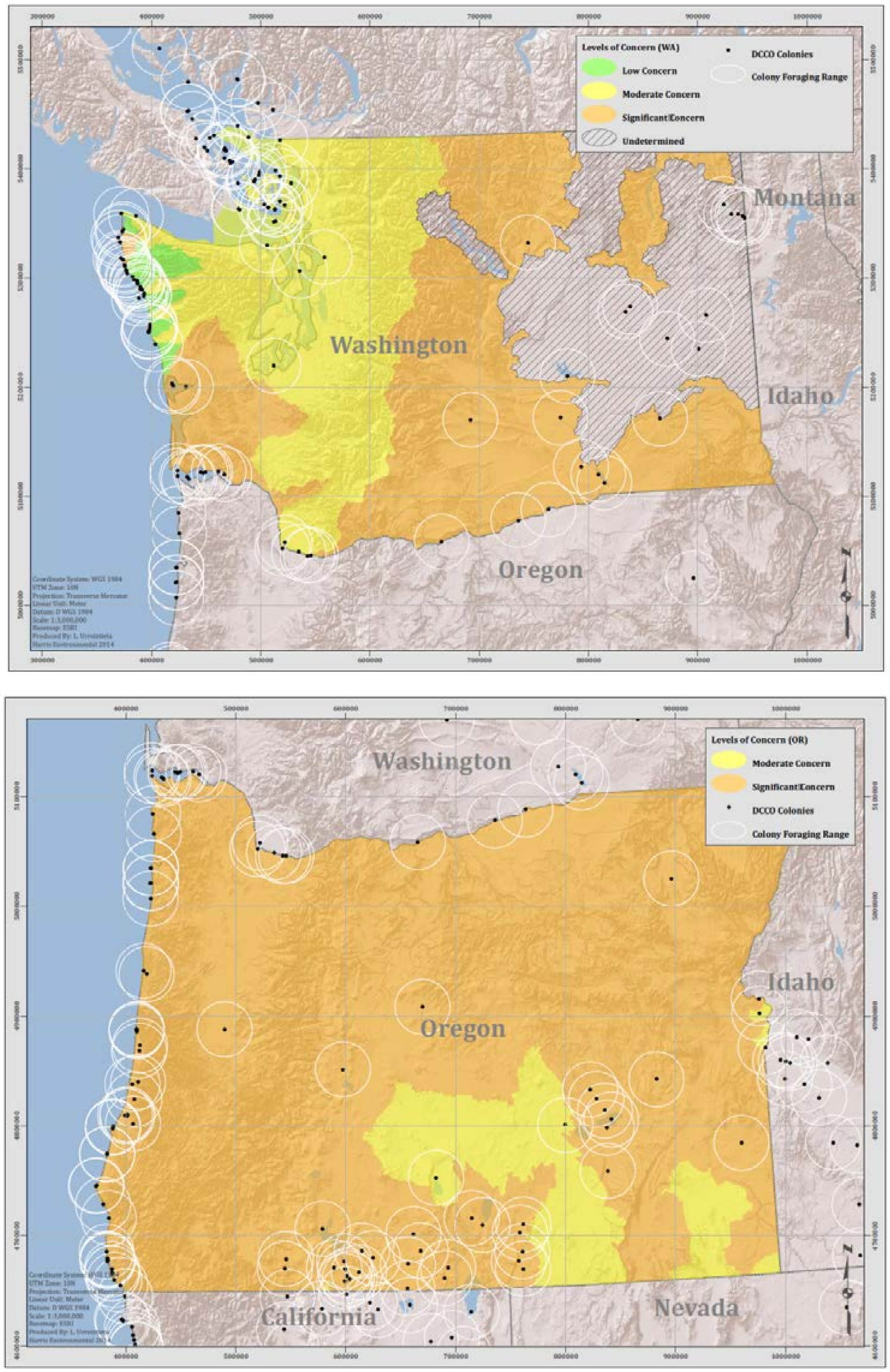


FIGURE 3-14. Map of Washington State (top) and Oregon State (bottom) depicting areas of significant management concern (orange), areas of moderate management concern (yellow), and areas of low management concern (green). Black dots identify DCCO breeding colonies at the time of the most recent surveys (1989-2010). Open circles delineate the expected foraging range (25 km radius) of DCCOs. Maps were created by ODFW and WDFW and may not represent all interested parties within the states.

3.3 Socioeconomic Environment

This section addresses the social and economic issues associated with DCCOs, with primary focus on Columbia River in-river fisheries (tribal, recreational, and commercial), public resources (including existence and aesthetic values), and historic properties on East Sand Island. Columbia River in-river fisheries are defined as the regions wherever Columbia River Basin production contributes to in-river fisheries, which include the Columbia Basin ecological provinces for the Columbia Estuary, Lower Columbia, Columbia Gorge, Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake (see Appendix I for a more complete description and map of the geographic area considered for Columbia River in-river fisheries). The human dimension of wildlife management is important to understanding the underlying issues with human-wildlife conflicts, and these issues are discussed in Chapter 4, Section 4.6.6.

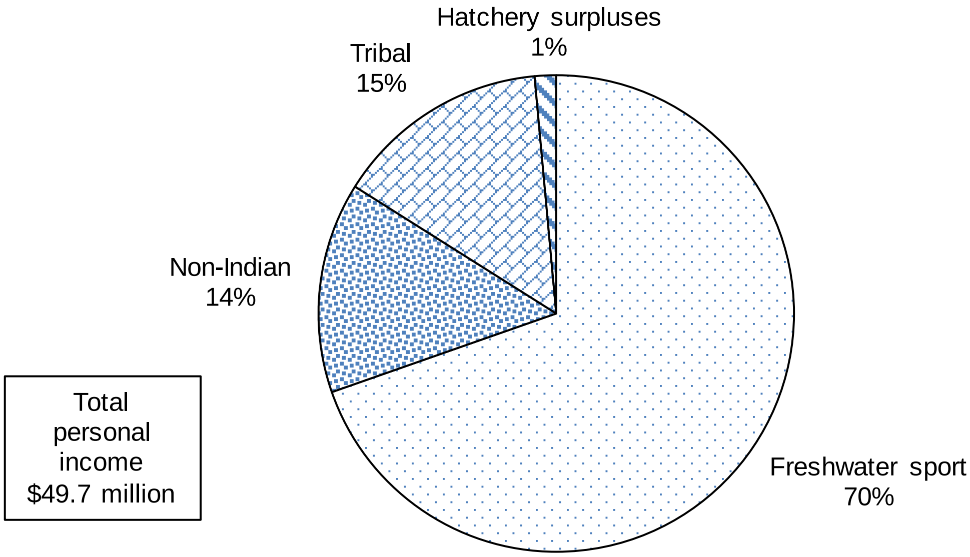
3.3.1 Columbia River Basin Salmon Fisheries

Because salmonids range over a large geographic area across a multitude of political boundaries, salmon production and harvest management is very complex. Five general governance processes give direction to salmonid production and harvest management. These include the: 1) Pacific Salmon Treaty, 2) Magnuson-Stevens Fisheries Conservation and Management Act, 3) Pacific Fisheries Management Council's Salmon Fishery Management Plan, 4) ESA-listed recovery stocks' harvest impact constraints, and 5) user group allocation agreements. Columbia River treaty tribes have authority to regulate treaty Indian fisheries. The ESA restricts the amount of wild salmon that may be harvested directly or indirectly once a species or sub-species has been placed on the threatened or endangered species list. Harvest managers must consult annually with NOAA Fisheries to ensure fishers are regulated to meet no-jeopardy standards established for ESA-listed salmonids. Columbia River fisheries are also regulated according to the Columbia River Fish Management Plan (2008-2017 agreement) adopted by the U.S. District Court order in 2008 and agreed to by the parties of U.S. v. Oregon. The parties to U.S. v. Oregon are the United States, acting through the Department of the Interior (USFWS and Bureau of Indian Affairs) and the Department of Commerce (NOAA Fisheries), the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, the Confederated Tribes and Bands of the Yakama Nation, the Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho. The Colville Confederated Tribes also have federally protected fishing rights on the Reservation, the former North

Half, and the Wenatshapam fishery (see Antoine v. Washington, 420 U.S. 194 (1975); Colville Confederated Tribes v. Walton, 647 F.2d 42, 48 (9th Cir. 1981); United States v. Oregon, 606 F.3d 698 (9th Cir. 2010)). Specifications for Colville Confederated Tribes harvest allocations are pursuant to a 2007 joint agreement between the Colville Confederated Tribes and WDFW.

Aside from Columbia River in-river and tributary fisheries, Columbia River Basin salmonid production contributes heavily to ocean fisheries from Oregon north to southeast Alaska, First Nation harvests in British Columbia, and other tribal, commercial, and personal use fisheries throughout this range. Although indirect benefits to fisheries could occur outside of the Columbia River Basin, the focus for this analysis is primarily limited to Columbia River Basin in-river fisheries and economies, as this is the area most likely affected by the proposed alternatives.

The Bonneville Dam separates the commercial gillnet fishery and commercial tribal fishery harvest areas. Commercial tribal fisheries are allowed below Bonneville Dam and in the Willamette River, if necessary, to attain seasonal fish allocations. Freshwater sport recreational fisheries include the popular fall season Buoy 10 fishery (west of Astoria, Oregon) as well as all other mainstem and tributary salmon and steelhead fisheries. An estimated $49.7 million in total personal income (2012 dollars) was generated from in-river fishery sectors, including hatchery surpluses (1 percent), tribal commercial (15 percent), non-Indian commercial (14 percent), and freshwater sport recreational fisheries (70 percent; Figure 3-15; TRG 2014). These different fisheries are discussed below in more detail.

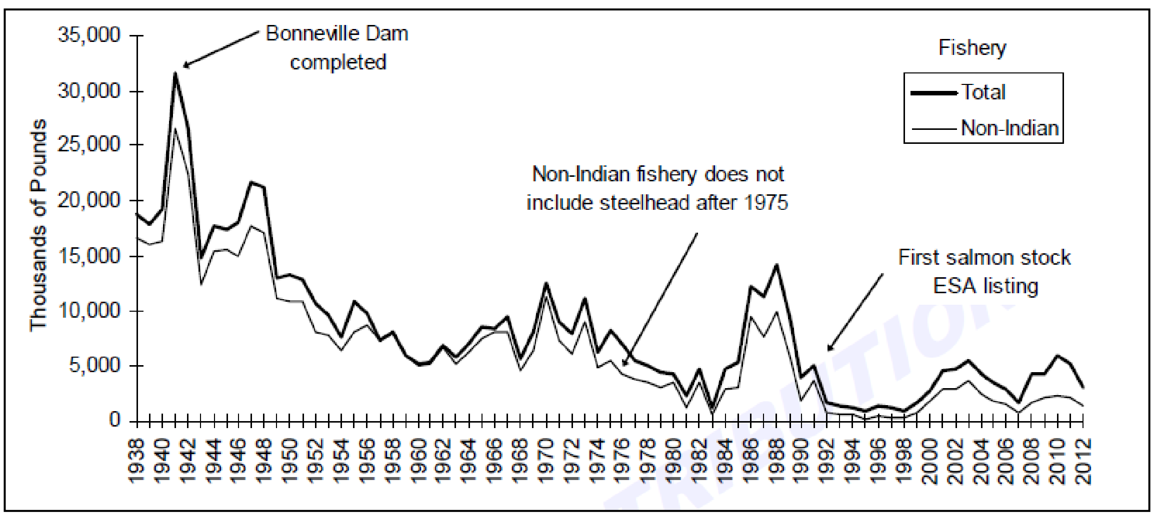


*Values are Regional Economic Impact (REI) measurements (see Appendix I for how measures are calculated); value includes minor economic contributions from business use of marketable hatchery returns. REI does not include economic contributions from hatchery operations. Tribal and Non-Indian only include economic value from commercial fisheries.

FIGURE 3-15. Columbia River in-river fisheries regional economic impacts (REI) for current conditions in total personal income in 2012 dollars.

Trends in commercial fisheries are generally representative of the fisheries of the Columbia River as a whole. Overall trends show a precipitous decline in harvest, compared to harvest levels during the 1930s and 1940s, which ranged between 15 and 30 million pounds (Figure 3-16). Harvest levels were lowest during the 1990s and have rebounded to some extent. During 2008–2012, harvest levels were between 2.5 and 5 million pounds (Table 3-6). Converted to annual dollars during 2008–2012, this amount of commercial harvest in real market price value equaled from $6 to 11 million (Table 3-6). The total number of fish tickets issued from commercial fisheries deliveries in 2012 was 10,620, with 5,253 for landings below Bonneville Dam and 5,367 above Bonneville Dam. Of all of the deliveries made on the Oregon side, 93 percent of tickets were issued below Bonneville Dam, with 7 percent above Bonneville Dam. On the Washington side, 20 percent of tickets were issued below Bonneville Dam, with 80 percent above Bonneville Dam (TRG 2014).

The Astoria (Clatsop County, Oregon) and Ilwaco (Pacific County, Washington) area located at the Columbia River ocean entrance has the largest commercial fishing industry presence of all regional economies adjacent to the Columbia River. However, this fishing industry is not particularly vulnerable to in-river fisheries, as this composes about five percent (measured by harvest revenue) of all fisheries deliveries (i.e., the vast majority are from ocean or other fisheries harvest; TRG 2014). There were 70 different businesses that purchased Columbia River commercial non-Indian and tribal-caught salmon and steelhead in 2012 (TRG 2014). There are five larger processors in the Astoria area that receive, process, and market fish harvested from the lower Columbia River gillnet fishery (TRG 2014). There are seven large processors with similar sales and manufacturing characteristics that purchase commercial tribal fisheries. In addition, the Columbia River Inter-Tribal Fish Commission (CRITFC) developed a tribal-owned and operated processing center at East White Salmon, Washington on an in-lieu fishing access site. Much of the salmon harvested in the Columbia River and processed to a product is sent to the Seattle/Bellingham area. This is an area that handles fish from Alaska, as well as from the Pacific Northwest. In addition to buyer and processor businesses handling harvest distribution to consumers, there are a number of harvesters that make direct sales to the public. There is a greater proportion of tribal commercial catch handled with this type of distribution than in the lower Columbia River non-Indian fishery (see Appendix I for additional information about regional and worldwide salmon fisheries markets).



*Weight is round pound equivalents; Sources: WDFW and ODFW (August 2004), Pacific Fishery Management Council (PFMC; February 2008), and TRG (2014).

FIGURE 3-16. Columbia River in-river fisheries commercial landings, total and non-Indian fisheries from 1938 to 2012.

TABLE 3-6. Columbia River In-river Fisheries Commercial Harvest Ex-vessel Price, Value, and Pounds during 2008–2012.

		Price					Ex-vessel Value (thousands)					Pounds (thousands)				
Fishery	Species	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
TOTAL COLUMBIA RIVER (OREGON AND WASHINGTON)																
Non-treaty	Chinook															
Gillnet	Spring	6.71	5.07	5.16	5.03	5.92	1,093	791	2,526	1,548	1,386	163	156	490	308	234
	Fall	2.67	2.05	2.14	2.18	2.14	1,637	1,513	1,469	2,233	1,627	612	738	688	1,026	762
	Tules	0.61	0.57	0.62	0.59	0.54	68	95	160	138	110	112	168	257	234	204
	Coho	1.38	1.26	1.42	1.64	1.62	1,006	1,391	1,147	980	211	731	1,108	807	597	130
	Chum		0.00	1.00	1.00				3	1			1	3	1	
	TOTAL						3,804	3,790	5,305	4,900	3,334	1,618	2,171	2,245	2,166	1,330
Treaty	Chinook															
All gears	Spring	4.77	3.24	4.02	3.58	4.81	1,374	800	2,675	1,883	996	288	247	666	526	207
	Fall	1.75	1.13	1.31	1.93	1.84	2,692	1,456	2,280	3,566	2,054	1,538	1,283	1,747	1,849	1,117
	Tules	0.48	0.38	0.66	0.72	0.71	62	38	92	31	5	129	100	140	43	7
	Coho	0.92	0.73	1.36	1.46	1.38	210	51	57	268	47	228	70	42	183	34
	TOTAL						4,338	2,345	5,104	5,748	3,102	2,183	1,700	2,595	2,601	1,365
Columbia River Total							8,142	6,138	10,407	10,648	6,436	3,801	3,871	4,842	4,766	2,696

Notes: Dollars are adjusted to 2012 using the GDP implicit price deflator.
Source: PFMC, Review of Ocean Salmon Fisheries, annual in February.

Hatchery Production

Another important economic consideration in regard to Pacific salmonid fisheries is the importance of economic contributions that come from operating fishery enhancement and supplementation hatcheries. Smolt production costs can range from $0.20 to $2.00 per individual (TRG 2009). Production of fall Chinook subyearlings (released at 25 to 50 per pound and comprising about 50 percent of all releases) are lesser, and production of steelhead yearlings (released at 8 to 12 per pound and comprising about 12 percent of all releases) are higher (TRG 2014). If hatchery production funding is considered new money into a region, then the costs for labor, materials, administration, monitoring, and construction provide significant economic contributions, particularly to rural economies where the hatcheries are located. Depending upon returning hatchery origin adults goals and realized return levels, hatchery production can be altered, which could change funding levels (economic inputs) to a given area. Additionally, the area of production may not be the area in which economic returns (adult harvest) are received. Thus, there are complex positive and negative feedback loops with regard to adult salmonid abundance correlating to increases or decreases in regional or local economic effects.

Economic Impact of DCCO Predation

Juvenile salmonid consumption estimates and predation rates from DCCOs on East Sand Island are described in Chapter 1, Section 1.1.6, Chapter 3, Section 3.2.5, Chapter 4, Section 4.2.5, and Appendix C. These estimates and rates are variable across time but have been as high as 20 million out-migrating smolt in recent years (Roby et al. 2014). This consumption has economic impacts with regard to direct losses of investment cost from hatchery production and subsequent losses to fisheries and economies from lower numbers of returning adult salmonids. TRG (2014) estimated that current levels of juvenile salmonid predation by DCCOs on East Sand Island (i.e., compared to zero DCCOs on East Sand Island) resulted in potential annual losses of $2.6 million to Columbia River in-river fisheries (i.e., 6.1 percent of direct financial value and 5.3 percent of regional economic impact of Columbia River in-river fisheries) and $6.4 million in hatchery production investment costs (see Chapter 4, Section 4.3.1 and Appendix I for a more detailed description and additional results from economic analysis). Hatchery production investment losses do not include potential losses to investments that governmental agencies and other entities make toward the production of wild origin salmonids, which are considerable.

3.3.2 Tribal Fisheries

Salmon are a significant resource to tribes in the Pacific Northwest. Tribal cultures, economies, religion, and technologies have all been influenced by salmon. Columbia River tribes participate in commercial, ceremonial, and subsistence fisheries. Northwest Tribes celebrate the annual arrival of adult salmon coming back from the ocean in “First-Salmon” ceremonies. These ceremonies differ from tribe to tribe, but generally consist of honoring the annual return of salmon through ceremonies involved with the first salmon caught. The annual salmon harvest allows the transfer of traditional values from generation to generation. Salmon also serve to foster cultural values and cement social relationships within the community and with trading partners. Loss of access to salmon has had profound effects on the dietary habits and wellbeing of the Northwest Tribes (NOAA 2008). Commercial salmon and steelhead fishing provides a means for continuing with parts of tribal historical lifestyle and represents a main source of livelihood for some tribal members. Additionally, Columbia River tribes contribute greatly to the production of hatchery fish for the purposes of both harvest and conservation of Columbia River Basin salmonids. The following are the tribal hatchery facilities: Colville Tribes Cassimer Bar; Chief Joseph Hatchery; Cowlitz Salmon Hatchery; Confederated Tribes of the Umatilla Indian Reservation-Three Mile Dam Facility; Nez Perce Tribal Fish Hatchery; Yakama Nation Cle Elum Hatchery, Marion Drain Hatchery, Prosser Hatchery, and Klickitat Hatchery.

The Columbia River encompasses many different kinds of tribal cultural and natural resource interests from at least 16 federally-recognized Tribes which collectively span the entire length of the river. The four Columbia River Treaty Indian Tribes include the Bands of the Yakama Nation, Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe. Treaty Indian commercial catches became a larger portion of the total Columbia River commercial catches following the 1968 Federal court ruling regarding equitable Indian and non-Indian harvest sharing. Since 1968, commercial fishing in the area between Bonneville and McNary dams has been the exclusive province of the Treaty Indian Tribes. Colville Confederated Tribes members exercise federally protected fishing rights in the mainstem Columbia River between Chief Joseph Dam and the confluence with the Okanogan River, harvesting sockeye, summer/fall Chinook, and steelhead, and harvesting spring Chinook on Icicle Creek. Colville Confederated Tribes members harvest salmonids only for subsistence and ceremonial use (see Table 3-7).

Tribal fisheries occur on the Columbia River and tributary locations and generally take place above Bonneville Dam, but other locations are sometimes used to fulfill treaty and trust responsibilities. A wide range of fishing gear is utilized, including purse seine, hook and line, tangle nets, beach seines, hoop and dip nets, and weirs; set nets are commonly used. Catch is allocated first for ceremonial purposes, next for subsistence (ceremonial and subsistence are sometimes considered together), and last for commercial purposes. No fish of any stock are sold for commercial purposes until ceremonial and subsistence needs are met. As recently as 1995, spring Chinook salmon were available for ceremonial purposes only. Fall Chinook salmon are routinely harvested for commercial sale. Total tribal harvest (including commercial, ceremonial, and subsistence) of spring and fall run salmon has averaged about 25,000 and 110,000 fish, respectively, during the early 2000 period (Mann 2004). Tribal commercial fisheries account for approximately 15 percent of total revenue from Columbia River in-river fisheries (Figure 3-15). Harvest for ceremonial and subsistence fisheries averaged approximately 14,000 fish per year during 2003–2012 (Table 3-7).

TABLE 3-7. Columbia River Tribal Ceremonial and Subsistence Harvests 2003–2012.

	High		Low			
	Amount	Year	Amount	Year	Mean	Median
Last 10 Years						
Coho	1,277	2003	22	2006	510	370
Spring/Summer Chinook	15,482	2012	6,435	2007	10,485	9,652
Fall Chinook	832	2012	15	2009	379	404
Steelhead	3,759	2005	1,596	2006	2,971	3,265

Notes:
1. The 10 year period is 2003 to 2012. Coho and steelhead central tendency analysis only inclusive of years 2003 to 2006. Year 2012 is preliminary.
2. Willamette River surplus hatchery fish have been used in some years to augment C&S harvests.
3. Chinook C&S are primarily mainstem fisheries between Bonneville and McNary dams. Significant subsistence fisheries also occur in tributaries throughout the Columbia and Snake River basin, especially for spring Chinook, which are not included in these estimates.
4. The Colville Confederated Tribes' C&S harvests are not included in these estimates. The Tribes harvest in two locations. The Tribes use selective harvesting gear at the mouth of the Okanogan to take advantage of a temporary thermal barrier that keeps salmon in the Columbia before they enter the Okanogan on their migration into Canada. Retained species include both hatchery-origin summer/fall Chinook and wild sockeye (both unlisted salmonid ESU's in the upper Columbia). Wild summer/fall Chinook and steelhead are released. The harvests on the mainstem Columbia River in 2013 were: 4,276 sockeye, 3,142 summer/fall Chinook, and 127 steelhead. The Tribes also harvest spring Chinook in Icicle Creek near Leavenworth, Washington. The harvests were from 2010 through 2012: 2010 – 310 adults, 13 jacks; 2011 – 248 adults, 117 jacks; 2012 – 123 adults, 8 jacks. The harvested fish from the two locations are used for C&S as well as exchanged with other tribes.

Sources: Chinook from PFMC (2013), coho and steelhead from ODFW and WDFW (July 2007), and Colville Confederated Tribes harvest from personal communication (2014).

3.3.3 Recreational and Commercial Fisheries

Recreational Fisheries

Before 1975, lower Columbia River sport recreational fisheries focused primarily on salmon and steelhead harvest. Seasonal closures to protect declining salmonids transitioned much of the recreational fisheries to sturgeon and other fisheries. Recreational salmonid angling effort has rebounded in recent years. Recreational fishing occurs throughout the Columbia River Basin. Depending on the time of year, different salmonids are targeted, including spring and summer Chinook, winter and summer steelhead, fall Chinook, coho, and sockeye. Detailed regulations are issued annually for time and area closures, bag limits, gear restrictions, and other techniques to keep total mortalities within the allocation and ESA-listed population impact schemes.

Recreational fisheries account for approximately 70 percent of total revenue from Columbia River in-river fisheries (Figure 3-15).

Commercial Fisheries

Columbia River commercial fisheries became important in the 1860s. Since the early 1940s, Columbia River commercial catches of salmon and steelhead have steadily declined, reflecting changes in fisheries in response to declines in salmonid abundance (Figure 3-16). Lower Columbia River non-Indian commercial fisheries occur below Bonneville Dam in the mainstem or in select off-channel fishing areas. The Columbia River above Bonneville Dam to McNary Dam (Zone 6) was open to non-Indian commercial fishing until 1956. Commercial fishing for salmonids (gillnet and tangle net) occurs in the estuary and lower Columbia River, although it is heavily restricted in time and space. Washington and Oregon establish season dates and gear restrictions for mainstem commercial fisheries according to the Columbia River Compact.

In 2004, there were 576 gillnet fishery permits in Washington (258) and Oregon (318), which, after accounting for permittee double permit holders and other factors, was 481 vessels (TRG 2014). For WDFW and ODFW issued gillnet permits, 51 percent are registered to Clatsop and Pacific county addresses. About 98 percent are issued to addresses in Washington and Oregon. WDFW Columbia River gillnet licensees can also fish Grays Harbor or Willapa Bay locations. Most commercial fishermen in the Columbia River also fish for other species, aside from salmonids, and hold permits in other states. Approximately 30 percent of gillnet permittees were found to have Alaska fishing permits. In 2012, there were 244 vessels uniquely identified with the deliveries in the Lower Columbia River. Of these 244 vessels, the top 44 vessels by revenue harvested 50 percent of the total ex-vessel revenue in the gillnet fishery. The average active vessel gillnet revenue was $13,853, and the average top 10 vessel's gillnet revenue was $50,361 (TRG 2014). Non-Indian commercial fisheries account for approximately 14 percent of total revenue from Columbia River in-river fisheries (Figure 3-15).

3.3.4 Public Resources

Several comments from the public scoping period raised concerns over public health and other resources being impacted due to dispersal of DCCOs from managing such a large colony. This section addresses public health and human safety (as it relates to possible exposure to concentrations of DCCO guano), transportation facilities (i.e., DCCOs roosting or nesting on bridges, docks, airports, etc.), and dams and hatcheries (where DCCOs congregate and predate upon juvenile salmonids). The Corps worked with USDA-WS (the federal agency authorized by Congress to respond to wildlife conflicts) to provide an overview of DCCO-specific damage reports in the states of Oregon and Washington. When USDA-WS receives a damage report, they may investigate it to verify damage has occurred and assess the economic impact of the damage. In Washington, during a 5-year period from 2008-2013, reports of DCCO damage were highest at dams, hatcheries, and transportation facilities (airports, bridges, ferries, docks). In Oregon, the Salem airport made the only report of DCCO damage to USDA-WS.

Public Health and Human Safety

Waterbird excrement can contain coliform bacteria, streptococcus bacteria, Salmonella, toxic chemicals, and nutrients, and can affect water quality and denude vegetation (USFWS 2003). USDA-WS commonly receives requests for assistance with bird damage caused by the accumulation of avian feces (guano). Guano contains corrosive acids and is laden with bacteria, either of which may endanger human health or impact buildings, bridges, and other structures (e.g., excessive fecal matter on handrails, stairs and walkways, ventilation intakes, etc.).

The disease most often associated with DCCOs is Newcastle disease, which is chiefly a disease of the central nervous system and is caused by infection with a type of avian paramyxovirus (Kuiken 1999). In 1997, Newcastle disease was diagnosed in juvenile DCCOs from breeding colonies in the Columbia River Estuary and Great Salt Lake, Utah by the National Wildlife Health Center. DCCO fledglings from East Sand Island have since been diagnosed with the disease in multiple years (i.e., 2003, 2005, 2007, 2009, 2013; BRNW unpublished data; see Roby et al. annual reports). While DCCOs on East Sand Island have tested positive for Newcastle Disease, they have tested negative for the highly virulent or velogenic form of the virus (“Exotic Newcastle Disease”) that can severely impact commercial poultry operations (Roby et al. 2014). Evidence suggests that Newcastle disease is not an important cause of mortality in other wild bird species that nest in close association with DCCOs (Kuiken 1999).

Disease transmission may occur when people come in contact with contaminated areas or diseased birds. However, the people at greatest risk are those who come into direct contact with bird feces or are exposed to feces-contaminated dust in ventilation systems (USDA-WS 2011a). Symptoms in humans can include mild conjunctivitis and influenza-like symptoms (USGS 2010). Protective measures were taken (e.g., use of gloves, full coverage clothing, respirators, goggles, etc.) by research personnel on East

Sand Island to avoid the potential for disease transmission. While there are concerns regarding the impacts of elevated contaminant levels and disease associated with concentrations of breeding or roosting DCCOs, direct disease transmission between DCCO and humans or adverse health effects to public health associated with DCCOs is unlikely to occur, even for research personnel in direct contact with DCCOs on East Sand Island.

Transportation Facilities

DCCOs can damage structures with fecal contamination. Corrosion damage to metal structures and painted finishes, including those on automobiles and boats, can occur because of uric acid from bird droppings. Accumulated bird droppings can reduce the functional life of some building roofs by 50 percent (Weber 1979). Damage of structures is more likely when high densities of DCCOs use these sites.

Given past dissuasion experiments, it is expected the Astoria-Megler Bridge will be a likely destination for DCCOs seeking new habitat (Figure 3-17). Several thousand DCCOs were observed roosting on the Astoria-Megler Bridge during the 2013 breeding season (D. Winterboure, personal communication 2013; Roby et al. 2014), marking a large increase in the numbers of DCCOs previously observed using the bridge. DCCO nesting on the Astoria-Megler Bridge has also increased. DCCOs were first observed nesting on the bridge in 2004, when six nests were counted. In 2013, 231 nests were counted (Roby et al. 2014). The colony is centered on the northern end of the northern truss of the bridge. The height of the bridge and the amount of boat traffic in the navigation channel make it an extremely difficult location to haze. Water cannons were the only successful method of hazing, but were discontinued due to corrosion concerns over use of saltwater on the steel structure.

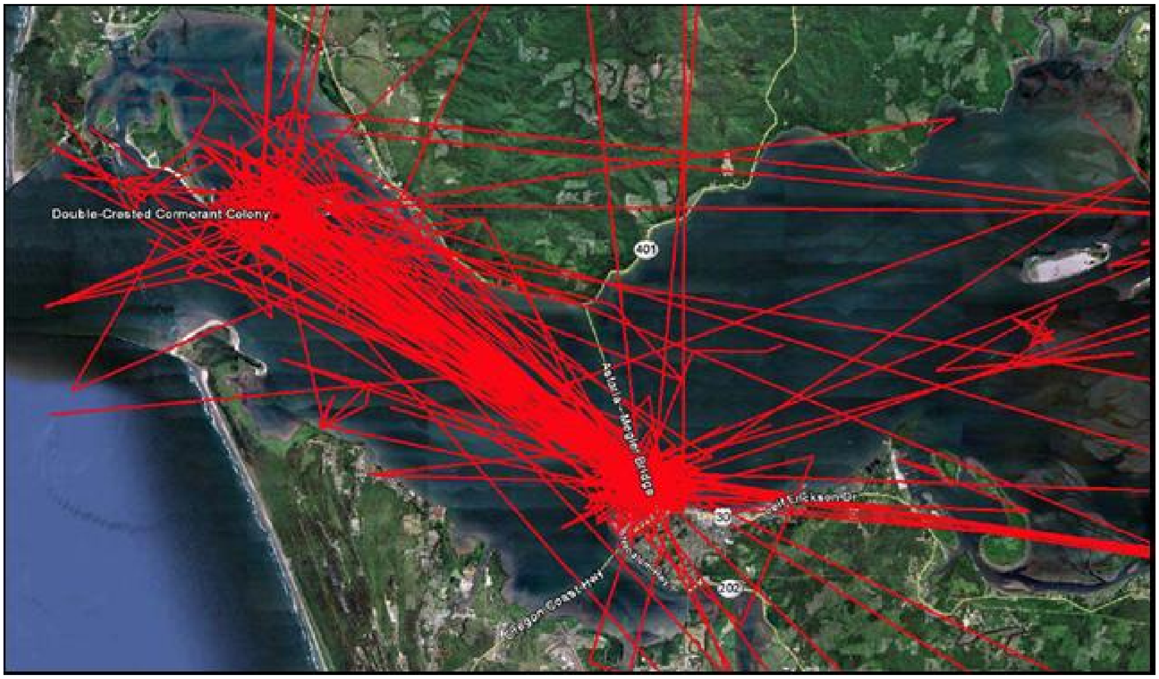


FIGURE 3-17. Movement of satellite-tagged DCCOs as a result of dissuasion experiments during the week of April 18, 2013. The majority of tagged DCCOs visited the Astoria-Megler Bridge.

Dams and Hatcheries

Dams and hatcheries are places of concern for depredation of fish by DCCOs. Juvenile salmonids become more susceptible to predation as they pass through the dams, which concentrate their numbers. The currents at outfalls can cause juvenile salmonids to become temporarily disoriented and remain near the surface, where they are more vulnerable to predation. USDA-WS works cooperatively with agencies and tribes to manage DCCOs and reduce predation damage at dams and hatcheries in Washington and Oregon. USDA-WS conducts avian predation control activities at many of the dams along the Columbia River. The majority of visits by USDA-WS to investigate potential DCCO-specific damage were at Ice Harbor, Little Goose, Lower Monumental, McNary, Priest Rapids, Rock Island, and Wanapum dams, with 1,861 person-day visits during 2008–2013, and to the Cowlitz Hatchery, with 766 person-day visits (USDA-WS, unpublished data).

3.3.5 Existence and Aesthetic Values

Several comments received on the DEIS requested that the Corps address the inherent value of DCCOs, including potential impacts that management actions may have on an individual's aesthetic or existence values of DCCOs. Whether or not these values can be accurately measured is debatable (Diamond and Hausman 1994; Portney 1994; Conover 2002). However, aesthetic and existence values are important concepts in describing the human dimension component of this EIS (see additional discussion in Chapter 4, Section 4.6.6) and describing how these values for various user groups and stakeholders may be affected by the EIS alternatives. Existence value is the value that an individual associates with the knowledge that a resource (such as the DCCO, salmonids, co-nesting birds, or other species) exists, even if that individual has no plans to directly use that resource. Individuals may hold this value for a number of reasons: 1) they wish to preserve the resource for future generations; 2) they wish to hold open the option to use the resource in some way in the future, although they have no immediate plans to do so; or 3) they may simply feel that preservation of a resource is the right thing to do (USFWS 2014).

Aesthetic value refers to our sense of beauty. An individual's perception of the beauty of a given species can be affected by the extent to which members of that species have negatively or positively impacted something of value to the individual (USFWS 2014). For example, the world's largest DCCO breeding colony at East Sand Island may be a thing of beauty and a wonder of nature to one person, whereas others might perceive this colony as an aesthetic detriment because of noise, smell, destruction of vegetation, or a visible reminder of impacts to salmonid species. Thus, a birdwatcher and a fisherman may view the same objective ecosystem and location from entirely different subjective standpoints. Even fisheries entail a wide range of non-market values, including cultural significance and heritage, job satisfaction and livelihood, and recreational experience, which cannot be quantified in pure dollar terms (TRG 2014).

Wildlife has some degree of economic value with regard to sightseeing and recreation. In Oregon in 2011, there were about twice the participants and trip spending by wildlife watchers (1.4 million participants and $1.7 billion spending) as hunters (0.2 million participants and $0.2 billion spending) and anglers (0.6 million participants and $0.6 billion spending) combined (USFWS and USCB 2014). Wildlife has less quantifiable values, such as inherent value to ecosystems and social or spiritual value to user groups. However, no studies have been carried out to estimate the dollar value that Americans specifically assign to DCCOs and, if there were, this value would certainly vary considerably from person to person (USFWS 2003).

3.3.6 Historic Properties

The affected environment for historic properties is referred to as the area of potential effect. This terminology comes from Section 106 of the National Historic Preservation Act. For the purposes of this FEIS, that area is defined as the entire island, in order to address the placement of temporary dissuasion materials and construction of bird blinds, platforms, etc., for field personnel, as well as the proposed excavation for terrain modification. Ground-disturbing activities from the proposed terrain modification method described in the alternatives (i.e., excavation of sand and lowering of rock armored shoreline to inundate the DCCO use area) could potentially affect historic properties in that area. This section provides a historic context for Sand Island and describes in general terms the cultural resources and historic properties found on East Sand Island.

Historic Context of Sand Island

Historically, East Sand Island did not exist in its present configuration and was a part of the larger Sand Island, which in the early 1900s was adjacent to Fort Canby in Baker Bay. Dynamic forces, such as shifting sand bars (shoals), rolling breakers, severe storms and winds, and a strong current at the entrance where the Columbia River dissipates into the Pacific Ocean, create an environment that, prior to jetty construction and stabilization efforts, allowed for considerable changes and movement of Sand Island at the mouth of the Columbia River. Historical maps and surveys indicate that Sand Island moved nearly a mile to the west between 1840 and 1915 (McArthur 1915). In 1942, the *Oregonian* referred to Sand Island, stating: "A low elongated goose shaped sand bar in the mouth of the Columbia River is tagged the 'problem child' of the Columbia. In the course of time it changed its shape, cut itself in two, changed the course of ship channels, caused shipwrecks and became an enemy of navigation." It was not until the late 1930s when stabilization efforts on the recently breached Sand Island created the current configuration of East Sand Island.

Navigation

The Columbia River is one of the most treacherous areas in the world for navigation and is known as the "graveyard of the Pacific," due to the numerous shipwrecks, many of which are scattered on the bottom of the river. The *Isabella*, a Hudson's Bay supply ship that sunk in 1830, is off the northern shore of East Sand Island in approximately 48 feet of water, and is on the National Register of Historic Places. The *Great Republic,* one of the largest passenger liners on the Pacific Coast, ran aground offshore of Sand Island in 1879. This shipwreck site can be seen approximately 1 mile west of East Sand Island at some low tides. Historically, a north and south channel were used for navigation, but the north ship channel was abandoned in 1882, due to shoals forming between the Sand Islands and the mainland. Fishermen were blamed for the shoaling-in of the North Channel from the many piles and fish traps that slowed the water and allowed sand and silt to fill the channel (Darby 2014). To stabilize the navigation channel, a jetty system was constructed to keep the channel open with more predictability. The Sand Island pile dike system was a late element and part of the engineered navigation improvement system for the mouth of the Columbia River between 1880 and 1942. Periodic repairs, modifications, and construction took place along deteriorating and damaged portions of the islands' jetty and pile dike system throughout the twentieth century, with the last documented maintenance reportedly having taken place in the mid-1960s.

Military

In the late 1800s through World War II, the mouth of the Columbia River was a critical strategic location for harbor defenses and was protected by three military forts. Sand Island was set apart for military purposes (military reserve) by an Executive Order signed by Abraham Lincoln, dated August 29, 1863. Lieutenant Colonel H.R. Casey, stationed at Fort Canby in 1902, reported that "troops stationed at Fort Canby used Sand Island during Artillery practice as a location for fixed targets for practice with the 8" converteds and 15" smoothbores" (USACE 1992; HTRW Initial Assessment). Improvements to the Harbor Defense System in 1944 included installation of a system of anti-submarine mines in the river and a mine communication system on the recently stabilized East Sand Island. Three small concrete pillboxes, called "mine cable huts," were built, which were used in the mining operations of the mouth of the river. These mine cable huts are still present on the island, although two are half submerged on the southern shoreline.

Fishing

Baker Bay (also called "Bakers Bay") was historically the most important fishery on the lower Columbia, and rights to the fishing grounds were highly contested, especially on Sand Island. Conflicts occurred between gillnetters and trap fishermen, because fish traps blocked the nets. "Enormous hauls are sometimes made by these huge nets. At Sand Island where the first seining grounds inside the river are located, more than 20 tons of salmon have been caught in a single haul by one seine, and as high as 84 tons of salmon have been taken in a day" (*Oregonian* January 1, 1922). In 1935, soldiers were placed on Sand Island during the summer fishing season to prevent fishermen from occupying the island, closing the island permanently to fishing, due to ongoing fighting between various groups of fishermen.

Breach of Sand Island and Stabilization of East Sand Island

By the early 1930s, the south shoreline of Sand Island was eroding by increased current action, in part caused by the new river dynamics associated with jetty construction. In 1931, a small breech occurred on Sand Island, separating the island, and the general area of East Sand Island began taking shape. The Army had begun constructing a pile dike system on Sand Island, but could not prevent further erosion. The gap that separated Sand Island and East Sand Island became permanent by 1946, though there were efforts to repair it as late as 1952.

Historic Properties on East Sand Island

Four historic properties associated with military use and jetty or pile dike construction have been identified and recorded on East Sand Island (Figure 3-18). One site associated with military use consists of three antisubmarine mine cable huts used for communications during World War II. These huts are small "bomb-proof" pillbox concrete buildings, constructed in 1942. A second site associated with military use of East Sand Island is the ruins of an observation tower used as part of the World War II-era Harbor Defense System. A historic, multiple-feature site associated with the efforts to stabilize East Sand Island includes the rock armored (basalt) shoreline and pile dikes or jetty system, extending from the southern shore remains of the work areas, as well as equipment used in that construction effort. Remains on the island associated with this work include the basalt rubble mounds and wood pilings that once supported a train trestle, as well as track that transported rock used to armor the shore and construct the pile dikes. A related historic site located in the easternmost portion of the DCCO use area includes remains of a steam engine watering area (where a water tank for the steam engine once stood) and disposal area (boneyard) for discarded construction equipment. Several wheel sets from the rail cars and other artifacts are present in this location.

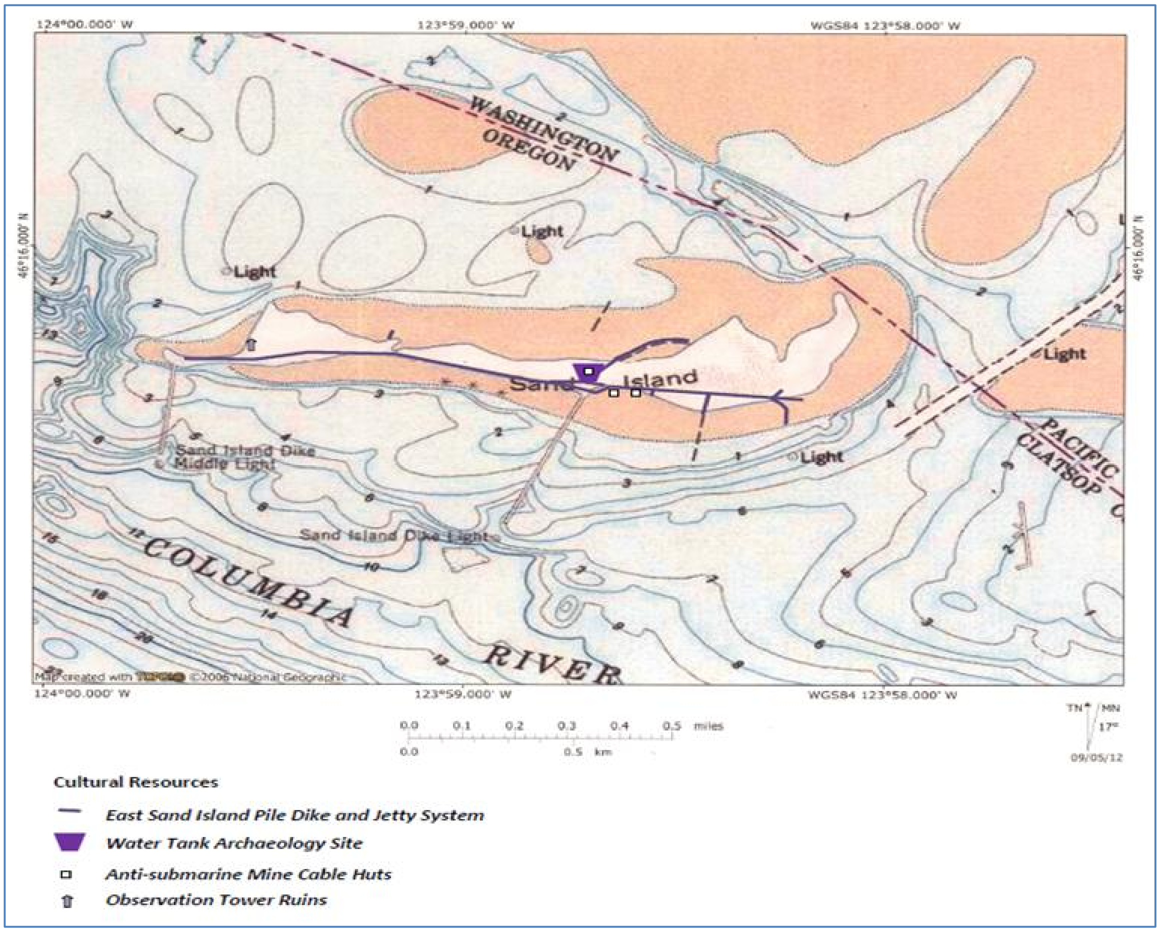


FIGURE 3-18. Historic properties recorded on East Sand Island.

Chapter 4 Environmental Consequences

4.1 Introduction

This chapter discusses the environmental consequences (effects) that may occur from implementing the various alternatives. Effects may be direct (an effect that is caused by an action and occurs at the same time and place) or indirect (an effect that is caused by an action but is later in time or farther removed in distance, but still reasonably foreseeable). The analysis of effects considers the context, duration, intensity, and type of effect. Generally speaking, effects could be beneficial and improve resources or conditions, or adverse and deplete or negatively alter resources or conditions. When effects are similar between alternatives, this is noted with a short statement (e.g., same as Alternative B).

Section 4.2 considers the effects to the biological environment, focusing most attention on the direct effects from proposed alternatives to DCCOs on East Sand Island, the western population of DCCOs, other birds that commonly use East Sand Island (i.e., Brandt's cormorants, California brown pelicans, Caspian terns, and gulls), and ESA-listed Columbia River juvenile salmon and steelhead. This section also includes discussions of other species that could be affected by DCCO dispersal and hazing. Those effects may be more indirect, occurring as a result of management actions on East Sand Island, but realized later in time or further removed from the site of the management action. For example, DCCOs may disperse to nearby Columbia River Estuary islands or relocate under redistribution alternatives to active or historic colonies along coastal Oregon and Washington, where ESA-listed fish may be consumed. Section 4.3 considers the effects to the socio-economic environment, focusing attention on potential benefits to fisheries if DCCO predation rates decrease in the Columbia River Estuary. This section also considers effects to public resources from potential increases of DCCOs in new areas. Finally, this section addresses potential impacts to historic properties on East Sand Island under the different alternatives.

Section 4.4 considers cumulative effects in the context of other past, present, or reasonably foreseeable future actions that, when combined with the proposed alternatives, may cumulatively impact the resources described in Chapter 3. Section 4.5 documents relevant climate change policies, identifies climate impacts likely to be relevant to East Sand Island and DCCO predation, and assesses potential inundation and land cover change under sea level rise scenarios. Section 4.6 considers other important factors for disclosure, such as unavoidable adverse environmental effects, energy requirements, and irreversible or irretrievable commitment of resources. This section also discusses uncertainty in analyses and compensatory mortality in relation to the alternatives and describes the human dimension of wildlife management given the context of the EIS. Section 4.7 provides a narrative comparison of the alternatives and summary table of environmental consequences associated with the proposed alternatives.

4.2 Biological Environment

4.2.1 Effects to Vegetation and Soils on East Sand Island

Alternative A

Under the no action alternative, no management efforts would occur to reduce the DCCO colony, and the presence of DCCOs would likely continue to prevent establishment of vegetation in the space that the colony continues to occupy on East Sand Island. Several trees on the central portion of the island have been used for roost sites and may be used by DCCOs for nesting if no management occurs to prevent expansion of the colony to other areas. Field personnel have noted the excrement of DCCOs is toxic to the species of plants upon which DCCO nest on East Sand Island, and former DCCO nesting sites, where there was previously vegetation, are now bare of all vegetation. DCCOs have shown preference for some minimal amount of nesting substrate compared to no nesting substrate, and once vegetation was killed off, DCCOs have moved to new areas with vegetation (D. Lyons, OSU, personal communication 2014). Given the known impacts that DCCOs have on vegetation (Lemmon et al. 1994; Weseloh and Ewins 1994) and what has been observed on East Sand Island, it is likely that the diversity of tree and herbaceous plant species would be reduced if no management action is taken to reduce the DCCO colony or limit their expansion on the island. The large colony would continue to attract other colonial waterbirds, and accumulation of guano on the island would likely increase over time.

It is unknown what effect the DCCO colony may have had or may currently have on East Sand Island's soil nutrient status. DCCO guano can contribute to higher levels of soil nitrogen, phosphorus, carbon, potassium, and calcium (Ishida 1996; Hobara et al. 2001; Cuthbert et al. 2002; Ligeza and Smal 2003; Wait et al. 2005; Breuning-Madsen et al. 2010; Mizota 2009; Rush et al. 2011). However, nutrient accumulation is likely less pronounced (or less persistent) in high-rainfall environments with sandy-textured soils such as East Sand Island. Hogg and Morton (1983) found that, in the Great Lakes region, most nutrient levels, salts, and pH had returned to near normal within one season of abandonment of gull nests. Because sandy soils have a low water-holding capacity and high infiltration rate, rainwater mobilizes deposited guano and rapidly leaches it through the soil profile. In addition, sandy-textured soils that are low in organic matter have a low cation exchange capacity, so nutrients in solution are not retained on soil particle surfaces. Most nutrients and contaminants deposited in seabird guano likely have a short residence time in the soil profile before being flushed through and into the river system.

Alternative B

<u>Phase I –</u> Alternative B proposes to use non-lethal methods to reduce the DCCO colony to approximately 5,600 pairs, which may result in the transition of vegetation to later seral stages of vegetational succession of plant communities on East Sand Island. As noted, sandy soils in high rainfall environments could flush out nutrient loads associated with guano within one to a few years. As the habitat is managed to constrict nesting to approximately 2 acres in the first year of management and to 1 acre or less thereafter, it is likely that passive restoration of soils and vegetation on East Sand Island, outside of the designated nesting area, would occur over a short period of time. Methods to exclude DCCOs would likely reduce or exclude other waterbirds from nesting and denuding vegetation; thus, restoration potential of plant communities where nesting and use is excluded is expected to be high.

<u>Phase II –</u> Modifying the terrain would exclude approximately 17 acres of nesting habitat on the western portion of the island and create intertidal mudflat or tidal marsh. Given the current state of vegetation on the western portion, creation of tidal mudflats and open marsh is expected to have direct and indirect short- and long-term effects on habitat and vegetation complexity on the island. Direct impacts to soils and vegetation from construction activities associated with terrain modification would be low, as there is little complexity in the soil horizon and vegetation communities in the area to be inundated. Impacts to soils and vegetation in the area where the remaining DCCOs would nest would be similar to what has been observed in the past, and this area would likely need to be constantly managed to ensure DCCOs do not expand in numbers on the island. A re-vegetation and invasive species plan would be developed prior to implementation of the action and strategies would be employed to minimize the effect of field personnel and construction equipment impacting vegetation or unintentionally spreading invasive or unintended plant species on the island.

There are no wetlands on the western portion of the island and none would be affected by the proposed excavation of approximately 300,000 cubic yards of sand within the DCCO use area. Direct impacts to wetlands could occur during disposal of this excavated sand on the eastern portion of the island. Additionally, disposal of sand in areas below high tide line (e.g., along the shoreline) would constitute a fill to Waters of the U.S. and state. Placement of rock armor or other bio-engineered soft armoring on the northern shoreline below high tide would constitute a fill to jurisdictional waters. Disposal locations would be selected to avoid and minimize impacts to delineated wetlands and other Waters of the U.S. where feasible. If, through final design of and selection of disposal sites, impacts to wetlands are determined unavoidable and there is no practicable alternative to placing disposal sites in delineated wetlands, appropriate mitigation measures would be developed to offset the impacts. All efforts to avoid and minimize impacts to wetlands would be made through final design. Should disposal sites be located on the eastern portion of the island, it is possible that two delineated tidal estuarine wetlands, approximately 0.6 acre in size, could be permanently filled. Potential mitigation for this impact could be enhancing other tidal estuarine wetlands present on the island or using a mitigation bank (see Appendix B for additional evaluation under Section 404 Clean Water Act).

Changes to inundation patterns, as proposed by the terrain modification, were modeled using the area-time inundation index model (Chapter 4, Section 4.5.4). The expected inundation of the island at four water surface elevations is presented in Figure 4-1 to illustrate the range of inundation in the modified terrain condition. The lowest water surface elevation shown, 1.2 m (NAVD88), is equivalent to the current lower boundary of marsh elevation at reference sites in Baker Bay (Borde et al. 2011). The highest water surface elevation shown, 3.0 m, was the maximum water surface elevation reached for the modeled period, March to October 2009. The most notable change from the inundation pattern seen in the existing condition is that, with the modified terrain, much of the western side of the island is inundated at water surface elevations greater than 2.2 m.

FIGURE 4-1. Water inundation outputs from the ATIIM for the terrain modification, representing four surface elevations: 1.2, 1.7, 2.2 and 3.0 m (NAVD88).

Alternative C

Effects to vegetation and soils under this alternative would be the same as Alternative B in Phase I and Phase II.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Effects to vegetation and soils under this alternative would be the same as Alternative B in Phase I and Phase II. The amount of vegetable oil used for egg oiling would have no or negligible measurable effect on wetlands, soils, or vegetation.

Alternative D

Effects to vegetation and soils under this alternative would be the same as Alternative B in Phase I. In Phase II, all DCCOs would be prevented from nesting on the island and long-term effects from passive restoration and potentially active restoration on the island would be greater than Alternatives B, C, and C-1 and likely increase diversity of vegetation communities, assuming no other nesting waterbirds replace the DCCO colony.

4.2.2 Effects to Double-crested Cormorants

Alternative A

Summary — Under this alternative no actions would be taken to reduce the rate of predation on juvenile salmonids from DCCOs nesting on East Sand Island or to reduce the DCCO colony size. During 2004 to 2013, the size of the DCCO colony on East Sand Island averaged approximately 26,000 breeding individuals, but 2013 was the greatest size ever recorded (i.e., 30,000 breeding individuals; see Chapter 1, Section 1.1.1). Under Alternative A, the DCCO colony on East Sand Island would likely remain concentrated on the western portion of the island, and the colony size would likely remain similar to current estimates in the near-term (approximately 26,000 breeding individuals; Figure 4-2; see Appendix E-3 for description of modeled future projections). The East Sand Island colony would continue to account for approximately 40 to 50 percent of the breeding western population. DCCO nesting success on East Sand Island would likely remain similar to the average during 1997 to 2013 (i.e., 1.83 fledglings produced per breeding pair; see Figure 3-11). The potential for DCCOs to increase their abundance within the Columbia River Estuary and the affected environment would likely be unchanged. The large DCCO colony would likely continue to attract other DCCOs and other colonial waterbirds to East Sand Island and the Columbia River Estuary.

Abundance of the western population of DCCOs is expected to remain similar to current estimates in the near-term (approximately 62,400 breeding individuals) but may decline in the future (Figure 4-3) due to potential loss of habitat from cumulative adverse effects, such as drought caused by climate change, increasing depredation by an expanding bald eagle population, and other regional impacts (see Chapter 4, Sections 4.4 and 4.5). Based on modeled results of long-term trend, a gradual decrease from current levels is predicted, with abundance stabilizing at approximately 53,000 breeding individuals in 20 years, approximately 11,300 breeding individuals more than observed in ca. 1990. With more than 40 percent of the western population of DCCOs at one colony, disease outbreak or other natural mortality events at East Sand Island would result in a greater adverse effect to the western population of DCCOs than if the population were more evenly distributed.

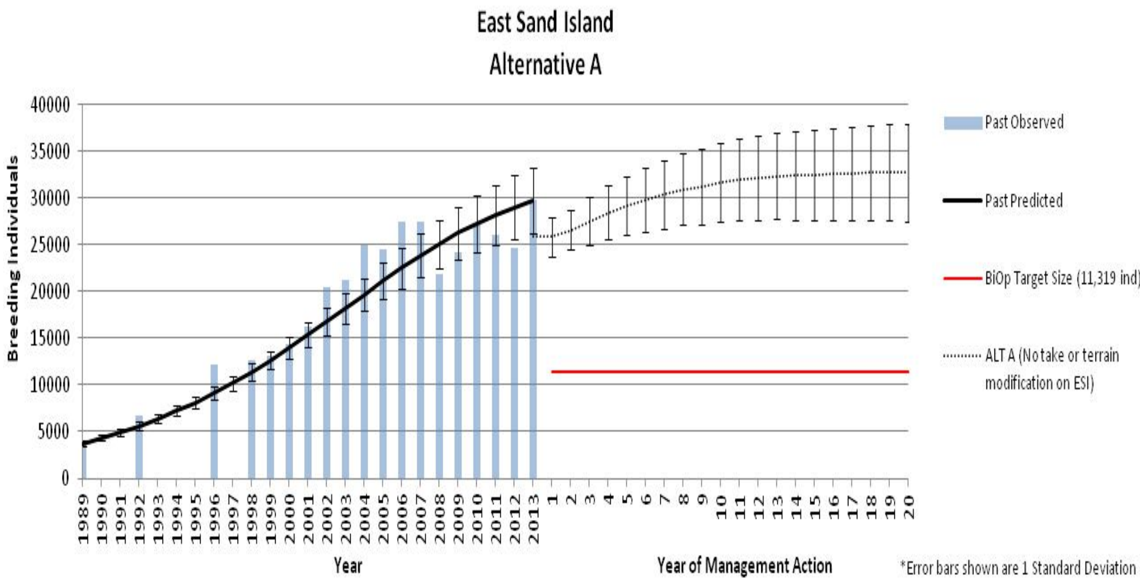


FIGURE 4-2. Predicted size of the DCCO colony on East Sand Island under Alternative A.[7]

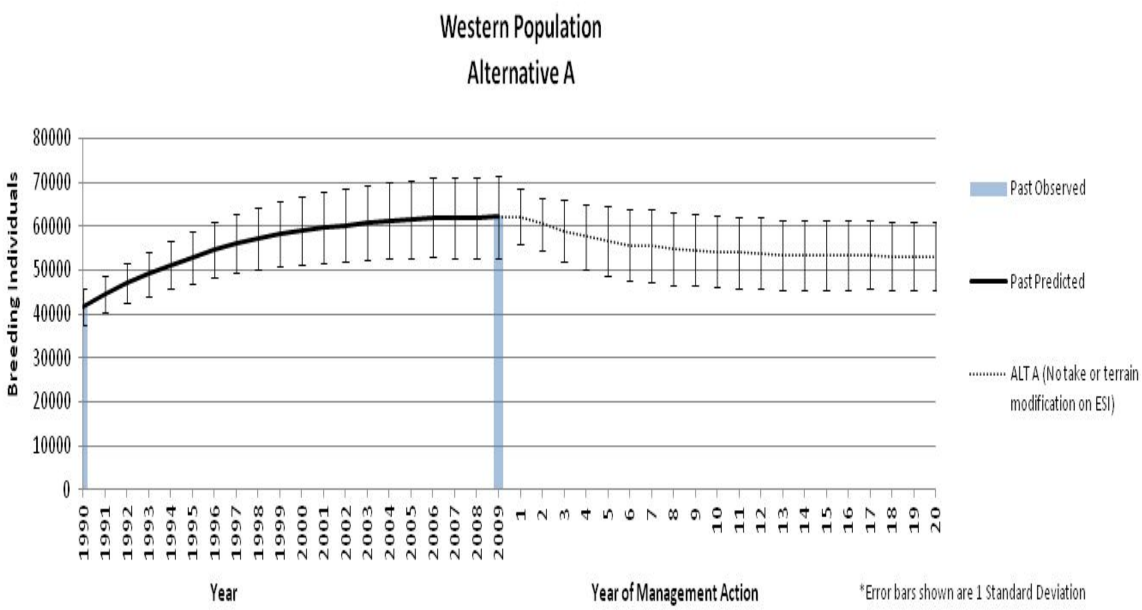


FIGURE 4-3. Predicted size of western population of DCCO under Alternative A.[7]

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[7] For all alternatives, East Sand Island future abundance trajectories included the 10-year average (2004-2013) as the initial abundance and maximum past observed abundance as the carrying capacity value. Past observed data (Year) and future years (Year of Management Action) were modeled separately and shown on the same graph for convenience. For all alternatives, western population future population abundance trajectories included the current population estimate as the initial abundance and an

Alternative B

Summary — Under this alternative, the Corps would implement non-lethal methods (i.e., those described in Chapter 2) to reduce the DCCO colony on East Sand Island from the current colony size of approximately 13,000 breeding pairs to approximately 5,380 to 5,939 breeding pairs during Phase I, a 56 percent reduction (Figure 4-4). Limited egg take (up to 750 DCCO eggs in total; 500 on East Sand Island and 250 on Corps dredge material islands in the Columbia River Estuary) would also occur to facilitate successful implementation of non-lethal techniques. In Phase II, non-lethal methods (i.e., terrain modification, supplemented with temporary habitat modification and hazing, as necessary) supported with limited egg take would be used to ensure that Phase I abundance is not exceeded.

Because this alternative proposes to utilize primarily non-lethal methods to achieve the management objective for colony size on East Sand Island, the abundance of the western population of DCCOs is expected to remain similar to current levels in the near term (62,400 breeding individuals) but may decline to a greater extent than Alternative A due to the factors described plus additional loss of habitat at East Sand Island from the Phase II terrain modification and future limitation of the colony. Based on modeled results of long-term trend, a gradual decrease is predicted, with abundance stabilizing at approximately 46,000 breeding individual in years 13-20 after implementation (Figure 4-5), approximately 4,300 breeding individuals more than observed in ca. 1990. Approximately 24 percent (11,200/46,000) of the western population of breeding DCCOs could nest at East Sand Island.

Since only breeding DCCOs are typically counted during colony monitoring and many breeding age DCCOs may fail to breed in the years immediately following implementation of this alternative, monitoring might yield a lower estimate for the western population than currently. There could likely be a decrease in productivity and recruitment until DCCOs dispersed from East Sand Island find new breeding sites and successfully produce fledglings at rates comparable to those on East Sand Island. Additionally, constraining abundance and future growth of the DCCO colony at East

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additional take of 936 DCCOs per year from take elsewhere in the western population. For Alternative A, abundance trajectories include no take on East Sand Island and, for the western population trajectory, a reduced carrying capacity of 7 percent (58,216 breeding individuals) compared to current estimated abundance, which includes approximately half loss of the DCCO numbers associated with Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals) but not East Sand Island DCCOs since no habitat will be removed under this alternative (62,400 – 4,184 = 58,216). See Appendix E for additional details.

Sand Island could likely reduce overall growth of the western population of DCCOs, as most documented growth over the past decades has occurred at this colony. However, if DCCOs successfully relocate and breed at other established or new colonies, size of the western population of DCCOs in the future could be similar to current levels or decline as described in Alternative A.

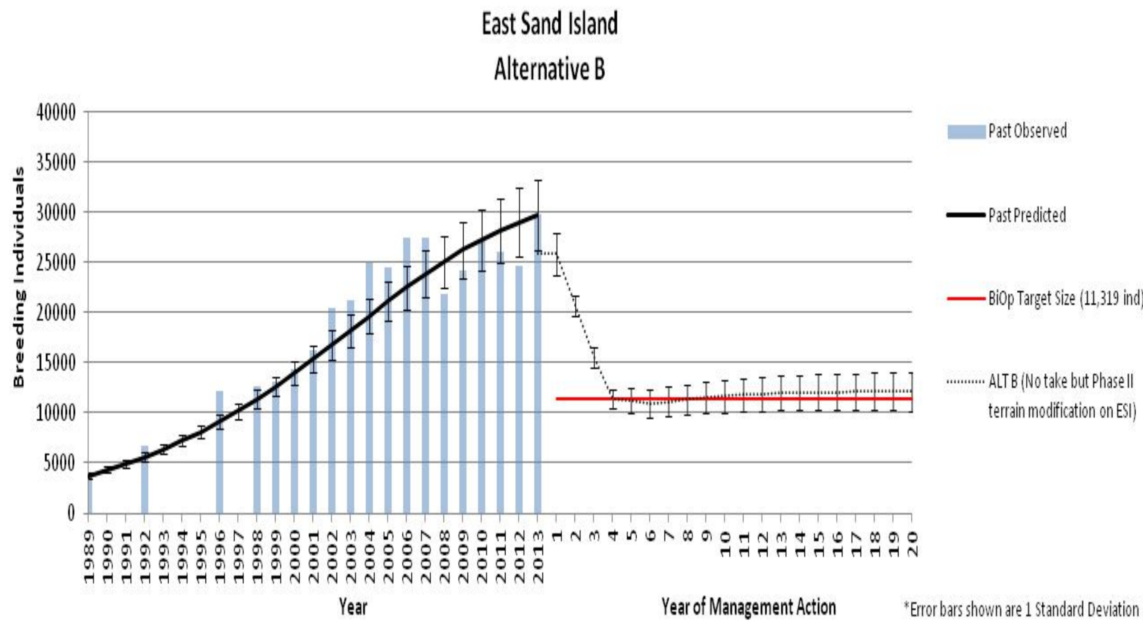

FIGURE 4-4. Predicted size of the DCCO colony on East Sand Island under Alternative B.

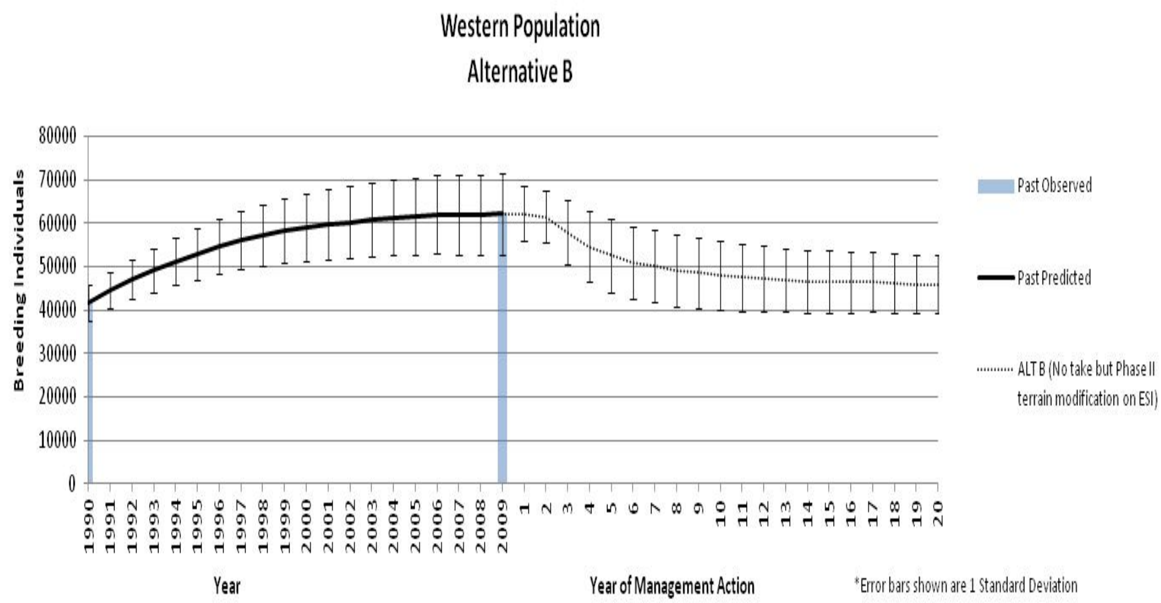

FIGURE 4-5. Predicted size of western population of DCCO under Alternative B.[8]

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[8] Western population abundance trajectories include the additional 936 DCCOs taken per year and a reduced carrying capacity of 18 percent (same as Alternative C and C-1; half loss of the DCCO numbers associated with the Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals) and approximately half of the colony size reduction proposed on East Sand Island (7,258 individuals; 62,400 – 4,184 – 7,258 = 50,958) since the same amount of habitat will be removed under Phase II terrain modification of Alternatives B, C, C-1. Alternative B includes no take on East Sand Island, whereas

Phase I - Effects on East Sand Island — The DCCO colony on East Sand Island would be reduced to a colony size of 5,380 to 5,939 breeding pairs and would comprise a smaller proportion of the western population of DCCOs than currently. The proposed colony size is approximately between the 1997 (5,023 breeding pairs) and 1998 (6,285 breeding pairs) observed abundance for the East Sand Island colony (Roby et al. 2014; see Chapter 1, Section 1.1.1). Based on past research on East Sand Island, use of human hazers and privacy fencing was effective at dissuading DCCOs from nesting on certain areas of the island without precluding a viable DCCO breeding colony or having overall negative effects to DCCOs in the designated nesting area (BRNW 2013a; Roby et al. 2014). This would be the primary method used. Other non-lethal management techniques (those described in Section 2.1.2) could be implemented under the adaptive management process described in Alternative B. These other non-lethal techniques have a similar overall adverse effect as disturbance and hazing described herein, resulting in flushing adults, and could result in subsequent nest or colony abandonment. DCCOs flushing when eggs or chicks are present could result in nest failure because of increased exposure and potential for predation (i.e., typically gulls prey upon eggs and chicks immediately after a disturbance event; Kury and Gochfield 1975; Carney and Sydeman 1999; BRNW 2013a). These effects would be greater the longer management actions extend past the initiation of nesting. Best management practices and adaptive management strategies described in Chapter 2 would be used to minimize potential effects. Adverse effects to DCCOs within the designated nesting area, where management activities would not occur or would be very limited, are expected to be negligible and similar to impacts of past research efforts. Productivity within the designated nesting area would likely remain similar to the average during 1997 to 2013 (i.e., 1.83 fledglings produced per breeding pair; see Figure 3-11).

To ensure that Alternative B can be implemented effectively, a limited amount of egg take could occur (i.e., up to 750 DCCO eggs in total; up to 500 eggs on East Sand Island and 250 on Corps dredge material islands in the Columbia River Estuary). Take of 500 eggs on East Sand Island represents approximately 1.0 percent of potential eggs from the East Sand Island colony in a given year (i.e., assuming 10-year average colony size (12,917 breeding pairs/nests) and 3.85 eggs per nest; [500/ (12,917 * 3.85)]). Take of 250 eggs in other areas of the Columbia River Estuary represents approximately 0.5 percent of potential eggs from the East Sand Island colony in a given year (250/ (12,917

Alternatives C and C-1 included the proposed take levels of each alternative. Also see footnote 7 and Appendix E for additional detail.

* 3.85)). In total, take of 750 eggs represents approximately 1.5 percent of potential eggs from the East Sand Island colony in a given year (750/ (12,917 * 3.85)).

Effects to DCCOs from non-lethal management have been well described (Parkhurst et al. 1987; Wires et al. 2001; USFWS 2003; Sullivan et al. 2006; Pacific Flyway Council 2012; Russell et al. 2012; BRNW 2013a). DCCOs attempting to nest outside of the designated nesting area would be actively hazed to preclude them from nesting. Direct adverse effects from hazing and disturbance include: 1) precluding DCCOs from nesting and using presumably optimally chosen areas on East Sand Island and 2) reducing individual fitness from the increased energetic demands from being flushed. DCCOs often depart nesting areas during a disturbance event (Ellison and Cleary 1978; Carney and Sydeman 1999; BRNW 2013a; Roby et al. 2014). Fidelity to a nest or a nesting area is typically greater later in the nesting cycle or breeding season, commensurate with individual investment toward producing and rearing offspring (Kury and Gochfield 1975; Ellison and Cleary 1978). Hazing in the dissuasion area on East Sand Island would be implemented frequently and repeatedly during the nest initiation period and likely extend greater than 11 weeks and into the late chick or early fledgling stage of the breeding season.

Constricting the nesting area and hazing would result in approximately 7,250 DCCO breeding pairs being displaced from East Sand Island. DCCOs dispersed from East Sand Island could: 1) breed at other existing DCCO colonies; 2) breed at new locations; or 3) forego breeding until a suitable nesting habitat is found. It is unknown whether individual breeding success, survival, or DCCO-related management activities would be higher or lower in new breeding areas compared to East Sand Island.

Indirect adverse effects from reducing available nesting habitat on East Sand Island could likely include: 1) higher DCCO and other bird nesting concentrations on the west end and 2) higher DCCO use and nesting attempts outside the designated nesting area and on the east side of the island. Displaced DCCOs and other birds (i.e., Brandt's cormorants, gulls) would likely attempt to nest within the designated nesting area, resulting in greater nesting density and concentration than observed on East Sand Island in the past. The DCCO colony would likely become more uniformly distributed within the designated nesting area at an approximate nesting density of 1.28 nests per square meter (the maximum nesting density observed during 2005–2013; BRNW unpublished data; see Figures 1-5 and 4-6) or greater. An increase in nest density and concentration could affect individual nesting success and overall productivity because of the potential adverse effects of increased nest-site competition. Concentration of the DCCO colony within a smaller area would likely increase the proportion of individuals affected during natural disturbance events (i.e., bald eagle and mammalian disturbance). Based on past dissuasion research results, magnitude and direction of effects from higher nesting density and concentration are uncertain. When nesting habitat was restricted during 2011 and 2012 (see Figures 1-5 and 4-6 for a visual of the colony restriction), nesting success was much lower than prior years and approximately 30 percent lower than the average during 1997 to 2013 of 1.83 fledglings produced per breeding pair (see Figure 3-11). Increased levels of bald eagle predation were suspected of causing the decline. In 2012, as many as 19 bald eagles were observed at one time on the west end of East Sand Island preying upon DCCOs and DCCO eggs and chicks (Roby et al. 2013). However, during 2013, the year of greatest habitat restriction, highest nesting concentration, and bald eagles present in comparable numbers to prior levels, nesting success was 2.36 fledglings produced per breeding pair, the third highest for the period of record (1997–2013) and approximately 30 percent greater than the long-term average. In 1997 (i.e., when the colony size was similar to approximately 5,600 breeding pairs), nesting success was slightly lower but comparable to the long-term average. These data show increased nesting density and concentration does not directly correlate to productivity rates, and large-scale factors aside from conditions on East Sand Island, such as ocean conditions and prey availability, likely affect nesting success to a large degree (Roby et al. 2014). Additionally, higher nesting density and concentration could potentially increase the risk for transmission of Newcastle's disease. However, during dissuasion research, this risk factor was present and did not appear to jeopardize the viability of the colony or suggest that further restriction of the colony would do so.

The likelihood of complete loss or abandonment of the DCCO colony on East Sand Island during Phase I from management activities under Alternative B is low. Although extensive hazing outside the designated nesting area and management activities on island would occur during much of the breeding season, the designated nesting area would remain rather undisturbed and would provide adequate nesting habitat. The remaining colony on East Sand Island would still be the largest within the western population of DCCOs.

Effects off East Sand Island — DCCOs that are unable to nest on East Sand Island would likely prospect for new breeding, roosting, and foraging sites within the Columbia River Estuary area before emigrating to other areas of the affected environment. DCCO abundance would likely increase at prior use sites such as the Astoria-Megler Bridge or Rice Island or potentially new sites within the Columbia River Estuary that are suitable for DCCO nesting. Alternative B (and all action alternatives to some degree) includes hazing in the Columbia River Estuary to ensure that displaced DCCOs from East Sand Island are re-located outside the estuary to achieve the reduction in juvenile salmonid predation rates specified in the 2014 FCRPS Biological Opinion (NOAA 2014). Boat- and land-based human hazing supported with limited egg take (250 eggs, see above) would be the primary techniques used to limit DCCO breeding, roosting, and foraging in the Columbia River Estuary, but other non-lethal management techniques (Section 2.1.2) could be implemented under an adaptive management process (Section 2.1.4). DCCOs hazed in the Columbia River Estuary would be exposed to direct and indirect adverse effects of disturbance as previously described for DCCOs on East Sand Island. Adverse effects from disturbance in foraging areas include decreased individual fitness (Grémillet et al. 1995). Overall DCCO occurrence in the Columbia River Estuary would likely be higher than current levels but could decrease to current levels or lower after repeated years of active hazing. Completely deterring all DCCO from using the Columbia River Estuary seems unlikely in the short-term and likely in the long-term due to the size of the scope of the area involved, logistical constraints, limited accessibility to many areas, and results of prior large-scale dissuasion research (see Chapter 2, Section 2.2.2 about feasibility and King 1996, Mott et al. 1998, and Tobin et al. 2002). However, DCCO breeding, roosting, and foraging in the Columbia River Estuary would likely be reduced to some degree compared to no hazing effort (i.e., Alternative A). Avian hazing efforts that occur under the Corps' Dredge and Harbors Program have been successful in precluding Caspian terns from establishing nesting colonies on many of the Corps' dredge material islands over the past decades (see Roby et al. annual reports). Additionally, based on past research, hazing efforts would also likely preclude DCCO foraging and roosting from localized areas of the Columbia River Estuary (see Parkhurst et al. 1987, Wires et al. 2001, Dorr et al. 2010, and Russell et al. 2012).

The level of disturbance necessary before a DCCO would emigrate from the Columbia River Estuary is unknown and would likely be influenced by individual variability and temporal environmental conditions. DCCOs are habitat generalists and express high nest site fidelity to breeding areas, and this is true of the East Sand Island colony. Given the substantial growth and size of the East Sand Island colony compared to other areas, the Columbia River Estuary is likely one of the most productive foraging and breeding areas within the western population of DCCOs' range. The Columbia River Estuary is an area that DCCOs would likely not abandon easily based upon results of the past management feasibility studies and dissuasion research. Additionally, DCCOs are colonial waterbirds attracted to nest with other colonies of birds and the other colonies of birds that would remain on East Sand Island (gulls, Caspian terns, and brown pelicans) would continue to provide social attraction.

DCCOs within the affected environment, outside of the Columbia River Estuary, could be indirectly affected by DCCOs that disperse to those areas. Within the affected environment, the sub-regions most likely to experience DCCO abundance increases outside of the Columbia River Estuary would be the Washington Coast and the Salish Sea. The effect of DCCOs immigrating to new areas on other DCCOs already present within those areas is unknown, and would most likely be site-specific. Potential adverse effects of increased DCCOs on existing colonies include intra-specific nesting and foraging competition and an increase in the potential for disease transmission. Potential beneficial effects include increased colony size that could result in excluding inter-specific nest site competition and buffering against disturbance events and predation.

Phase II — DCCOs are highly philopatric and adults have high breeding site fidelity (Wires et al. 2001). Since the proposed reduction in colony size would be achieved non-lethally through dispersal in Phase I, future immigration to the colony and repeated nesting attempts by displaced DCCOs would likely be high. DCCOs that are deterred from nesting on East Sand Island in a given year or hatched on East Sand Island would likely continue to visit or prospect to breed at East Sand Island and within the Columbia River Estuary in later years, to some degree. Terrain modification supplemented with non-lethal management on East Sand Island in Phase II would be implemented to ensure the objective for colony size is not exceeded and DCCO juvenile salmonid predation rates remain at reduced levels. Direct and indirect adverse effects to DCCOs from non-lethal management would be the same as described in Phase I. The duration of effects is unknown and largely dependent upon how long DCCOs remain committed to the estuary, but would likely decrease through time as displaced DCCOs disperse to current and historical colonies and establish nesting. These effects would likely decrease through time as terrain modification changes are completed. No adverse direct effects are expected from construction activities from the terrain modification, as construction activities would occur outside the peak breeding season.

Alternative C

Summary — Under this alternative, the Corps would implement primarily lethal methods (i.e., on-island and boat-based culling) during Phase I to reduce the DCCO colony on East Sand Island to between 5,380 and 5,939 breeding pairs (ca. 1997 to 1998 colony abundance; Figure 4-6). Non-lethal methods supported with limited direct egg take up to 750 eggs (i.e., 500 on East Sand Island and 250 for Corps dredge material islands in the Columbia River Estuary), as described in Alternative B, would be used concurrently with lethal methods.

An adaptive approach would be used to achieve the East Sand Island DCCO management objective for colony size. The Corps would undertake a 4-year lethal strategy scheduled to be completed at the end of 2018 if implementation began in 2015; see Chapter 2, Section 2.2.3 for description of field methods and adaptive approach and Appendix E-2 for modeling and effects of take levels). Under this strategy, 24 percent of the DCCO colony would be culled each year, resulting in a total take of 18,185 DCCOs in all years (6,202, 4,887, 3,881, and 3,214 DCCOs in years 1 to 4, respectively). Proposed individual take levels would include and account for the associated amount of indirect nest loss that could occur from taking the proposed number of individuals. Through adaptive management, take levels could change based upon observed abundance as compared to the predicted abundance (as described in Chapter 2 and Appendix E-2) for the East Sand Island colony (Figure 4-6) and the western population (Figure 4-7). Under Phase II, management would shift to a non-lethal focus (same as Alternative B) to ensure that the management goal for colony size is not exceeded and DCCO juvenile salmonid predation rates remain at reduced levels. Under Alternative C, abundance of the western population of DCCOs is projected to be approximately 35,000 breeding individuals after Phase I and increase to a long-term 20 year projected size of approximately 44,500 breeding individuals (Figure 4-7).

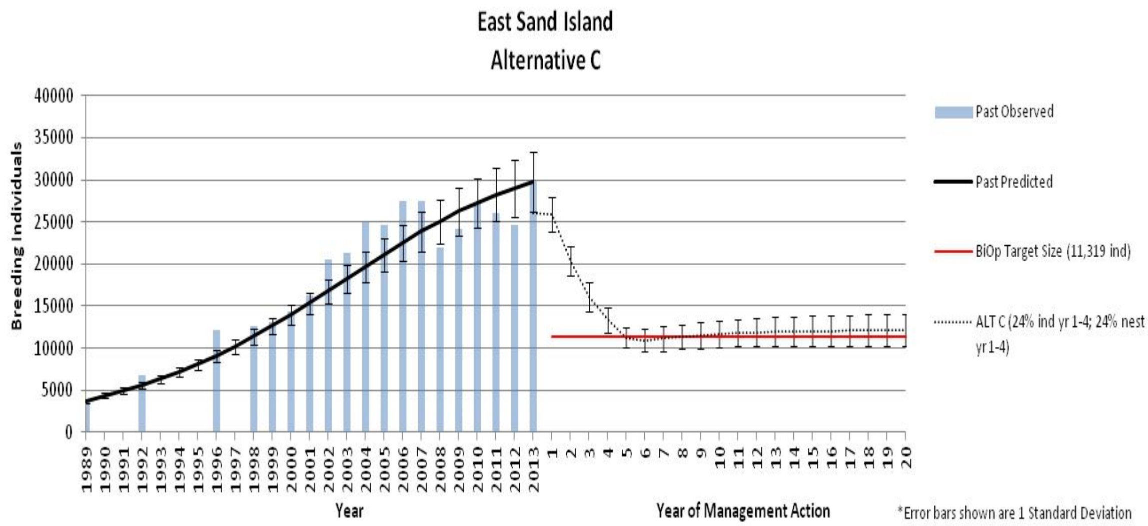


FIGURE 4-6. Predicted size of the DCCO colony on East Sand Island under Alternative C. [7, 8]

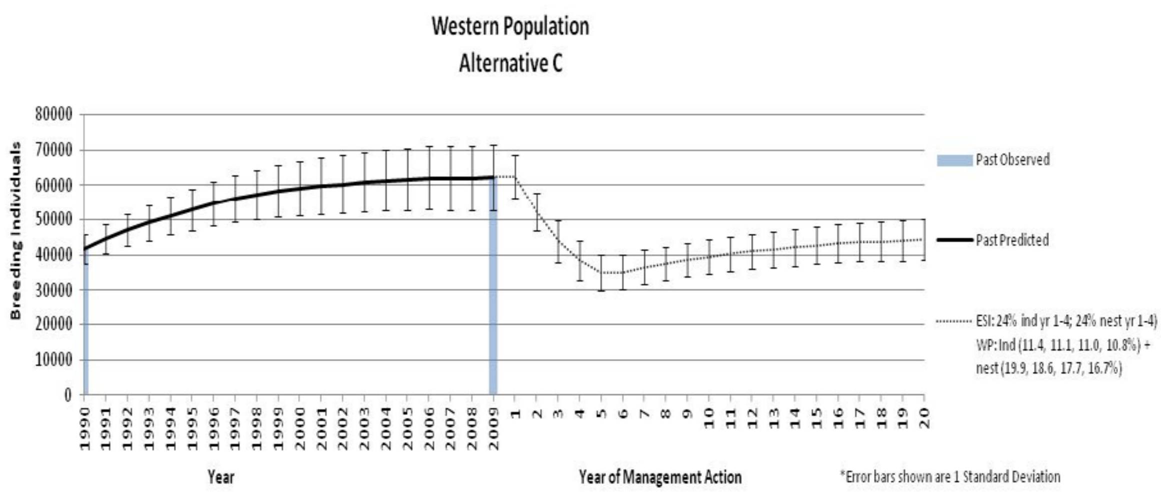


FIGURE 4-7. Predicted size of western population of DCCO under Alternative C.[7, 8]

Phase I - Effects on East Sand Island — Lethal management techniques for DCCOs and effects to DCCOs resulting from lethal management have been well described (Bedard et al. 1997; Wires et al. 2001; USFWS 2003; Ontario Parks 2008; Pacific Flyway Council 2012; Russell et al. 2012; Guillaumet et al. 2014). In general, lethal techniques result in the loss of individuals or eggs, chicks, or fledglings; a reduction in abundance, for a given area or to a population or colony, depends upon the scale of lethal management and whether the level of loss is greater than the effects of immigration, recruitment, and other density-dependent mechanisms (USFWS 2003). Of the life stages on which lethal take could occur, lethal take of breeding adults has a greater impact on reducing abundance than removing eggs, chicks, or fledglings, as DCCOs are a long-lived species with high adult survival relative to other life stages and breed throughout their adult lives (Ludwig and Summer 1995; Hatch and Weseloh 1999; Blackwell et al. 2002; also see Appendix E). Ludwig and Summer (1995) estimated that culling adults had a 3- to 6-fold greater effect on the population than culling fledglings, chicks, or eggs. DCCOs typically breed in their third year (Hatch and Weseloh 1999), and with egg take there would be a multiple year delay before decreased recruitment affects the colony or population size (Bedard et al. 1997; Guillaumet et al. 2014). The primary lethal technique proposed for Alternative C is culling individuals. Other lethal management techniques (Section 2.1.2) are not proposed but could be implemented under an adaptive management process (Section 2.1.4). The direct adverse effect of take of individuals under the 4-year lethal strategy (see summary above) is loss of 24 percent of DCCOs from the colony annually, including the number of associated nests that are indirectly lost.

The primary method of lethal take over water would be with shotguns from boats or stationary positions. Direct adverse effects to individuals in close proximity to those taken include injury and disturbance from visual stimuli (i.e., shooter, loss of other individuals) and noise due to the sound of the firearm, if silencers and suppressors are not used (see Alternative B for discussion of effects from disturbance). Retrieval rates over water would likely not be 100 percent, as DCCOs may be lost in the water. Techniques described in Chapter 2 would be used to ensure retrieval rates that are as high as possible given field conditions. Because of the distance of actions associated with boat-based shooting, potential direct adverse effects to DCCOs on East Sand Island would be negligible.

The primary method of lethal take on-island would be rifles. Direct adverse effects from take with rifles include disturbance to individuals in close proximity to those taken and disturbance to the immediate area when carcasses are retrieved. The number of disturbances to the DCCO colony on-island would be dependent upon the number of proposed shooting events on island, but is estimated to be approximately 6-8 events. Injury to proximal DCCOs would be negligible with rifles and presumably all culled individuals would be retrieved as soon as practicable. Because of the effectiveness of privacy fencing and the use of sub-sonic shot, silencers, and night-shooting, potential direct adverse effects to DCCOs within other areas where shooting or removal of carcasses does not occur are assumed to be minimal.

Direct take of active nests, eggs, chicks, or fledglings is not proposed as a primary lethal technique, but this loss would occur indirectly resulting from the take of breeding adults that may be actively nesting when culled. Since both parents equally care for offspring, if one individual of a breeding pair is culled, the remaining individual of a breeding pair cannot sufficiently protect offspring and provide them food (Bedard et al. 1997; Strickland et al. 2011). The most extreme active nest loss scenario was modeled and included within the proposed take percentages (1 active nest per 1 individual, which represents each individual being from a separate breeding pair; see Appendix E-2). Actual nest loss is expected to be lower, as some individual take would occur before nesting or would not be associated with a nest and some of the individuals taken would be pairs. Individuals of a breeding pair that lose their partner would have no productivity in subsequent years until becoming paired again (Strickland et al. 2011). Both Bedard et al. (1997) and Strickland et al. (2011) documented male bias when culling, approximately 2:1 males per female. Males generally are more territorial and stay longer when disturbed and typically are the first to return after a disturbance (Bedard et al. 1997; Strickland et al. 2011). Culling a higher proportion of males than females could skew sex ratios within the pool of available DCCOs attempting to breed at East Sand Island, resulting in faster reduction in the colony size than anticipated, as was documented by Bedard et al. (1997) and Strickland et al. (2011). Productivity would be decreased until unpaired individual birds are able to pair again.

Best management practices and adaptive management strategies described in Chapter 2 would be used to minimize potential effects. To reduce impacts to nesting DCCOs, lethal take would occur as early in the year as possible and occur over water to the extent practicable. Greater direct and indirect adverse effects to DCCOs would occur if: 1) lethal take extends into the breeding season or the longer lethal take extends into the breeding season; 2) the more frequent lethal take sessions occur; and 3) a larger area on-island and over-water is included for lethal take. Exposure to multiple shooting events or repeated and persistent disturbance, particularly early in the breeding season, could increase dispersal. Effects described would be greater during the primary time period when the majority of lethal take occurs. The exact level of dispersal from Alternative C is unknown; however, the expected magnitude of dispersal would likely be minimal compared to Alternative B. Direct adverse effects from non-lethal management (i.e., hazing elsewhere on the island) would be the same as described in Alternative B; effects are expected to be less under Alternative C compared to Alternative B because fewer individuals are expected to be displaced because more DCCO would be directly taken and not displaced and hazed.

Proposed annual take levels on East Sand Island are comparable to take levels of other culling programs in Canada and the United States that effectively reduced DCCO abundance to acceptable levels for mitigating impacts to resources in particular areas. In total abundance, reducing the DCCO colony on East Sand Island from the 10-year abundance average (12,917 breeding pairs) to the management objective (5,380 and 5,939 breeding pairs) is an approximate 56 percent reduction in colony size. During 2004–2006 at Presqu'ile Provincial Park, DCCO nesting abundance was reduced by approximately 6,000 breeding pairs (i.e., 67 percent reduction), and annual culling and nest take rates were 20 to 51 percent and 5 to 36 percent, respectively (Ontario Parks 2008). Within Thunder Bay, Lake Huron, 33 percent culling rates were used to reduce colony abundance (USFWS 2003). At Young Island, Vermont, a DCCO colony was reduced from approximately 1,500 breeding pairs in 2004 to zero breeding pairs in 2008, when culling 20 percent of adults and oiling 100 percent of nests annually (Duerr et al. 2007; Strickland et al. 2011). Within the St. Lawrence River Estuary, DCCO abundance was reduced from 17,361 breeding pairs in 1989 to 9,561 breeding pairs in 1993 (i.e., 45 percent reduction) with approximate annual culling rates of 5.7 to 9.4 percent and nesting oiling rates of 31 to 51 percent (Bedard et al. 1997). At the Les Cheneaux Islands, Michigan, total DCCO nesting pairs were reduced approximately 74 percent from 5,487 in 2003 to 1,436 in 2007 with approximate annual culling rates of 9.7 to 47.2 percent and nesting oiling rates of 41.9 to 77.7 percent (Dorr et al. 2010).

The risk of colony abandonment or the size of the DCCO colony on East Sand Island dropping or staying below 5,380-5,939 breeding pairs, based on the take levels proposed, is low. Measures to minimize disturbance would be put in place to ensure a viable nesting colony within the designated nesting area, and other large-scale culling programs in Canada and the United States at well-established and large colonies have not resulted in colony abandonment, even if the take levels were greater than the proposed take levels in the FEIS (see Bedard et al. 2007; Ontario Parks 2008; USDA-WS 2009; Dorr et al. 2010). The designated nesting area would provide adequate nesting habitat for the reduced colony size and the remaining colony on East Sand Island would still be the largest within the western population of DCCOs. A large number of fledglings would likely be produced each year and the colony would continue to attract DCCOs to the area. Additionally, conservative measures were used in the modeling approach for deriving take levels (see Appendix E-2), and take would occur within a well-monitored and adaptive management framework, with take and other management activities ceasing if annual peak colony size falls below the management objective for colony size.

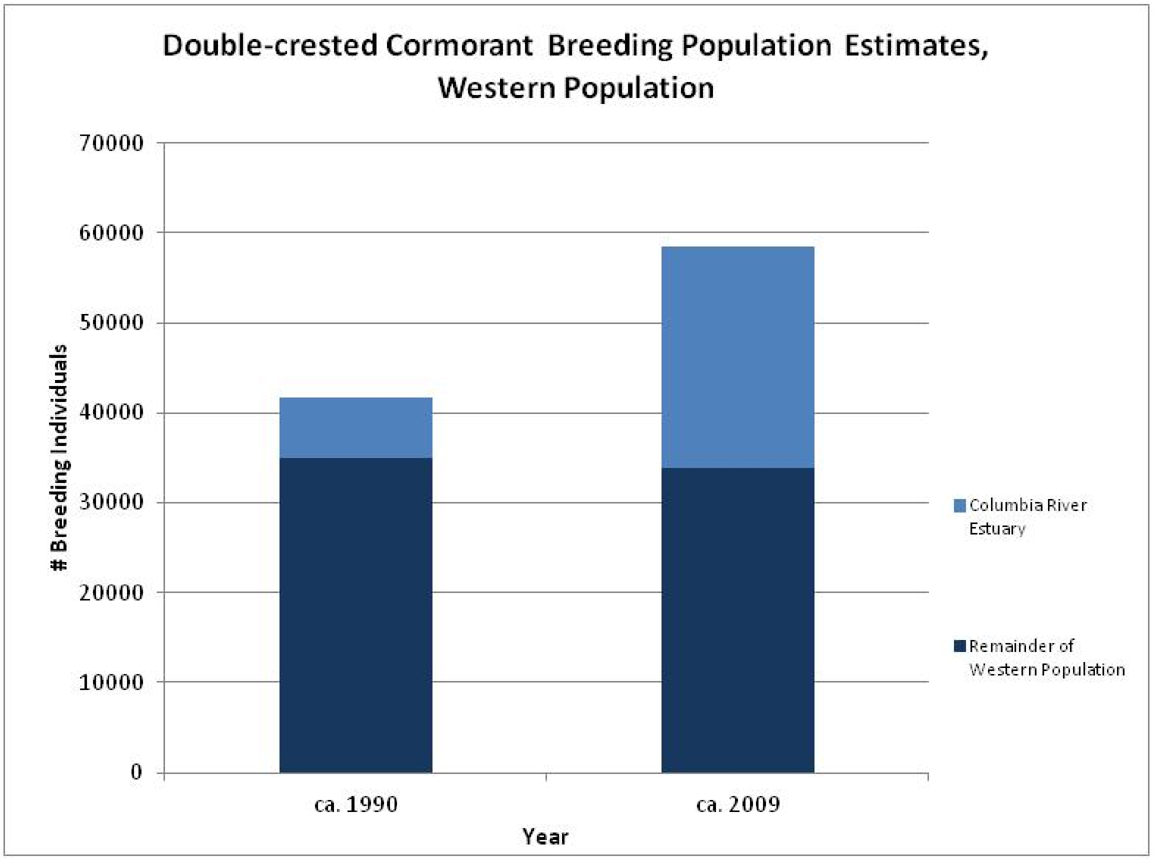
<u>Effects off East Sand Island —</u> Effects would be similar to what was described in Phase I of Alternative B. However, overall effects are expected to be less compared to Phase I of Alternative B because of less expected dispersal of DCCOs.

<u>Effects to the Western Population—</u> Based on modeled population trajectories of the western population of DCCOs, which includes the additional authorized take of 936 DCCOs that occurs annually within other areas of the western population (see Appendix E-2), abundance of the western population of DCCOs is projected to be 34,979 (+/- 1 SD =29,899–40,058) breeding individuals after Phase I (Figure 4-7), or a 44 percent decline in the western population of DCCOs from its current abundance (62,400 breeding individuals; Adkins et al. 2014). This predicted abundance is approximately 6,700 breeding individuals less than observed abundance in ca. 1990 for the western population of DCCOs (41,660 breeding individuals; Tyson et al. 1997). The projected abundance falls below ca. 1990 population level for 9 years after implementation of Phase I actions and increases to a long-term 20 year projected size of 44,349 (+/- 1 SD =38,585–50,113) breeding individuals (Figure 4-7), approximately 2,800 breeding individuals greater than observed abundance in ca. 1990. The resulting East Sand Island DCCO colony would comprise a smaller portion of the western population than currently observed, but would still be the largest in the western population; approximately 25 percent (11,200/44,500) of the western population of breeding DCCOs could nest at East Sand Island.

Abundance of DCCOs in North America has been documented through several assessments and compilations of surveys and has fluctuated through time (see Carter et al. 1995; Tyson et al. 1997; Wires et al. 2001). DCCO populations declined during the 19th century, including the western population, due to overexploitation, egg-collecting, and other human disturbances (Hatch 1995). The Interior population has the most available data and mostly likely represents what had occurred throughout North America. The Interior population increased from the 1920s to the 1950s (Hatch 1995; Wires et al. 2001). Pesticides then started to have major impacts and the Interior population fell to low levels about 1970; DCCOs were then recognized as a species of “Special Concern” in several states (Wires et al. 2001). Environmental contaminants were shown to have impacts in California as well through the 1960s and 1970s (Gress et al. 1973). Coordinated, regional survey data is not available prior to the 1990s for the western population of DCCOs; thus, an accurate depiction of historic abundance and trend is not available. Much of the current population growth observed across North America occurred between the late 1970s and early 1990s and was the result of reduced levels of environmental contaminants (particularly DDT, which was banned in 1972), protection of DCCO under the MBTA in 1972, human induced changes in aquatic ecosystems (e.g., improvements in water quality, overfishing), and creation of additional breeding and foraging habitat (e.g., reservoirs and dredge material islands, expansion of aquaculture; Wires et al. 2001). Since the 1970s, a broad suite of environmental regulations have been enacted (e.g., the Clean Water Act) which have greatly improved water and environmental quality, and avian and waterbird conservation and planning have improved (see Chapter 4, section 4.4).

Documented changes in distribution of the western population of DCCOs occurred in the 1980s and 1990s with growing breeding colony sizes along the Oregon Coast coinciding with declines in British Columbia and Washington (Carter et al. 1995). Since 1990, growth of the western population of DCCOs has been primarily associated with growth of the East Sand Island colony (Adkins and Roby 2010; Figure 4-8). However, DCCOs are migratory birds and those that nest on East Sand Island typically spend half of the year away from East Sand Island. Thus, environmental conditions outside of just East Sand Island since the 1990s likely have contributed to past trends and the current overall status of the western population of DCCOs. It is important to note that the estimated annual sums of breeding individuals across other western colonies, not including East Sand Island, are similar or higher when comparing population data from ca. 1990 to current, even when accounting for losses in portions of the range. Thus, a re-distribution has taken place; some locations have declined while others have increased. Also, the number of active colonies has increased. In about 1990, Carter et al. (1995) noted 99 active colonies in British Columbia, Washington, Oregon, and California. That number increased to 160 active colonies (2008-2012) for these same states and province (Pacific Flyway Council 2013). Thus, based on this past population trend and current number of active colonies, it appears that the western population is sustainable around 41,660 breeding individuals (ca. 1990). A sustainable population is defined for this analysis as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered.

Based on model simulations presented in Appendix E-2, take levels proposed in Alternative C are expected to result in approximately 6,700 breeding individuals less than observed in ca. 1990 after Phase I but increase and stabilize at abundances approximately 2,800 breeding individuals greater than observed abundance in ca. 1990. Within the coastal states and provinces, which account for approximately 90 percent of the western population of DCCOs, DCCO abundance increased 71 percent (approximately 3 percent per year) during the last two decades, but nearly all of the growth of the western population of DCCOs was attributed to abundance increase at the East Sand Island colony (Adkins et. al 2014; see Figure 4-8). With nesting habitat reduced and growth on East Sand Island limited and previous and new threats as likely limiting factors of the western population (e.g. predation, human disturbance, and climate; see Adkins et al. 2014), the western population of DCCOs would likely decrease in the future. However, the western population would likely rebound to some extent if abundance levels were to temporarily drop below the ca. 1990 level, given: 1) that mortality factors known to limit DCCO populations prior to the 1970s have been reduced or eliminated (see above), 2) since the ca. 1990 time period the western population has exhibited growth on the whole, and 3) the sum of the breeding colony counts of the western population (excluding East Sand Island) ca. 2009 is similar to that observed in ca. 1990. Risk to the long-term sustainability of the western population is further reduced given that take on East Sand Island would occur within a well-monitored and adaptive management framework (see Chapter 2, Section 2.1 and Appendix E-2), monitoring of the western population will occur annually and this information will be used to evaluate and adjust future management activities, and an annual depredation permit application would need to be approved and issued prior to take. Additionally, there are extensive examples throughout the United States and Europe of DCCO and Great cormorant (*P. carbo*) populations increasing concurrent with and after lethal management (USFWS 2003, 2009, 2014; Russell et al. 2012; Guillaumet et al. 2014). However, these populations are an order of magnitude larger than the western population of DCCOs, and there is more uncertainty in how the western population of DCCOs could respond to the proposed levels of culling.



*Estimate for western population of DCCOs ca. 1990 was from Tyson et al. 1997, Appendix 1 minus Alaska. Date ranges were 1975–1992. Western population estimate for ca. 2009 was from Adkins and Roby (2010). Data were from 2009, except for coastal California (2008) and many interior California sites (1999). Columbia River Estuary estimates for ca. 2009 were from Adkins and Roby (2010) and were from 2009; Columbia River Estuary estimate ca. 1990 were from Carter et al. (1995) as reported in Adkins and Roby (2010). Date ranges were 1990–1992.

FIGURE 4-8. Double-crested Cormorant breeding population estimates for the western population, ca. 1990 (Tyson et al. 1997) and ca. 2009 estimate (Adkins and Roby 2010); the Columbia River Estuary portion of the western population is highlighted (Adkins and Roby 2010).

Proposed take rates are similar or higher than take rates proposed and implemented nationally and among states for DCCO management. Proposed take levels would be for 4 years of lethal management, whereas national and state management, described below, were for annual, on-going take; thus, rates are not entirely comparable. Additionally, there have not been large-scale culling programs within the western population of DCCOs, compared to interior DCCO populations. As previously mentioned, uncertainty in how the western population of DCCOs would respond is greater than that of interior DCCO populations, and this should be given consideration when comparing culling programs from those regions. Population growth rates were higher in the interior population, compared to the western population of DCCOs (Wires et al. 2001; USFWS 2003; Adkins and Roby 2010), and East Sand Island is not within a connected matrix of other large breeding colonies within the affected environment, as is the case within the Great Lakes region. Annual take levels proposed on East Sand Island under the 4-year strategy, plus additional annual authorized take within the western population of 936 individuals, represents an approximate 11 percent individual and 17 to 20 percent nest loss of the western population of DCCOs (see Appendix E-2).

Under the preferred alternative of the national DCCO FEIS, the estimated expected total mortality to the continental population under both depredation orders was approximately 8 percent per year, and this level of take was expected to have minimal effects on the long-term conservation of DCCOs (USFWS 2003). Expected take rates of the actual populations within the 24 states included under the depredation order would be higher than the continental level (i.e., >8 percent per year). Actual take rates and population impacts under the depredation orders are difficult to estimate, as total population estimates are uncertain and take in Canada is not reported under the depredation orders. During 2004–2012, on average, 43,423 DCCOs were taken annually in the 24 states under the depredation orders (USFWS 2014). Take rates for Great Lakes populations are best known (including both U.S. and Canadian estimates). During 2009, the estimated annual percentage of the different Great Lake populations culled ranged from 0.04 to 8.9 percent (USFWS 2014). The estimated annual adult take and nest oiling rates under the Public Resource Depredation Order (PRDO) for the Great Lakes DCCO population were 6 percent and 14 percent, respectively (USFWS 2009, 2014). These levels of take were estimated to decrease the Great Lakes DCCO population by 20 percent by 2014 but would not significantly reduce or threaten the long-term conservation of DCCO populations (USFWS 2009). In Michigan, maximum annual adult take levels were approximately 3 to 18 percent of the state population during 2005–2009 (USDA-WS 2011b). In Wisconsin, annual DCCO take levels of 18 percent of the summer population were selected in an environment assessment (USDA-WS 2009).

Phase II — Direct and indirect effects from terrain modification would be the same as Alternative B. Direct adverse effects from non-lethal management supported with limited egg take to ensure the colony size does not exceed 5,939 breeding pairs would be the same type of effects as described in Phase II of Alternative B; effects to DCCO would likely be low in the short-term compared to Phase II of Alternative B because of reduced abundance levels, but could become higher if growth potential of the colony increases through time. Lethal take could result in a diminution of density-dependent regulatory mechanisms, which, over time, could result in higher in-situ recruitment (i.e., survival and productivity) at the colony or within the population, or higher rates of immigration of other DCCOs to the colony compared to prior observed levels.

Guillaumet et al. (2014) found density dependence to be the most important class of factors in explaining DCCO colony growth within the context of cumulative DCCO management. Additionally, higher growth rates were observed at colonies where culling of breeding adults occurred at least 2 years previously, suggesting in-colony recruitment or immigration from nearby colonies increased when density-dependent regulation was lessened. Terrain modification or similar habitat management, supplemented with hazing on East Sand Island in Phase II, would be implemented to ensure the size of the colony does not exceed 5,939 breeding pairs and DCCO predation rates of juvenile salmonid remain at reduced levels.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Summary — Under this alternative, the Corps would implement primarily lethal methods during Phase I, similar to Alternative C but modified by reducing the on-island and boat-based shooting while adding egg oiling, to reduce the DCCO colony on East Sand Island to 5,380 to 5,939 breeding pairs (Figure 4-9). All other aspects of the alternative are the same as Alternative C.

Similar to Alternative C, an adaptive approach would be used to achieve the East Sand Island DCCO management goal for colony size and the Corps would undertake a 4-year lethal strategy scheduled to be completed at the end of 2018 if implementation began in 2015; see Chapter 2, Section 2.2.4 for description of field methods and adaptive approach and Appendix E-2 for modeling and effects of take levels). Under this 4-year lethal strategy, 13.5 percent of the DCCO colony would be culled each year, resulting in a total take of 10,912 DCCOs in all years (3,489, 3,114, 2,408, and 1,902 DCCOs in years 1 to 4, respectively). In total, 72.5 percent of nests (including both associated nest loss and nests destroyed from egg oiling) would be lost in each year in years 1–3 and 13.5 percent in year 4, resulting in 26,096 total nests lost in all years (9,368, 8,361, 6,466, and 1,902 nests lost in years 1-4, respectively). Through adaptive management, take levels could change based upon observed abundance as compared to the predicted abundance (as described in Chapter 2 and Appendix E-2) for the East Sand Island colony (Figure 4-9) and the western population (Figure 4-10), DCCO colony and population response to lethal take, and knowledge gained during implementation concerning what levels of annual take can be effectively achieved. Under Alternative C-1, abundance of the western population of DCCOs is projected to be approximately 38,500 breeding individuals after Phase I and increase to a long-term 20 year projected abundance of approximately 45,000 breeding individuals (Figure 4-10).

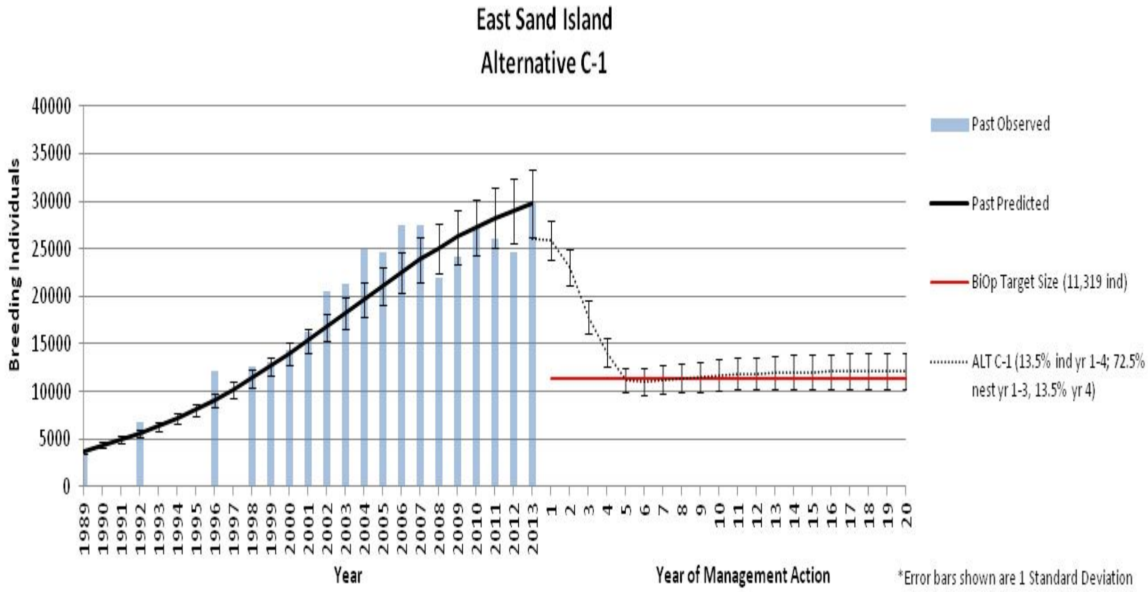


FIGURE 4-9. Predicted size of the East Sand Island DCCO colony under Alternative C-1. [7, 8]

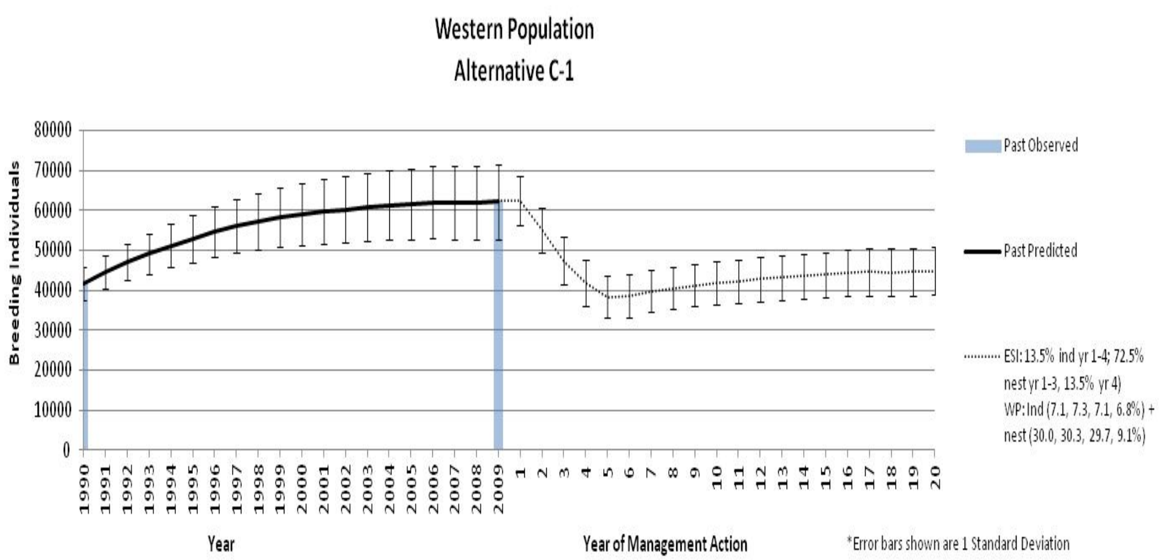


FIGURE 4-10. Predicted size of the western population under Alternative C-1. [7, 8]

Phase I – Effects to DCCOs on East Sand Island — Similar to Alternative C, but effects from on-island and boat-based shooting would be reduced since the number of individual DCCOs culled is reduced by approximately 40 percent. The effects of activities associated with egg oiling would cause some disturbance to nesting DCCOs, most likely similar to the effects of carcass retrieval as described in Alternative C, since both activities require colony incursions. Disturbance to neighboring nesting DCCOs is likely, potentially causing non-target DCCOs to flush off nests while egg oiling is occurring in that section of the colony. Visual barriers will be in place to limit visibility and disturbance from person(s) conducting the egg oiling in the non-targeted sections of the DCCO colony. Nests where adults are flushed will be more susceptible to predation until the adult(s) returns. These actions could result in nest destruction or abandonment, increased susceptibility to predation, and nest failure. These effects would be greater the longer management actions extend past the initiation of nesting. Best management practices and adaptive management strategies described in Chapter 2 would minimize potential effects. The total number of incursions (thus disturbance levels) into the colony to conduct both culling and egg oiling activities is expected to be similar to Alternative C because fewer culling events on-island is expected since fewer individuals will be culled and some culling would take place over water. However, if boat-based culling is ineffective at achieving proposed take levels, the majority of culling would occur on-island and this could mean the same number of culling events as Alternative C, plus the addition of egg oiling events which could increase overall amount of disturbances to the colony. The degree that this would occur would also depend upon the extent that culling and egg oiling activities can be kept spatially (and temporally) separate.

The direct effect of take of individuals under this 4-year lethal strategy is a loss of 13.5 percent of DCCOs from the colony annually. In addition, up to 72.5 percent of the DCCO nests on the colony will be lost each year during years 1-3, including approximately 46 percent of nests that would be directly oiled (other associated nest loss would occur indirectly from take of individuals). Egg oiling would not occur in year 4, but associated nest loss would occur indirectly from take of 13.5 percent of individuals in year 4.

Similar to Alternative C, the lethal methods proposed would result in the loss of individuals or eggs, chicks, or fledglings; a reduction in abundance, for a given area or to a population or colony, depends upon the scale of lethal management and whether the level of loss is greater than the effects of immigration, recruitment, and other density-dependent mechanisms (see Appendix E; USFWS 2003). Guillaumet et al (2014) found that the integrated method of culling and egg oiling had a greater effect in reducing population growth rate than either activity alone and that past control activities, particularly egg oiling and nest destruction, depressed future growth rates by negatively affecting local recruitment; however, in some instances when abundance was reduced, particularly from just culling alone or catastrophic events (e.g., natural predation or flooding), subsequent growth rates at locations increased, likely as a result of diminution of density dependence resulting in increased recruitment at, or immigration to, those areas.

Since most of the eggs will be oiled after incubation has begun, DCCOs will likely stay on the colony and incubate those nests through the average incubation period. These DCCOs will likely not re-nest once it is apparent that their eggs will not hatch because it will be too late in the breeding season (i.e., weather and foraging conditions are not optimal for raising chicks as it gets later in the breeding season). Some dispersal due to disturbance or nest failure may occur. If dispersal is observed during the breeding season, management techniques could change to decrease further dispersal as described in Section 2.2.4. Dispersal between breeding seasons will be more likely as unsuccessful birds would likely search for new nesting areas. Younger birds are more likely to disperse if their first nesting attempt on East Sand Island is unsuccessful. Older birds with more experience of successful nesting on East Sand Island are likely more committed to breed at successful nesting sites. DCCOs that move from East Sand Island for breeding and roosting will likely seek out historic and current DCCO nesting colonies within the affected environment (See Figure 3-1 and Table 3-1). DCCOs express high nest site fidelity to breeding areas, and this is true of the East Sand Island colony. Given the substantial growth and size of the East Sand Island colony compared to other areas, the Columbia River Estuary is likely one of the most productive foraging and breeding areas within the western population of DCCOs' range. The Columbia River Estuary is an area that DCCOs would likely not abandon easily based upon results of DCCO dissuasion/relocation research (Table 3-1). Additionally, DCCOs are colonial waterbirds attracted to nest with other colonies of birds and the other colonies of birds that would remain on East Sand Island (gulls, Caspian terns, and brown pelicans) would continue to provide social attraction.

Effects to DCCOs off East Sand Island — Effects would be similar to that described in Phase I of Alternative B. However, overall effects are expected to be less compared to Phase I of Alternative B because of less expected dispersal of DCCOs, but similar or potentially higher than Alternative C.

*Effects to the Western Population of DCCOs —*Potential effects to the short- and long-term population trend of the western population of DCCOs under Alternative C-1 are expected to be less than Alternative C because the number of adults lethally removed annually would be reduced. Under Alternative C-1, the number of individual DCCOs culled would be reduced by approximately 40 percent compared to Alternative C (i.e., total take of 10,912 versus 18,185 breeding individuals). Annual take levels proposed on East Sand Island under the 4-year strategy, plus additional annual authorized take of 936 individuals within the western population, represents an approximate 7 percent individual and 9 to 30 percent nest loss of the western population of DCCOs (see Appendix E-2).

Based on modeled population trajectories of the western population of DCCOs, which includes the additional authorized take of 936 DCCOs that occurs annually within other areas of the western population (see Appendix E-2), abundance of the western population of DCCOs is projected to be approximately 38,365 (+/- 1 SD=32,984–43,746) breeding individuals after Phase I (Figure 4-10), or a 38.5 percent decline in the western population of DCCOs from the current abundance (62,400 breeding individuals; Adkins et al. 2014). This predicted abundance is approximately 3,300 breeding individuals less than observed abundance in ca. 1990 for the western population of DCCOs (41,660 breeding individuals; Tyson et al. 1997).

The projected abundance falls below ca. 1990 population level for 4 years after implementation of Phase I actions and increases to a long-term 20 year projected size of approximately 44,903 (+/- 1 SD = 38,900–50,908) breeding individuals, approximately 3,300 breeding individuals greater than observed abundance in ca. 1990. Approximately 25 percent (11,200/45,000) of the western population of breeding DCCOs could nest at East Sand Island. As similarly described in Alternative C (see above), the western population would likely rebound to some extent if abundance levels were to temporarily drop below the ca. 1990 level. Additionally, risk to the long-term sustainability of the western population is further reduced given that take on East Sand Island would occur within a well-monitored and adaptive management framework (see Chapter 2, section 2.1 and Appendix E-2), monitoring of the western population will occur annually and this information will be used to evaluate and adjust future management activities, and an annual depredation permit application would need to be approved and issued prior to take. This allows time for annual evaluation and adaptive management changes and increases the ability for the western population to respond from any potential catastrophic event.

Phase II — Direct and indirect adverse effects from terrain modification or other habitat modification and non-lethal techniques supported with limited egg take would be similar to that described in Phase II of Alternative B; however, effects would likely be less since the DCCO colony size would be reduced.

Alternative D

Summary — Under this alternative, the Corps would implement lethal management during Phase I, the same as Alternative C-1, to reduce the DCCO colony on East Sand Island to 5,380 to 5,939 breeding pairs. In Phase II, the same terrain modification and non-lethal management supported with limited egg take as in Alternatives B and C would be used to remove all DCCO nesting on East Sand Island and to disperse the remaining approximate 5,600 breeding pairs away from the Columbia River Estuary (Figure 4-11).

Precluding all DCCO nesting on East Sand Island would likely have greater effects to the western population of DCCOs than Alternative C-1 since additional DCCO nesting habitat would be lost, and greater effects than Phase I of Alternative B, where just a portion of the colony is redistributed. The projected abundance is expect to decrease in Phase I as in Alternative C-1 and remain below the ca. 1990 population level. Abundance of the western population of DCCOs is projected to be reduced to a low abundance of 33,286 (+/- 1 SD = 28,194–38,378) breeding individuals (Figure 4-12). During Phase II, the projected abundance falls and remains below the ca. 1990 population and increases slightly to a long-term 20 year projected size of approximately 37,710 (+/- 1 SD = 32,728–42,491) breeding individuals (Figure 4-12), or approximately 4,200 breeding individuals less than observed abundance in ca. 1990. There could likely be a decrease in productivity until DCCOs dispersed from East Sand Island find new breeding sites and successfully produce fledglings at rates comparable to those on East Sand Island.

Excluding East Sand Island as a DCCO breeding colony could likely reduce subsequent growth of the western population of DCCOs. However, if DCCOs successfully relocate and breed at other established or new colonies, growth of the western population of DCCOs could likely be similar to current rates. Extensive hazing efforts, in addition to terrain modification, would likely be needed to remove all DCCOs from nesting on East Sand Island and to preclude re-establishment in subsequent years. Once the colony is removed and subsequent re-establishment is deterred for multiple years, effort to maintain zero DCCOs nesting on East Sand Island would likely be low thereafter, in the long-term, as there would be no large colony to continue to attract DCCOs to the area and produce offspring with philopatry to the area. Likelihood of deterring all DCCOs from nesting, roosting, and foraging from the entire Columbia River Estuary would be much less likely than deterring all DCCO nesting on East Sand Island. A long-term hazing effort, comparable or greater than that described in Phase I of Alternative B, would likely be needed to relocate all DCCOs from the Columbia River Estuary.

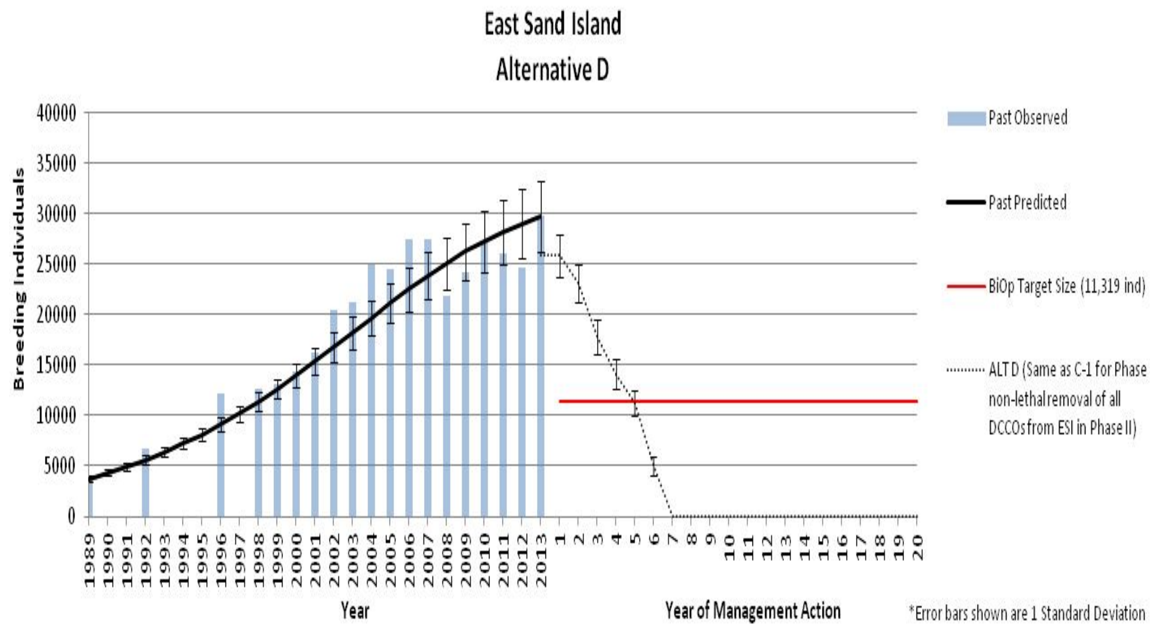


FIGURE 4-11. Predicted size of the East Sand Island DCCO colony under Alternative D. [7, 8, 9]

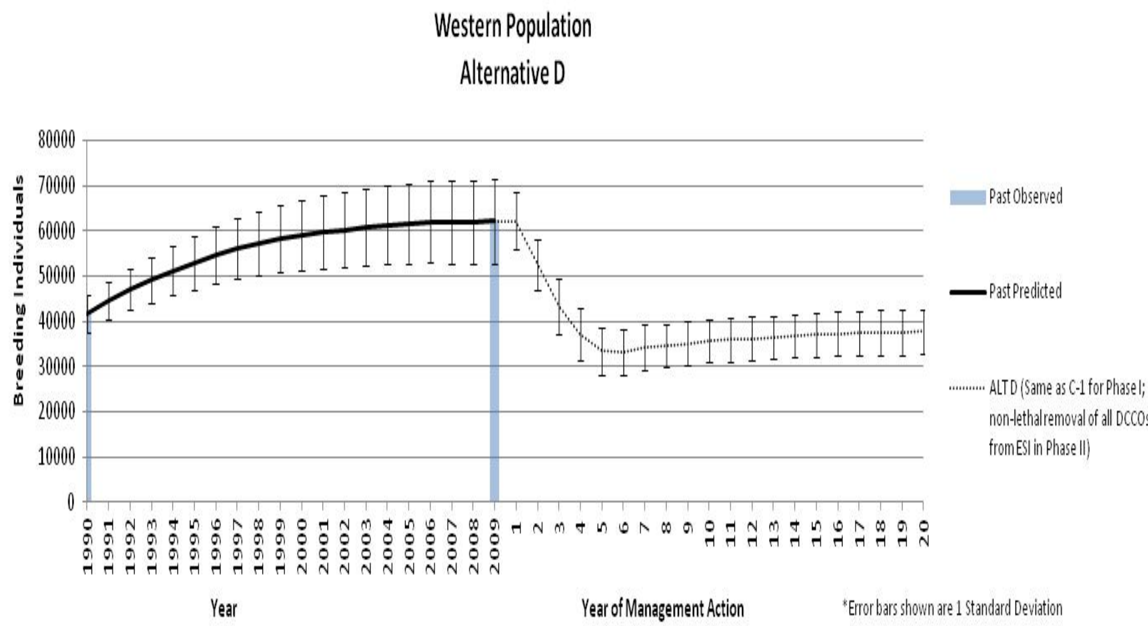


FIGURE 4-12. Predicted size of the western population under Alternative D.[9]

[9] Western population abundance trajectories include C-1 take on East Sand Island during Phase I plus additional 936 DCCOs taken per year and a reduced carrying capacity of 30 percent (43,700 breeding individuals) compared to current estimated abundance, which includes half loss of the DCCO numbers associated with the Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals) and all of the colony size reduction proposed on East Sand Island (14,516 breeding individuals; 62,400 – 4,184 – 14,516

Phase I— Effects would be the same as Alternative C-1.

Phase II— Direct and indirect adverse effects from terrain modification and non-lethal techniques supported with limited egg take would be the same type as described in Phase II of Alternative B; effects would likely be high in the short-term to preclude all DCCO nesting and re-establishment but low or negligible thereafter in the long-term since few or no DCCOs would be present on East Sand Island and within the Columbia River Estuary. The expected amount of DCCO dispersal from East Sand Island (approximately 5,600 breeding pairs) would be similar to Phase I of Alternative B (approximately 7,250 breeding pairs); thus, effects would be similar as described in Phase I of Alternative B. Effects would likely initially be high and then decrease should all DCCOs be effectively hazed out of the Columbia River Estuary.

4.2.3 Effects to Other Birds Common to East Sand Island

Effects to other birds on East Sand Island from management activities would be similar to those described for DCCOs and include: 1) direct effects from disturbance to proximal individuals when implementing non-lethal or lethal techniques; 2) restriction of habitat and hazing resulting in higher levels of nesting concentration, co-nesting with other species, or dispersal; and 3) loss of individuals or eggs from implementation of management actions, including misidentification during lethal take. Effects would be most pronounced to species that nest on East Sand Island during the duration of the year when DCCOs occur and management activities are underway, and to species that nest within the DCCO colony or nest on the west side of the island where the majority of management activities would occur.

With regard to temporal usage, other waterbird species that typically nest on East Sand Island (i.e., Caspian terns, ring-billed gulls, Glaucous-winged/western gulls, and Brandt's cormorants) nest in close temporal overlap with DCCOs, with the minor exception that Brandt's cormorants arrive later and have later breeding than DCCOs by approximately 2 weeks (Table 4-1). California brown pelicans typically use East Sand Island for night roosting (2013 was the first documented instance of egg laying; n=3 nests) and peak use and attendance is later (typically August) compared to the other waterbird species nesting on the island (typically early June; Figure 4-13). California brown pelican

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= 43,700) since additional habitat will be lost compared to Alternatives B, C, and C-1. Also see footnote 7 and 8 and Appendix E for additional detail.

abundance shows great inter-annual variation in total numbers, and diurnal use is strongly positively correlated with tide cycles (i.e., higher abundance observed during high tide; lower abundance during low tide due to more prevalent foraging during low tides; Wright et al. 2007).

Table 4-1. Nesting Chronology and Attendance Patterns of Piscivorous Waterbirds on East Sand Island.

Species	Arrival		First egg		First chick		First fledgling		Peak attendance (adults) in 2013		Departure
	Range	**2013**	**Range**	**2013**	**Range**	**2013**	**Range**	**2013**	**Count**	**Date**	**2013**
Double-crested cormorant	3/27 - 4/11	4/11	4/21 - 5/5	4/27	5/21 - 6/2	5/27	7/5 - 7/22	7/12	14,916 (b)	6/8	October
Caspian tern	3/25 - 4/7	4/7	4/14 - 5/2	4/23	5/13 - 6/3	5/28	6/19 - 7/15	7/5	11,424 (c)	6/16	September
Brandt's cormorant	4/10 - 4/16	4/11	5/6 - 5/10	5/6	6/7 - 6/8	6/8	7/28	7/28	1,720 (c)	6/9	October
Glaucous-winged/western gull	<March	<March	no data		no data		no data		4,580 (d)	6/8	November
Ring-billed gull	March	March	no data		no data		no data		2,676 (d)	6/8	August
California brown pelican	3/16 - 4/28	4/22	7/15	7/15(a)	n/a	n/a	n/a	n/a	3,850 (e)	8/7	November

a) first year egg laying documented on ESI in 2013; typically use East Sand Island for night roost
b) peak number nests from aerial photo
c) peak ground count from blind
d) adults from aerial photo at peak nesting
e) peak island-wide ground count

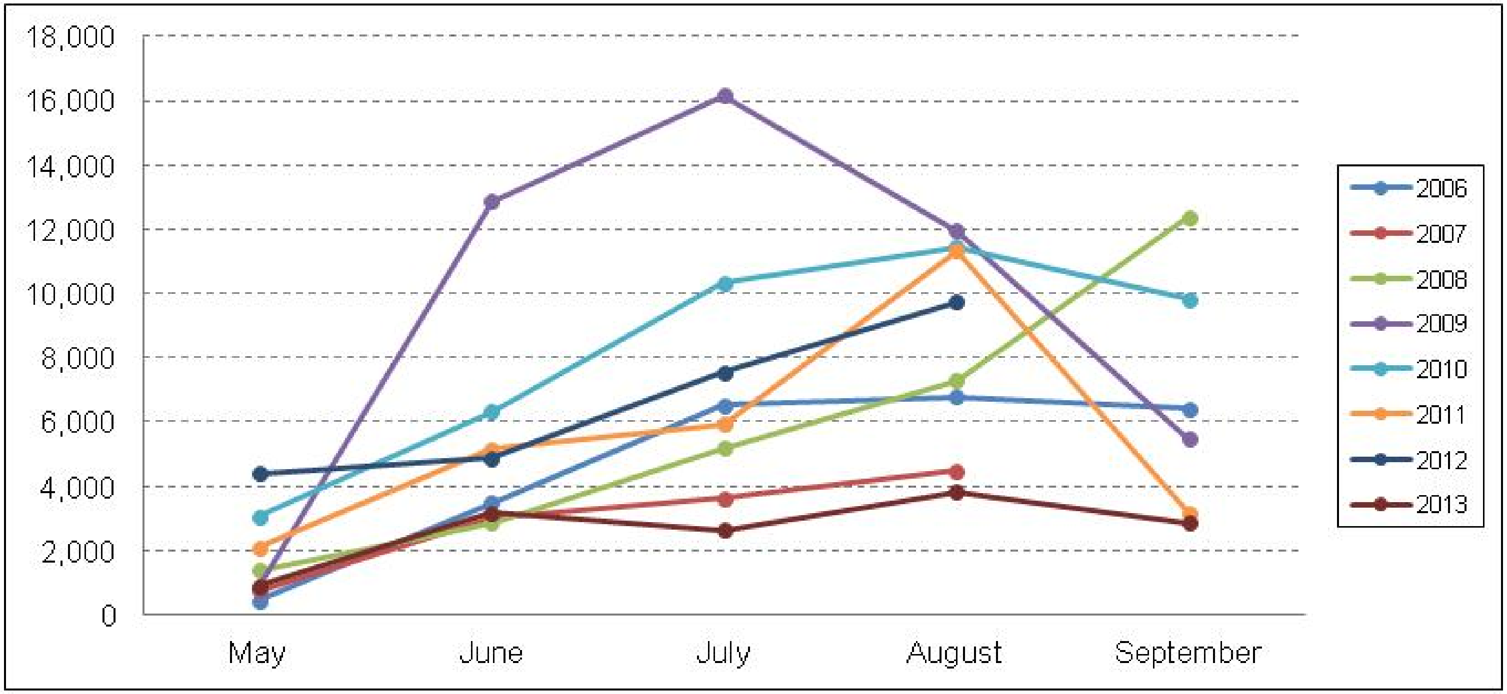

FIGURE 4-13. Monthly average number of brown pelicans roosting on East Sand Island during evening surveys conducted between 2006 and 2013.

With regard to spatial distribution of species that co-nest with DCCOs on East Sand Island, Caspian terns and ring-billed gulls nest exclusively on the eastern portion of the island (Figure 4-14). Glaucous winged-western gulls nest throughout the island, including the western portion (Figure 4-15). Brandt's cormorants nest in closest association with DCCOs, nesting entirely within the boundaries of the DCCO colony (Figure 4-16).

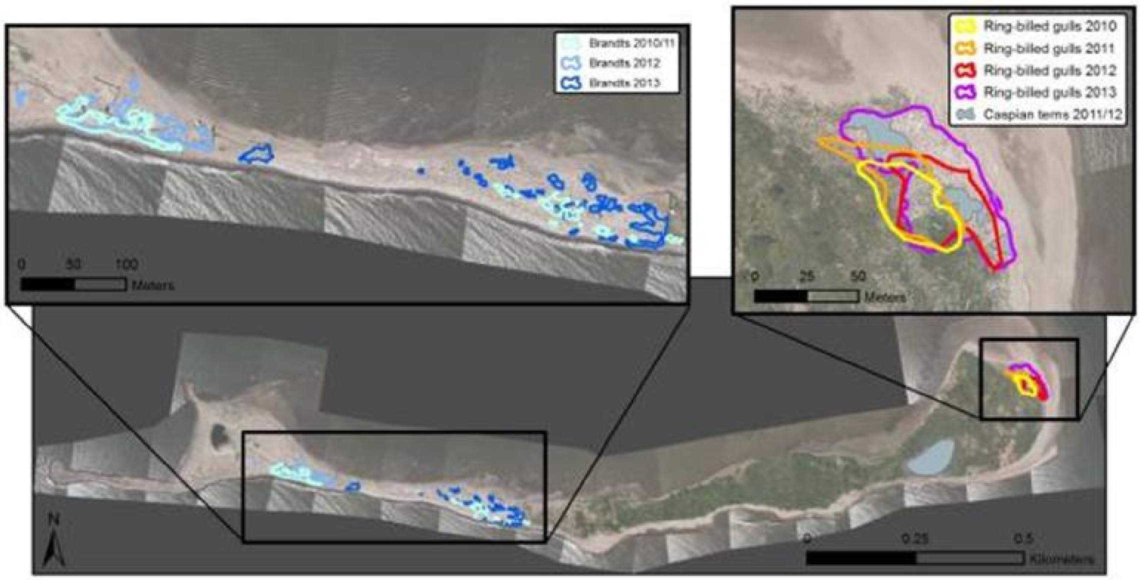

FIGURE 4-14. Spatial distribution of Brandt's cormorants (2010–2013), Ring-billed gulls (2010–2013), and Caspian terns (2011–2012) on East Sand Island.

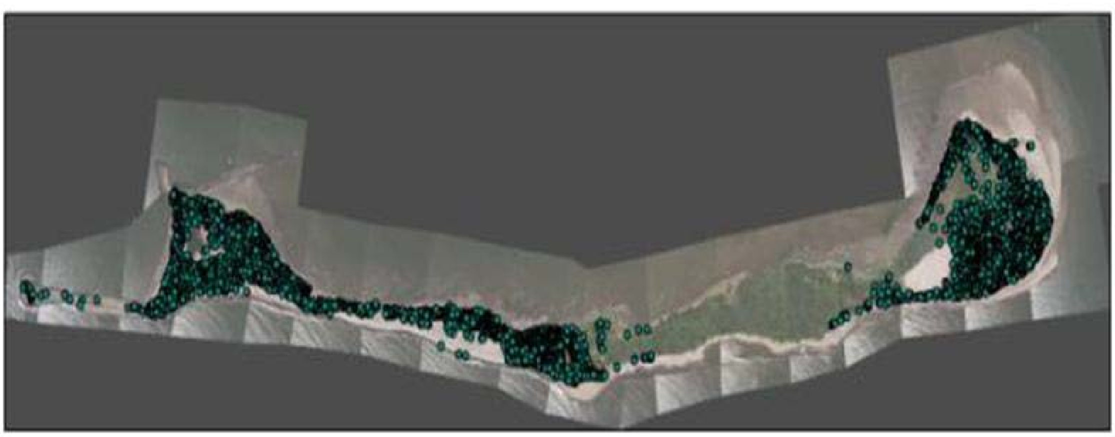

FIGURE 4-15. Spatial distribution of Glaucous-winged/western gull (2013) on East Sand Island.

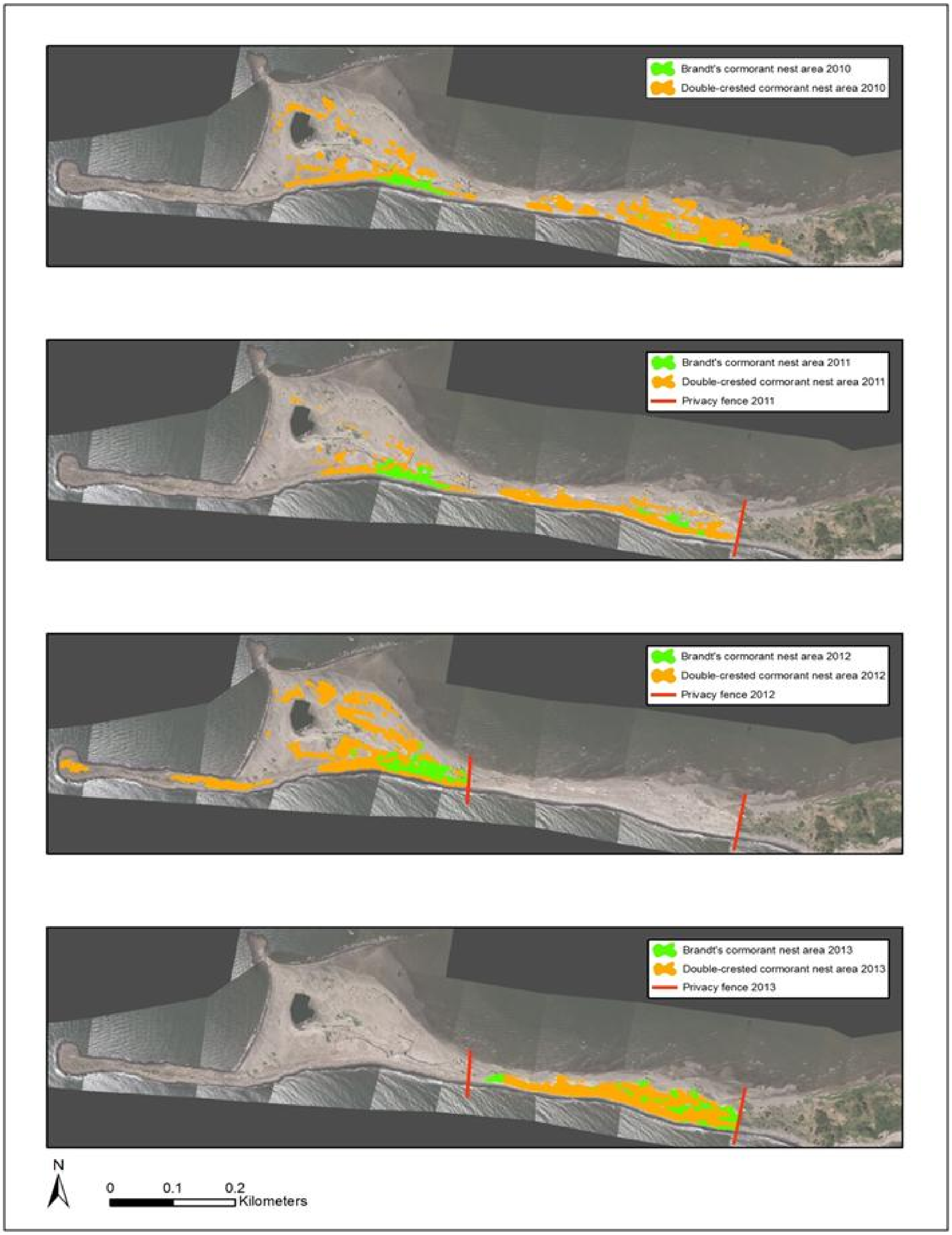

FIGURE 4-16. Spatial overlap of Brandt's cormorant and DCCO nesting (2010–2013) on East Sand Island.

Alternative A

No actions to manage DCCOs would occur under Alternative A and colony size and abundance of other co-nesting species on East Sand Island would presumably remain similar to current levels in the near-term, with the exception of Caspian terns who would continue to be managed under the 2005 FEIS to achieve a reduced colony size of approximately 3,000 nesting pairs (USFWS 2005a). Human presence and resulting disturbance on the island, due to DCCO research and monitoring, would cease. Spatial distribution of species would likely remain similar to current distribution, with the exception that California brown pelican usage may be more temporally and spatially uniform in response to reduced management activity (Caspian tern and other management activities would still occur).

Alternative B

Phase I - Direct adverse effects from implementing Alternative B are expected to be higher than prior dissuasion research, as more habitat would be restricted and greater levels of hazing would be needed to disperse approximately more than 7,250 DCCO breeding pairs from East Sand Island. A high potential exists for DCCOs deterred from nesting in the designated nesting area to use the east side of the island; thus, high levels of hazing and disturbance are expected throughout and on the east side of the island to preclude DCCOs from nesting. Management activities (e.g., accessing areas) and expansion of hazing to reduce the DCCO colony would adversely affect other nesting and roosting species (i.e., gulls, terns, pelicans described in Section 3.3) in those areas or cause individuals to emigrate temporarily or permanently from East Sand Island. Management activities and non-lethal techniques could cause nest destruction, abandonment, or failure, and increased susceptibility of eggs and chicks to predation, resulting in loss of nests, eggs, or chicks of other nesting species on East Sand Island. These effects would be greater the longer management actions extend past the initiation of nesting. Best management practices and adaptive management strategies described in Chapter 2 would be implemented to minimize potential effects and take of non-target species. Quantifying this level of take is not possible, but levels would likely be comparable or higher than those that occurred during past dissuasion research and have similar effects to these populations. Management activities are expected to extend into July or later, which would overlap most of the nesting cycle for species that typically nest on East Sand Island and push into the peak time period of usage by California brown pelicans.

Effects to bald eagles and other raptor species are expected to be negligible. Bald eagles and other raptor species do not nest on East Sand Island, so actions could only impact foraging opportunity. Based on prior dissuasion research, management activities have had little impact on precluding bald eagles and raptors from foraging on-island. These species are opportunistic and generalist predators and actions would not appreciably limit or change overall prey availability. For example, Watson et al. (1991) found that fish compose the majority of bald eagle diet in the Columbia River Estuary.

High disturbance to or potential loss of the Brandt's cormorant nesting colony on East Sand Island could occur, since they nest in close association with DCCOs. Establishment of a mono-species nesting colony outside of the designated nesting area would likely not be feasible, since DCCOs would likely be associated (thus there would be hazing in that area). Additionally, Brandt's cormorants typically arrive and initiate nesting a few weeks after DCCOs. If Brandt's cormorants are forced to nest within the designated nesting area, it is unknown how competitively Brandt's cormorants would fare in comparison to DCCOs, if nesting habitat is limited and DCCOs are already established within the designated nesting area. Since establishment of the colony in 2006, the estimated size of the Brandt's cormorant colony decreased in comparison to the year prior for the first time in 2013, the year of greatest habitat restriction. Although this represents only one year, it could suggest some limiting of Brandt's cormorant abundance when DCCO habitat is restricted. Loss of the Brandt's cormorant colony on East Sand Island (i.e., approximately 3,200 breeding individuals or 4 percent of the regional population) and subsequent dispersal of individuals would likely have negligible effects on the regional population, which is estimated to be approximately 74,000 breeding individuals.

Non-lethal management activities would likely affect spatial distribution of California brown pelicans to a greater extent than during past research efforts, given expected expansion of hazing efforts, but likely would have little effect on limiting or reducing overall California brown pelican annual abundance. California brown pelicans typically use the intertidal zone and adjacent upland habitat, and tend to avoid roosting on broad mud flats or densely vegetated interior portions of East Sand Island (BRNW 2013b). Spatial distribution and primary use areas vary throughout the year, with the majority of usage typically occurring in areas that have least associated disturbance (i.e., both boating and on-island and both natural and human caused). In 2013, California brown pelican egg laying was documented for the first time on the eastern end of East Sand Island, and nesting activities could be affected by DCCO dispersal and management actions in those areas.

During 2010–2013, when DCCO habitat modification and dissuasion research was on-going and predominantly focused on the west end of the island, California brown pelicans were more abundant on the East Beach and South Beach during the early months of the field season (i.e., May and June), with other areas (i.e., West End and North Beach) becoming more populated in later months as the total numbers of roosting California brown pelicans increased island-wide (BRNW 2013b; Figure 4-17). During 2001 and 2002, Wright et al. (2007) also observed distributional changes in California brown pelican usage over the course of the year, largely in response to disturbance activities on the island. Wright et al. (2007) found that land-based human activity and, in particular, shotguns fired within 400m of the roost had the greatest effect on California brown pelicans roosting on East Sand Island. During 2013, the year of greatest DCCO habitat restriction and hazing, California brown pelicans were observed roosting in and adjacent to the dissuasion area throughout the active hazing period (up to June 30, which is prior to the peak usage of California brown pelicans), with up to 3,500 individuals observed roosting in these areas at times. California brown pelicans were disturbed during nine hazing events, with a maximum of 500 individuals flushed during one event (Roby et al. 2014). Additionally, during 2010–2012, primary areas of active DCCO management were subject to variable and continuous use by California brown pelicans, despite ample alternative roosting habitat elsewhere on East Sand Island (BRNW 2013b).

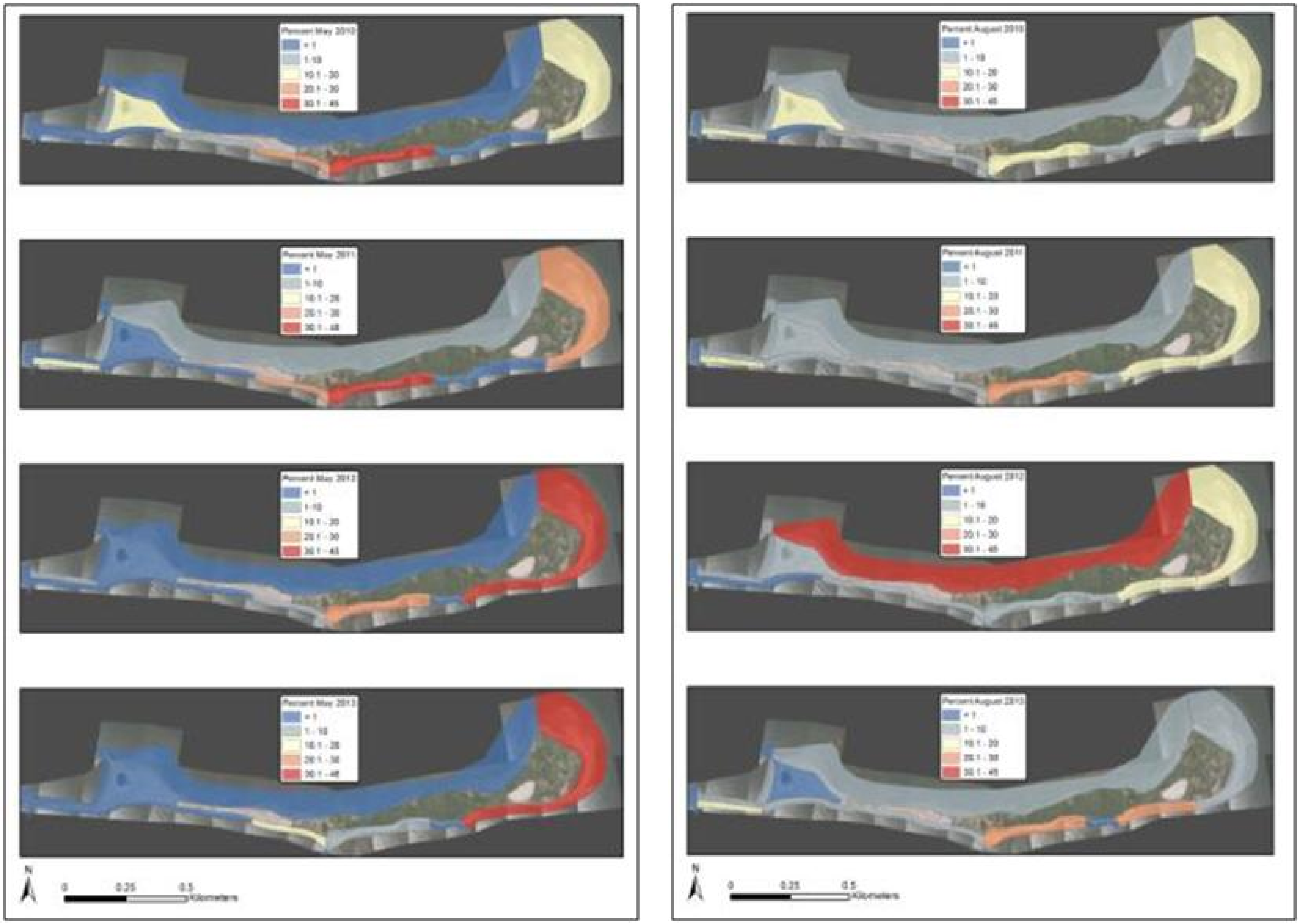

FIGURE 4-17. California brown pelican use on East Sand Island by sighting zone (as percent of total) during May (left panel) and August (right panel) during 2010–2013. Blue=<1 percent; Grey=1-10 percent; Yellow=10.1-20 percent; Orange=20.1-30 percent; Red=30.1-45 percent.

Reduced DCCO abundance and DCCO use of the east side of the island and subsequent hazing could reduce Caspian tern and Ringed-billed gull abundance or nesting success. It is likely that DCCOs would attempt to seek out the most undisturbed areas on East Sand Island if continuously hazed. DCCOs have not previously attempted to nest within the designated area prepared for Caspian terns, so likelihood of, and effects from, direct nest site competition are unknown. DCCO use of areas proximal to the Caspian tern and ring-billed gull colonies (i.e., close enough so that hazing would affect them too) could be high if these areas are undisturbed compared to the rest of the island. Reduced DCCO abundance on East Sand Island could intensify disturbance and predation to Caspian terns and Ringed-billed gulls by bald eagles, Glaucous-winged/western gulls, and other predators, as these species would compose an overall higher proportion of the prey base on East Sand Island. Bald eagle disturbance and subsequent predation has been cited as a factor limiting nesting success of Caspian terns in recent years (Roby et al. 2014).

Of the nesting species on East Sand Island, impacts to Glaucous-winged/western gulls would likely be negligible. Glaucous-winged/western gulls nest throughout the island and would be less impacted by spatial use changes of DCCOs. Additionally, they appear to be rather resilient to levels of disturbance expected from hazing. During past dissuasion research, several thousand Glaucous-winged/western gulls nested and raised young within the DCCO dissuasion areas (Roby et al. 2014). Reduced DCCO abundance could reduce or shift prey base of Glaucous-winged/western gulls, but it is not known to what degree or if this would reduce their abundance.

Phase II - Under Alternative B, the need for continued non-lethal management (thus disturbance) on the remaining available habitat outside the designated nesting area would be high for both the short- and long-term in Phase II. For other species on East Sand Island, this could likely alter spatial distribution of use on-island, decrease abundance or nesting success, or promote emigration for both the short- and long-term. No short-term adverse direct effects are expected from construction activities from modifying the terrain because construction activities would occur outside the peak breeding season.

Long-term adverse and beneficial effects of modifying the terrain are expected for other birds using the island. Inundation of the western portion would also preclude Brandt's cormorants from nesting and reduce, to a great extent, Glaucous-winged/western gulls nesting on the west end of the island. This would reduce available habitat overall for nesting species on East Sand Island and would increase nesting concentration and levels of co-nesting on the east side of the island. This may adversely affect species that currently nest on the east side of the island, including Caspian terns, ringed-billed gulls, and small numbers of California brown pelicans. As the terrain modification would increase the amount of inter-tidal area and habitat, similar or greater amounts of roosting habitat for California brown pelicans would be available in the future. The vegetative cover on the east side may become denuded or deteriorated if DCCO nesting in that area becomes prevalent and consistent, creating a habitat structure and type similar to that currently on the west end. This may increase potential available habitat on the east side for the other nesting species on East Sand Island, as all species nest in open habitat.

Alternative C

Phase I - Since DCCO abundance decrease would occur primarily from lethal take, not dispersal, less non-lethal management (i.e., hazing) is expected under Phase I compared to Alternative B. If hazing is necessary to prevent DCCO from moving into new areas on East Sand Island (i.e., on the central or eastern portion of the island) effects to other bird species on the island would be similar, but likely be shorter in duration and intensity than described in Alternative B. There would be little to no direct disturbance from lethal take activities to species on the east end of the island. Lethal take on the island would likely occur prior to or extend into only a portion of the breeding season. The potential for management-related adverse effects to species in later nesting stages (i.e., late egg laying, chick, and fledgling) and impacts to California brown pelicans would be low since the majority of management activities would occur prior to chick rearing and the arrival of the majority of California brown pelicans. These effects would be greater the longer management actions extend past the initiation of nesting. During the primary periods of lethal take, there is potential for more direct and indirect adverse effects to occur, such as deterring other species from using and nesting within areas where lethal take occurs, changing spatial distribution of use on the island, and likely changing short-term and possibly long-term emigration. Best management practices and adaptive management strategies described in Chapter 2 would be implemented to minimize potential effects and take of non-target species.

Brandt's cormorants are the non-target species with the highest potential for take due to close association with DCCOs and the potential for misidentification due to similar body size and color, aside from the gular pouch during the breeding season. During 16 years of diet studies on Rice and East Sand Island, in which 2,351 total DCCOs were lethally taken with shotguns, take of 12 Brandt's cormorants occurred during 8 of those years (BRNW 2013a). This is a take rate of 0.5 percent. Given the magnitude of take and different methodologies, higher take rates would likely occur under Alternative C. Under Alternative C, 18,185 DCCOs could be taken in total (6,202, 4,887, 3,881, and 3,214 DCCOs in years 1–4, respectively) and a 3 percent take rate of Brandt's cormorants (determined from input by cooperating agencies; up to 546 [18,185 x 0.03] Brandt's cormorants taken) could occur during years 1 to 4.

The Brandt's cormorant colony on East Sand Island is approximately 3,200 breeding individuals, which is approximately 4 percent of the regional population for Washington, Oregon, and California (74,000 breeding individuals; see Table 3-3). There is a potential for take of up to approximately 0.3 percent of the regional population of the Brandt's cormorants per year, or up to 6 percent of the East Sand Island colony per year. Take of 546 Brandt's cormorants would have direct adverse effects on individuals and associated breeding pairs and likely limit or reduce the size of the Brandt's cormorant colony on East Sand Island. However, this level of take would likely have negligible effects on the regional population (i.e., take of approximately 0.25 percent [186 individuals ([6,202*0.03]/74,000 [regional population])], 0.20 percent (147/74,000), 0.16 percent (116/74,000), and 0.13 percent (96/74,000) of the regional population during years 1–4, respectively).

Expected take levels would likely be lower, given the best management practices and adaptive management strategies described in Chapter 2 to minimize take of non-target species. Additionally, if lethal take occurs early in the year soon after arrival of DCCOs, expected rates would be lower since Brandt's cormorant arrival and nesting cycles are a few weeks delayed compared to DCCOs. If DCCO take levels increase in subsequent years under adaptive management, increased take thresholds for Brandt's cormorants would be considered, but would be determined after evaluating amount of actual take during implementation.

Phase II - Effects to other birds on East Sand Island under Phase II would be the same type as described in Alternative B, but the need for high levels of non-lethal management on East Sand Island in Phase II in the short-term is expected to be low; need for non-lethal management would increase if the growth potential of the DCCO colony increases after lethal take commences.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Phase I - Since DCCO abundance decrease would occur primarily from lethal take and egg oiling, less non-lethal management (i.e., hazing) is expected under Phase I compared to Alternative B; thus, effects would be similar to those described in Alternative C. Little to no direct disturbance from lethal take is expected to affect species on the east end of the island since culling and egg oiling activities likely will not occur there. Effects to DCCO and non-target species on-island would be similar to Alternative C, mainly due to disturbance associated with carcass removal and egg oiling. As with Alternative C, during the primary periods of lethal take (both of adults and oiling of eggs), potential for pronounced adverse effects could occur, resulting in deterring other species from using and nesting within areas where lethal take occurs, changing spatial distribution of use on the island, and likely short-term but possibly long-term emigration. If the majority of culling occurs on-island and requires the same number of culling events as Alternative C, the addition of egg oiling events could increase overall disturbance levels to East Sand Island and thus increase adverse effects to other nesting and roosting bird species. Additionally, egg oiling activities under Alternative C-1 could likely extend later into the nesting season than Alternative C, and effects to nesting species would be greater the longer management actions extend past the initiation of nesting. Best management practices and adaptive management strategies described in Chapter 2 would be implemented to minimize potential effects. The application of the food-grade vegetable oil used for egg oiling would have short-term persistence in the immediate, localized environment and no or negligible measurable effect on non-target species.

Brandt's cormorants are the non-target species with the highest potential for take due to their close association with DCCOs. Effects are expected to be similar to Alternative C but potentially reduced because fewer individual DCCOs are proposed for culling (10,912 DCCO taken in total; 3,489, 3,114, 2,408, and 1,902 DCCOs taken in years 1–4, respectively). However, a greater proportion of individuals could be culled over water compared to Alternative C to reduce incursion and disturbance to the colony, which would result in a comparative higher take rate of Brandt's cormorants compared to Alternative C. Additionally, there could be an increase in the potential for nest disturbance during egg oiling activities.

As described in Alternative C, a 3 percent take rate of the East Sand Island Brandt's cormorant colony could occur due to misidentification during the lethal removal of DCCO, resulting in up to 327 (10,912 x 0.03) Brandt's cormorants taken in total during years 1 to 4. There is a potential for take of up to approximately 0.1 percent of the regional population of Brandt's cormorants per year. Take of 327 Brandt's cormorants would have direct adverse effects on individuals and associated breeding pairs and likely limit or reduce the size of the Brandt's cormorant colony on East Sand Island. However, this level of take would likely have negligible effects on the regional population (i.e., take of approximately 0.14 percent [105 individuals ([3,489*0.03]/74,000 [regional population])], 0.13 percent (93/74,000), 0.10 percent (72/74,000), and 0.08 percent (57/74,000) of the regional population during years 1–4, respectively).

Expected take levels would likely be lower, given the best management practices and adaptive management strategies described in Chapter 2 to minimize take of non-target species. Additionally, if lethal take occurs early in the year, soon after arrival of DCCOs, expected rates would be lower since Brandt's cormorant arrival and nesting cycles are a few weeks delayed compared to DCCOs. If DCCO take levels increase in subsequent years under adaptive management, increased take thresholds for Brandt's cormorants would be considered but would be determined after evaluating amount of actual take during implementation. Brandt's cormorant pairs nesting in proximity to culled birds or nests that are oiled could experience disturbance from the retrieval of carcasses or from egg oiling. However, based on implementation of the measures described in Chapter 2 to avoid and minimize take of non-target species, the potential effects are expected to be minimal and have negligible effects on the regional population.

Glaucous-winged/western gulls nesting in proximity to culled birds or nests that are oiled could experience disturbance from the retrieval of carcasses or activities associated with egg oiling. However, based on implementation of the measures described in Chapter 2 to avoid and minimize take of non-target species, the potential effects are expected to be minimal. During past dissuasion research, several thousand glaucous-winged/western gulls nested and raised young within the DCCO dissuasion areas (Roby et al. 2014). Because glaucous-winged/western gulls nest across East Sand Island and not just where DCCOs nest (Figure 4-15), the overall effect to this colony of gulls from the management action will be negligible. The glaucous-winged/western gull colony on East Sand Island is approximately 4,000 individuals, which is approximately 5 percent of the regional population for Washington and Oregon (73,000 breeding individuals; see Table 3-3).

Phase II - Effects to other birds on East Sand Island under Phase II would be the same type as described in Alternative B.

Alternative D

Phase I - Same as Alternative C-1.

Phase II - Effects from terrain modification would be the same as described in Alternative B. Effects associated with concurrent non-lethal management activities supported with limited egg take would likely be high in the short-term to preclude all

DCCO nesting and re-establishment but low or negligible thereafter in the long-term since few or no DCCOs would be present on East Sand Island. To prevent all DCCO nesting on East Sand Island, hazing would likely have to occur throughout the entire island during the entire breeding season; thus, adverse effects to other nesting bird species, including abundance reduction and potential for colony abandonment from management actions would be very high. Exclusion of only DCCOs, which have significant temporal overlap with other nesting species on island and can nest in close spatial association with those species, would likely be difficult without significantly affecting other co-nesting species. Exclusion of all DCCOs on East Sand Island could adversely affect Caspian terns and ring-billed gulls by increasing and intensifying predation on these species. With regard to regional populations, dispersal of a large majority or all of a given nesting species from East Sand Island would likely have the greatest impact on Caspian terns, which have a high concentration of the regional abundance at East Sand Island (i.e., 60 percent) compared to the other species (2–16 percent; see Table 3-3). Conversely, exclusion of DCCOs could benefit other nesting bird species on the island, as more suitable nesting, roosting, or foraging opportunities may become available.

4.2.4 Effects to Other Birds

Species considered in Section 3.2.3 were those within the sub-regions of the affected environment, particularly the Columbia River Estuary, Washington Coast, and Salish Sea that co-nest or overlap in habitat use with DCCOs and are a conservation concern. Additionally, species in the Columbia River Estuary may be directly impacted by management actions, including hazing and take of non-target species. Islands identified as potential dispersal and hazing locations (i.e., Rice, Miller Sands Spit, Pillar Rock) and other islands in the Columbia River Estuary and locations along the Washington coast were recently designated critical habitat for the streaked horned lark (50 C.F.R. § 17.95(b)). In addition to effects from hazing DCCOs in the estuary, bird species within the affected environment may be affected by DCCO abundance increases resulting from DCCO emigration from East Sand Island. However, predicting or quantifying these direct or indirect effects can be difficult or tenuous in complex systems, even with detailed study.

Alternative A

Abundance and distribution of other bird species considered in this section would presumably remain similar to current conditions in the near- and long-term. Direct or indirect adverse effects to other birds are expected to be similar to levels prior to habitat modification and hazing research, which likely increased dispersal levels.

Alternative B

Phase I - Approximately more than 7,250 DCCO breeding pairs would be dispersed from East Sand Island into the Columbia River Estuary and affected environment. Co-nesting species that use the same habitat and forage for the same prey species as DCCOs have the greatest potential to be affected via inter-specific competition. Adverse effects from DCCO abundance increases to new areas may include: 1) increased nesting and foraging competition; 2) increased dispersal, colony abandonment, or disruption in breeding; 3) increased disease transmission; and 4) destruction of nesting habitat for certain species through defoliation or denuding vegetation. Interactions concerning competition are complex, and DCCO abundance increases alone at a given location does not necessarily correlate to increased nesting or foraging competition. For example, sub-sites or habitat within a site could be used differentially by DCCOs and co-nesting species (e.g., cliffs [pelagic cormorants] vs. level areas [DCCOs]; see Siegel-Causey and Hunt 1981). Beneficial effects from DCCO abundance increase could include: 1) increased colony size buffering against predation and 2) denuding of vegetation, making areas more desirable to species that use open habitats. Actual effects to other birds would be commensurate with dispersal levels to new areas and subsequent site-specific interactions.

Adverse effects to herons and other obligate tree nesting species from destruction of trees by DCCO guano accumulation have been documented in the northeastern United States (USFWS 2003). This has not been documented in the affected environment; thus, no direct or indirect adverse effects are expected to herons as there is little overlap between the species at existing breeding colonies within the sub-regions of the affected environment.

Potential for DCCO dispersal to and the need for DCCO hazing at islands designated critical habitat for streaked horned larks would be high. For example, Rice Island is an important streaked horned lark nesting area in the Columbia River Estuary and a former colony site for DCCOs. Streaked horned larks have the greatest potential to experience direct and indirect adverse effects under Alternative B due to expected DCCO dispersal in the estuary and subsequent hazing activities. Regional population size for the species is much smaller than other bird species considered (see Table 3-3). Additional hazing on islands that streaked horned larks occupy and use for nesting is likely to result in incidental adverse effects to streaked horned larks, depending on the timing, location, and intensity of hazing and dissuasion. While a single hazing event on these islands may not jeopardize the streaked horned lark population, effects from repeated events during the nesting season could significantly impact the Columbia River population, which is estimated to be approximately 45-60 breeding pairs in the Columbia River Estuary (Anderson 2013). Rice Island supports a substantial proportion of streaked horned larks and is estimated to sustain over 20 pairs of breeding adults (Anderson 2013). Direct effects may include flushing adults or young, increasing exposure of eggs and juveniles to weather and predation, nest abandonment or destruction, and possible mortality of eggs or young (USFWS 2014c). Depending on the proximity, frequency, and duration of these activities, hazing could result in reduced survival of affected streaked horned larks. Dissuasion measures could preclude the use of suitable nesting habitat which would indirectly affect individual streaked horned larks (USFWS 2014c).

Potential for DCCO dispersal to and need for DCCO hazing at Astoria-Megler Bridge, which could adversely affect the pelagic cormorant colony by disturbing nesting birds resulting in nest failure, and Miller Sands Spit, which could adversely affect the American white pelican colony, would be high. Monitoring and hazing at these areas would likely need to occur over a long period of time. Non-lethal techniques could result in nest destruction, abandonment, or failure, and increased susceptibility of eggs and chicks to predation. These actions could result in take of nests, eggs, or chicks of other nesting species. Adaptive Management approaches described in Chapter 2 would be implemented to minimize take of non-target species. Adverse effects to the regional population of American white pelicans and pelagic cormorants from management actions would likely be negligible since the colonies in the Columbia River Estuary compose a small proportion of these species' regional populations; approximately 0.2 percent and 0.5 percent, respectively (Section 3.2.4).

Phase II - Need of continued DCCO non-lethal management and hazing would be high. Effects to other birds in the affected environment outside of the Columbia River Estuary would be commensurate with dispersal levels to new areas and subsequent site-specific interactions, and would likely be less than Phase I. Long-term adverse effects to species that overlap with DCCOs in the estuary are expected from hazing, as described under Phase I. No direct or indirect adverse effects are expected from the proposed terrain modification to any other birds that do not commonly use East Sand Island. Indirect benefits may result from an increase in intertidal mudflats that could support foraging and roosting opportunities for shorebirds.

Alternative C

Phase I - DCCO dispersal from East Sand Island is assumed to be minimal under this alternative compared to more than 7,250 breeding pairs considered under Alternative B. Effects to other birds would be commensurate with dispersal levels to new areas and subsequent site-specific interactions, but is assumed to be low. Streaked horned larks are the primary species of concern in the Columbia River Estuary. Under Alternative C, additional hazing beyond what is currently done for the Corps' Channels and Harbors program is not expected; thus, adverse effects from hazing would be comparable to past levels. If abundance reduction of the DCCO colony on East Sand Island results in DCCO immigration from other areas, effects to other bird species in areas of DCCO emigration would be reduced. The same adaptive hazing plan as described in Alternative B would be used, but the need for hazing in the Columbia River Estuary and associated adverse effects would be lower due to less DCCO dispersal.

Due to the potential for misidentification, the potential exists for take of pelagic cormorants during boat-based culling. However, pelagic cormorants are recognizably different in size from DCCOs and do not nest in close association with the DCCO colony on East Sand Island (i.e., the nesting colony is on the Astoria Bridge); thus, potential take of pelagic cormorants is less likely than Brandt's cormorants. During 16 years of diet studies on Rice and East Sand Island, in which 2,351 total DCCOs were lethally taken, take of 3 pelagic cormorants occurred during one year (BRNW 2013a). This is a take rate of 0.13 percent. Given the magnitude of take and different methodologies, higher take rates could occur under Alternative C. Under Alternative C (18,185 DCCO taken in total; 6,202, 4,887, 3,881, and 3,214 DCCOs taken in years 1–4, respectively) a 0.3 percent take rate of pelagic cormorants (determined from input by cooperating agencies; up to 55 [18,185 x 0.003] pelagic cormorants taken) could occur during years 1 to 4.

The pelagic cormorant colony in the Columbia River Estuary is approximately 150 breeding individuals, which is approximately 0.5 percent of the Pacific Region population (29,000 breeding individuals; see Table 3-3). There is a potential for take of up to 0.06 percent of the regional population of pelagic cormorants per year under the 4-year strategy, or up to 12 percent of the colony in the Columbia River Estuary per year. Take of 55 pelagic cormorants would have direct adverse effects on individuals and associated breeding pairs and likely limit or reduce the size of the pelagic cormorant colony in the Columbia River Estuary. However, this level of take would likely have negligible effects on the regional population (i.e., take of approximately 0.06 percent [19 individuals ([6,202*0.005]/29,000 [regional population])], 0.05 percent (15/29,000), 0.04 percent [12/29,000), and 0.03 percent (10/29,000) of the regional population during years 1–4, respectively).

Expected take levels would likely be lower given the Adaptive Management approaches described in Chapter 2 to minimize take of non-target species. Additionally, the majority of lethal take would likely occur on-island where potential for take of pelagic cormorants is very low. If DCCO take levels increase in subsequent years under adaptive management, increased take thresholds for pelagic cormorants would be considered but would be determined after evaluating amount of actual take during implementation.

Phase II - Adverse effects from DCCO dispersal and associated hazing would likely be lower in the short-term, compared to Phase I, but could become higher if DCCO dispersal increases after lethal take commences. Effects from modifying the terrain are the same as Phase II of Alternative B.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Phase I – Similar or higher to Alternative C for most non-target species, but less for pelagic cormorants. Due to the potential for misidentification during boat-based culling activities, the potential exists for take of pelagic cormorants. Effects are expected to be similar to Alternative C, but potentially reduced because of fewer DCCOs culled (10,912 DCCO taken in total; 3,489, 3,114, 2,408, and 1,902 DCCOs taken in years 1–4, respectively); however, a greater proportion of individuals could be culled over-water compared to Alternative C to reduce incursion and disturbance to the colony, which would result in a comparative higher take rate of pelagic cormorants compared to Alternative C. Under these take levels and a 0.3 percent take rate of pelagic cormorants, which was determined from input by cooperating agencies, up to 33 (10,912 x 0.003) pelagic cormorants could be taken in total during years 1 to 4 under this scenario.

The pelagic cormorant colony in the Columbia River Estuary is approximately 150 breeding individuals, which is approximately 0.5 percent of the Pacific Region population (29,000 breeding individuals; see Table 3-3). There is a potential for take of up to approximately 0.04 percent of the regional population of pelagic cormorants per year, or up to 7 percent of the colony in the Columbia River Estuary per year. Take of 33 pelagic cormorants would have direct adverse effects on individuals and associated breeding pairs and likely limit or reduce the size of the pelagic cormorant colony in the Columbia River Estuary. However, this level of take would likely have negligible effects on the regional population (i.e., take of approximately 0.04 percent [10 individuals

([3,489*0.003]/29,000[regional population])], 0.03 percent (9/29,000), 0.02 percent [7/29,000), and 0.02 percent (6/29,000) of the regional population during years 1–4, respectively). Expected take levels would likely be lower, given the BMPs and Adaptive Management approaches described in Chapter 2 to minimize take of non-target species. If DCCO take levels increase in subsequent years under adaptive management, increased take thresholds for pelagic cormorants would be considered but would be determined after evaluating amount of actual take during implementation.

Phase II - Adverse effects from DCCO dispersal and associated hazing would likely be lower in the short-term compared to Phase I but could become higher if DCCO dispersal increases after lethal take commences. Effects from modifying the terrain are the same as Phase II of Alternative B.

Alternative D

Phase I - Same as Alternative C-1.

Phase II - Additional dispersal of all remaining DCCOs from East Sand Island, approximately 5,600 breeding pairs, would occur. Effects to other birds would be commensurate with dispersal levels to new areas and subsequent site-specific interactions. Expected levels of dispersal and need for hazing in the Columbia River Estuary would be similar to Phase I of Alternative B in the short-term. Potential effects would be high in both the short- and long-term if hazing cannot redistribute all DCCOs outside the Columbia River Estuary. There would be no effects in the long-term after all DCCOs are redistributed outside the Columbia River Estuary. Effects from modifying the terrain are the same as Phase II of Alternative B.

4.2.5 Effects to ESA-Listed Fish in Lower Columbia River Basin

The revised RPA action 46 from the 2014 FCRPS Supplemental Biological Opinion projected that a colony size of approximately 5,600 DCCO breeding pairs would reduce the gap in steelhead and Chinook salmon survival and return DCCO predation rates to levels observed during the FCRPS base period (NOAA 2014). The NOAA Fisheries analysis (Appendix D) utilized bioenergetics data (described in Section 1.1.6) and estimated total available smolts in determining predation rates. The Corps adopts NOAA Fisheries analysis and associated "survival gap" estimates, but proposes to use PIT tag recoveries in the future to evaluate management actions. PIT tags provide ESU- or DPS-specific estimation of predation rate, consistent with NOAA Fisheries (2014) directive to obtain stock-specific data when possible. Predation rates on ESA-listed Columbia River Basin ESUs or DPSs, using PIT tag recoveries on the East Sand Island DCCO colony over the last ten years, are provided in Section 3.2.5 and Appendix C.

Provided in this section are estimates of potential benefits (increases in survival) to ESA-listed juvenile salmonids using PIT tag data for the reductions in DCCO colony size, as proposed in the alternatives. Potential increases in survival differ from those presented by NOAA Fisheries in the 2014 FCRPS Biological Opinion (Appendix D) because: 1) different time periods were used to estimate fish effects; 2) different groups of fish were evaluated (e.g., NOAA Fisheries analyzed species-level impacts, not ESU- or DPS-level impacts); and 3) different analytical methods (e.g., PIT tag predation rates versus absolute consumption rates) were used to estimate predation losses. As such, direct comparisons between NOAA Fisheries analysis (Appendix D) and those presented here should be made cautiously. Common elements of both analyses are a reduction in colony size to approximately 5,600 nesting pairs (Alternatives B-D, Phase I) and the use of per capita impacts to measure potential increases in fish survival rates.

Methods for Evaluating Benefits to Juvenile Salmonids

PIT tag data were available for 8 of 13 ESA-listed anadromous salmonid ESU or DPS that occur in the Lower Columbia River Basin. Impacts to ESA-listed juvenile salmonid ESU or DPS were estimated by dividing the average annual predation rate (see Appendix C) by the average annual DCCO colony size to generate an average annual per capita (per bird) predation rate. Per capita predation rates were generated during a ten year (2004-2013) reference period. To account for inter-annual variation observed in salmonid predation rates, per capita estimates were also generated for the lowest and highest annual predation rates observed during the reference period. Potential benefits (an increase in survival) were then estimated by multiplying the per capita predation rate by the colony size identified in Phases I and II of Alternatives A–D.

Predation rate data were not available for all DPS or ESU evaluated during the 10-year reference period (2004-2013). Per capita predation rate impacts were generated for a 5-year reference period (2009-2013) for Snake River steelhead, a 7-year reference period (2007-2013) for Upper Willamette River Chinook and Middle Columbia River steelhead, and the entire 10-year reference period (2004-2013) for the remaining five ESU or DPS evaluated. Actual benefits to ESA-listed juvenile salmonids from DCCO management actions in the Columbia River Estuary would depend on a number of factors. The analysis presented here assumes that per capita salmonid impacts observed during the last decade, a constant rate applied over a range of biotic and abiotic conditions and fisheries management practices that affect juvenile salmon abundance, timing, and susceptibility to predation, would persist in the next decade. If this proves to be false, however, per capita impacts in the future could differ to an unknown degree. Additionally, the analysis does not include any degree of compensatory mortality and the reduction in DCCO predation is based upon the end colony size for the alternative (5,380-5,939 breeding pairs); thus, benefits presented are potentially maximum benefits that could occur and would ultimately depend upon the degree of compensation actually observed and other factors that could result in the management objectives not being achieved throughout the entire Columbia River Estuary, such as DCCO dispersal and the effectiveness at precluding DCCOs from the Columbia River Estuary.

Summary Tables of Potential Benefits

The tables below (Tables 4-2 and 4-3) provide potential increases in juvenile salmonid survival in the Columbia River Estuary if DCCO colony size on East Sand Island is reduced to levels identified in Phase I and Phase II of Alternatives A–D. Increases represent the average (lowest-highest) annual percent increase in juvenile survival.

TABLE 4-2. Potential Benefits (Survival Increase) to Select Juvenile Chinook ESUs from Alternatives.

	Snake River Spring/Summer Chinook		**Snake River Fall Chinook**		**Upper Columbia River Spring Chinook**		**Upper Willamette River Spring Chinook**	
Alternative	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
A	0%	0%	0%	0%	0%	0%	0%	0%
B	3% (1-4)	3% (1-4)	2% (1-3)	2% (1-3)	2% (1-3)	2% (1-3)	1% (0-2)	1% (0-2)
C	3% (1-4)	3% (1-4)	2% (1-3)	2% (1-3)	2% (1-3)	2% (1-3)	1% (0-2)	1% (0-2)
D	3% (1-4)	4% (2-7)	2% (1-3)	3% (2-5)	2% (1-3)	4% (2-6)	1% (0-2)	2% (0-4)

TABLE 4-3. Potential Benefits (Survival Increase) of Select Steelhead DPSs and Snake River Sockeye from Alternatives.

	Snake River Steelhead		**Upper Columbia River Steelhead**		**Mid Columbia River Steelhead**		**Snake River Sockeye**	
Alternative	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
A	0%	0%	0%	0%	0%	0%	0%	0%
B	4% (1-9)	4% (1-9)	4% (2-7)	4% (2-7)	4% (1-9)	4% (1-9)	2% (2-5)	2% (2-5)
C	4% (1-9)	4% (1-9)	4% (2-7)	4% (2-7)	4% (1-9)	4% (1-9)	2% (2-5)	2% (2-5)
D	4% (1-9)	8% (3-17)	4% (2-7)	6% (3-11)	4% (1-9)	8% (2-15)	2% (2-5)	4% (3-6)

In general, benefits from a reduction in DCCO colony size on East Sand Island are expected to be greater for steelhead compared with salmon ESUs. Comparisons of potential benefits within the same species (Chinook, steelhead, sockeye) by ESU or DPS indicate that juvenile salmonids originating from the Snake River Basin may receive the greatest benefit. Based on the lowest and highest annual predation rate observed during the reference period, results indicate that substantial deviation from the average benefit could be expected in any given year. For example, although average annual benefits to Snake River steelhead were estimated at 4 percent in any given year, the annual benefit could fall between 1 and 9 percent. Hence, average benefits should be realized over a course of many years, with annual benefits falling within the estimated range (1 to 9 percent).

Alternative A

Under this alternative the Corps would take no action to reduce the rate of DCCO predation on juvenile salmonids. As habitat and available prey base are not limiting factors on East Sand Island, it is likely the DCCO colony would continue to cause significant mortality to juvenile salmonids in the estuary, comparable to recent levels. There would be no benefit in survival of juvenile salmonids from this alternative. Significant direct effects (i.e., mortality) and indirect effects (i.e., reduced numbers of juvenile salmonids entering the ocean and the large colony of DCCOs continuing to attract more piscivorous waterbirds to the island resulting in potential increases in predation impacts to juvenile salmonids) would continue and likely vary from year to year, similar to prior conditions.

Alternative B

Phase I - Direct benefits from a reduction in the current DCCO colony size could result in average annual survival increases of 1 to 4 percent, depending on ESU or DPS. However, benefits to juvenile salmonids under Phase I of Alternative B are not expected to be fully realized, at least in the short-term, because benefits assume hazing efforts would be 100 percent successful in preventing DCCOs dispersed from East Sand Island from consuming juvenile salmonids in the Columbia River Estuary. Data from Collis et al. (2002) and Evans et al. (2012) indicate that per capita impacts to salmonid smolts were higher for DCCO nesting further upstream in the Columbia River Estuary and at an inland colony near the confluence of the Columbia and Snake rivers, compared with DCCOs nesting on East Sand Island. Impacts to juvenile salmonids may even be greater than was identified in the affected environment (Section 3.2.6) if a large number of DCCOs disperse and relocate in the estuary, particularly further upriver. The likelihood is high this could occur, given the magnitude of geographic scope, limited access to areas, and potential restrictions for hazing at some areas that are critical habitat for streaked horned larks. Predation rates would not be fully reduced until DCCOs dispersed from East Sand Island permanently emigrate away from the estuary.

Phase II - Same average annual survival increases as Phase I (1–4 percent depending on ESU or DPS). Similar to Phase I, benefits to juvenile salmonids under this alternative would not likely be fully realized until DCCOs that disperse from East Sand Island emigrate from the estuary.

The proposed terrain modification has the potential for localized adverse effects to juvenile salmonids and other aquatic species during construction activities. Construction activities could increase fish mortality risk in the immediate construction area and have short-term effects on water quality, resulting in direct adverse effects to fish species and other aquatic organisms proximal to the construction areas or excavation disposal sites during the time period construction activities occur. East Sand Island is located at approximately River Mile 5, and direct effects would be localized to that area. Disposal of excavated sand on the island and placement of rock armor would have no effect or discountable effects on water circulation, fluctuation, and/or salinity in the vicinity of the area compared to current river conditions near East Sand Island because the proposed action is not at a large enough scale to affect these processes.

Disposed excavated sand would contain some amount of nutrients from DCCO guano, which contain nitrogen, phosphorus, carbon, potassium, and calcium (Craig et al. 2012). The quantified amount is unknown. However, nutrient accumulation is likely less pronounced or persistent in high-rainfall environments with sandy-textured soils, such as East Sand Island, because sandy soils have a low water-holding capacity and a low cation exchange capacity. Thus, most nutrients and contaminants deposited from waterbird guano likely have a short residence time in the soil profile before being flushed through and into the river system. Construction activities would occur approximately two to three months after DCCOs have left the island and after the colony size has been significantly reduced. Thus, potential nutrient inputs would likely be small and it is unlikely that any chemical contamination would be present in the excavated soil.

Short-term turbidity increases are expected during disposal of excavated material near the shoreline or below delineated high tide line. Sands and other finer materials likely have accumulated within the rip-rap on the south side of the western portion of the island. Relocation of this rip-rap material would also release sediments into the water column. Due to the high sand content of the disposal material, however, the dredged material is expected to settle out of the water column quickly and the turbidity plume resulting from the activity would be temporary. In comparison to the natural fluctuations in the turbidity regime in the mouth of the Columbia River, disposal-induced turbidity would be a minor contributor to existing turbidity levels in the water column and would be within the range of the current river conditions.

There would be little to no change in the aquatic ecosystem or ecosystem function from construction activities. Adverse impacts from construction are expected to be short-term and minor within the context of the high-energy environment of the mouth of the Columbia River. Some aquatic and benthic organisms, vegetation, and fish within the proximal construction area may be physically impacted, buried, or temporarily displaced or affected by placement of excavated material below delineated high tide line and relocation of rip-rap material. These effects are not expected to be at a scale large enough to alter aquatic ecosystems. Excavated material is native to the Columbia River Estuary; thus, no invasive material is present that would change the mouth of the Columbia River's aquatic ecosystem. Subsequent deposition of excavated material into the Columbia River Estuary from placement on or in the nearshore area of East Sand Island would likely mirror natural erosive processes of current estuarine conditions.

The terrain modification would likely change the 17 acres on the west end of East Sand Island from un-vegetated, open, sandy, upland habitat to tidal wetlands and marsh areas and intertidal mudflats similar to proximal areas within Baker Bay at similar elevations and inundation regimes. Compared to the current topographical conditions of East Sand Island, beneficial effects to juvenile salmonids from the conversion to these habitat types would include: 1) increased insect and invertebrate communities that are dependent upon these habitat types, thus increasing salmonid prey base; 2) increased shallow water rearing habitat for juvenile salmonids; and 3) increased primary productivity and nutrient input from macrodetritus. Based on the annual estimate of approximately 400 grams of carbon per square meter produced by marshes in the riverine habitat of the Columbia River Estuary (Sherwood et al. 1990), conversion of 17 acres to marsh habitat would result in an increase of 68,799 grams of carbon production annually for the terrain modification area.

Potential adverse effects of the terrain modification could occur from the placement of rock armoring by decreasing the habitat functionality in those areas if any was present prior. Direct adverse effects to juvenile salmonids, including physical impaction, burial, and temporary displacement, or adverse effects from temporary effects to water quality and turbidity and potential of take, could occur but are expected to be discountable at the population level. Additionally, a large breeding colony of approximately 5,600 DCCO nesting pairs could remain on East Sand Island, as well as a multitude of other piscivorous waterbirds that reside on East Sand Island and are not managed. Attraction of juvenile salmonids to created habitat from the terrain modification could result in an increased potential for predation by piscivorous waterbirds. Additionally, the decrease in DCCO abundance on East Sand Island and loss of colonial waterbird nesting habitat from the proposed action would reduce nutrient input into the Columbia River Estuary (i.e., adverse effect to juvenile salmonids) from reduced amounts of DCCO guano and other waterbird colony-related nutrient materials (i.e., DCCO carcasses, fish carcasses). The beneficial effects of increased primary production and juvenile salmonid prey base versus the adverse effects of increased predation risk and decreased nutrient input from decreased DCCO colony size is not known, nor likely quantifiable. However, in general terms, the habitat conversion would likely be most beneficial to salmonid species that utilize this area outside of the piscivorous waterbird nesting season (i.e., approximately March to October) or are smaller than optimal prey length when utilizing this area.

Direct adverse effects to adult salmonids, including physical impaction, burial, temporary displacement, or adverse effects from temporary effects to water quality and turbidity and potential of take, could occur but are expected to be discountable at the population level. Adult salmonids typically utilize the Columbia River Estuary near East Sand Island primarily or entirely as a migration corridor to reach further upriver spawning or overwintering habitat. Persistent or frequent use by adults of shallow water habitats immediately proximal to nearshore habitats on East Sand Island is not expected. Additionally, adult salmonid in-migration times largely or entirely occur outside the construction time period, and adult salmonids are highly mobile and likely able to avoid direct impact or burial and would not be substantially affected by short-term and localized changes in water quality from the proposed action. Potential for direct adverse effects would be further minimized by impact reduction measures implemented during construction activities.

Adult eulachon typically enter the Columbia River from mid-December to May, with peak entry and spawning during February and March, and typically migrate rather quickly through the mainstem channel to spawning grounds (Gustafson et al. 2010). Pacific eulachon eggs hatch in approximately 30-40 days (i.e., peak hatching dates and out-migration would be approximately March and April). Larvae are feeble swimmers and are passively and rapidly carried downstream to estuarine portions of rivers and inlets within hours or days of hatching (Gustafson et al. 2010). In the Columbia River, larval eulachon are primarily located near the bottom during their downstream migration, but they may be found throughout the water column (Howell et al. 2001; Gustafson et al. 2010). Larval eulachon may remain for weeks or months in estuaries before entering the ocean (McCarter and Hay 1999). Effects to adult and juvenile eulachon from the proposed terrain modification would likely be similar to those described for salmonid species, with the exception that juvenile eulachon are too small to be a prey species for DCCOs.

Green sturgeon use the Columbia River Estuary in the summer and early fall and occupy the mainstem channel, not shallow waters; thus, few, if any, individuals would be present during and in close proximity to construction activities related to terrain modification. Impacts to water quality from the proposed terrain modification would likely result in no or perhaps only discountable behavioral and physical response to green sturgeon as turbidity levels would be within natural ranges of the Columbia River Estuary, and green sturgeon are less affected by turbidity and suspended solids compared to salmonid species (NOAA 2013a). Indirect effects from the habitat conversion are expected to have no or perhaps only discountable effects to green sturgeon because they primarily utilize them mainstem channel, not shallow water/nearshore habitats; any increases in food web productivity from the habitat conversion would likely have no or only beneficial effects to green sturgeon.

Alternative C

Phase I - Same average annual survival increases of 1 to 4 percent (depending on ESU or DPS) as Alternative B. Benefits to juvenile salmonids are expected to be realized more quickly and with more certainty because colony size reduction would occur primarily from lethal take and minimal dispersal is expected.

Phase II - Similar to Phase I. Benefits to juvenile salmonids are expected to be realized in the short-term because of limited DCCO dispersal from East Sand Island but could decrease with time if dispersal increases. Direct and indirect benefits for juvenile salmonids associated with the terrain modification would be the same as Alternative B.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Phase I and II - Same as Alternative C but benefits would be reduced if greater DCCO dispersal occurs than under Alternative C.

Alternative D

Phase I - Same as Alternative C-1.

Phase II - Complete exclusion of the DCCO colony on East Sand Island is expected to result in average annual survival increases of 2 to 8 percent, depending on ESU or DPS. Similar to Phase I of Alternative B, benefits of the additional reduction in DCCO from non-lethal management would be less certain and not be fully realized until all DCCOs emigrate from the Columbia River Estuary. Direct and indirect benefits associated with the terrain modification are the same as described in Phase II of Alternatives B. Benefits to juvenile salmonids would be the highest under this alternative and phase.

4.2.6 Effects to Other ESA-Listed Fish

ESA-listed fish species within the affected environment outside of the Columbia River Estuary that could be affected by DCCO predation were described in Chapter 3, Section 3.2.7. With the exception of a few temporally limited studies within a few Oregon Coast estuaries, little to no empirical data are available to estimate rates of DCCO predation on these fish species. Predicting or quantifying these direct or indirect effects can be difficult or tenuous in complex systems, even with detailed study. In general, effects would be commensurate with DCCO dispersal levels to new areas and subsequent site-specific interactions.

DCCO impacts on ESA-listed fish are likely to be greater in freshwater and estuary habitats where fish may be more densely concentrated and thus more vulnerable to avian predation (Lyons 2010; Adrean 2013). Impacts to ESA-listed fish from DCCO predation in each sub-region (i.e., Oregon Coast, Washington Coast, Salish Sea, and outer Vancouver Coast) would vary greatly depending on numerous factors, including availability of alternative prey, fish behavior and life history characteristics, foraging range of DCCOs nesting or roosting at a specific location, and other factors. Conversely, at coastal sites, non-listed marine forage fish (e.g., anchovy, herring, surfperch, and numerous others) are usually abundant, and ESA-listed fish may be more dispersed in the ocean environment, factors that may buffer predation risks to ESA-listed fish in marine waters (Ainley and Anderson 1981; Loeffler 1996; Collis et al. 2012). The potential impacts from DCCO predation would occur at the juvenile life stage for most ESA-listed fish in the affected environment, with the exception of Pacific eulachon, which, due to their small size, are susceptible to DCCO predation throughout their life cycle.

Alternative A

No change in the current conditions of DCCO predation of ESA-listed fish would be expected; DCCO dispersal and associated effects would likely be lower in the near-term than prior years when management feasibility studies and dissuasion research occurred.

Alternative B

Phase I - Approximately 7,250 DCCO breeding pairs would be redistributed outside the Columbia River Estuary. Effects to fish species outside the Columbia River Basin would be commensurate with DCCO dispersal levels to new areas and subsequent site-specific interactions. Pacific eulachon are believed to be widely distributed; however, there is little temporal overlap between the DCCO nesting season (April–September) and the eulachon spawning run, and juvenile eulachon may be too dispersed in the open ocean and deep in the water column to be susceptible to DCCO predation; thus, adverse impacts to Pacific eulachon from DCCO redistribution are not expected. Specific areas in the affected environment, identified below, are likely to be more impacted by DCCO dispersal and a redistributed western population.

Oregon Coast - Oregon Coast Coho juveniles out-migrate as yearlings in the spring. ODFW is concerned that DCCO may be significantly impacting coastal salmonid populations and is partway through a 3-year study to assess the impacts of DCCO predation on salmonid populations along the Oregon coast. Results to date indicate that juvenile salmonids in coastal estuaries are susceptible to DCCO predation; based on current analyses, Coho smolts along the northern Oregon Coast may also be vulnerable to DCCO predation in estuary environments, and estuaries with DCCO colonies exist in this sub-region (i.e., Rogue River Estuary, Oregon). Past dissuasion research and movement data have shown low levels of DCCOs from East Sand Island prospecting in Oregon. Effects to coastal coho juveniles could be higher if prior patterns change and DCCOs prospect for new nesting locations in Oregon.

Washington Coast / Salish Sea Areas - Based on their use of deep water habitat and large size at reproduction, interactions among bocaccio, canary and yelloweye rockfish, and DCCOs in the Salish Sea sub-region are likely minimal and adverse effects are not expected, although larvae and juveniles may be more susceptible to DCCO predation. Bull trout susceptibility to DCCO predation may be greater for migratory fish compared with resident fish, especially for bull trout that utilize estuaries. Extended use of estuaries and nearshore marine environments by juvenile Puget Sound Chinook and juvenile Hood Canal chum suggests they would be more vulnerable to DCCO predation if DCCOs disperse to coastal estuaries in Washington. Puget Sound steelhead smolts may move offshore more quickly, as compared with Puget Sound Chinook and Hood Canal chum salmon (NOAA 2011a), and this would likely lessen their susceptibility to DCCO predation. Impacts to Ozette Lake sockeye are unknown but the potential for conflict exists, especially if sockeye use estuary or nearshore habitats for extended periods of time.

Phase II - The potential for DCCO dispersal would likely be high in both the short- and long-term as DCCO redistribute in the region. Effects to fish species would be commensurate with DCCO dispersal levels to new areas and subsequent site-specific interactions.

Alternative C

Phase I - Overall DCCO dispersal from East Sand Island is assumed to be minimal, compared to more than 7,250 DCCO breeding pairs considered under non-lethal management. Effects to ESA-listed fish species outside the Columbia River Basin would be commensurate with DCCO dispersal levels to new areas and subsequent site-specific interactions, but are assumed to be low. If abundance reduction of the DCCO colony on East Sand Island results in DCCO immigration from other areas, effects to fish species in areas of DCCO emigration would be reduced.

Phase II - Same type of effects from terrain modification and limiting the DCCO colony size on East Sand Island as Alternative B; effects are assumed to be minor in the short-term but could become greater if DCCO dispersal increases after lethal take commences.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Phase I - Same as Alternative C but greater effects would occur if greater DCCO dispersal occurs than under Alternative C.

Phase II - Same as Alternative C.

Alternative D

Phase I - Same as Alternative C-1.

Phase II - Additional dispersal of all remaining DCCOs from East Sand Island, approximately 5,600 breeding pairs, would occur. Effects to fish species outside the Columbia River Basin would be comparable to Phase I of Alternative B in the short-term and long-term.

4.3 Socioeconomic Environment

This section addresses potential effects to social and economic resources from the proposed alternatives, with the primary focus on in-river Columbia River tribal fisheries (4.3.2), commercial and recreational fisheries (4.3.3), public resources (4.3.4), existence and aesthetic values (4.3.5), and historic properties on East Sand Island (4.3.6).

4.3.1 Columbia River Basin Salmon Fisheries

An analysis was conducted to assess economic impacts to Columbia River Basin in-river salmonid fisheries resulting from reducing the size of the DCCO colony on East Sand Island to the size identified in the proposed alternatives (TRG 2014; summary provided herein, see Appendix I for full report with additional details on methods and assumptions). Columbia River in-river fisheries are defined as the regions wherever Columbia River Basin production contributes to in-river fisheries, which include the Columbia Basin ecological provinces for the Columbia Estuary, Lower Columbia, Columbia Gorge, Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake (see Appendix I for a more complete description and map of the geographic area considered for Columbia River in-river fisheries). A deterministic simulation model was developed to show relative effects among the proposed alternatives: the no action alternative (Alternative A), a reduction of the DCCO colony to approximately 5,600 breeding pairs (Alternatives B, C, C-1, and Phase I of Alternative D), and reduction of all DCCOs on East Sand Island (Phase II of Alternative D). Economic models were used to translate reduction of DCCO juvenile salmonid predation (i.e., increase in out-migrating smolts survival) to in-river fisheries economic impacts in the Columbia River Basin.

The environmental baseline (Alternative A) and change to that baseline resulting from DCCO predation on East Sand Island were determined from the following sources and procedure (see Appendix I for schematic diagram of economic analysis):

1) Determine the presence of out-migrating smolts. This was accomplished by using average 2008-2012 annual hatchery release data expanded to account for wild production and reduced by passage mortality. Hatchery releases were from CRFPC (August 2013 and 2014) and estimated wild smolt production was based on Zabel (2013). Passage mortality was based on Zabel (2014), Welch et al. (2008), Rechisky et al. (2013), and Carter et al. (2009).

2) Apply DCCO predation probabilities to smolt presence near East Sand Island to estimate consumption. For consistency with the fish effects analysis in Section 4.25, predation probabilities used in the economic analysis were the average 2008–2012 PIT tag predation probabilities estimated in Appendix C (see Appendix I [sub-Appendix C] for comparative economic analysis output using bioenergetic-based consumption estimates). The year range chosen was based upon congruence with other datasets. At this step, investment cost and curtailment of investment cost of hatchery origin fish consumed by DCCO predation was calculated. Average hatchery production operation and administrative expenditure (i.e., species specific cost per-released fish) were from TRG (2009).

3) Use fishery-specific smolt-to-adult survival (SAS) rates and distribution and harvest statistics to generate the number of salmonid adults for the various alternative scenarios that would have contributed to in-river fisheries within different regions. SAS estimates were from HSRG (2009) and fisheries effort and distribution and catch information were derived from the All-H-Analyzer (AHA) Model (Mobrand, Jones, and Stokes).

4) Use economic models and statistics from other studies to estimate economic value from the returning adult salmonids (i.e., #3) under the various alternative scenarios. The unit statistics were from TRG (2009).

Three output economic measures are reported: 1) direct financial value (DFV), 2) regional economic impact (REI), and 3) investment cost, which is calculated at step #2. A brief description of these measures is included herein (see Appendix I for full description and discussion of assumptions).

1) DFV is commercial gillnet and commercial tribal fisheries harvest revenue plus recreational angler trip expenditures. An economic value for tribal ceremonial and subsistence fisheries was not included in this measure, as an economic value cannot be assigned to this fishery (see Chapter 3, Section 3.3.2 for discussion of ceremonial and substance fisheries).

2) REI shows the significance of economic contributions to regional economies and is economic value within a specified geographic region stemming from changes being made to expenditures within that region. The measurement units are in personal income. The personal income measure can be interpreted to be

household net earnings and a region's average household net earnings statistic can be used to translate the measure to an equivalent job metric. DFV is the beginning measure for calculating REI. For example, the revenue received by commercial fishers affords them to spend money within the economy (e.g., for hiring crew, costs at local supply and services businesses for the cost of fishing). Similarly, recreational anglers spend money at local businesses. This commercial and recreational fishing spending starts the dollar flows that are tracked by the input/output modeling to determine total economic contribution. Capital expenditures were considered similar among alternatives as it was assumed capital items such as boats would have been purchased with or without management plan actions.

3) Investment costs are hatchery operation and administration expenditures associated with DCCO consuming out-migrating, hatchery-reared smolts. The hatchery production costs per smolt release range from $0.20 to $2.00 per individual (TRG 2009). This measure allows for comparative assessment of the alternatives with regard to costs directly associated with hatchery practices. This measure is a partial measure of true, total economic investment cost, as this measure does not include an investment cost for the estimated wild origin portion of the DCCO consumption (see Appendix I for additional detail). An investment value for wild origin fish is considerable as government agencies and private industries devote millions of dollars toward salmon and steelhead recovery (GAO 2002).

DFV, REI, and investment cost measurements for the alternatives are shown for the three industry sectors in Table 4-4, Table 4-5, and Table 4-6 (see Appendix I for break-down by fish species and industry sector and model input values). The analysis does not include any degree of compensatory mortality and the reduction in DCCO predation is based upon the end colony size for the alternative (see Chapter 4, Section 4.6.5 for discussion on compensatory mortality); thus, economic benefits presented are potentially maximum benefits that could occur and would ultimately depend upon the degree of compensation actually observed and other factors that could result in the colony size objective not being achieved throughout the entire Columbia River Estuary, such as DCCO dispersal and the effectiveness at precluding DCCOs from the Columbia River Estuary. Additionally, economic benefits presented for the Columbia River Estuary could potentially be offset by economic losses in other areas outside of the Columbia River Basin. The potential for economic offset would be greater under alternatives that promote DCCO dispersal (Alternative B and Alternative D, Phase II). Costs to implement each alternative (see Table 2-11) should also be considered when evaluating the expected net economic benefit of an alternative.

TABLE 4-4. Economic Effects from DCCO Predation Reduction to Columbia River In-river Fisheries by Sector for Participant Direct Financial Value (DFV).

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	33,941	1,284	3.8%	2,293	6.8%
Non-Indian commercial	4,152	78	1.9%	139	3.3%
Tribal commercial	3,785	79	2.1%	141	3.7%
Total	41,879	1,441	3.4%	2,574	6.1%

Notes:
1. Direct financial value (DFV) is commercial gillnet and tribal fisheries participant harvest revenue plus recreational angler trip expenditures.
2. DFV is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
3. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

TABLE 4-5. Economic Effects from DCCO Predation Reduction to Columbia River In-river Fisheries by Sector for Regional Economic Impacts (REI).

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	34,626	1,148	3.3%	2,049	5.9%
Non-Indian commercial	7,131	133	1.9%	238	3.3%
Tribal commercial	7,253	172	2.4%	306	4.2%
Total	49,010	1,452	3.0%	2,593	5.3%

Notes:
1. Regional economic impacts (REI) are expressed as personal income. REI is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

TABLE 4-6. Economic Effects from DCCO Predation Reduction to Columbia River In-river Fisheries for Hatchery Investment Costs.

	Alternative A	Effect (Change From Alternative A)			
		Alt B-C; Phase I, Alt D		Phase II, Alt D	
	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Consumption	3,776.5	-2,114.8	-56.0%	-3,776.5	-100.0%
Effective hatchery releases	5,425.6	-3,038.4	-56.0%	-5,425.6	-100.0%
Investment cost	6,435.6	-3,603.9	-56.0%	-6,435.6	-100.0%

Notes: 1. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions. A negative consumption or investment cost means a savings from the Alternative A status quo conditions. Consumption is the number of out-migrating hatchery salmonid smolts consumed by DCCOs. Effective hatchery releases is consumption numbers converted to effective hatchery releases accounting for passage mortality. Investment cost is the value of the effective hatchery releases based upon hatchery production costs per smolt release.

4.3.2 Effects to Tribal Fisheries

Native American tribes in certain Columbia River Basin geographic areas are particularly vulnerable to fishery-related changes, given the tribes' thousands of years of life dependency on Columbia River fish resources. The conditions creating the DCCO depredation issue result from post-European settlement and the problem is additive to the drastic alteration from historic tribal fisheries. While the analysis in this section provided for a quantitative analysis for potential economic outcomes of DCCO management, it does not include value of tribal ceremonial and subsistence harvests, which cannot be measured in terms of dollars and are culturally significant beyond economic gain; thus, economic values given below only include tribal commercial fisheries (see Chapter 3, Section 3.3.2 for additional information related to tribal fisheries, including ceremonial and subsistence harvests during 2003–2012).

Alternative A

No reduction of East Sand Island DCCO colony abundance or reduction in DCCO juvenile salmonid predation. Annual economic value of in-river Columbia River fisheries would likely remain similar to baseline conditions in the near-term for tribal commercial fisheries: total direct financial value of $3.8 million and regional economic impact of $7.3 million. Compared to Alternative D, which proposes to exclude all DCCO nesting on East Sand Island, current levels of juvenile salmonid predation by the DCCO colony on East Sand Island would likely continue to result in annual loss of 3.7 percent ($0.1 million) of DFV and 4.2 percent ($0.3 million) REI to tribal commercial fisheries. Total hatchery investment costs (both tribal and non-tribal-related) from DCCO consumption would likely remain similar to baseline conditions in the near-term at $6.4 million.

Alternative B

DCCO colony abundance reduced to 5,600 breeding pairs during Phases I and II through primarily non-lethal methods. Annual DFV increases of 2.1 percent ($0.1 million) and annual REI increases of 2.4 percent ($0.2 million). Annual total hatchery investment cost savings (both tribal and non-tribal-related) from DCCO consumption of 56 percent ($3.6 million). Economic benefits are less certain and not expected to be fully realized, at least in the short-term, because benefits assume hazing efforts would be 100 percent successful in preventing DCCOs hazed off East Sand Island from consuming juvenile salmonids in the Columbia River Estuary. Benefits would be fully realized should DCCOs dispersed from East Sand Island permanently emigrate away from the estuary.

Alternative C

The same economic increases as Alternative B because the final colony size on East Sand Island would be the same. However, benefits are expected to be more certain and realized more quickly in Phase I of Alternative C because minimal dispersal is expected. In Phase II, benefits are expected to be realized in the short-term because of limited DCCO dispersal from East Sand Island, but could decrease with time if dispersal increases.

Alternative C-1 *(Preferred Alternative/Management Plan)*

The same economic increases as Alternative C but realized benefits would be reduced if greater DCCO dispersal occurs than under Alternative C.

Alternative D

Annual economic increases would be the same as Alternative C-1 in Phase I. In Phase II, annual DFV increases of 3.7 percent ($0.1 million) and annual REI increases of 4.2 percent ($0.3 million). Annual total hatchery investment cost savings (both tribal and non-tribal-related) from DCCO consumption of 100 percent ($6.4 million). Economic benefits from the additional reduction in DCCOs from non-lethal methods are less certain and not expected to be fully realized in the short-term. Benefits would be fully realized should DCCOs dispersed from East Sand Island permanently emigrate away from the estuary.

4.3.3 Effect to Recreational and Commercial Fisheries

Alternative A

No reduction of East Sand Island DCCO colony abundance or reduction in DCCO juvenile salmonid predation. Annual economic value of in-river Columbia River fisheries would likely remain similar to baseline conditions in the near-term for freshwater sport recreational fisheries: DFV of $34.0 million and REI of $34.6 million. Compared to Alternative D, which proposes to exclude all DCCO nesting on East Sand Island, current levels of juvenile salmonid predation by the DCCO colony on East Sand Island would likely continue to result in annual loss of 6.8 percent ($2.3 million) DFV and 5.9 percent ($2.0 million) REI to freshwater sport recreational fisheries. Annual economic value of in-river Columbia River fisheries would likely remain similar to baseline conditions in the near-term for non-Indian commercial fisheries: DFV of $4.2 million and REI of $7.1 million. Predation by the DCCO colony on East Sand Island would likely continue to result in annual loss of 3.2 percent ($0.1 million) DFV and 3.3 percent ($0.2 million) REI to non-Indian commercial fisheries. Total hatchery investment costs (both tribal and non-tribal-related) from DCCO consumption would likely remain similar to baseline conditions in the near-term at $6.4 million.

Alternative B

DCCO colony abundance reduced to 5,600 breeding pairs during Phases I and II through primarily non-lethal methods. For freshwater sport recreational fisheries, annual DFV increases of 3.8 percent ($1.3 million) and annual REI increases of 3.3 percent ($1.1 million). For non-Indian commercial fisheries, annual DFV increases of 2.0 percent ($0.1 million) and annual REI increases of 1.9 percent ($0.1 million). Annual total hatchery investment cost savings (both tribal and non-tribal-related) from DCCO consumption of 56 percent ($3.6 million). Economic benefits are less certain and not expected to be fully realized, at least in the short-term, because benefits assume hazing efforts would be 100 percent successful in preventing DCCOs hazed off of East Sand Island from consuming juvenile salmonids in the Columbia River Estuary. Benefits would be fully realized should DCCOs dispersed from East Sand Island permanently emigrate away from the Estuary.

Alternative C

Same potential economic increases as Alternative B since the final colony size would be the same for Phase I; however, benefits are expected to be more certain and realized more quickly in Phase I of Alternative C because minimal dispersal is expected. In Phase

II, benefits are expected to be realized in the short-term because of limited DCCO dispersal from East Sand Island, but could decrease with time if dispersal increases.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Same potential economic increases as Alternative C but realized benefits would be reduced if greater DCCO dispersal occurs than under Alternative C.

Alternative D

DCCO colony abundance reduced to 5,600 breeding pairs through primarily lethal methods during Phase I and non-lethal methods to disperse all remaining DCCOs in Phase II. Economic increases would be to the same as Alternative C-1 in Phase I. In Phase II, for freshwater sport recreational fisheries, annual DFV increases of 6.8 percent ($2.3 million) and annual REI increases of 5.9 percent ($2.0 million). For non-Indian commercial fisheries, annual DFV increases of 3.3 percent ($0.1 million) and annual REI increases of 3.3 percent ($0.2 million). Annual total hatchery investment cost savings (both tribal and non-tribal related) from DCCO consumption of 100 percent ($6.4 million). Economic benefits from the additional reduction in DCCOs from non-lethal methods are less certain and not expected to be fully realized in the short-term. Benefits would be fully realized should DCCOs dispersed from East Sand Island permanently emigrate away from the estuary.

4.3.4 Effects to Public Resources

Alternatives B (Phase I) and D (Phase II) propose redistributing more than 7,250 and 5,600 DCCO breeding pairs, respectively, through primarily non-lethal methods. These two alternatives have the greatest potential for effects to public resources. Based upon past dissuasion research, DCCOs displayed high site fidelity to East Sand Island and nearby sites in the Columbia River Estuary (Roby et al. 2014). Thus, the transportation structure of most concern is the Astoria-Megler Bridge, as it could be impacted by DCCO abundance increase from management actions on East Sand Island. Potential for impacts to other transportation structures at dams and hatcheries and to public health would be greater under alternatives with greater DCCO dispersal, but actual impacts would depend on DCCO dispersal levels and site-specific interactions. Newcastle's disease has been present in juvenile DCCOs during many years of the past decade. However, there are no records of this disease being transmitted to humans, and the highly virulent form of the virus that can impact commercial poultry operations has never been detected. Research personnel on East Sand Island have documented no adverse health effects. Risk of adverse effects to field personnel on the island is low but would be higher comparatively under greater levels of management on-site.

Alternative A

Direct or indirect adverse effects to public resources (public health and human safety, transportation facilities, dams and hatcheries) would be similar to past conditions before dissuasion research, which potentially increased DCCO dispersal. The DCCO colony on East Sand Island would likely remain relatively stable at approximately 13,000 breeding pairs in the near term. Potential for future disease outbreak would be similar to prior levels with similar colony size but potential transmission away from East Sand Island would be low. Discontinuing research and monitoring on the East Sand Island colony may prevent future increase of DCCOs at the Astoria Bridge, as the numbers of DCCOs increased during the management feasibility studies and dissuasion experiments. This could be a beneficial effect for bridge maintenance and could prevent additional corrosion from DCCO guano. There would be no potential health risks to field researchers on East Sand Island, as DCCO research and management would be discontinued.

Alternative B

With dispersal of more than 7,250 DCCO breeding pairs during Phase I and high potential for lower, but sustained levels of DCCO dispersal during Phase II, there could be potential effects to public resources. Persistent DCCO use of the Astoria-Megler Bridge during the breeding season would likely be similar to or higher than use during past management feasibility studies and dissuasion research on East Sand Island. During past research, thousands of DCCOs used and roosted on the bridge following hazing events, and the number of nesting pairs approximately quadrupled between 2010 (63 nests) and 2013 (231 nests). There is approximately 6 to 10 times more suitable nesting habitat on the bridge (OSU unpublished data; see Figure 4-18 for use area).

With sustained DCCO dispersal from East Sand Island, it is likely that the DCCO breeding colony on the bridge could increase by this amount without hazing on the bridge, which could be difficult to effectively implement. Thus, adverse effects to the Astoria-Megler Bridge from DCCO guano corrosion could be high. Effects to other transportation structures and at dams and hatcheries would be commensurate with DCCO dispersal levels and subsequent site-specific interactions. No direct or indirect effects to public health and human safety are expected, as direct human contact with DCCOs or DCCO fecal matter would be minimal.

Water cannons, noise, or visual deterrents (e.g., wires) would likely be used to deter DCCO nesting on transportation structures, dams, and hatcheries. Nesting concentration of the remaining 5,600 breeding pair DCCO colony would likely be higher than previously observed on East Sand Island, which could increase the potential for transmission of Newcastle's or other diseases among DCCOs on East Sand Island, and potentially to other areas and breeding colonies because of high levels of dispersal. The associated risk of spreading disease to other public resources is low. Potential health risks to field researchers would be low and similar to prior levels during dissuasion research.

FIGURE 4-18. Steel truss section of "Bent 164" on the Astoria-Megler Bridge that is most used by DCCOs.

Alternative C

DCCO dispersal would be minimal compared to more than 7,250 DCCO breeding pairs during Phase I, and low in the short-term, but could become higher during Phase II. Effects to the Astoria-Megler Bridge, other transportation structures, and at dams and hatcheries would be commensurate with DCCO dispersal levels and subsequent site-specific interactions, but is assumed to be low during Phase I and could increase during Phase II. Short-term DCCO displacement to the Astoria-Megler Bridge could occur when implementing lethal strategies during Phase I.

Persistent DCCO use of the Astoria-Megler Bridge throughout the duration of the breeding season is expected to be low because primary implementation of lethal take would occur during a shorter period than management actions under Alternative B, and available habitat on East Sand Island would not be limited for returning DCCOs that temporarily displace. Associated risks of spreading disease to other public resources is low and would likely be lower than during prior dissuasion research because nesting concentration would be lower and low levels of dispersal are expected. Additionally, field personnel would remove carcasses on-island, some of which could have died of natural mortality, which would further reduce potential of disease transmission. Potential health risks to field researchers would be low. Field personnel would directly handle, bury, and potentially transport DCCO carcasses, but no associated health risks have been documented from such activities.

Because of the proposed precautionary measures when implementing lethal take and USDA-WS' record of safe conduct for similar efforts, risk to public safety would be low under Alternative C. To assure that all lethal techniques would not result in risk to human safety, personnel conducting lethal take would adhere to all safety standards of firearm operation and training as described in the USDA-WS Policy Manual, Directive 2.615 (Firearm Use and Safety), Firearms Safety Training Manual, and local, state, and federal regulations. A shooting protocol would be developed prior to implementation of lethal take, which would include specific measures to reduce risk to human safety. Boat-based shooting with shotguns would have very low public safety concerns, as effective range is less than 100 m; shooting would not occur near shorelines where the public could be impacted or if other boats were in close vicinity.

For on-island shooting, the island would be closed to public use during implementation, and any violations of the closure or interference to management activities would be enforced as specified in 18 U.S.C. 111. Shooters would be stationed from elevated vantage points when possible and ensure there is sufficient backdrop before shots are taken. Ammunition would be a frangible, subsonic, lead-free bullet. Because of the frangible nature there is minimal chance of ricochet as the bullet breaks apart at impact. In addition, slower subsonic ammunition would be used where feasible, which would cause the bullet to travel much less distance than standard ammunition due to its heavier weight and slower speed. Prior to and during lethal activities, observers would monitor areas for any potentially unsafe shooting situations, including the use of thermal vision or other devices to check for human presence in the vicinity of the island during night-time or other low visibility operations.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Same as Alternative C but greater effects would occur if greater DCCO dispersal occurs than under Alternative C. Potential risk to public safety would likely be similar or less than Alternative C, since fewer individuals would be culled.

Alternative D

Same as Alternative C-1 during Phase I. Dispersal of more than 5,600 DCCO breeding pairs in Phase II, similar to effects described for Phase I of Alternative B. Adverse effects to the Astoria-Megler Bridge from DCCO guano corrosion could be high during Phase II until all DCCOs are redistributed outside the Columbia River Estuary. Effects to other transportation structures and at dams and hatcheries would be commensurate with DCCO dispersal levels and subsequent site-specific interactions and would be nil after all DCCOs are redistributed outside the Columbia River Estuary. Potential health risks to field researchers on East Sand Island would be low, and there would be no risk once management discontinues after all DCCOs are dispersed from East Sand Island.

4.3.5 Effects to Existence and Aesthetic Values

Aesthetic and existence values are difficult to quantify, but they are important concepts in describing how these values for various stakeholders may be affected. The proposed actions in the alternatives under consideration will have variable effects on these values, depending on an individual's value system and perspective. For example, to some individuals, any killing of DCCOs or their eggs is perceived as a loss of maximized existence value, and therefore anything more than a non-lethal approach compromises this value. Conversely, others perceive DCCOs as threatening the existence value of endangered and threatened salmonid populations, and any DCCOs compromise this value. FEIS alternatives generally would have the same direction of effect (i.e., adverse or beneficial) for both values for a given individual, as existence and aesthetic values are similarly related.

Alternative A

This alternative would likely result in the largest future abundance of DCCOs of the alternatives considered and predation would likely continue to be a substantial source of mortality for juvenile salmonids. There could be beneficial effects to individuals who have high existence values for DCCOs. Conversely, there could be adverse effects to individuals who have high existence value for salmonids or other species that could be affected by an increased abundance of DCCOs. Not managing DCCOs could reduce overall existence value of DCCOs if the lack of management contributes to increased conflicts and more individuals in the future perceiving DCCOs negatively and taking DCCO illegally; conversely, if similar or greater DCCO abundance or the existence of the world's largest breeding colony of DCCOs is perceived positively by more individuals in the future, existence value for DCCOs could increase in the future.

Beneficial effects could occur to individuals who find DCCOs aesthetically pleasing and value their presence in ecosystems and for individuals who place value in less human-managed ecosystems. Adverse effects could occur to individuals who find DCCOs aesthetically displeasing and are frustrated by what they perceive as competition over scarce resources (salmonid fisheries). Not managing DCCOs could reduce overall aesthetic value of the species if the lack of management contributes to increased conflicts and more individuals in the future perceiving DCCOs negatively; conversely, if similar or greater DCCO abundance or the existence of the world's largest breeding colony of DCCOs is perceived positively by more individuals in the future, aesthetic value for DCCOs could increase in the future.

Alternative B

Under Alternative B, non-lethal management would result in similar or decreased DCCO abundance from the no action alternative but could increase predation of juvenile salmonids in the short-term if DCCO relocate upriver of East Sand Island, and could increase predation of other ESA-listed fish species whose size and migratory patterns make them more susceptible to predation.

Effects to individuals who have high existence or aesthetic values for DCCOs could be similar to Alternative A since overall DCCO abundance could be similar. However, the limited direct egg take and potential adverse indirect effects of non-lethal management on DCCO abundance may have adverse effects to individuals who have high existence value for DCCOs and believe that humans should not manage nature or ecosystems. There could be adverse effects to individuals who have high aesthetic value for the large colony at East Sand Island as the size of the colony would be reduced. There could be greater adverse effects to individuals who have high existence or aesthetic value for salmonids or other species that could be affected by an increased abundance or redistribution of DCCOs if they become more susceptible to predation. The dispersal of large numbers of DCCOs could increase or decrease existence value of DCCOs depending upon the individual's perception of DCCOs in areas where DCCO relocate.

Alternative C

Under Alternative C, primarily lethal take (culling) would result in the smallest DCCO abundance of the alternatives considered in Phase I. Effects to existence and aesthetic values would be similar to those described in Alternative B, but effects would be greatest under Alternative C for Phase I because DCCO abundance would be lowest and DCCOs would be culled in large numbers. There is potential for greater beneficial effects to individuals who have high existence or aesthetic value for salmonids and/or place a higher value on the management of ecosystems. There is a potential for greater effects to individuals who find DCCOs aesthetically pleasing and/or have high existence value for DCCO and directly see management activities or are associated indirectly with management activities.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Under Alternative C-1, primarily lethal take (culling and egg oiling) would result in reduced DCCO abundance but at higher levels than Alternative C. Effects to existence and aesthetic values would be similar to those described in Alternative C but could be lessened because DCCO abundance would be higher and fewer adult DCCOs would be culled; the integrated methods of culling and egg oiling could have less negative effects to individuals who perceive the method of egg oiling versus just culling adults as having less of an effect on their existence values for DCCOs.

Alternative D

Under Alternative D, implementation of Alternative C-1 in Phase I and additional exclusion of all DCCOs nesting on East Sand Island would result in the smallest DCCO abundance of the alternatives considered in Phase II and no DCCO nesting on East Sand Island and possibly throughout the Columbia River Estuary. This alternative has the potential to have the greatest benefit to Columbia River juvenile salmonids if DCCO were prevented from nesting and foraging in the Columbia River Estuary.

Effects to individuals with high existence and aesthetic values for DCCOs would be similar to those described in Alternative C-1 in the short-term of Phase I. In Phase II, although the overall regional abundance would still be large, loss of the species from the local geographic area could have greater adverse or beneficial effects (depending on the individual’s values and perspective) than just a reduction in colony size abundance.

There is potential for greater beneficial effects to individuals who have high existence or aesthetic value for Columbia River salmonids as there is potential that DCCO predation could be reduced to greater levels and even eliminated in Phase II.

4.3.6 Effects to Historic Properties

With each of the action alternatives, some minor and temporary ground-disturbing activities could occur over the majority of upland areas island-wide in Phase I. Past experience on East Sand Island has demonstrated that nest site fidelity (commitment) is high and, because of this, the Corps expects to implement an adaptive approach recognizing the potential need to haze over the entire island, if necessary, to achieve the desired colony size objective. More intensive and ground-disturbing activities would occur under Phase II with terrain modification, excavation of sand, and removal of rock armor in the DCCO nesting area on the western portion of the island.

Alternative A

Under the no action alternative, no actions would occur as part of DCCO management and no efforts to archive or record historic properties would be made. Currently, public use of East Sand Island has been restricted during research efforts and to minimize impacts to nesting birds. Public accessibility to the island could change in the future if no action is taken to manage DCCO, and further consideration of potential effects to historic properties on the island could be done at that time. No actions to manage DCCOs would also mean no ground disturbance and no direct adverse effects would occur to historic properties.

Alternative B

Under Alternative B, the Corps would employ an adaptive approach during Phase I to haze birds on the island, restricting habitat of DCCOs to one acre or less depending upon nesting densities, using non-lethal methods. Many non-lethal methods to haze birds do not require any ground-disturbing activity, such as human presence on the island using visual or noise deterrents. However, some methods would require some minor and temporary ground disturbance in upland areas on East Sand Island. This temporary habitat modification barrier method would involve placing 3- to 4-foot long wood lathes or stakes in sandy soils to a depth of approximately 12 inches in suitable nesting habitat. Stakes would be placed a minimum of 10 feet apart with flagging secured to the stakes and a rope interlaced between the stakes. This barrier is placed prior to nesting and colony establishment and would be removed at the end of the nesting season before winter storms.

Additional minor and temporary ground-disturbing activities would be the preparation and use of areas needed for field personnel to stage activities, which includes installation of temporary foundational structures, including dissuasion fences, bird blinds, platforms, or temporary structures (weatherports) for field camp. Equipment necessary to support the activities would be transported by boat, off-loaded on the northern shore of the island, and moved along the northern shore. These temporary and minor ground-disturbing activities are expected to have no effect to historic properties on East Sand Island. Consultation with the Oregon State Historic Preservation Officer would be completed prior to conducting activities that have potential to affect historic properties.

Phase II actions would include all of the Phase I efforts where needed and expand in scope to allow for terrain modification, which would involve excavation of sand on the western portion of the island and some removal of the rock armor along the southern shore to allow for frequent inundation of the island by tidal events and to prevent DCCO nesting. The rock armor is considered to be a historic property associated with early twentieth century navigation improvements in the Columbia River. Because removal of some of this rock is likely to occur under Phase II, the site may be adversely affected. One other historic site recorded on East Sand Island is within the area of excavation on the western portion. This site is the remains of an observation tower associated with the World War II Harbor Defense System. The observation tower may be left in place but inundated by tidal events.

Alternative C, Alternative C-1 *(Preferred Alternative/Management Plan),* and Alternative D

Effects to historic properties under these alternatives would be the same as Alternative B. No indirect effects associated with the proposed alternatives are expected.

4.4 Cumulative Impacts

This section addresses the potential cumulative impacts to affected resources addressed in the previous sections of Chapter 4. Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 C.F.R. § 1508.7). The scope of analysis for the EIS is at a large scale and many of the affected resources described in Chapter 4 that would either be directly or indirectly impacted by the proposed alternatives were addressed at the population level, the range of which extends in geographic scope far beyond East Sand Island and, in some instances, beyond the affected environment.

Geographic scope for the affected resources in Section 4.4 is at the regional population level for birds (pelicans, cormorants, terns, and gulls common to East Sand Island), at the watershed level for juvenile salmonids, at the Washington Coast and Columbia River islands population level for streaked horned larks, and at the mouth of the Columbia River for historic properties. The temporal scope is based on the duration of effects from the proposed alternatives, which is different for every affected resource. Some effects may be temporary or short-lived (i.e., hazing a bird away from a foraging area) while others (i.e., reduction of colony through lethal removal) may have longer lasting beneficial impacts to ESA-listed Columbia River Basin juvenile salmonids, in terms of increased survival during out-migration.

This section focuses on salmonid populations in the Columbia River Basin, the western population of DCCOs, and the regional populations of other birds on East Sand Island and in the Columbia River Estuary where management actions such as monitoring and hazing is proposed and where direct and indirect effects were identified. Direct adverse effects from non-lethal management actions are expected to be greatest to DCCOs and Brandt's cormorants as loss of habitat for DCCOs would also mean loss of habitat for Brandt's cormorants. Streaked horned larks are the non-target bird species of most concern off East Sand Island, as hazing activities in the Columbia River Estuary may likely become more intensified. Brandt's cormorants (and to a much lesser extent, pelagic cormorants) are the non-target bird species of most concern for FEIS alternatives that involve lethal take.

4.4.1 Past Actions

The Council on Environmental Quality (CEQ) issued a memorandum on June 24, 2005 regarding analysis of past actions. This memorandum states, "…agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions." Chapter 3, Affected Environment, characterizes the existing conditions of the affected resources more completely, and thus only a brief summary of the aggregate effects of past actions on the affected resources is provided here.

Human Population Growth and Development along the Columbia River Basin

During the twentieth century, human-caused development (rural and urban development along the floodplain of the Columbia River and flow alteration and management of the Columbia River) is typically cited as a major cause affecting environmental conditions of the Columbia River Basin. Development of urban and rural areas, agriculture, timber harvests, commercial fisheries, canneries, and expansion of navigation and commercial development can generally be thought of in terms of increased impervious surfaces, pollutant loading from stormwater runoff originating in residential, commercial, industrial, and other land uses for economic development, habitat loss, and loss of genetic diversity due to smaller population sizes.

Degraded habitat conditions, loss of habitat, overfishing, and construction of dams (see below) adversely affected salmonid populations, causing them to be listed under the ESA in the late twentieth century. The construction of the Astoria-Megler Bridge in 1966 was a major infrastructure improvement that promoted transportation and allowed for continued expansion of the residential, commercial, and industrial development along the Oregon and Washington coasts. Stormwater discharges associated with past development adversely affected water quality for fish and other aquatic organisms, causing disease, loss of forage opportunities, and lowered productivity. Expansion of impervious surface areas limits natural groundwater recharge and bisects habitat typically near rivers and floodplains where the majority of human development has occurred in the Columbia River Basin.

During the late nineteenth and early twentieth century, habitat loss from westward settlement and direct hunting of DCCOs and other wildlife species, in absence of environmental and wildlife laws, led to precipitous population declines of many species. During the mid-twentieth century, environmental stressors, particularly widespread use of chlorinated hydrocarbons (e.g., DDT) as pesticides, which contaminated the DCCO forage base, continued loss of habitat, particularly along the coasts, and continued unregulated take further reduced DCCO and many other migratory bird populations. This resulted in many species being listed under the MBTA or ESA (e.g., brown pelicans), led to restrictions or banning of some environmental pollutants, and created the impetus for and implementation of many waterbird conservation planning documents, monitoring programs, and conservation actions to improve populations. These efforts were largely successful in stabilizing, or, as in the case of DCCOs, causing dramatic population increases in the late twentieth century.

Management of the Columbia River (Dam Construction, Stabilization of the Navigation Channel, and Maintenance Dredging)

More than any other past action, management of the Columbia River has most affected environmental conditions for the resources described in this document. Construction of dams on the Columbia River in the twentieth century has altered flow patterns, reduced the amount of habitat available for fish for spawning and rearing, and allowed for expansion of residential and commercial development along port towns of the Columbia River. Parallel to dam construction, stabilization efforts at the mouth of the Columbia River, starting during the late nineteenth century and concluded during the twentieth century, enabled more reliable commercial navigation, which made Portland a major port city and increased potential for development and population growth. The construction of jetties and associated stabilization efforts (including those on East Sand Island) realigned the ocean entrance to the Columbia River, established a consistent navigation channel, and significantly improved navigation (Figure 4-19; NOAA 2012).

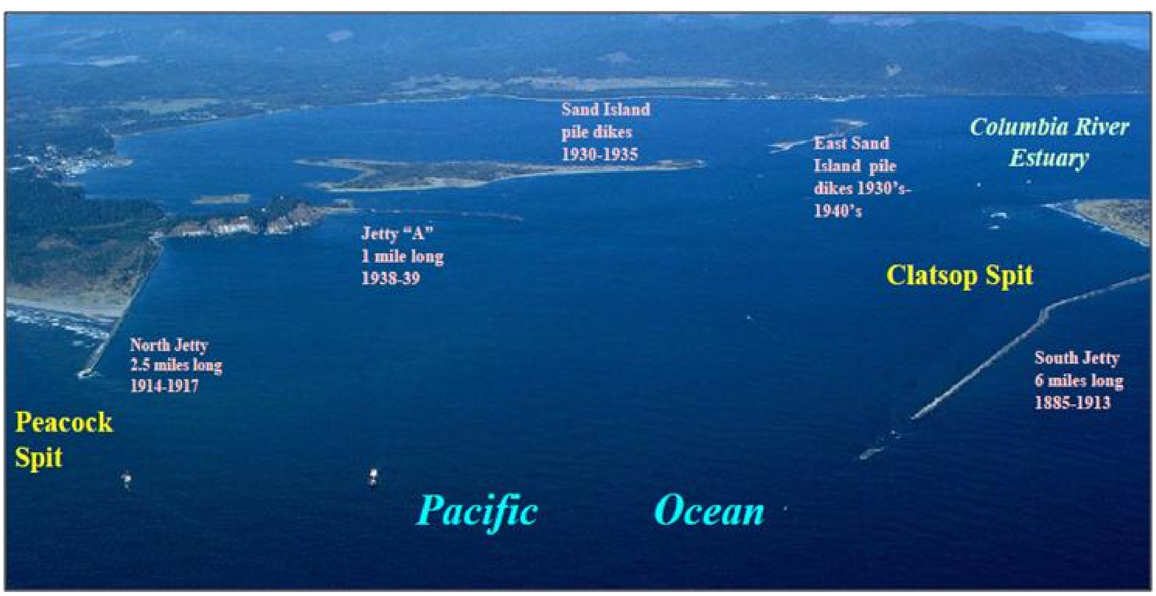

FIGURE 4-19. Mouth of the Columbia River jetty system.

To operate and maintain the federal navigation channel, which was deepened in the early twenty-first century, routine dredging is necessary. Dredged material was deposited on islands along the Columbia River Estuary. In the early 1980s, a dredged disposal event on East Sand Island (Figure 4-20) created suitable habitat for Caspian terns, resulting in the first occurrence of Caspian terns observed nesting in the Lower Columbia River Estuary.

FIGURE 4-20. East Sand Island in 1981 (left) and in 1984 (right) after the dredge disposal event that created suitable nesting habitat for Caspian terns.

Over the last 30 years, Caspian terns and DCCOs nesting on two dredged disposal islands (East Sand Island and Rice Island) have exhibited exceptional growth and their consumption of juvenile salmonids has risen to be a significant source of mortality for juvenile salmonids, considered one of the factors currently limiting recovery for some listed ESUs and DPSs. Most recently the upland dredged disposal areas on islands in the Columbia River have been recognized for providing suitable nesting habitat for the recently ESA-listed streaked horned lark. More recent actions in the late twentieth century and early twenty-first century, specific to the Columbia River Basin, thought to have contributed to DCCO and other piscivorous waterbird abundance increases, include creation of stable, permanent nesting habitat in the estuary and an increase of hatchery fish production and release into the Columbia River Basin at times that coincide with the nesting seasons of these species.

Columbia River Basin Salmon and Steelhead Conservation Planning

The decline of Columbia River Basin salmon and steelhead populations caused them to be listed under the ESA. In the late twentieth century and early twenty-first century, thirteen ESUs of Columbia River Basin salmon and steelhead were listed under the ESA. As a result of their listing, many actions have occurred to restore habitat, improve fish passage at the dams, and remove other barriers (e.g., undersized culverts at road crossings), improve water quality, and promote stormwater management plans to reduce discharge of pollutants associated with human development.

In the early twenty-first century, efforts to manage predators of salmon and steelhead began with the pike minnow program, sea lion removal, and avian predation management, which first concentrated on hazing piscivorous birds from the dams and then concentrated on moving Caspian terns from Rice Island to East Sand Island in early 2000. More recent past actions have focused on socially attracting Caspian terns from East Sand Island to constructed islands in the Pacific flyway and on conducting dissuasion experiments on DCCOs nesting on East Sand Island.

Colonial Waterbird Conservation Planning

For a comprehensive review of colonial waterbird conservation in the United States, see Kushlan (2012). The roots of colonial waterbird conservation can be traced back to the birth of the conservation movement as a whole in the late nineteenth and early twentieth century. Early conservation efforts were led by the American Ornithologists Union and the Audubon Society to protect colonial waterbirds from human exploitation and the plume trade. The first conservation area of what would later become the National Wildlife Refuge System, Pelican Island in Florida, was established to protect a Brown pelican colony.

Throughout the early and mid-twentieth century, study and knowledge of colonial waterbirds increased through an assortment of primarily natural history studies, but systematic conservation, monitoring, and management did not gain hold as it did with game management in the 1920s and 1930s and waterfowl management in the 1940s. Colonial waterbirds became a conservation focal species in regards to pesticide use and pollutants during the 1960s and 1970s, which prompted some regional waterbird conservation efforts and monitoring. The first ever large-scale inventory of colonial wading bird nesting sites was conducted in 1975 along the east coast of the United States, and other state or local efforts, such as the Texas Waterbird Survey and bi-national Great Lakes Surveys, came into being during this time. Additionally, professional organizations concerning colonial waterbirds, such as the Colonial Waterbird Society (later the Waterbird Society) and the Pacific Seabird Group, formed during this period. During the 1980s and 1990s, large-scale national and continental conservation and planning efforts for various bird species, other than for colonial waterbirds, came about, including the North American Waterfowl Management Plan (1986) and advent of Joint Ventures (1987), Partners in Flight (early 1990s), and the U.S.

Shorebird Conservation Plan (late 1990s). In 2002, the North American Waterbird Conservation Plan was developed (Kushlan et al. 2002) and later broadened in scope to become Waterbird Conservation for the Americas (see Waterbird Conservation for the Americas 2012). More recently, there have been efforts to align focus of all bird conservation across North America (see North American Bird Conservation Initiative 2012).

Currently, funding and monitoring efforts for waterbird conservation come from a diverse amalgam of federal, state, NGO, private, and other agencies and organizations, and monitoring occurs under an assortment of national, regional, state, and local monitoring programs. Larger or regional colonial waterbird monitoring surveys within the Pacific Region are the Western Colonial Waterbird Survey (USFWS 2008) and any continued or appended state monitoring programs, USFWS coastal helicopter and boat surveys, and monitoring strategies for the Pacific Flyway. There is no national or multi-national monitoring program or central repository for colonial waterbird data, although efforts to do so were originally initiated in the 1970s. Christmas Bird Count and Breeding Bird Survey data are still used often to assess long-term trends of these species, but the designs of these surveys are ill-fitted for colonial waterbirds.

Bald Eagle Conservation

The bald eagle population has increased exponentially since the banning of DDT and increased protections under the ESA in 1978. Their recovery is a true conservation success story. Bald eagles were delisted in 2007. They are now protected concurrently under the Bald and Golden Eagle Protection Act (16 U.S.C. 668(a)) and the MBTA. Based on potential versus occupied breeding areas in Oregon and along the lower Columbia River in 2007, Isaacs and Anthony (2011) predicted that the breeding population of bald eagles will continue to increase two- to three-fold in the future. As bald eagle populations have increased, so has their impact on nesting seabird colonies. Bald eagles impact seabird colonies by directly taking adults, chicks, and eggs and indirectly by flushing adults off of breeding colonies and providing access to nest predators. Hunting bald eagles cause repeated disturbances often associated with synergistic predation by gulls. Bald eagle disturbance contributed to nesting failures and declines in colony sizes at several of the major DCCO colonies along the Oregon Coast (S. Stephensen, USFWS, personal communication 2014), in northern Washington (Carter et al. 1995), and British Columbia (Moul and Gebauer 2002; Chatwin et al. 2002). These disturbances are implicated in seabird colony abandonment and breeding pair declines across the Northern Pacific Coast (Hipner et al. 2012). Predation related to these disturbances is a suggested limiting factor to many DCCO colonies along the Pacific Coast (Roby et al. 2014).

4.4.2 Present and Reasonably Foreseeable Future Actions

The following general categories of actions are ongoing present or reasonably foreseeable future actions that continue to contribute and are expected to continue to contribute to environmental conditions for the affected resources. Some present actions, like human population growth and development, or conservation planning efforts for salmon and steelhead, are a continuation of past actions or historic trends. Consideration of reasonably foreseeable future actions was given only to proposals that have been approved or funded or are highly probable given trends.

Human Population Growth and Development along the Columbia River Basin

Approximately 6 million people live in the Columbia River Basin, concentrated largely in urban parts of the lower Columbia River and the Willamette Valley. The population is presently expanding and is likely to continue to grow in the foreseeable future. Human population growth and development can be expressed as potential increases in discharges of pollutants in stormwater runoff from residential, commercial, industrial, agricultural, recreational, and transportation land uses. These are all sources of contaminants that currently degrade water quality.

Recent trends in design and regulation include more context-sensitive design through regional planning processes, which promote more open spaces and require stormwater treatment for new construction.

Effects — There is no way to quantify future contaminants and natural resource demands as a result of increased human population and development, but it is reasonable to assume the level of demand for residential, commercial, industrial, and other land uses that produce stormwater runoff would continue along similar historical trends.

Management of the Columbia River

The management of streamflow on the Columbia River and its tributaries is presently occurring and is a reasonably foreseeable future action that contributes to environmental conditions affecting the resources described in Chapter 3. A series of 60 major dams and reservoirs are operated throughout the basin, including 31 federally owned projects that comprise the FCRPS. To maintain the federal navigation channel, the Corps annually dredges portions of the Columbia River to the Bonneville Dam in order to maintain a depth sufficient to allow for commercial navigation, and disposes of dredged material on estuary islands (Figure 4-21). The Corps also maintains the jetties and other navigational structures in the mouth of the Columbia River. The jetties are considered eligible for the National Register of Historic Places. Continued maintenance of the jetties is a reasonably foreseeable future action. The consequences of jetty failure (a breach through either jetty) would be rapid and lead to significant degradation of navigation through the mouth of the Columbia River.

Effects — Placement of dredged material on upland sites in the Columbia River Estuary creates potential nesting habitat for avian species such as terns and cormorants. Repair work for the jetties enables navigation and provides for the most secure passage through the mouth of the Columbia River. Impacts from the repairs of the jetties are not expected to affect National Register eligibility, as their significance derives from historical events and their original alignment. Several years after placement disposal, sites become suitable habitat for streaked horned larks. Continuous placement and site preparation can allow for alternate reduction and creation of suitable nesting habitat on islands designated critical habitat for the larks.

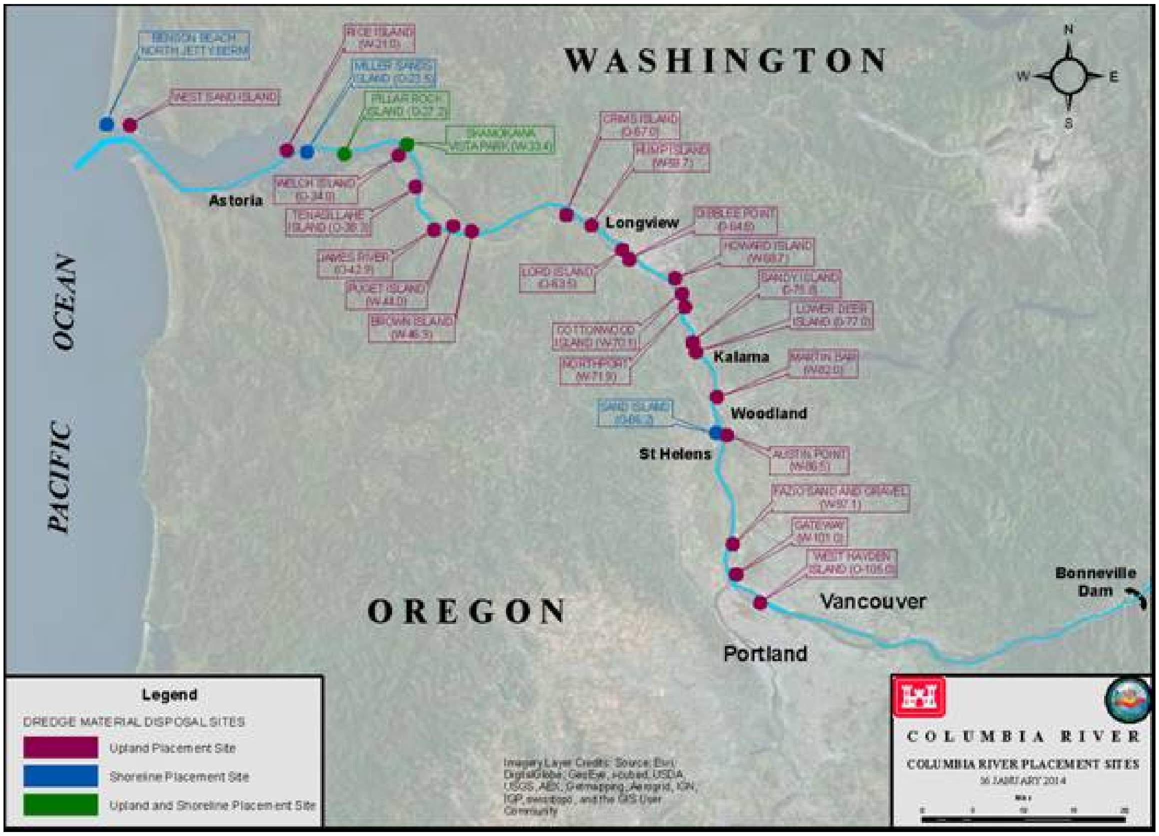

FIGURE 4-21. Upland and shoreline dredged material site network.

Management of DCCOs in the Western Population

The following actions are presently occurring and are reasonably foreseeable future actions concerning take of DCCOs within the western population. The USFWS annually issues take authority of DCCOs via depredation permits, scientific collecting permits, and special purpose permits. From 1998 to 2014, the number of DCCOs authorized to be taken under these permit types ranged from 1,670 (in 1999) to 2,525 (in 2004) for the western population of DCCOs. Approximately 2,300 DCCOs per year are currently authorized to be lethally taken under these permit types within the western population, but only 1,364 per year were taken on average (range = 682–1,994) from 1998-2008 (USFWS, unpublished data). The possibility that all authorized DCCOs per year (i.e., 2,300) were actually taken was accounted for in modeling future trajectories of the western population (see Appendix E-2 for more detail).

Site-specific management of DCCOs in the west include: 1) use of lethal take to support hazing DCCOs from dams, hatcheries, aquaculture facilities, and transportation structures (i.e., bridges, docks, marinas); 2) ODFW and other organizations conduct hazing efforts in the Oregon coastal estuaries, including boat-based hazing in April and

May, to discourage DCCO from foraging (i.e., non-lethal management, thus no permit is required); and 3) ODFW diet studies to quantify predation impacts to fish of conservation concern. Additionally, ODFW has developed DCCO predation thresholds for the north, mid, and southern Oregon coast regions based on a moving 3-year abundance average for each zone, and intends to manage coastal DCCO populations at those levels. Both the ODFW hazing program and diet studies are likely to continue. Future DCCO management activities by WDFW and California Department of Fish and Wildlife (CDFW) are unknown. DCCOs are managed collectively with other avian species under Corps, and other agency, avian predation management activities throughout the Columbia River Basin (see below for description). These activities will likely persist and could possibly intensify in the future. There is virtually no information available for local or privately funded activities involving hazing of DCCOs where no take is occurring, as a permit or reporting is not required.

Effects — Direct effects of management of DCCOs include precluding DCCOs from optimal areas and adverse effects from disturbance. Mortality of individuals would occur during authorized lethal take management and research. Indirect effects are decreases in individual fitness, survival, or fecundity from exclusion from areas and hazing.

Other Avian Predation Management Actions in Columbia River Basin

The following actions are presently occurring and are reasonably foreseeable future actions concerning management of other piscivorous waterbirds (avian predators). The FEIS and management plan developed by USFWS, USACE, and NOAA Fisheries for Caspian terns on East Sand Island was completed in 2005 (USFWS 2005a). This management plan seeks to redistribute greater than half of the East Sand Island Caspian tern colony (from approx. 9,000-10,000 breeding pairs pre-management to approximately 3,000-4,000 breeding pairs post management) to alternative colony sites in Oregon and California (constructed habitat outside the Columbia River Basin) using social attraction techniques. The management plan also seeks to reduce nesting habitat on East Sand Island; in 2006 the Corps signed a record of decision proposing to reduce nesting habitat for Caspian terns from 5 acres to 1.5-2 acres (Table 4-7).

TABLE 4-7. Summary of Caspian tern Habitat Restriction on East Sand Island. “Available habitat” does not Consider Habitat Suitability for Nesting.

Year	Available Colony Area (acres)	Colony Area Used (acres)	Available Colony Area as % of Mean Unrestricted Area Used	Nesting CATEs (number of breeding pairs)	Nesting CATEs as % of Unmanaged Colony Size
Pre-management (2000-2008)	≥ 5	3.4 - 4.7 Mean=4.0	NA	8,500-10,700 Mean=9,200	NA
2009	3.5	3.2	88% (3.5/4)	9,700	106% (9,700/9,200)
2010	3.1	2.9	78% (3.1/4)	8,300	90% (8,300/9,200)
2011	2.0	2.0	50% (2.0/4)	7,000	76% (7,000/9,200)
2012	1.58	1.5	40% (1.58/4)	6,400	69% (6,400/9,200)
2013	1.58	1.5	40% (1.58/4)	7,100	77% (7,100/9,200)

In 2012, the Corps reduced Caspian tern habitat on East Sand Island to 1.5 acres. Since that time, hazing and placement of dissuasion material has been necessary to prevent Caspian terns from nesting outside of the designated colony area. In 2014, Caspian tern dissuasion activities continued on East Sand Island. Ropes, flagging, and stakes were placed to dissuade nesting attempts in two sites: one on the southeast side of the island and the other on the western portion adjacent to the DCCO colony. Installation of approximately 1.2 acres of dissuasion fencing was installed in early April 2014 near the DCCO colony. No nesting attempts were made by Caspian terns on the west side; however, roosting by Caspian terns was observed on sand flats north of the dissuasion area when the tide was low. Numbers of Caspian terns observed roosting on the western portion of the island peaked during May, ranging from 100 to over 300 individuals during the month. On the eastern portion of the island, near the Caspian tern colony, approximately 1.9 acres of dissuasion fencing was installed.

Per the record of decision implementing the Caspian tern management plan on East Sand Island, hazing and habitat reduction efforts are likely to continue. The Corps is considering further reductions of habitat to 1 acre on East Sand Island. In 2014, the Corps proposed this action in an Environmental Assessment but did not proceed with the action. Construction of approximately two acres of Caspian tern habitat at Don Edwards NWR, planned for completion in 2015, was one of the final components of the management plan needed to permanently reduce Caspian tern habitat to one acre on East Sand Island.

The Corps actively monitors and hazes Caspian terns and other avian species on dredge material islands in the Columbia River under the Channels and Harbors Operation and

Maintenance Program. Final Section 7 consultation with the USFWS, which includes monitoring schedules and impact avoidance measures for streaked horned larks, was completed in 2014 (USFWS 2014c). Monitoring Caspian terns, hazing Caspian terns with human disturbance or placing dissuasion materials, and collecting up to 100 Caspian tern eggs from lower estuary islands (Rice, Miller Sands Spit, and Pillar Rock Islands) would likely continue in the future. Hazing activities and effects to terns and non-target species (e.g., streaked horned larks, American white pelicans) occur annually during the breeding season with boat-based or pedestrian surveys beginning in mid-April and lasting until mid-June.

In 2014, USACE Walla Walla District and the U.S. Bureau of Reclamation completed the Inland Avian Predation Management Plan Environmental Assessment as part of the overall effort to comply with the 2014 FCRPS Biological Opinion, specifically RPA action 47 and RPA action 68 (USACE 2014). The Environmental Assessment identified actions to reduce Caspian tern predation on ESA-listed salmonids in the inland Columbia River Basin above Bonneville Dam. The plan proposes habitat modification and active hazing combined with limited egg removal at Goose Island (Potholes Reservoir in Grant County, Washington) and Crescent Island (McNary Reservoir on the Columbia River in Walla Walla County, Washington) to dissuade Caspian terns from nesting at these locations. Adaptive management actions will be implemented to limit Caspian terns from forming new colonies and/or expanding existing colonies within the Columbia River Basin. The plan includes provisions for developing out-of-basin Caspian tern nesting sites to attract terns to areas where they will not feed on Columbia River ESA-listed fish species (USACE 2014). Hazing and other non-lethal methods in the Columbia Plateau to achieve the plan's objectives occur and will likely persist at the same or increased levels in the future.

In 2011, USDA-WS released an Environmental Assessment for Bird Damage Management in Washington, which includes descriptions of current avian predation management activities at fish hatcheries and Snake and Columbia River dams (USDA-WS 2011a). Activities include limited lethal take and non-lethal methods to deter avian species from areas where they prey on ESA-listed salmonids. In response to RPA action 48 of the 2014 FCRPS Biological Opinion, which directs the Corps to "continue to implement and improve avian deterrent programs at all lower Snake and Columbia River dams," USACE Walla Walla District adopted the USDA Wildlife Services' 2011 Environmental Assessment-Bird Damage Management in Washington and signed a Finding of No Significant Impact (FONSI) on March 17, 2014. This action expanded the current non-lethal avian hazing program at five Corps dams (McNary and Lower Snake

River dams) and includes measures to incorporate limited lethal "take" of certain piscivorous birds (i.e., maximum total of 650 ring-billed gulls, 1,200 California gulls, and 150 DCCOs each year) if non-lethal methods are not successful. Annual hazing, implementation of other non-lethal methods, and limited lethal take of piscivorous birds at the Snake and Columbia River dams and other locations occur and will likely persist at the same or increased levels in the future.

Effects — Direct effects include loss of Caspian tern and other avian species' nesting habitat and productivity as a result of hazing and modifying habitat, mortality of individuals from issuance and execution of depredation permits or scientific collection permits, and other adverse effects from disturbance. Indirect effects to avian species referenced above are decreases in individual fitness, survival, or fecundity from exclusion of optimal foraging or nesting areas. Projected direct and indirect effects to ESA-listed salmonids are increased survival of juvenile salmonids in localized areas and potential increases in populations.

Columbia River Basin Salmon and Steelhead Restoration and Recovery Efforts

Primary factors limiting recovery of salmonid ESUs/DPSs include the loss, damage, and modification of natural habitats, including decreased floodplain connectivity and function, channel structure and complexity, riparian areas and large woody debris recruitment, and stream substrate amount, stream flow, and water quality (NOAA 2014b). Alterations to hydrologic processes and functions from water diversion and hydropower projects and other anthropogenic practices (e.g., agriculture, forest management, mining, road construction, urbanization, water development) continue to limit the quality, quantity, and accessibility of habitats throughout the Columbia River basin. Harvest, natural predation, competition with non-native species, impacts from hatcheries and other fish management practices, and fish stranding also limit recovery of various ESUs/DPSs to varying degrees (NOAA 2014b). The extent of these effects are driven by a combination of economic conditions, general resource demands associated with settlement of local and regional population centers, and social groups dedicated to environmental protection and restoration or use of natural resource amenities. Demands on the environment from humans for resources and cultural, aesthetic, and recreational amenities continue to threaten ESA-listed salmonid species or limit their recovery. Continued residential and commercial development and a general increase in human activities are expected to cause localized degradation of freshwater and estuarine habitat (NOAA 2014b). In general, for ESA-listed fish species in the Columbia River, the adverse effects of resource-based industries (e.g., timber harvest, agriculture, mining, shipping, and energy development) are likely to continue in the future, although their net adverse effect is likely to decline slowly (NOAA 2014b). Additionally, net beneficial effects to river restoration are likely to increase in the future (NOAA 2014b). As a result of cumulative effects anticipated to ESA-listed fish species in the Columbia River Basin, NOAA (2014b) determined that trends in habitat quality are expected to remain flat or improve gradually over time, resulting in neutral or positive effects on population abundance trends and neutral or positive trends for the quality and function of critical habitat.

Restoring the runs of Columbia River salmon and steelhead continues to be a regional priority. Numerous actions are currently being implemented or would be implemented in the foreseeable future, resulting from ESA consultations and biological opinions. These consultations result in terms and conditions or as design criteria for programmatic biological opinions, and function to improve stormwater management, promote habitat restoration, and improve fish passage to critical habitat. Reforms of harvest practices are underway to protect, rebuild, and enhance Columbia River fish runs while providing harvest for treaty Indian fisheries and non-treaty fisheries. Implementation of hatchery and genetic management plans are on-going to update hatchery practices to best support recovery of ESA-listed salmonids.

Effects — Water quality is improved through enforced and optional stormwater management. Estuary and stream habitat is restored and rearing and spawning habitats increase in complexity, which improve salmonid fitness and increase abundance. Structural improvements at the dams improve downstream passage and increase survival and overall abundance of juveniles in the estuary. Hatchery reforms improve broodstock management and reduce unintentional straying of hatchery fish into known wild fish spawning and rearing areas. With long-term increases of returning salmon, there would be an increase of ocean-source energy (i.e., converted to weight gain on salmon) coming back to the terrestrial system, which provides energy inputs into those food webs, ecosystems, etc.

Maintenance of the Astoria-Megler Bridge

The Oregon Department of Transportation (ODOT) actively maintains the Astoria-Megler Bridge by re-painting the structure above the guardrails and rehabilitating steel components of the bridge as required. Phase 1 of a multi-year maintenance program began in March 2012. Maintenance is to be completed December 2015 and involves coating all steel above the deck of the highway. Phase 2 involves coating all steel below the deck of the highway. The expected construction timing is one year from January

2016 through December 2016. Due to the numbers of DCCOs and pelagic cormorants that use the bridge, ODOT implements a hazing program to clear the bridge of migratory birds prior to maintenance activities. Depending upon the efficacy of hazing, a federal Migratory Bird Permit may be requested to implement activities during the nesting season.

Effects — Direct effects include loss of DCCO and pelagic cormorant nesting habitat and productivity as a result of hazing and modifying habitat, mortality of individuals from issuance and execution of depredation permits or scientific collection permits, and other adverse effects from disturbance. Indirect effects to species referenced above are a decrease in individual fitness, survival, or fecundity from exclusion of optimal foraging or nesting areas.

4.4.3 Cumulative Effects from the Proposed Alternatives

Alternative A

Alternative A would maintain baseline conditions for the East Sand Island DCCO colony and DCCO depredation impacts to juvenile salmonids in the Columbia River Estuary would continue. Compliance with reasonable and prudent alternative 46 and fulfillment of the purpose and need of the FEIS would not be met.

Cumulative Effects of Alternative A — Environmental baseline conditions, as described in the affected environment, would likely not change, or would continue upon current trends, for affected resources (East Sand Island colonial waterbirds, Columbia River Estuary birds, public resources, historic properties, fisheries, or Columbia River Basin juvenile salmon and steelhead). As a result of no change in the current baseline predation from DCCOs on East Sand Island, predation impacts on juvenile salmonids would remain significant. It is not known if other salmon recovery efforts would be undertaken or if they would be adequate to compensate for the large source of mortality.

The DCCO colony at East Sand Island would likely remain the largest colony in western North America and the vast numbers of colonial waterbirds would continue to attract other birds seeking roosting, foraging, or nesting opportunities. A no action alternative could increase the risk that individuals, at some point in the future, may use illegal measures to reduce or attempt to reduce the DCCO colony on East Sand Island. Future growth of the western population of DCCOs would likely remain similar or potentially decreased compared to baseline conditions due to cumulative adverse effects, such as effects from climate change, drought, bald eagles, and other regional impacts.

Alternative B

Alternative B would reduce the East Sand Island DCCO colony from baseline conditions to the FCRPS Biological Opinion reasonable and prudent alternative 46 prescribed range of approximately 5,600 breeding pairs (approximate 1997 to 1998 abundance) through primarily non-lethal methods. Abundance of the western population of DCCOs would not be directly reduced, but future growth could be. The colony size would be reduced and maintained so that it does not exceed management objectives through primarily non-lethal methods.

Cumulative Effects of Alternative B — Reduction of a significant point-source mortality factor of Columbia River juvenile salmonids (DCCO predation) would cumulatively contribute to other efforts that are improving the health and viability of these fish populations. A broad labyrinth of regulatory, monitoring, conservation, and restoration measures aimed at salmon recovery have been instituted which have stabilized or increased the Columbia River salmonid population since the lows of the 1990s. Elimination or reduction of identified threats or bottlenecks to population growth, in conjunction with continued accumulation of knowledge, would likely increase Columbia River salmonid population viability and abundance. Increases in Columbia River salmonids would have positive impacts to affected fisheries and economies. Continued environmental demands and potential cumulative environmental degradation, associated with population increase along the Columbia River, would limit, to some extent, salmonid recovery efforts. Additionally, the void created by decreasing one mortality factor (DCCO predation) could be filled, to some extent, by other predators of juvenile salmonids, resulting in potential abundance increases of other predatory species.

Abundance of the western population of DCCOs would not be directly reduced under Alternative B. Abundance of the western population of DCCOs is predicted to remain similar to current levels in the near term but may decline to a greater extent than Alternative A due to the factors described plus additional loss of habitat at East Sand Island from the Phase II terrain modification and future limitation of the colony. An initial decrease in productivity could occur until DCCOs dispersed from East Sand Island find new breeding sites. Based on generalist foraging and nesting behavior and adaptability of DCCOs, elimination or reduction of mortality factors known to limit DCCO populations prior to the 1970s, and that since the ca. 1990 time period the western population has exhibited growth on the whole and the sum of the breeding colony counts of the western population (excluding East Sand Island) ca. 2009 is similar to that observed in ca. 1990, abundance and future growth rate of the western population over time would likely stabilize and could potentially return to baseline conditions. Based on modeled results of long-term trend, a gradual decrease of the population is predicted, with abundance stabilizing at approximately 46,000 breeding individuals.

Dispersal of more than 7,250 DCCO breeding pairs from East Sand Island would result in a more even distribution of the western population of DCCOs. The number of localized areas outside of the Columbia River Basin with perceived or real DCCO-fish conflicts would increase. More effort would be devoted toward DCCO monitoring and management in these areas in regard to both time and resources. More depredation permit applications would likely be requested in more areas compared to baseline conditions. Monitoring proposed under this alternative and future local and regional monitoring would contribute cumulatively to increased fossil fuel consumption and carbon dioxide emissions. Greater certainty about abundance and distribution of the western population of DCCOs would exist, with increased coordinated regional monitoring and abundance tied more closely to management objectives. DCCO dispersal and related hazing efforts, combined with existing hazing efforts from the Corps' Channels and Harbors Operation and Maintenance Program in the Columbia River Estuary, would likely limit other species' use of these areas. These activities could diminish cumulative efforts aimed toward streaked horned lark recovery in the estuary. Persistent DCCO use of the Astoria-Megler Bridge and corrosion from DCCO guano would increase the frequency and extent of maintenance. Hazing DCCO at the bridge would supplement ODOT's hazing program and could mean increased adverse effects to pelagic cormorants and DCCOs.

The proposed terrain modification on East Sand Island would have no cumulative impacts to vessel navigation of the Columbia River. The primary criteria of any terrain modification would be maintaining the integrity of navigation channels. Any displaced soil would be relocated to areas that would not negatively impact navigation. Terrain modification would likely reduce overall nesting waterbird use of East Sand Island, but would benefit and increase usage of species that require marsh, mudflat, and inundated beach habitat. Species diversity on East Sand Island would likely increase. Less nutrient loading into the Columbia River Estuary would occur with decreased nesting waterbird abundance on East Sand Island. The rock armor on the shoreline would be directly affected by the terrain modification, but cumulative effects from other proposed maintenance of navigation structures in the Columbia River would be reviewed by architectural historians, and overall effects to the various elements associated with the history of navigation improvements in the mouth of the Columbia River are expected to be negligible, as they would be independently reviewed.

Alternative C

Alternative C would reduce the East Sand Island DCCO colony from baseline conditions to the FCRPS Biological Opinion reasonable and prudent alternative 46 prescribed range of approximately 5,600 breeding pairs (approximate 1997 to 1998 abundance) primarily through culling. Abundance of the western population of DCCOs would be directly reduced; future growth could be potentially reduced. The colony size would be maintained (i.e., not to exceed 5,939 breeding pairs) through primarily non-lethal methods.

Cumulative Effects of Alternative C — Reduction of DCCO predation would increase to some extent the viability and abundance of salmonid populations in the Columbia River and affected fisheries and economies as described in Alternative B. There would be greater certainty of benefits to fish occurring because of limited expected DCCO dispersal from Alternative C.

Abundance of the western population of DCCOs would likely be less than baseline conditions during the next decades and future growth of the western population of DCCOs could likely be decreased compared to baseline conditions due to expected loss in individuals and nesting habitat from the management action (i.e. Phase II terrain modification) and from other cumulative adverse effects, such as effects from climate change, drought, bald eagles, and other regional impacts. However, based on the factors described in Alternative B above, abundance and future growth rate of the western population over time would likely stabilize and could potentially return to baseline conditions. Based on modeled results of long-term trend, abundance of the western population of DCCOs is projected to be approximately 35,000 breeding individuals after Phase I and increase to a long-term 20 year projected abundance of approximately 44,500 breeding individuals. Distribution of the western population of DCCOs would be less concentrated at the East Sand Island colony.

With minimal dispersal, no cumulative effects to fisheries or species in other areas or to the Astoria-Megler Bridge would be expected. Regional abundance of Brandt's and pelagic cormorants would likely remain similar to current abundance in the near term and continue along prior observed population trends. There would likely be negligible effects to these species because colonies in the Columbia River Estuary compose a very small percentage of their regional populations (Brandt's cormorants [approximately 4 percent]; pelagic cormorants [0.5 percent]) and upper levels of potential take are a negligible percentage of the regional populations (0.3 percent and 0.1 percent, respectively). Likewise, DCCO-fish conflicts and requested number of depredation permit applications outside of the Columbia River Estuary would be similar to the baseline conditions. Fossil fuel consumption would occur and contribute cumulatively to climate change, but levels of fuel consumption would be less than described in Alternative B. Cumulative effects from terrain modification would be the same as described in Alternative B.

Alternative C-1 *(Preferred Alternative/Management Plan)*

Alternative C-1 would reduce the East Sand Island DCCO colony from baseline conditions to the FCRPS Biological Opinion reasonable and prudent alternative 46 prescribed range of approximately 5,600 breeding pairs (approximate 1997 to 1998 abundance) primarily through culling and egg oiling. Abundance of the western population of DCCOs would be directly reduced; future growth could be potentially reduced. The objective for colony size would be maintained through primarily non-lethal methods.

Cumulative Effects of Alternative C-1 — Same as Alternative C except less adverse effects to the western population and the western population would have a greater potential to recover from any unforeseen catastrophic event, due to a lesser degree of culling of breeding adults. Abundance of the western population of DCCOs is projected to be approximately 38,500 breeding individuals after Phase I and increase to a long-term 20 year projected abundance of approximately 45,000 breeding individuals.

Alternative D

Alternative D would reduce the East Sand Island DCCO colony from baseline conditions to the FCRPS Biological Opinion reasonable and prudent alternative 46 prescribed range of approximately 5,600 breeding pairs (approximate 1997 and 1998 abundance) through primarily lethal methods. Abundance of the western population of DCCOs would be directly reduced. All DCCOs (remaining approximate 5,600 breeding pairs) would then be excluded from nesting on East Sand Island through primarily non-lethal methods. Future growth of the western population of DCCOs could be potentially reduced.

Cumulative Effects of Alternative D — No DCCOs nesting on East Sand Island would increase, to the greatest extent of the alternatives considered, viability and abundance of salmonid populations in the Columbia River and affected fisheries and economies. No DCCOs nesting on East Sand Island could also reduce attraction and thus abundance of other nesting waterbird species. This would result in an additional decrease of avian predation of juvenile salmonids (i.e., additional benefits to salmonids) and less nutrient inputs into the Columbia River from DCCO guano than baseline conditions.

Similar to Alternative C-1, abundance of the western population of DCCOs would likely be less than baseline conditions during the next decades and future growth could be reduced. Complete elimination of East Sand Island as a DCCO breeding colony and dispersal of approximately 5,600 breeding pairs could likely further reduce future growth compared to Alternative C. Abundance is projected to decrease to a low of approximately 33,000 breeding individuals and slightly increase to a long-term 20 year projected abundance of approximately 37,500 breeding individuals. Distribution of the western population of DCCOs would be more even than baseline conditions. The number of localized areas outside of the Columbia River Basin with perceived or real DCCO-fish conflicts would likely increase. More depredation permit applications would likely be requested in more areas than baseline conditions.

Dispersal in Phase II would have similar effects as those described in Phase I of Alternative B. With high levels of DCCO dispersal, cumulative effects to fisheries outside the Columbia River Estuary, the Astoria-Megler Bridge, streaked horned lark, and other species would be similar to Alternative B. Fossil fuel consumption would occur and contribute cumulatively to climate change; levels of fuel consumption would be similar to Alternative B. Cumulative effects from terrain modification would be the same as those described in Alternative B.

4.5 Climate Change

This section addresses climate change policy and effects specific to the management action and DCCO predation of juvenile salmonids on East Sand Island, which is a tidally influenced system. Relevant points in recent climate change guidance and policy documents are provided in Section 4.5.1. The literature review (Sections 4.5.2 and 4.5.3) qualitatively indicates which of the many potential climate change impacts on both inland and coastal physical processes are likely to be of importance to DCCO predation near the mouth of the Columbia River, focusing on changes in habitat at East Sand Island. The literature review incorporates historical analyses and uses the best available science and models. The analysis in Section 4.5.4 quantitatively assesses multiple sea level rise scenarios for the existing conditions and terrain modification proposed under Phase II of the action alternatives per CEQ guidance and using Corps methods. Specifically, the analysis examines changes in inundation that might directly affect avian behavior or indirectly affect avian species through habitat changes, based on a set of metrics developed specifically for this EIS. Section 4.5.5 provides a summary of the analysis.

4.5.1 Policy Direction

There are four recent documents guiding climate change impact assessment relevant to this EIS. The CEQ has issued guidance that explains how climate change adaptation can be incorporated into NEPA processes. CEQ's Principles and Requirements for Federal Investments in Water Resources were finalized in March 2013 (CEQ 2013a) and the Interagency Guidelines are still in draft form at the time of completing the FEIS (CEQ 2013b). The Corps has issued policies documenting the four major climate change drivers affecting mission and operations and has provided engineering guidance for addressing sea level rise in coastal project planning (USACE 2011a, 2012).

Council on Environmental Quality and Corps Guidance on Integrating Climate Change in Federal Projects

The incorporation of climate change into federal agency planning processes has rapidly evolved in recent years. Executive Order 13514 and subsequent guidance from the CEQ (CEQ 2011a, 2011b) led to the development of USACE policy and planning documents. As a result, the Corps has developed the *Climate Change Adaptation Policy Statement* (USACE 2011a) and the *Climate Change Adaptation Plan and Report* (USACE 2012, 2013a). The policy states, “Mainstreaming climate change adaptation means that it will be considered at every step in the project lifecycle for all Corps projects, both existing and planned . . . to reduce vulnerabilities and to enhance the resilience of our water resource infrastructure."

Two recent CEQ guidance documents (*Principles and Requirements for Federal Investments in Water Resources* and *Interagency Guidelines for Federal Investments in Water Resources*) recommend that climate change adaptation processes be incorporated into NEPA processes to avoid instituting parallel planning (CEQ 2013a, 2013b). According to this guidance, climate change can be accounted by: 1) forecasting the key assumptions of future conditions; 2) characterizing the degree of uncertainty; 3) using multiple baselines; 4) accounting for changes resulting from a changing climate, including hydrologic and other conditions, increases in temporal and spatial variability of precipitation and water availability, and inundation in coastal areas; 5) using historical records and best available models to forecast projected future condition; and 6) giving particular consideration of climate change to long-lived projects (CEQ 2013b). The draft guidance encourages using the best available science to forecast the effects of climate change "to enable evaluation of each alternative's impacts on ecosystem resilience, the sustainability of critical ecosystem services, and the vulnerability of human and natural systems to climate change" (CEQ 2013b). Accordingly, it is the policy of the Corps to use the best available and actionable climate science and climate change information in all long-term planning, prioritization, and decision making (USACE 2011a).

Corps Policies on Sea Level Rise and Coastal Areas

The Corps has developed policies for sea level rise engineering and adaptation that are consistent with all six elements outlined by the CEQ draft guidance, and these were used to address climate change effects in this document. In 2009, the Corps (working with NOAA's National Ocean Service and the U.S. Geological Survey) established policy guidance for estimating the effects of sea level rise in project planning (USACE 2009) based on a 1987 National Research Council Report, *Responding to Changes in Sea Level: Engineering Implications* (NRC 1987; USACE 2012; Tebaldi et al. 2012).

The National Research Council report recommended that coastal project planning account for uncertainties about accelerating sea level rise during project design life using multiple scenarios, representing 0.5, 1.0, and 1.5-m increases in eustatic (global) sea level by the year 2100. The report provided an equation for the global contribution to relative sea level rise (NRC 1987, p. 28). The total relative sea level rise above present levels, at a given year in the future, is the sum of two components, the global and local; the local component varies from land subsidence (as land subsides, relative sea level increases) to land uplift (which counters the effects of global sea level rise; NRC 1987). The Corps updated its guidance for project planning in 2011 to adjust the historical global mean sea-level change rate from 1.2 mm/yr (NRC 1987) to 1.7 mm/yr and to incorporate the midpoint (1992) of the most recent National Tidal Datum Epoch of 1983-2001 (USACE 2011b).

The type of scenario-based planning encapsulated in the Corps' guidance (USACE 2009; 2011b; 2013a) continues to be recommended today. In 2013, adaptation to sea level rise began to be incorporated in project planning, design, and implementation (USACE 2013a). On December 31, 2013, the Corps issued an Engineering Regulation (ER) 1100-2-8162 (USACE 2013b). This new regulation continues to rely on the NRC (1987) approach, utilizing the 1.7 mm/yr rate of change in global mean sea level and integrating local historical tide gage records.

In general, national policies regarding the effects of climate change on inland hydrology and coastal storm effects and for project implementation guidance are less developed than those for sea level rise. Through a high-level vulnerability assessment, the Corps identified four categories of climate change effects with the potential to impact its national mission and operations in its *2013 Climate Change Adaptation Plan* (USACE 2013a). These four categories are: 1) increasing air temperature; 2) changing precipitation; 3) increases in extreme events; and 4) sea level change and associated tides, waves, and surges (Table 4-8). Though it is understood that the greatest coastal damage generally occurs when high waves, storm surge, and high tide occur together, there is not a consensus regarding how the frequency and magnitude of storms may change on United States coasts (Parris et al. 2012).

4.5.2 Literature Review Relevant to Climate Change Policy

This section contains a summary review of key synthesis reports on the effects of climate change on physical processes in the Pacific Northwest relevant to this EIS. This is followed by the results of a literature review on the possible effects of these physical changes on DCCO predation of juvenile salmon and steelhead.

Climate Change Effects in Physical Processes

The physical processes in both the ocean and the Columbia River Basin affect East Sand Island due to its proximity to the eastern Pacific Ocean within the estuary of the second largest coastal river in the continental United States (as measured by discharge).

Therefore, all four categories of effects identified by the Corps (increasing air temperatures; changing precipitation; increases in extreme events; sea level change and associated tides, waves, and surges) are active on the island (Table 4-8). Astronomical tides and coastal processes primarily affect water levels at East Sand Island. Of the total variance in water level in the lower 60 km of the Columbia River, weather contributes only 2 to 4 percent and river flow 5 to 15 percent of the total variance in the water level regime, while tidal processes account for more than 60 percent (Jay et al. in revision).

TABLE 4-8. Four Categories of Projected Climate Change, with the Associated Potential Impacts and Potential Corps Vulnerabilities and Opportunities, Extracted from the 2013 Climate Change Adaptation Plan (USACE 2013a). Additional sources included are specific to the Pacific Northwest and the Columbia Basin.

Potential Impacts*	Potential Corps Vulnerabilities/Opportunities	Regional References
Increasing air temperatures		
Increases to average temperature, which will vary regionally and over time; increasing frequency and intensity of extreme heat; increasing length of frost-free season; changes in form of precipitation (snow vs. rain); changes in snowpack and melting cycles which can alter stream flow timing and volume; reduced ice volume and extent on lakes, rivers, oceans, and in glaciers; changes in water and energy demand; altered habitat suitability; increased water temperature and associated lake stratification and water quality; changes in invasive species or pest distribution; warmer sea surface temperatures and potentially altered circulation patterns; changed evapotranspiration impacting reservoirs and soil moisture.	Altered environmental windows; greater uncertainty of water supply and demand affecting navigation, ecosystem restoration, hydropower, recreation, and water supply; potential for coastal extreme high water events associated with altered ocean circulation; threatened and endangered species may be adversely affected or benefitted.	"The Pacific Northwest has warmed about 1.0 °C since 1900 or about 50 percent more than the global average warming over the same period. The warming rate for the PNW over the next century is projected to be in the range of 0.1-0.6 °C/decade" (ISAB 2007, NOAA 2014). An increase in average annual temperature of 3.3°F to 9.7°F is projected by 2070 to 2099 (compared to the period 1970 to 1999; Mote et al. 2014). An increase in maximum and minimum annual temperatures of 5.5°F to 9.0°F is projected by 2050 to 2074 (compared to the period 1950 to 2005) with temperature increases across all months of the year but greatest during summer months; Alder and Hostetler 2013). Crozier et al. (2011) showed a rise of 2.6°C in mean July water temperature in the lower Columbia River at Bonneville Dam between 1949 and 2010. "Modeling of future water temperatures in the Columbia and Snake rivers predicts an increase of 1 °C or greater by 2040" (ISAB 2007, NOAA 2014). "Downscaling of multiple global climate models for the Pacific Northwest coastal zone suggests that ocean water could warm by approximately 1°C by 2050" (Miller et al. 2013).

Potential Impacts*	Potential Corps Vulnerabilities/Opportunities	Regional References
Changing precipitation		
Changes in seasonal precipitation that vary regionally and seasonally: in general, the northern U.S. is projected to see more winter and spring precipitation; increase in the frequency and intensity of heavy and very heavy precipitation events; increasing frequency, duration, and extent of drought; summer droughts are expected to intensify in most regions of the U.S.; changes in snow volume and onset of snowmelt; more variable stream flow and lake levels; altered habitat suitability; changes in invasive species or pest distribution; change in magnitude and frequency of flooding and low flows; altered sediment regimes, streambank erosion, aggradation, and degradation; changes in stormwater magnitude and frequency and levels of pollutants in runoff; altered groundwater.	Increasing uncertainty in projected precipitation and/or non-stationary hydrology could alter design standards and criteria; more variable reservoir inflow, lake levels, and channel depths could impact performance of flood risk, navigation, ecosystem restoration, hydropower, recreation, and water supply missions; more intense flooding over most of the US; wetland and shoreline impacts; increasing very heavy precipitation and changes in dredging requirements for rivers and harbors; changes in soil moisture could alter infiltration and impact rainfall-runoff relationships; more intense precipitation and runoff generally increase sediment, nitrogen, and pollutant loads; shifts in ecosystem structure and function may adversely impact or benefit threatened and endangered species.	"Projected precipitation changes for the region are relatively modest… Most models project long-term increases in winter precipitation and decreases in summer precipitation….Warmer temperatures will result in more precipitation falling as rain rather than snow…Snow pack will diminish, and stream flow timing will be altered…Peak river flows will likely increase…projected changes in natural runoff, even under the most extreme warming scenarios for the late 21st century, are substantially smaller than the changes caused by the development and operation of the hydrosystem in the late 20th century" (ISAB 2007, NOAA 2014). Change in annual average precipitation in the Northwest is projected to be within a range of an 11% decrease to a 12% increase for 2030 to 2059 and a 10% decrease to an 18% increase for 2070 to 2099…relatively small projected changes in precipitation are likely to be masked by natural variability for much of the century…summer precipitation is projected to decrease by as much as 30% by the end of the century…By 2050, snowmelt is projected to shift three to four weeks earlier than the 20-century average and summer flows are projected to be substantially lower…Vulnerability to projected changes in snowmelt timing is probably highest in basins with the largest hydrologic response to warming and lowest management flexibility – that is, fully allocated, mid-elevation, temperature-sensitive, mixed rain-snow watersheds with existing conflicts among users of summer water (Mote et al. 2014). An increase in annual mean precipitation of 0.00-0.02 in/day is projected in the Northwest by 2050 to 2074 (compared to the period 1950 to 2005) with drier spring-fall periods and wetter winters; Alder and Hostetler 2013). An increase in annual mean precipitation of 0-5% is projected in the Northwest by 2040 to 2069 (compared to the period 1971 to 2000;

Potential Impacts*	Potential Corps Vulnerabilities/Opportunities	Regional References
		Abatzoglou 2011; Abatzoglou and Brown 2012 [Multivariate Adaptive Constructed Analogs; MACA]). “A consensus has not yet been reached on how the frequency and magnitude of storms may change in coastal regions of the US” (Parris et al. 2012).
Increases in extreme weather		
Increasing variability, altered seasonality, and changing intensity or frequency of heat waves, floods and droughts, depending on location; warming sea surface temperatures are projected to result in increasing tropical storm intensity for the largest storms.	Increasing uncertainty in the magnitude and frequency of extreme floods could impact life safety and alter design standards and criteria; more variable reservoir inflow and lake levels could impact performance of flood risk, navigation, ecosystem restoration, hydropower, recreation, and water supply missions; impacts to wetlands shorelines that impact the regulatory missions; increased floods, droughts, and storms impact sedimentation and shoaling, altering dredging requirements.	In the Pacific Northwest, the amount of precipitation falling in *very heavy* precipitation events (the heaviest 1 percent of all daily events) increased 16 percent from 1958 to 2007 (CEQ 2011b; Karl et al. 2009). “Studies of observed changes in extreme precipitation use different time periods and definitions of “extreme,” but none find statistically significant changes in the Northwest. Regional climate models project increases of 0% to 20% in extreme daily precipitation, depending on location and definition of “extreme” (for example, annual wettest day)” (Mote et al. 2014). Extreme high-sea-level events (>99.99th percentile level or 1.41 m above historical mean sea level) increase under sea-level rise scenarios, but the duration of extremes differs substantially (NRC 2012, p. 104). Several observational studies have reported that high waves have been getting higher and that winds have been getting stronger in the northeastern Pacific over the past few decades (NRC 2012, p. 82).
Sea-level change and associated tides, waves, and surges		
In Alaska and the Pacific Northwest, locations experiencing glacial rebound may be impacted by falling local relative sea levels, increasing	Increased need for emergency preparedness, response, and recovery for more frequent inundation; increasing uncertainty in the	Global sea levels have risen about 8 inches since 1880 and are projected to rise another 1 to 4 feet by 2100...Much of the Northwest coastline is rising…because of this, apparent sea level rise is less than the currently observed global average…Coastal sea surface temperatures have in-

Potential Impacts*	Potential Corps Vulnerabilities/Opportunities	Regional References
shoreline erosion, and the need for dredging. Elsewhere, rising local relative sea level will cause more frequent inundation of low-lying land; increased shoreline erosion and changes to barrier islands and inlets; increased storm waves, surges, and tides; loss of or changes to coastal wetlands; changes in estuarine structure and processes; increased saline intrusion into coastal aquifers; altered sedimentation and shoaling in channels and harbors; changes in ecosystem structure and species distributions, including invasive species and pests; altered frequency and extent of harmful algal blooms and coastal hypoxia events.	magnitude and frequency of storm tides and surges could alter design standards and criteria; higher average and extreme water levels could impact performance of navigation, coastal risk reduction, ecosystem restoration, and missions; changes in sedimentation and shoaling could impact dredging; decreases in harbor and port performance reliability; impacts to wetlands that affect the scope of the regulatory mission.	creased…between 1900 and the early 2000s…which could be consequences of weaker upwelling winds…Projected changes include increasing but highly variable acidity, increasing surface water temperature (2.2°F from the period 1970 to 1999 to the period 2030 to 2059), and possibly changing storminess. Climate models show inconsistent projections for the future of Northwest coastal upwelling (Mote et al. 2014). "Historically, most coastal damage has occurred when storm surges and large waves coincided with high astronomical tides and El Niños—a combination that can raise short-term sea level above sea levels projected for 2100. All climate models project ample winter storm activity, but a clear consensus has not yet emerged on whether storm frequency or intensity will change in the northeast Pacific" (NRC 2012, p. 82). "We have very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100" (Parris et al. 2012, p. 10). Sea level at Astoria depends on global sea level and the effects of physical processes on uplift and subsidence of the solid earth surface: Alaskan glacier melt, glacial isostatic adjustment, groundwater withdrawal, and Cascadia Subduction Zone tectonics. Calculated corrected trend in tide gage records at Astoria is +0.30 mm/yr (95 percent CL: +0.61, -0.01) (NRC 2012, p. 66, 70, 74, 156). On the Washington Coast, the timing and magnitude of upwelling and corresponding coastal productivity may be influenced by changes in sea-surface temperature, though it is considered unlikely that upwelling-

Potential Impacts*	Potential Corps Vulnerabilities/Opportunities	Regional References
		favorable winds will considerably change by 2100. The magnitude and extent of ocean water with pH reduced relative to contemporary values is expected to increase; this water is currently drawn to the surface only during intense upwelling but exposure of shallow coastal areas to corrosive water is expected to increase by 2050, and calcifying organisms will experience reduced availability of carbonate ions. Concentrations of dissolved oxygen in coastal locations are expected to continue to decline (Miller et al. 2013).

***Note: In consideration of space, impacts and vulnerabilities identified by the Corps (2013a) that are not relevant to this EIS were not included in columns 1 and 2.**

4.5.3 Potential Climate Change Effects Relative to Double-crested Cormorant Predation of Juvenile Salmonids

The changes to physical processes in the Columbia River Basin and Pacific Ocean expected from climate change (Table 4-8) have the potential to influence habitat condition, habitat availability, and predator-prey relationships (ISAB 2007; Mote et al. 2014; NOAA 2014). While there are numerous ecological implications of climate change effects throughout the basin, the following section considers the potential impacts as they relate to DCCOs and predation on juvenile salmon in the Columbia River Estuary. The ecological implications of climate change are presented at a broad level because studies specific to the question of climate change effects on predation of juvenile salmonids by DCCOs in the region are not available at this time. The review covers evidence from the literature regarding the four areas of potential impacts identified by the Corps: increasing air temperatures, changing precipitation, increases in extreme events, and sea level change and associated ocean effects (Table 4-8). The potential effects of sea level rise, specific to DCCO nesting on East Sand Island, are further analyzed using modeling approaches in Section 4.5.3.

Effects of Discharge on Prey Availability

Climate change effects in the Columbia River Basin are expected to result in changes to river discharge in terms of timing and magnitude of peak flow events. It is expected that flows will be higher during winter and early spring and lower during summer (ISAB 2007, Alder and Hostetler 2013, NOAA 2014). Lower freshwater flows in late spring and summer lead to intrusion of marine water into the estuarine area (i.e., upstream extension of the salt wedge), possibly influencing the distribution of salmonid prey and predators (ISAB 2007; NOAA 2014). Marine and estuarine waters of the Lower Columbia River Estuary are generally considered productive, as several species of marine forage fish (anchovy, smelt, herring) occupy these waters and provide a diverse forage base (Bottom and Jones 1990). The highest proportion of juvenile salmon in the diets of DCCOs typically occurs during early May, which corresponds with a period of high river flows, high abundances of juvenile salmon, and low abundances of marine forage fish (Weitkamp et al. 2012; Roby et al. 2013).

Later in the season, when salmonids are less abundant and river flows decrease, the diets of DCCOs include greater proportions of other marine and freshwater taxa (Roby et al. 2013). In the Columbia River Estuary, Lyons (2010) noted that high river flows reduced saltwater intrusion into the estuary and diminished the availability of marine forage fish to Caspian terns. Several researchers have put forth the notion that river flow and intrusion of salt water into the estuary influence the diet of DCCOs in the Columbia River Estuary (Anderson et al. 2004a; Weitkamp et al. 2012; Roby et al. 2013). Similar patterns have been observed in other estuaries and by other piscivorous avian species. For example, in the Minho estuary (Southwest Europe), great cormorants (*Phalacrocorax carbo*) consumed fewer marine species and a greater proportion of freshwater species when river discharge was high (Dias et al. 2012).

Effects of Climate Change on Timing of Juvenile Salmon Migration

Given that salmonids exhibit multiple life history strategies, requiring a variety of habitats and conditions throughout their life cycles (Groot and Margolis 1991), the effects of climate change will likely promulgate throughout various life stages. As reviewed by Crozier (2011), changes in climate are affecting numerous taxa in terrestrial, freshwater, and marine environments, such that the timing of various life functions (e.g., migrations) are occurring earlier and at increased rates. Given the broad-scale predictions of climate changes to river discharge patterns, as well as increased water temperatures, it is plausible that changes to these important environmental cues will elicit shifts in life history patterns (ISAB 2007) and juvenile migration timing (Crozier et al. 2008) by some populations of salmon.

Environmental shifts are capable of causing trophic level shifts, such that there becomes a mismatch between the occurrences of predators and prey (Gremillet and Boulinier 2009; Tillmann and Siemann 2011). An example of this decoupling occurred in the California current during 2005, when upwelling occurred later than normal, delaying primary production and resulting in recruitment failure of rockfish, decreased survival of salmon, and nesting failure and mortality of seabirds (Peterson and Schwing 2008). Population level shifts of large magnitude can have serious consequences for the overall ecosystem (Crozier et al. 2011). In the case of changes to migration timing by juvenile salmon, if peak migration occurs before the DCCO breeding season (April), such a phenological shift may reduce the temporal overlap of DCCOs and certain juvenile salmonid ESUs/DPSs in the Columbia River Estuary. While this could potentially have negative consequences for DCCOs, predation rates on certain juvenile salmonids may be reduced. The converse could also be true.

Effects of Increased Water Temperature on Prey Availability

Increased water temperatures can cause prey to shift to other locations, which may constrain foraging ability for some seabirds (Thompson and Hamer 2000). Within the Columbia River Basin, locations within the Snake and Willamette Rivers already experience thermal conditions that are at the upper limits of tolerance for salmonids (Beechie et al. 2012).

It is anticipated that warmer water occurring upstream and in tributaries would likely be transported to the Columbia River Estuary (ISAB 2007). Additional temperature increases may exacerbate conditions for juvenile salmonids, causing additional stress and harm (Beechie et al. 2012). For example, Petersen and Kitchell (2001) determined that juvenile salmon were more vulnerable to predation by piscivorous fish when water temperature was warmer. Hostetter et al. (2012) found that, for juvenile steelhead, a reduction in fish condition increased the likelihood of predation by DCCOs in the estuary. Increased water temperature in the Columbia Basin has the potential to adversely affect physiological processes and increase stress in juvenile salmon. The results of warmer temperatures and higher stress in juvenile salmon may increase predation-related mortality rates (ISAB 2007) by predators such as DCCOs. NOAA (2014) states that in the mainstem Columbia and Snake rivers there is fairly high confidence in the prediction that increased temperatures during the juvenile out-migration will have a negative effect on survival because the principal source of mortality during this stage is predation by piscivorous fish or birds. Additionally, increased temperature of freshwater inflows and seasonal expansion of freshwater habitats may extend the range of warm-adapted non-indigenous species, but the specific effects from this expansion on salmon and steelhead abundance, productivity, spatial distribution, and diversity are poorly understood (NOAA 2014).

Effects of Changes in Precipitation, Flooding, and Storms on Double-crested Cormorant Nesting

Changes in weather patterns, such as increased storms, flooding, and precipitation, are capable of degrading avian nesting and foraging habitats (Brinker et al 2007; ISAB 2007). Alterations to habitat caused by drought and flooding affect DCCOs, particularly within interior regions of the Pacific Flyway (Adkins et al. 2014, Carter et al. 1995, Pacific Flyway Council 2012). Although there is uncertainty in predicting future extreme weather projections, there has been a documented increase in very heavy precipitation events in the Pacific Northwest (Table 4-8). In the Columbia River Estuary, increased flooding and storms may be exacerbated by ocean weather and could affect nesting success of DCCOs in the Columbia River Estuary. Relatively small amounts of nest inundation (at least 6 inches during the course of a week) may preclude nesting by DCCOs at East Sand Island (D. Lyons, OSU, personal communication 2013).

Influence of Climate-Driven Ocean Conditions on Double-crested Cormorant Prey, Mortality, and Breeding

Effects of climate change in marine environments include increased ocean temperature, increased stratification of the water column, and changes in intensity and timing of coastal upwelling (NOAA 2014). Additionally, large-scale climatic events influence physical properties within the ocean and, in turn, the ecosystem of the eastern Pacific. The biological response of such events influences many organisms, with seabirds being affected by ocean-climate conditions through changes in prey availability, which can influence survival and reproductive success (McGowan et al. 1998; Sydeman et al. 2001; Chaves et al. 2003). The strength and frequency of climatic events such as El Niño have been associated with high adult mortality and breeding failure among seabirds (Thompson and Hamer 2000). DCCOs are among those seabirds whose populations can be adversely affected through changes in food availability due to climate-driven ocean conditions (Wilson 1991; Adkins and Roby 2010).

Large-scale climate indices (e.g., Pacific Decadal Oscillation Index, El Nino/Southern Oscillation Index) and regional oceanic climate measures (e.g., upwelling strength and timing) influence, to varying degrees, the availability of forage fish in the estuarine environment and DCCO predation rates of juvenile salmonids in the Columbia River Estuary (see Appendix C, Retrospective Analysis). While salmonids comprise appreciable portions in the diets of DCCOs, anchovy are the most abundant prey resource for these birds in the Columbia River Estuary (Roby et al. 2013). During periods that correspond to reductions in marine forage fish, DCCOs do not appear limited by food resources but likely shift diet to more readily available prey species, including juvenile salmonids (ISAB 2007; Roby et al. 2013; Appendix C, Retrospective Analysis).

Effects of Sea Level Rise on Double-crested Cormorant Habitat Availability

On a broad scale, in Washington and Oregon, more than 140,000 acres of coastal lands lie within 3.3 feet in elevation of high tide (Mote et al. 2014). As sea levels continue to rise, these areas will be inundated more frequently and many coastal wetlands, tidal flats, and beaches will likely decline in quality and extent as a result of sea level rise, particularly where habitats cannot shift inland because of topographical limitations or physical barriers resulting from human development (Mote et al. 2014). This will impose adverse impacts to shorebirds in coastal areas (Galbraith et al. 2002) as well as populations of breeding seabirds requiring low elevation estuarine habitats (Brinker et al. 2007). The Oregon Climate Change Research Institute (OCCRI 2010) acknowledges that potential loss of habitat as a result of sea level rise is of particular concern in the Columbia River Estuary due to its important role in providing nesting and roosting areas for several avian species, including DCCOs. The combined effects of sea level rise, changes with associated tides, and increased storm and wave surges have the potential to adversely affect DCCOs in the Columbia River Estuary through breeding failure or displacement to other more hospitable areas. The potential effects of sea level rise on inundation of nesting area on East Sand Island are modeled in Section 4.5.4.

Summary

There are numerous potential effects of climate change on DCCOs nesting at East Sand Island. For example, increased storm surge and waves, combined with increased precipitation and inundation, could reduce DCCO nesting and available habitat in low-lying nearshore areas. Oceanic climatic events can adversely affect populations of DCCOs by diminishing the availability of food resources (Wilson 1991; McGowan et al. 1998; Adkins and Roby 2010). Shifts in the timing, strength, and location of upwelling, thermal conditions, and ocean currents can cause large-scale ecosystem responses by the food chain in the eastern Pacific (McGowan et al. 1998; Sydeman et al. 2001; Chaves et al. 2003).

Despite the potential effects of oceanic, climatic, and environmental conditions on DCCOs and seabird species, the DCCO East Sand Island colony has not experienced responses akin to those in other coastal and interior areas. DCCOs appear to be more responsive to oceanic and climatic conditions at breeding areas along other areas of the coast (e.g., Washington and British Columbia coasts), as well as to environmental conditions in interior areas of the Pacific Northwest (e.g., Klamath Basin) compared to East Sand Island with regard to decreasing or fluctuating colony abundance and/or productivity (Pacific Flyway Council 2012; Adkins et al. 2014). The growing and stable DCCO colony at East Sand Island has largely been attributed to stable nesting and foraging conditions within the Columbia River Estuary (Anderson et al. 2004b). The continued growth and stability of the DCCO colony on East Sand Island, despite declines in marine forage fish during some years, indicates that food is not a limiting factor at this site (Adkins and Roby 2010).

Many of the anticipated responses of climate change predict adverse constraints to organisms (e.g., loss of habitat), yet some species may actually benefit through opportunities resulting in increased foraging potential, and others may be well suited to adapt to new conditions (Thompson and Hamer 2000). With the ability to practice generalist feeding strategies (USFWS 2003) and consume a diversity of prey types (Roby et al. 2013), DCCOs appear to be successful at adapting their feeding strategies when some prey resources become scarce. Gremillet and Boulinier (2009) suggest that the generalist foraging adaptability by cormorants to various biotic and abiotic situations makes it very difficult to predict the response of this species to climate change. Additionally, accurately predicting the strength and timing of large-scale oceanic and climatic events poses additional challenges (NOAA 2014). Understanding potential climate change impacts to species and ecosystems becomes an even greater hurdle when contemplating the synergies of biotic and abiotic conditions as well as anthropogenic influences (Thompson and Hamer 2000; Galbarith et al. 2002). For example, increased river temperatures will likely impose additional stress on juvenile salmonids, making them more susceptible to predation by DCCOs (ISAB 2007; NOAA 2014) – a potentially beneficial effect of climate change for DCCOs. However, these same climate-driven events, such as pervasive increased temperatures, could reduce total salmonid prey base or ocean production, shift prey timing, or result in drought in interior portions of Oregon causing DCCO colonies to fail or increasing levels of emigration – potentially adverse effects of climate change for DCCOs.

4.5.4 Modeling Climate Change-Related Effects to East Sand Island

As described in the preceding literature review, few of the climate change-related factors affecting DCCO predation on juvenile salmonids at East Sand Island are directly controlled by the Corps. Due to its proximity to the Pacific Ocean and location in the Columbia River, East Sand Island can be expected to experience many of the climate change-related effects discussed in Sections 4.5.2 and 4.5.3. Moreover, uncertainty about the potential effects of climate change on predation is high due to the complicated relationships of physical drivers and biological responses involved in the ecological pathways of the Columbia River Estuary.

Under Phase II of each action alternative, the Corps is proposing to modify the terrain of East Sand Island. This will mean substantial changes to the topography of the island and exposure to frequent inundation from tidal events and storm surges. While the Corps does not consider East Sand Island critical infrastructure for risk planning, it is important in maintaining stability of the Federal navigation channel on the lower Columbia River.

Due to the probability of the island experiencing altered climate change effects from proposed terrain modification, a 4-step quantitative analysis was completed, specific to the terrain modification concept. The purpose of the analysis was to ascertain probable general consequences of climate change on the biological functions of the proposed modified terrain, compared to the existing condition. First, sea level rise scenarios that integrate global and local effects were developed according to Corps' regulation (USACE 2013b). Second, Corps adaptive hydraulics modeling (AdH) results corresponding to global sea level rise scenarios (Pevey et al. 2012) were interpolated for local effects of vertical change in land surface elevation at Astoria, Oregon. Third, changes to patterns of inundation under sea level rise scenarios were modeled. Fourth, the potential land cover distribution at East Sand Island under the baseline condition and sea level rise scenarios was modeled. This approach does not include hydrodynamic modeling of the potential effects of erosion associated with waves, storm surges, or movement of large wood on the long-term stability of the conceptual design for terrain modification; complete erosion analyses are anticipated as part of project engineering.

Relative to the CEQ guidance regarding projects with long life spans, it is noted that the terrain modification design for East Sand Island in Phase II (see Chapter 2, Section 2.2.3) has a 50-year design life. Together, these four steps make it possible to consider a range of inundation and land cover changes that span the potential effects of various impacts on sea level, a scenario-based planning approach that was recommended by the National Research Council (NRC 1987, 2012) and is consistent with the climate change policy direction reviewed in Section 4.5.1.

Development of Sea Level Rise Scenarios

For this EIS, sea level rise scenarios for the proposed 50-year design life (2017-2067) of the modified terrain at East Sand Island were developed with tide gauge data from Astoria, Oregon using an online tool (http://globalchange.gov/what-we-do/assessment/coastal-resilience-resources). Astoria is the nearest long-term tidal record site to East Sand Island, and the net local change in relative sea level, based on 82 years from 1925 is -0.31 mm/yr (95 percent CI = +/- 0.40) (http://tidesandcurrents.noaa.gov/sltrends/msltrendstable.htm). That is, regional land uplift has been occurring faster than global sea level rise. However, this relationship is anticipated to change as sea level rise escalates, so a recent estimate of the future trend is +0.30 mm/yr (95 percent CI = +/- 0.31; NRC 2012). This estimate made use of local tide gauge data, corrected for atmospheric pressure and land uplift, measured with global positioning systems. The online tool developed by the Corps, FEMA, and NOAA and required by engineering regulation (Parris et al. 2012; USACE 2013b) produced seven sea level rise scenarios (Table 4-9).

TABLE 4-9. Estimated Relative Mean Sea Level Change (Expressed in Meters) Under Seven Scenarios Developed by Corps (2013b) and NOAA (Parris et al. 2012) for Astoria, Oregon, at 5-year Intervals for the Project Life 2017 – 2067.

Year*	NOAA Low	Corps Low	NOAA Int-Low	Corps Int	NOAA Int-High	Corps High	NOAA High
2017	-0.01	-0.01	0.01	0.01	0.04	0.06	0.09
2022	-0.01	-0.01	0.01	0.01	0.07	0.09	0.13
2027	-0.01	-0.01	0.02	0.02	0.09	0.12	0.18
2032	-0.02	-0.02	0.03	0.03	0.12	0.16	0.23
2037	-0.02	-0.02	0.04	0.04	0.16	0.21	0.3
2042	-0.02	-0.02	0.05	0.05	0.2	0.26	0.37
2047	-0.02	-0.02	0.06	0.06	0.24	0.32	0.45
2052	-0.02	-0.02	0.07	0.07	0.29	0.38	0.54
2057	-0.03	-0.03	0.09	0.09	0.34	0.45	0.63
2062	-0.03	-0.03	0.1	0.1	0.4	0.53	0.73
2067	**-0.03**	**-0.03**	**0.12**	**0.12**	**0.46**	**0.61**	**0.85**

*These results are relative to the 2017 baseline, and the 2067 data (50-year design) are the basis for simulations in this EIS. Results for Corps "low" are equivalent to NOAA "low" and results for Corps intermediate ("Int") are equivalent to NOAA intermediate-low ("Int-Low"). This table was produced using online tool: http://www.corpsclimate.us/ccaceslcurves.cfm.

A low scenario of 0.0 m, an intermediate scenario of +0.12 m, and a high scenario of +0.5 m over the 50-year design life were selected from the scenarios for further modeling analysis in steps 2-4 of this procedure. At the end of the 50-year design life in year 2067, the Corps and NOAA low sea level rise scenario is for a small sea level fall (-0.03 m), very close to the base condition of 0.0 m change (Figure 4-22). The Corps' intermediate scenario (+0.12 m) is equivalent to the NOAA intermediate-low scenario, "…based on the upper end of IPCC Fourth Assessment Report (AR4) global sea level rise projections resulting from climate models using the B1 emissions scenario… The intermediate-low scenario allows experts and decision makers to assess risk primarily from ocean warming" (Parris et al. 2012; also see IPCC 2001, 2007a, 2007b). The NOAA intermediate-high scenario (+0.46 m, conservatively rounded to +0.5 m) was used as the high scenario in this EIS and "…is based on an average of the high end of semi-empirical, global sea level rise projections." The intermediate-high scenario allows experts and decision makers to assess risk from limited ice sheet loss (Parris et al. 2012). Semi-empirical projections are based on statistical relationships between observations of global sea level change. This intermediate-high scenario of +0.5 m over the 50-year design life (2017-2067) incorporates ocean warming and limited ice sheet loss and is considered sufficient for the low level of risk associated with a terrain alteration project for habitat management purposes on an uninhabited island without critical infrastructure.

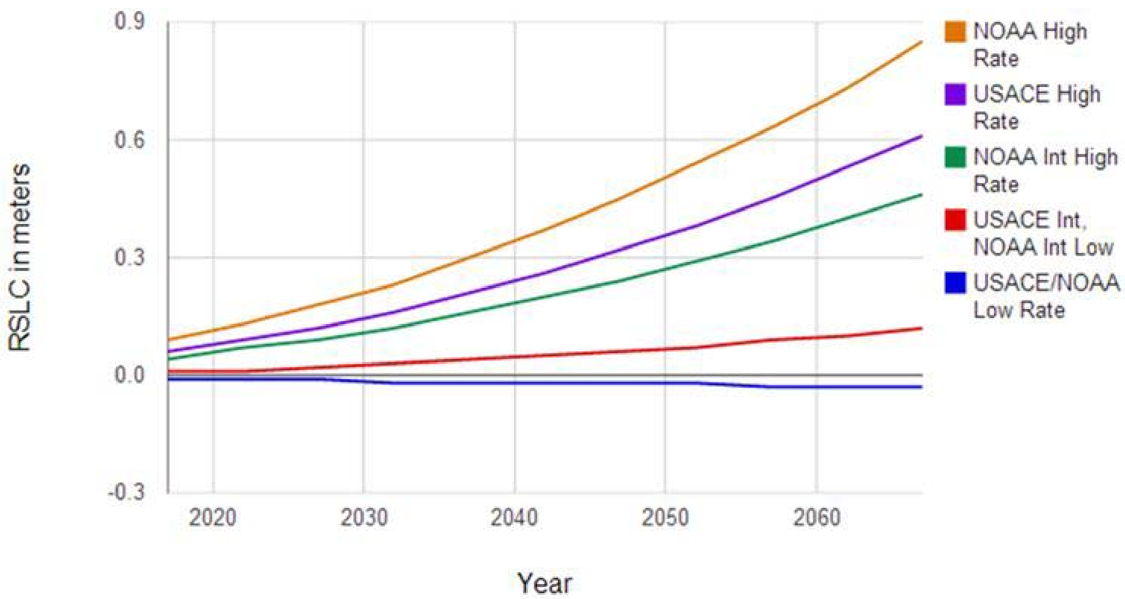

FIGURE 4-22. Relative sea level change (RSLC) scenarios for planning, 50-year design life from 2017–2067, based on analyses in Corps (2011b) and Parris (2012). The curves were calculated with an online tool associated with the Corps regulation at: http://www.corpclimate.us/ccaceslcurves.cfm.

Water Surface Elevation Modeling of Sea Level Rise Scenarios

In accordance with guidance (USACE 2011b), the Corps modeled three sea level rise scenarios greater than baseline conditions by 0.5, 1.0 and 1.5 m (Pevey et al. 2012). The Adaptive Hydraulics Model (AdH) (Savant and McAlpin 2014) was used with the assumption that riverbed morphology is unchanged between the three conditions (Pevey et al. 2012). The duration modeled was from March 15, 2009 to October 31, 2009. To illustrate the global sea level rise component of relative sea level rise in the estuary, a location south of East Sand Island was chosen for extracting data from model outputs, because it is not influenced by short-term water surface elevation changes caused by structures extending from the shoreline of the island (Figure 4-23).

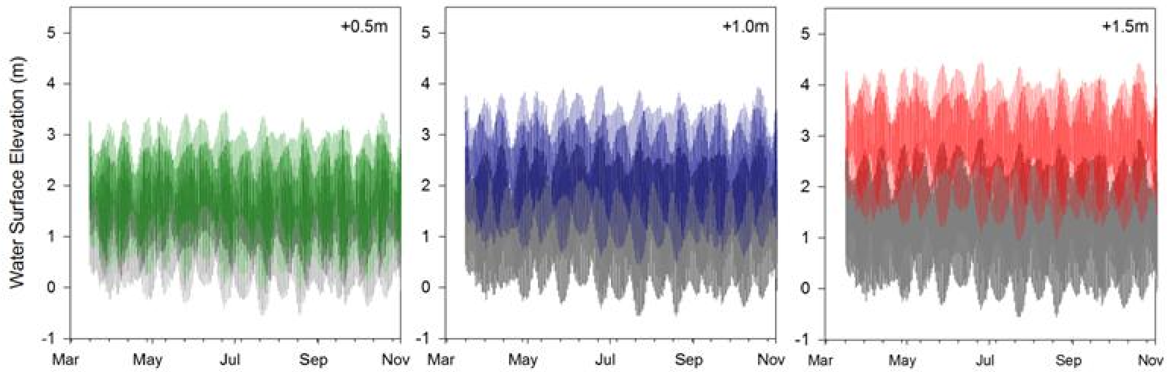

FIGURE 4-23. Water surface elevation outputs of the AdH model for March-October 2009 near East Sand Island under baseline (gray) and three global sea-level rise scenarios (+0.5, +1.0, and +1.5m). These data are uncorrected for the effects of vertical changes in local land elevation.

The mean of historical records of local sea level change was added to the global sea level rise projections to produce scenarios for project planning. Thus, before AdH model outputs could be used as inputs for steps 3 and 4 of this analysis, they needed to be adjusted for local effects. The time series, water surface elevation data for inputs to these analyses were developed as follows: 1) the AdH model output for baseline condition (+0.0m) was used for the "low" sea level rise scenario because the estimate for Astoria is slightly negative (-0.03m sea level fall is the USACE and NOAA low scenario) and well within the uncertainty of available modeling methods; 2) for the Corps' intermediate sea level rise scenario, an estimated offset of +0.12m (equal to the NOAA intermediate-low scenario) was added to the AdH model baseline condition outputs; and 3) an offset of +0.5m was added to the AdH model baseline condition outputs to generate the high sea level rise scenario described in the preceding section.

Based on the modified AdH results, the three scenarios, +0.0 m, +0.12 m, and +0.5 m, had median water surface elevation values of 1.3 m, 1.4 m, and 1.8 m (NAVD88), respectively. In the first quartile, 25 percent of the modeled water surface elevation (WSE) observations were less than 0.67m, 0.79m, and 1.17m and for the third quartile, 25 percent of the modeled WSE observations were greater than 1.92m, 2.04m, and 2.42m for the respective three scenarios (Figure 4-24). Model results have an inherent level of uncertainty that must be considered; however, the uncertainty related to the modeled results in this analysis is fairly low. Pevey et al. (2012) present water surface elevation statistical analysis results near Astoria, Oregon (and other locations). At Astoria, Oregon the statistics of the comparisons between the AdH model results and the field data indicated either a "great" fit (variation in the elevation between 0.05 and 0.10 m) or "exceptional" fit (variation in elevation of less than 0.05 m) for all metrics, which means that over the validation period the water surface elevation differences between field observations and model estimates were less than 0.10 m.

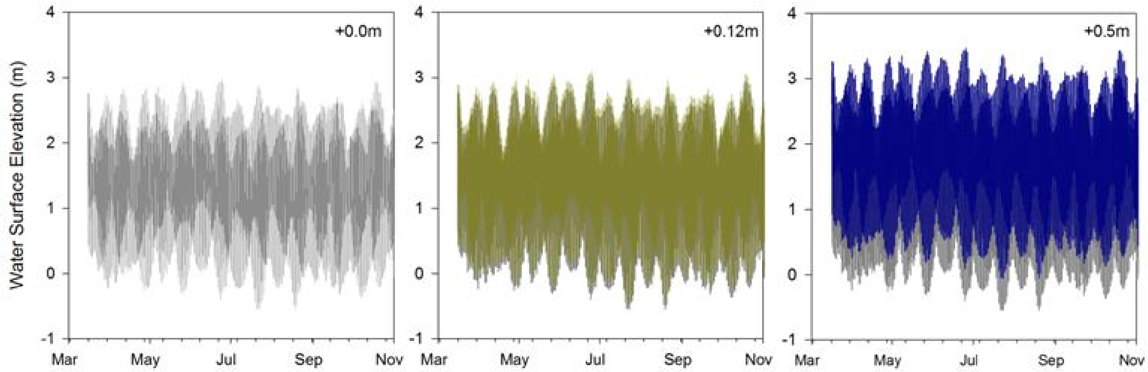

FIGURE 4-24. Water surface elevation outputs of the AdH model modified for two locally corrected 50-year sea level rise scenarios (+0.12, +0.5) near East Sand Island (2009 baseline in gray).

Inundation Modeling at East Sand Island under Sea Level Rise Scenarios

Patterns of inundation are important factors for determining habitat quality and availability for DCCOs. These patterns can be measured in terms of area, timing, frequency, and duration. As noted in Section 4.6.2, inundation cycles at East Sand Island are primarily controlled by tidal cycles, and to a lesser extent, mainstem Columbia River flow and weather events. For the purpose of this assessment, inundation patterns were evaluated at East Sand Island for three sea level rise scenarios (+0.0, +0.12, and +0.5m), as described in the preceding sections. Both the existing terrain and an alternative terrain design described in Chapter 2 were evaluated for potential inundation.

Inundation modeling was performed using an area-time inundation index model (ATIIM) (Diefenderfer et al. 2008; Johnson et al. 2011; Coleman et al. 2014). ATIIM is a GIS-based rapid site assessment tool that makes use of WSE data and high-resolution topographic data. The sources of error in the model from WSE data were described in the preceding section. The elevation accuracy for the 2009 LiDAR data was reported based on a quality control process defined in USACE (2013c), where data on open, hard, flat surfaces were assessed for consistency through the full LiDAR collection area. The results report a minimum and maximum absolute elevation accuracy range of 1 to 13 centimeters, with a root mean square error (RMSE) of 4.6 cm determined by evaluating 40,266 ground survey points. Areas with complex terrain or dense vegetation may have a degraded accuracy but spot checks on the data indicate final data are within the project required 13 cm accuracy.

The WSE inputs were provided from AdH run scenarios for three sea level rise scenarios. The topographic data used for the existing terrain condition were sourced from 2009 high-resolution LiDAR data provided by the Corps (USACE 2010) and represent an average horizontal ground spacing of 1.0 m. At the core of the model is a spatially-based wetted area algorithm that tracks an hourly time-series of inundation at 10 cm increments while maintaining hydrologic connectivity. The analysis results from ATIIM can be used to help determine trade-offs between inundation and potential habitat, contrast alternative site designs, and predict impacts of altered flow or climate regimes.

The ATIIM outputs a wide suite of metrics over a spatial and temporal continuum. For this evaluation, eight key metrics were selected. These are thought to best characterize inundation events as they affect habitat quality and availability for local avian species. The following list provides the metrics used and a description of each:

- *Cumulative Frequency of Inundation*: This metric describes how often, on the basis of percent of total possible time, a specific elevation has been inundated over the study period.
- *Inundation Exceedance Probability*: A measure to indicate the probability of occurrence (based on the historical record) for a specific elevation to be inundated. A value of 99 percent will indicate that the particular elevation is inundated often (lower elevations) and a value of 1 percent will indicate rare occurrences of inundation (high elevations).
- *Total Inundated Hectare-Hours*: The sum of the total number of hectares at a site that are inundated at each hourly time-step over the study period.
- *Total Non-Inundated Hectare-Hours*: The sum of the total number of hectares at a site that are not inundated (i.e., dry areas) at each hourly time-step over the study period.
- *Longest Duration of Non-Inundation*: The longest period of time, in hours, that a specific elevation did not get inundated with at minimum 0.2 m water depth.
- *Mean Site Inundation Depth*: The average water depth for the site at a given water surface elevation.
- *Functional Hectares Excluded*: This is a general metric to understand how water inundation will reduce the potential area of DCCO nest locations.
- *Sum Exceedance Value*: Cumulative sum of the difference between hourly water surface elevation and land surface elevation during the growing season. Used as an indicator for vegetation communities. See the following section for details.

To understand the potential impacts of climate change on East Sand Island for DCCO, the ATIIM results were extracted for elevations of potential biological significance on DCCO nesting. The significant elevations were determined by using observed point-based DCCO nesting locations from 2010-2013 (BRNW, unpublished data) and the 2009 LiDAR elevation data. The data were analyzed for the mean and the upper and lower elevation bounds of nesting to support development of meaningful metrics and relationships between nesting and patterns of inundation. While 2011–2013 exemplifies an altered DCCO nesting distribution on the island, compared to 2010 (see Chapter 1, Section 1.1.6 about levels of habitat restriction), the summary statistics describing where nesting occurs are similar among years (Table 4-10).

TABLE 4-10. Observed DCCO Nesting Locations by Elevation from 2010-2013.

	2010	2011	2012	2013	Mean
Min	2.76	2.65	2.73	2.71	**2.7**
Mean	3.86	3.70	3.85	3.76	**3.8**
Max	4.67	5.19	4.70	4.71	**4.8**
SD	0.40	0.43	0.41	0.40	0.41

* Note that in 2011-2013 the DCCO nesting area was constrained during the management feasibility studies (see Chapter 1.1.6); however, the summary statistics for nesting elevations are similar to 2010 when available habitat was not substantially limited. Sea level rise scenarios were evaluated at the means of the upper and lower bounds and mean elevation (bold values).

Despite the similar range in the summary statistics over the four years, the frequency distribution of nesting elevation did alter from year to year (Figure 4-25). Nonetheless, the following three elevations, 2.7, 3.8, and 4.8 m, (lower bound, mean elevation, and upper bound, respectively) were determined from an average over the four nesting years and subsequently used to evaluate the sea level rise scenarios for both the existing and alternative terrains.

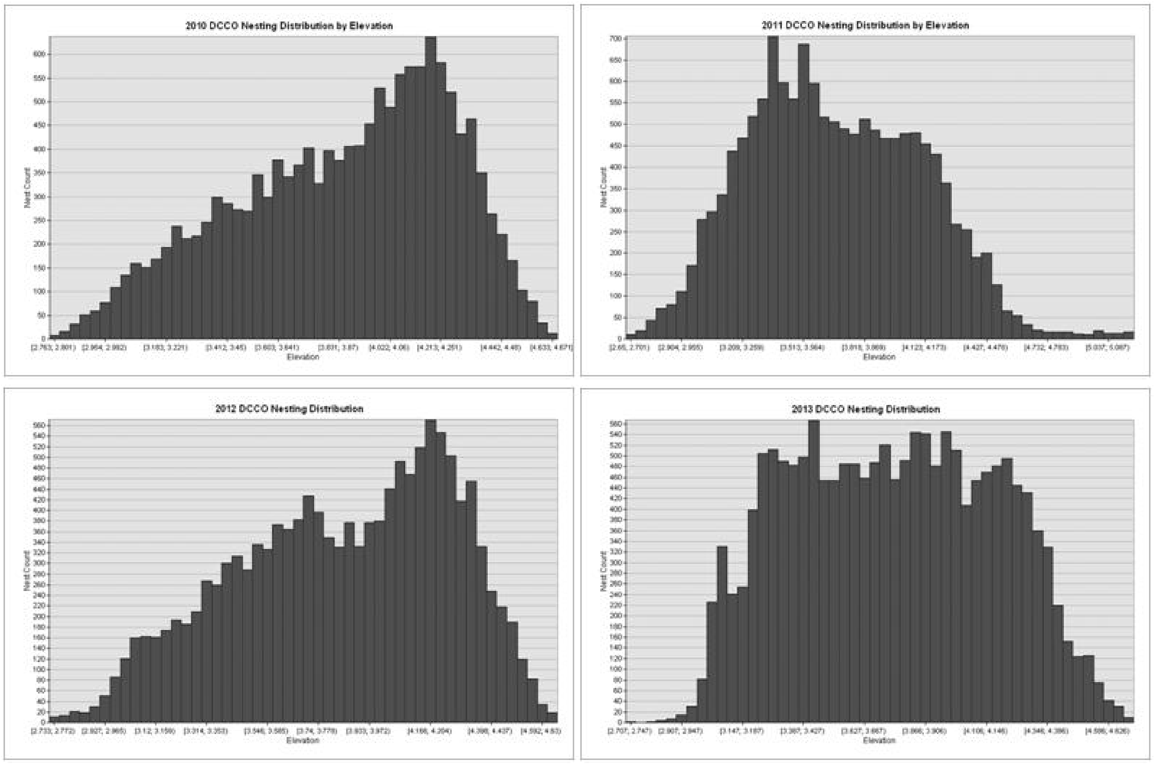

FIGURE 4-25. Frequency distribution plots of nests by NAVD88 elevation for the years 2010 (top-left), 2011 (top-right), 2012 (bottom-left), and 2013 (bottom-right).

As a simplifying assumption, the elevation range used for nesting was related to site hydraulics, such that to get an equivalent range of nesting habitat under sea level rise scenarios, the range could be shifted by the amount of sea level rise change. Hence, the sea level rise offsets were added to the original elevations derived from nesting data (2.7, 3.8, and 4.8 m) and the ATIIM metrics were evaluated for all resulting elevations. Table 4-11 presents the data for the existing and alternative terrain considering the +0.0, +0.12, and +0.5 m sea level rise scenarios for each of the elevations selected to represent low, mean, and high elevation bounds observed in DCCO nesting. It should be noted that although the nesting period of interest is April 1–June 15, 2009, this period of record has a limited number of lunar cycles that capture the tidal extremes and range of variability; thus, the full AdH simulation period from March 15–October 31, 2009 was evaluated to provide a more representative condition and the associated variability. There are a total of 5,544 hours in the study period; however, not all hours are considered in the metrics due to the WSE falling below the minimum land surface elevation of 0.1 m (NAVD88; the lower extent of the LiDAR elevation data).

TABLE 4-11. Subset of ATIIM Metrics Representing Inundation-influenced Conditions on the Existing and Alternative Terrains for Three Sea Level Rise Scenarios. The bold elevation values indicate the base elevations that are representative of the low, average, and high nesting elevations.

Sea Level Rise (SLR) Scenario	Water Surface Elevation (NAVD88-m)	Cumulative Frequency of Inundation (as % of total possible)	Inundation Exceedance Probability	Total Inundated Hectare-Hours	Total Non-Inundated Hectare-Hours	Longest Duration of Non-Inundation at 0.2m Depth (Hours)	Mean Site Inundation Depth (Meters)	Functional Hectares Excluded	SEV
Existing Terrain – lower bound nesting elevation									
SLR +0.0	**2.7**	1.9	1.3	3,124	295,411	2,744	1.34	0.00	3
SLR +0.12	2.82	1.1	1.3	2,895	299,883	2,744	1.42	0.77	10
SLR +0.5	3.25	1.4	1.3	7,889	320,172	3,117	1.77	4.60	93
Existing Terrain – average nesting elevation									
SLR +0.0	**3.8**	0.0	0	0	371,571	5,544	0	0.00	0
SLR +0.12	3.9	0.0	0	0	376,439	5,544	0	0.77	0
SLR +0.5	4.35	0.0	0	0	392,932	5,544	0	4.60	0
Existing Terrain – upper bound nesting elevation									
SLR +0.0	**4.8**	0.0	0	0	400,624	5,544	0	0.00	0
SLR +0.12	4.92	0.0	0	0	401,509	5,544	0	0.77	0
SLR +0.5	5.3	0.0	0	0	403,586	5,544	0	4.60	0
Alternative Terrain – lower bound nesting elevation									
SLR +0.0	**2.7**	1.9	1.3	3,549	335,591	2,744	1.28	7.29	3
SLR +0.12	2.82	1.1	1.3	3,265	338,246	2,744	1.37	7.72	10
SLR +0.5	3.25	1.3	1.3	8,779	358,637	3,117	1.78	10.81	93
Alternative Terrain – average nesting elevation									
SLR +0.0	**3.8**	0.0	0	0	383,690	5,544	0	7.29	0
SLR +0.12	3.92	0.0	0	0	386,216	5,544	0	7.72	0
SLR +0.5	4.35	0.0	0	0	395,515	5,544	0	10.81	0
Alternative Terrain – upper bound nesting elevation									
SLR +0.0	**4.8**	0.0	0	0	400,828	5,544	0	7.29	0
SLR +0.12	4.92	0.0	0	0	401,578	5,544	0	7.72	0
SLR +0.5	5.3	0.0	0	0	403,491	5,544	0	10.81	0

The metric "Functional Acres Excluded" was evaluated with observed nesting elevations and areas in mind. The total area at East Sand Island for the elevation band between 2.7 m and 4.8 m elevation (i.e., the nesting elevation band) was used as the baseline area. The change in this area was evaluated for sea level rise removing the lower elevation bands for both the existing terrain and alternative. As the alternative terrain modifications are in the area of DCCO nesting, the change was evaluated for the whole of East Sand Island. In summary, while sea level rise alone excludes little habitat, modifying the terrain excludes approximately 17 acres, a large portion of the total area (44 acres) in that elevation band on all of East Sand Island (Table 4-12, Figure 4-26).

TABLE 4-12. Total Available Nesting Acres Available and Denied within the 2.7-4.8 m (NAVD88) Elevation Band for the Existing and Alternative Terrains Considering the Three Sea Level Rise Scenarios.

	Total Available Nesting Acres		**Nesting Acres Denied**	
Sea Level Rise	*Existing Terrain*	*Alternative Terrain*	*Existing Terrain*	*Alternative Terrain*
+0.0	45.5	27.5	0.00	18.01
+0.12	43.6	26.4	1.9	19.0
+0.5	34.1	18.8	11.36	26.7

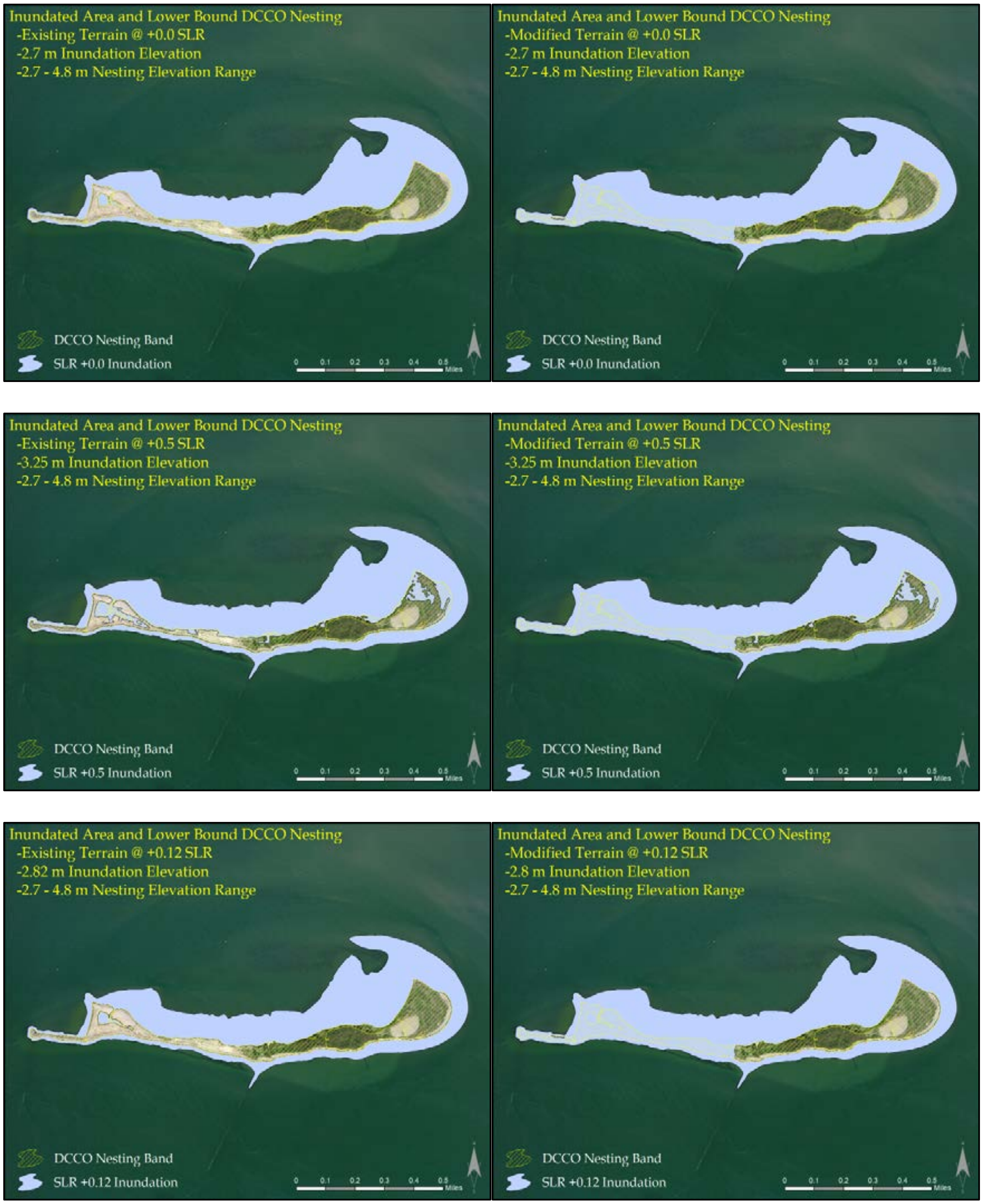

FIGURE 4-26. The inundated area and the nesting elevation range of DCCO, shown for existing and modified terrains and three sea level rise scenarios.

Land Cover Change Modeling under Sea Level Rise Scenarios

The total area of East Sand Island is 762,707 m^2 assuming a low elevation of +0.1 m (NAVD88) with a maximum elevation of 4.9 m (NAVD88). Based on reference site data in Baker Bay (Borde et al. 2011) and other observations in the region (e.g., Fox et al. 1984), in the absence of significant disturbance, estuarine marsh habitat will be expected to occur between elevations of 1.2 to 2.5 m (NAVD88), and areas above the high marsh will be expected to be colonized by dune grasses, shrubs, and trees. Field verification during wetland surveys identified typical marsh habitat occurring at slightly higher elevations than expected, approximately 2.4–3.1 m. Areas immediately below the low marsh are expected to be intertidal mud flats extending approximately to -0.1 m (NAVD88; 0.0 m MLLW). The wetland status of areas with plant cover also depends on their soil type and hydrology, but in this region shrub-dominated and forested wetlands are typically found above high marshes (Thomas 1983; Borde et al. 2011).

To project the potential distribution of major plant communities on East Sand Island under sea level rise scenarios, a sum exceedance value (SEV) approach was used. The SEV is an index of hydrologic conditions during the vegetative growing season (Gowing and Spoor 1998), which has been modified by Borde and others (2011, 2012a, 2012b, 2013) for the lower Columbia River and estuary. The SEV as used here is a cumulative sum of the difference between hourly surface water elevation and land surface elevation during the growing season. SEVs associated with the presence of marsh vegetation and the lower boundary of woody vegetation were previously calculated from data collected at two marsh reference sites in Baker Bay by Borde et al. (2011, 2013). The main assumption associated with this method is that the inundation tolerance ranges evidenced at reference sites are suitable for the same plant communities in the future and soils are suitable. Effects of potential salinity intrusion with climate change are not expected to change wetland type because the freshwater river flows keep wetlands in the estuary brackish. The analysis does not incorporate potential effects of air temperature on growing season or evolutionary adaptation by plant species.

For the purpose of this EIS, SEVs were calculated from the AdH model outputs for the baseline condition and sea level rise scenarios across the range of land elevations at East Sand Island. The SEVs were not calculated for the low scenario (decrease of -0.03m) because the difference between this scenario and the baseline condition was smaller than the errors associated with data sources used in this analysis. All SEVs were calculated at 10 cm land elevation increments (relative to NAVD88), permitting the SEVs calculated for sea level rise scenarios to be compared on a land-elevation basis.

The land elevation ranges at which SEVs suitable for marsh vegetation and woody plants occurred were identified for baseline and sea level rise scenarios (Table 4-13). The elevation ranges of marsh communities predicted by SEV analysis are shown in Figure 4-27. Results suggest that the current elevation ranges of plant communities will increase in response to sea level rise as expected, regardless of whether terrain is in the existing condition or modified (Figure 4-27). Woody plants are expected to occur above the marshes and mud flats are expected to extend slightly beyond the boundary of LiDAR data (white line) to -0.1m (NAVD88). With the existing condition terrain, the total area of potential wetland or upland vegetation, not including submerged aquatic vegetation, is projected to decrease as first the northern side of the island and then the western and eastern portions are subjected to increased inundation as sea level rises. The decrease in both total area and total percentage vegetated area is expected to accelerate over the 50 years; it is approximately twice as large between the medium and high scenarios as it is between the baseline and medium scenarios. With existing condition terrain, the area of mudflat is expected to progressively increase as sea level rises. Total potential marsh, woody plant, and mudflat area for the modified terrain is estimated to be 10-19 percent greater, 34-36 percent less, and 10-13 greater, respectively, than existing conditions under baseline and both sea level rise scenarios (Table 4-13).

TABLE 4-13. The Area of Potential Natural Vegetation Communities Based on the Controlling Factor of Tidal Regime, Under Baseline and Two Sea Level Rise Scenarios.

Scenario	Min/Max Elevation of Potential Marsh Community (NAVD88-m)	Total Area of Potential Marsh Community (acres)	Total Area of Potential Woody Plant Community	Percentage of East Sand Island With Potential Marsh Community*	Total Area of Mudflats to +0.1m (acres)**
Existing Terrain/Current Condition	1.3/2.6	72	234,463 m^2	38.5%	58
Existing Terrain/Base + 0.12m (NAVD88) (medium)	1.5/2.8	65	215,944 m^2	34.3%	70
Existing Terrain/Base + 0.5m (NAVD88) (high)	1.8/3.1	50	195,138 m^2	26.6%	90
Alternative Terrain/Current Condition	1.3/2.6	86	150,851 m^2	45.8%	65
Alternative Terrain/ Base + 0.12m (NAVD88) (medium)	1.5/2.8	76	143,343 m^2	40.1%	77
Alternative Terrain/ Base + 0.5m (NAVD88) (high)	1.8/3.1	55	128,286 m^2	29.2%	102

* The total area of the island is held steady in these calculations although the exposure of its lower elevation areas to hydrologic forces is expected to greatly increase with sea level rise.

** It is only possible to calculate area of mudflat above +0.1 m (NAVD88) because of LiDAR data limitations, so all mudflat estimates are somewhat less than the actual predicted.

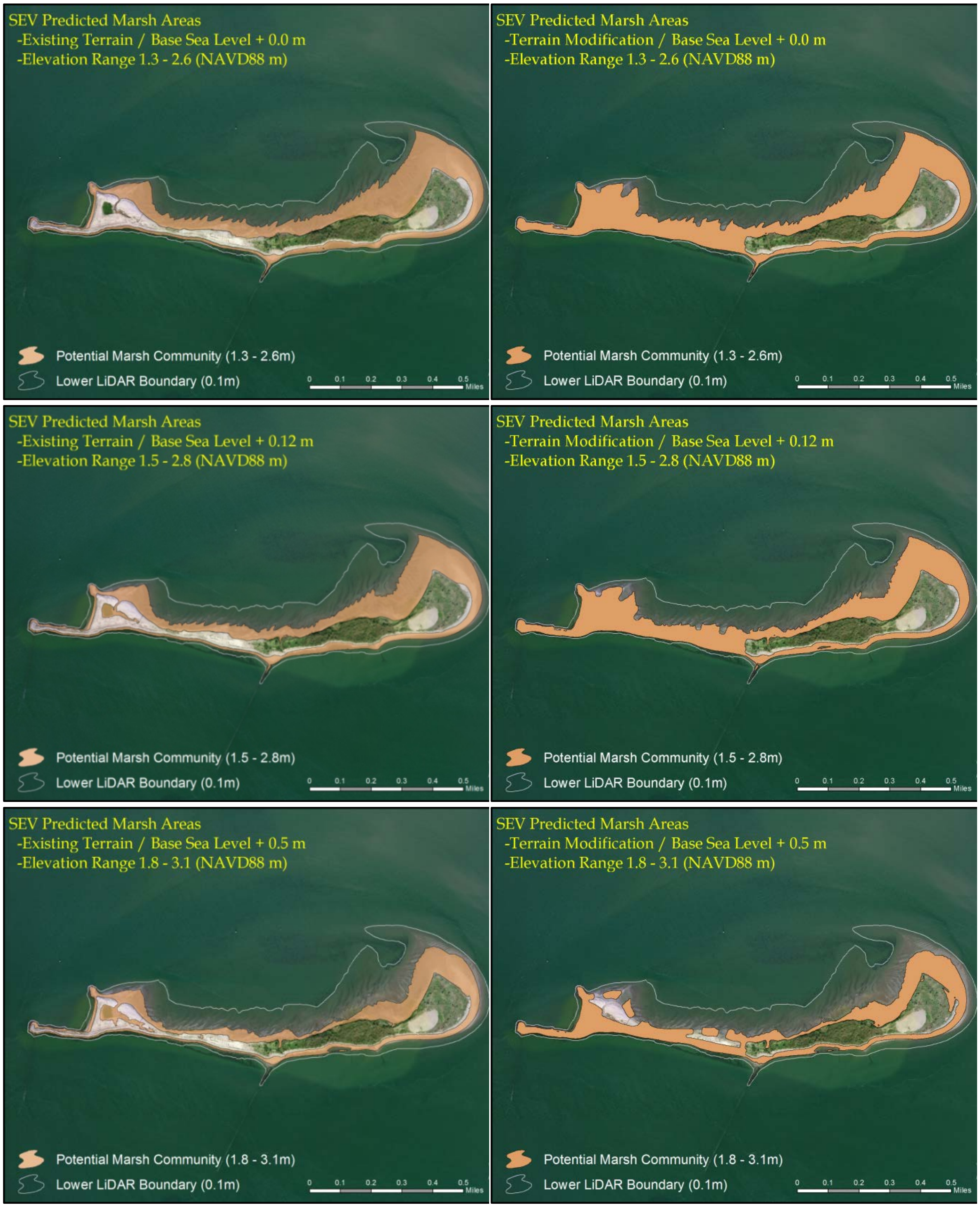

FIGURE 4-27. The potential areal extent of marsh vegetation under baseline and two sea level rise scenarios for existing terrain (left column) and modified terrain (right column), based on the controlling factor of tidal regime.

As a validation exercise, the elevation range of marshes predicted by analysis of the AdH model outputs for baseline condition, 1.3 to 2.6 m (NAVD88), was compared to that based on water surface elevation and vegetation data collected at reference sites, 1.2 to 2.5 m (NAVD88). Many sources of error could contribute to a difference of 0.1 m and it is within the range of error of the ATIIM model, field data collection, and LiDAR data.

Field work conducted in February 2014 to delineate wetlands on the island indicated that some differences from reference site conditions exist (Appendix J). Notably, in existing condition the site supports two general types of wetland areas: 1) those associated with the sandy, well-drained soils found along the tidally influenced, exterior portions of the island ranging from elevations of approximately 2.4 to 3.4 m (NAVD88) with species composition limited to a few forbs and grass species; and 2) perched, isolated wetlands at higher elevations where a clay layer limits drainage (see Chapter 3, Section 3.2.1). There is very little or no emergent marsh vegetation where predicted, i.e., between the elevations of 1.2 m and 2.4 m (NAVD88) on East Sand Island. Small patches of emergent marsh vegetation occurred along the shore in a narrow elevation range that is estimated to be from approximately 2.4 to 3.0 m (NAVD88), based on the elevations derived from the LiDAR used during the wetland delineation. The likely reasons there is little marsh vegetation between 1.2m and 2.4m include: 1) the sandy sediments, 2) the currents precluding the deposition of fines, and 3) the presence of large wood continually disturbing the vegetation in this elevation range.

American dunegrass (*Leymus mollis*) and European dunegrass (*Ammophila arenaria*) were observed on the island and are likely colonizing the sandy, well drained soils in the upper elevation ranges of predicted marsh at approximately 3.0 to 3.4 m (NAVD88), with some observations of occurrence up to 6.0 m (NAVD88). Limited wetland reference site data exists for these grasses in the Lower Columbia River Estuary; however, observations at Trestle Bay indicate it occurs at least from approximately 2.4 to 2.8 m (NAVD88) (Borde et al. 2011) and likely higher given the limited elevation range of the reference site. Wetland vegetation (primarily shrubs with some herbaceous freshwater wetland vegetation such as *Carex obnupta*) was also noted at some of the higher elevations of the site (5.5 – 6.1 m [NAVD88]) where clay soils may be acting to “perch” freshwater, creating wetland areas that are not directly connected to the tidal hydrology of the site.

Over time, tidally-influenced wetlands are predicted to develop in the modified terrain; however, the sandy soils in the location of the excavated areas may preclude the development of wetland vegetation in these areas at elevations of 1.2 to 2.4 m

(NAVD88) because of their drainage characteristics. The future deposition of fine sediments may increase the occurrence of emergent marsh species within these elevations, but the time period necessary for this to occur is unknown. The factors affecting it include the type of vegetation in the area (e.g., dune grasses have the potential to act as a controlling factor on sand stabilization and accretion) and physical disturbance (e.g., the alternative terrain design provides rip-rap barriers on the north and south sides of the potential marsh areas, which may deflect energy and could accelerate fine-sediment deposition and accumulation).

Additional controlling factors on vegetation establishment should be considered in alternative habitat designs and climate change analysis. These include the potential effects of physical and biological disturbance on marsh development at East Sand Island. Many disturbance processes related to vegetation establishment are active at East Sand Island, including biological factors associated with the diverse avian community and physical factors (e.g., wind waves, swells, and storm surges) associated with the position of the island near the mouth of the Columbia River. Marshes do not naturally occur in areas with high wave action and East Sand Island is exposed to a long fetch in the southwesterly direction toward the river mouth. Wave analysis conducted by the Corps for the south jetty at the mouth of the Columbia River concluded that the medium sea level rise scenario could increase wave run-up elevation by 0.2 m to 0.4 m and the highest expected sea level rise scenario could increase it by 0.7 m to 1.6 m (compared to no sea level rise; USACE 2013d).

4.5.5 Summary

This section reviewed recent developments in national guidance on climate change adaptation and related Corps policies. Nationally, the Corps has identified four areas of potential impacts of climate change to mission and operations: 1) increasing air temperatures, 2) changing precipitation, 3) increases in extreme events, and 4) sea level change and associated tides, waves, and surges. On this basis, the potential effects of both inland hydrology and sea level rise on DCCO predation of juvenile salmon were qualitatively assessed through a literature review. In general, the review identified high uncertainty about the ultimate effects of changes on DCCO predation because of complex ecological relationships involving physical processes and biota. Uncertainties regarding the potential effects of extreme events were outside the scope of this analysis and will be part of the engineering design phase.

The Corps has proposed a terrain modification in Phase II that will be affected by climate change. For coastal project planning, Corps policies focus particularly on scenario-based planning for sea level rise; similarly, specific guidance has not yet been developed for expected Columbia River Basin-scale hydrological changes. Therefore, the potential impacts of sea level rise on physical processes and biological relationships were quantitatively assessed through a four-step procedure: 1) development of sea-level rise scenarios, 2) water surface elevation modeling (using AdH model), 3) inundation modeling (using ATIIM), and 4) land-cover change modeling (using an SEV method).

The potential consequences of climate change on the biological functions of existing and modified terrains were compared through this 4-step procedure. In accordance with national policy, approved methods for estimating the combined effects of global sea level rise and local conditions using historical tide gauge records (Parris et al. 2012; NRC 2012; USACE 2013b) were followed. The future conditions were forecast through the 50-year design life, 2017-2067, for the existing condition and the modified terrain alternative. Multiple baselines were used for sea level rise, following the guidance for scenario-based planning for climate change (NRC 1987; NRC 2012; Parris et al. 2012; USACE 2013a; CEQ 2013b). Potential effects of sea level rise on inundation and land cover change at East Sand Island were estimated using the best available models based on data previously collected in the Columbia River Estuary (Borde et al. 2011; Coleman et al. 2014). Where available, associated uncertainty estimates are given in association with the data and models used.

In summary, as sea level rises, it is expected that lower elevation portions of the island will be converted to mud flats that would be unsuitable for DCCO nesting because of frequent inundation. The terrain modification would increase mudflat and marsh habitat on East Sand Island and the modified terrain exposes a greater proportion of the surface of the island to disturbance from tides and storm surges, thus reducing the potential for DCCO nesting. The ability to create tidal wetlands to indirectly support juvenile salmon through the production and export of macrodetritus and prey is possible, but less certain because of potential physical and biological disturbances not modeled herein, as well as the requirement for adequate sediment conditions. The potential accumulation of large woody debris cannot be predicted at this time. The results of analyses in this chapter indicate that a land cover matrix including both mud flats and vegetated areas—possibly including marshes, dune grasses, and woody plants at higher elevations—could persist on East Sand Island despite sea level rise for five decades.

4.6 Other Disclosures

4.6.1 Unavoidable Adverse Effects

NEPA requires disclosure of "…any adverse environmental effects which cannot be avoided should the proposal be implemented…" (40 C.F.R. § 1502.16). Beneficial and adverse effects on the human environment that might result from the implementation of alternatives carried forward for detailed study are analyzed earlier in this Chapter in Sections 4.2 and 4.3.

Several adverse effects of varying degrees to non-target species were identified during the analysis of environmental consequences for each of the alternatives, including the no action alternative. Certain measures to minimize adverse effects have been identified and included where appropriate as part of the detailed description for each action alternative or identified as BMPs. Under alternatives that consider lethal methods, loss of individuals, nests, eggs, chicks, and fledglings are unavoidable adverse effects.

4.6.2 Energy Requirements

For environmental impact statements, NEPA requires a discussion of "[e]nergy requirements and conservation potential of various alternatives and mitigation measures" (40 C.F.R. § 1502.16(e)). The alternatives under consideration require consumption of energy in the form of fuel for boat-based transportation to East Sand Island (and other locations in the Columbia River Estuary or coastal Oregon and Washington for monitoring and hazing) and fuel for planes for aerial surveys. All the action alternatives require a similar level of effort for accessing East Sand Island. Alternatives B and D which promote re-distribution of >7,500 breeding pairs could require substantially more energy in the form of fuel for boat-based and aerial surveys throughout the 172 mile long Columbia River Estuary. There is some conservation potential in utilizing more fuel efficient boats and this would be considered in the implementation. Additional conservation potential (respective of energy requirements) could be in the potential to use drones to conduct the aerial surveys and the Corps is currently reviewing opportunities to do this.

4.6.3 Irreversible and Irretrievable Commitment of Resources

For environmental impact statements, NEPA requires a discussion of "…any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented…" (40 C.F.R. § 1502.16). For NEPA purposes an irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed. Examples include permanent conversion of wetlands or permanent loss of wildlife or other biological resources, etc. Habitat and wetlands altered from the proposed habitat modification could be restored to their initial state with additional terrain modification. Potential loss of historic and cultural resources from the proposed actions is addressed in Chapter 4. This EIS analyzes impacts from alternatives that propose lethal take of DCCOs and eggs from the western population. This may be considered an irreversible and irretrievable commitment of a biological resource; however, permanent loss of the population would not occur (Chapter 4, Section 4.2; Appendix E).

4.6.4 Incomplete and Unavailable Information

CEQ NEPA regulation at 40 C.F.R. § 1502.22 (incomplete or unavailable information) requires an agency, when evaluating reasonably foreseeable significant adverse effects of a proposed action, to obtain, if possible, incomplete or unavailable information or disclose why such information is not attainable and provide a discussion of why the information is relevant and a summary of the best available existing scientific evidence used to predict the impacts.

One area of uncertainty related to this FEIS is the exact dispersal patterns of DCCOs as a result of the proposed action. While some information regarding possible dispersal locations has been obtained, it is impossible to predict exact locations DCCOs would relocate to and what specific effects, if any, there might be from their relocation. For several years, the Corps has attempted to obtain this information with banding DCCOs, placing radio and satellite tags on adult DCCOs and monitoring them, and conducting aerial surveys.

Although the sample sizes were limited during these monitoring efforts, there has been consistency in DCCO use areas, both during and after the nesting season. These regions are summarized throughout this document and addressed in the affected environment section. To obtain this information more precisely would be cost prohibitive as telemetry data can cost several thousand dollars per tracked bird. Reasonable estimates of impacts from DCCOs dispersing from East Sand Island to areas of the affected environment were made based on past research, likelihood of colonies to establish given habitat, food availability, and lack of predators or human disturbance, in coordination with the states of Oregon and Washington. To compensate for this uncertainty, all of the action alternatives include some monitoring to detect abundance of DCCOs in the estuary and abundance of DCCOs in coastal areas. Any information regarding effects of DCCO dispersal that is incomplete or unavailable at this time is equivalent among alternatives and therefore not essential to making a reasoned choice among alternatives.

4.6.5 Uncertainty and Compensatory Mortality

Uncertainty exists in estimating ecological effects or extrapolating results from past observed data to predict or estimate future conditions or effects. Modeling or analyses that contain more input parameters or have less direct information inherently have more associated uncertainty. To the extent possible, methods, limits, and assumptions made in modeling exercising have been discussed in the FEIS with justification as to why particular assumptions were made or particular approaches taken.

The issue of compensatory mortality was raised during public scoping and in public comments on the DEIS. Generally speaking, compensatory mortality is one type of mortality largely replacing or “compensating” for another kind of mortality, but the total mortality rate of the population remains constant. This is in contrast to additive mortality, meaning one source of mortality is added to another for a combined total effect. The degree to which a source of mortality is compensatory or additive is likely not a static condition but changes within the context of dynamically changing environmental conditions, population abundances, and complex food webs. Relevant to the FEIS is the degree to which juvenile salmonid mortality by DCCOs is compensatory (i.e., reduced juvenile salmonid mortality from DCCOs is replaced by another source of mortality).

The degree to which avian predation of juvenile salmonids in the Columbia River Basin is compensatory versus additive is currently unknown (Lyons et al. 2014). Recent research (Hostetter et al. 2012) and NOAA Fisheries’ alternative barge studies (Marsh et al. 2012) indicate DCCO predation of juvenile salmonids is neither completely additive nor completely compensatory. The Hostetter et al. (2012) study utilized PIT tag recoveries of

Snake River steelhead on a DCCO colony in the Columbia Plateau. Results indicated that fish in poor condition (i.e., diseased, injured, or otherwise compromised) were more susceptible to DCCO predation than apparently healthy smolts. Fish in poor condition would likely be more vulnerable to other sources of mortality, such as predation from other species or passage through the dams. If DCCO predation were decreased, these fish would still have a high probability of dying from other mortality factors, which would likely compensate for a reduction in DCCO predation. However, lower but still substantial levels of DCCO predation were observed on smolts seemingly in excellent condition, which suggests that some mortality from avian predation is additive or not likely to be compensated for by other sources of mortality. The extent that the results from this study upriver in the Columbia Plateau apply to the DCCO colony at East Sand Island at RM 5 is largely unknown. Out-migrating smolts near East Sand Island have already navigated and survived through the Columbia River and FCRPS; thus, these fish may be more proportionally representative of fish in excellent condition compared to those present upriver in the Columbia Plateau.

NOAA Fisheries' alternative barge study utilized paired groups of PIT-tagged steelhead and yearling Chinook smolts that were barged downstream and released in two locations: (1) downstream of Bonneville Dam, the location of current release site, and (2) downstream of Astoria, Oregon at night and on an outgoing tide to reduce avian predation impacts (Marsh et al. 2012). Groups that experienced lower avian predation rates in the estuary returned as adults at higher rates only some of the time (Marsh et al. 2012). These results provide no clear determination as to direction or magnitude of compensatory versus additive mortality for avian predation in the Columbia River Estuary. These results may also suggest that this effect is quite dynamic and depends upon environmental and biological conditions present at a given time since strength of evidence for either mortality type was variable among years.

A Corps-funded study evaluated DCCO predation impacts in the context of compensatory mortality using an age-structured salmonid population growth model and examining effects on the average annual population growth (i.e., lambda; Lyons et al. 2014). Lyons et al. (2014) noted that the actual degree of compensatory mortality of DCCO predation at East Sand Island is unknown but suggested that Lower Columbia River ESUs may experience more compensatory mortality than those from higher in the basin because upper basin smolts have experienced many of the rigors of out-migration by the time they reach the estuary, whereas Lower Columbia River smolts have not. Because the actual degree of potential compensation was unknown, the Lyons et al. (2014) analysis was structured and organized to represent a range of scenario-based conditions and respective minimum and maximum benefits to salmonids to provide context for understanding potential benefits in adult returns. The analysis represented scenarios of DCCO colony size reduction (i.e., 0, 25, 50, 75, and 100 percent) and various levels of compensatory mortality (i.e., 0, 25, 50, and 75 percent). Potential benefits to population growth rate were calculated as the survival benefit from the percent reduction in predation (as determined by reduction in colony size) less the percentage of considered compensation taken to the power of one divided by the generation time of the given species. For the completely additive scenario (i.e., no compensation), increases in lambda from one hundred percent colony reduction ranged from 0.4 to 2.1 percent depending on ESU/DPS (Lyons et al. 2014). The compensation scenarios approximately reduced the benefits of the completely additive mortality scenario by the percentage considered (e.g., the 25 percent compensation scenario reduced the benefits of the fully additive scenario for a given colony size reduction by 25 percent).

The NOAA Fisheries' 2014 Supplemental FCRPS Biological Opinion does not apply compensatory mortality to any of the RPA actions, including avian predation management (NOAA 2014). NOAA Fisheries Gap Analysis for determining RPA 46 colony size targets on East Sand Island (Appendix D) assumed that compensatory mortality, no matter what level it may be in actuality, would be similar between the "base" and "current" periods. The ultimate difference between the two periods results from the effect that the increase in DCCO abundance has had on salmonids populations; thus, the resulting target colony size to get back to the "base period" consumption rate under any level of compensation that is similar between the two periods would still need to be between 5,380 to 5,939 breeding pairs. In the FEIS, the fish effects analysis (Section 4.2.5 and Appendix C) and the economic analysis (Section 4.3 and Appendix I) does not apply compensatory mortality to any expected benefits (economic or juvenile survival) associated with reduced DCCO predation; thus, benefits from the proposed action are likely maximum benefits that could occur in the absence of compensatory mortality. Lyons et al. (2014) provide a relative range of potential increases that could occur to salmonid population growth rates from benefits to juvenile salmonid survival and for varying levels of compensation. These relative levels and scenarios could be applied to the juvenile survival benefits presented in Section 4.2.5 and Appendix C to approximate benefits to salmonid population growth rates.

For the purposes of this FEIS, benefits were presented in the manner they were because the degree to which avian predation of juvenile salmonids in the Columbia River Basin is compensatory versus additive is currently unknown; thus, there is no way to quantitatively include an exact measure in analyses aside from presenting the full potential range of scenarios, as was done in Lyons et al. (2014). Rather, benefits were presented as potential maximum values assuming no compensation, then it was qualitatively described that actual benefits could be less depending upon the degree of compensation actually observed and given other factors that are quantitatively unknown but could decrease potential benefits, such as actual levels of DCCO dispersal and the effectiveness at precluding DCCOs from the Columbia River Estuary if dispersed from East Sand Island. Additionally, the stated purpose and need is to reduce depredation damage caused by DCCO predation of juvenile salmonids, which is a well-studied and documented source of mortality. Constraining management due to unknown and speculative amounts of compensatory mortality would allow a known source of substantial mortality of juvenile salmonids within the Columbia River Estuary to continue unaltered.

In the context of the FCRPS BiOp, which comprehensively addresses mitigation measures across all salmonid life stages, individual RPA actions are most applicable to the life stage most directly involved, and mitigation measures and evaluation of the effectiveness of management should be directed toward that life stage. Thus, effects analyses for fish species and future management evaluation of DCCO predation impacts (i.e., PIT tag recoveries of juvenile salmonids) were limited to juvenile salmonids for these reasons. Economic effect analyses include adult fish returns and associated parameters because these are mandatory necessities to describe economic benefits.

4.6.6 Human Dimensions

This FEIS proposes alternatives to manage the largest colony of DCCOs in North America. The concept of wildlife management is fundamentally a human one that traditionally focused on managing wildlife and their habitats to attain game management or conservation goals. Success in this approach has led to some species becoming abundant or even overly abundant. As the needs or goals of humans conflict with the needs of wildlife there has been an increasing “human dimension” to wildlife management (Decker et al. 2001). This “human dimension” is driven by the way humans perceive, interact, or have conflict with wildlife over shared resources and is largely affected by an individual’s ethics and values.

Individual perceptions of the ethics of wildlife damage management and the appropriateness of specific management actions will depend on the value system of the individual. Values tend to be influenced primarily by socioeconomic status, age, gender, and experience or dependence on natural resources for cultural practice or subsistence (Kuentzel et al. 2012). Values of wildlife are generally oriented by one of two cultural ideologies: utilitarianism, which promotes beneficial “use” of wildlife (i.e., subsistence or economics) and egalitarianism, which promotes “non-use” and considers the inherent or aesthetic value of wildlife (Manfredo et al. 2008). An individual may value wildlife in more complex ways and not necessarily be restricted to any one set of values.

The differences in values held by various stakeholders interested in the Corps’ DCCO management plan were identified to some degree during public scoping and in public comments received. Many fishing groups expressed concern that too much time has passed without management, that the problem will only continue to worsen, compromising other recovery efforts and loss of personal income (perceived as reduced fishing opportunities due to DCCO predation), and that this situation is unacceptable. Many wildlife groups commented that DCCOs were being made scapegoats and suggested looking at the true causes endangering salmon and steelhead runs, which they stated were overfishing, too many hatchery fish being released that compete with wild fish, and the continued operation of the dams.

While there were some extremes in viewpoints, many comments received suggested a balanced approach in addressing the competing needs and recommended potential solutions, some of which have been integrated into the proposed alternatives and some of which were not due to concerns over their feasibility in meeting the purpose and need. The range of concerns expressed in public comments indicates there are substantial differences in the way DCCO predation impacts are perceived and the way to address the issue.

Some relevant social acceptability research has been done recently on the topic of DCCO management. Research suggests that support for DCCO management is influenced by attitude and values, beliefs about the impacts and species, and the context of the disturbance (Kuentzel et al. 2012; Bruskotter et al. 2009; Whittaker et al. 2006). DCCO social acceptability research regarding fishery impacts was completed in Lake Champlain. Boaters, anglers, individuals from environmental non-profits, and homeowners on the lake were surveyed to determine attitude strengths (degree of one’s feelings) about DCCOs, knowledge of DCCOs and their impacts to the fisheries, and to determine and predict support for DCCO management programs (Kuentzel et al. 2012). The survey results indicated that attitudes about DCCOs informed knowledge and beliefs. When attitudes were negative about DCCOs, respondents tended to exaggerate their knowledge on the topic of DCCO impacts to fisheries or property and were more supportive of management (Kuentzel et al. 2012). When attitudes were positive, respondents had more accurate knowledge of DCCO biology and were less concerned with DCCO impacts to the fishery and less supportive of management. Kuentzel et al. (2012) also found that approximately 21 percent of people expressed opposition to DCCO population controls, 24 percent were strongly supportive, and 53 percent were rather ambivalent. Individuals surveyed had some relative concern or connection with DCCO management or Lake Champlain, and a completely randomized sample of people might likely show higher levels of ambivalence toward DCCO management. Thus, the most vocal proponents on either side of DCCO management likely do not represent the vast majority of the public.

Both DCCOs and salmonids are natural components of the ecosystem and are protected under federal laws. Individuals that have an interest in the outcome of this plan do not all share common values, nor will any one management action or alternative appease all stakeholders. Thus, the issues presented in this FEIS pose a complex problem and the importance and relevance of the “human dimension” in this FEIS and management plan cannot be overstated.

4.7 Comparison of Alternatives and Summary of Environmental Consequences

This section provides a narrative comparison of the alternatives with focus on feasibility and summary of the environmental consequences. A more detailed description of the environmental effects of each alternative is included in Table 4-14.

Alternative A - No Action

Alternative A would not change the current conditions precipitating the need for action. Predation rates on juvenile salmonids would likely remain higher than rates estimated during the environmental baseline of the 2008 Federal Columbia River Power System Biological Opinion and would continue to be a substantial source of mortality. The abundance of and future growth of the East Sand Island colony would continue on current trends and would continue to account for approximately 40 percent of the western population. DCCOs are colonial waterbirds and the other colonies of birds nesting on East Sand Island (gulls, Caspian terns, brown pelicans) would continue to provide some social attraction (this would be true for all alternatives). The western population of DCCOs would likely remain at similar abundance levels in the near-term but may decrease in the future compared to current trends due to cumulative adverse effects, such as effects from climate change, drought, bald eagles, and other regional impacts.

Vegetation and soils within the DCCO colony would continue to be impacted by guano, resulting in the western end of the island largely denuded from vegetation and species diversity reduced. With the exception of the Caspian tern colony, which is currently subject to management and hazing, the colony size and abundance of other birds nesting on East Sand Island or within the region would remain similar to current estimates. Current levels of juvenile salmonid predation by DCCOs on East Sand Island (i.e., compared to Alternative D, which proposes to exclude all nesting by DCCO on East Sand Island would likely continue to result in potential annual losses of $6.4 million in hatchery production investment cost and $2.6 million to Columbia River in-river fisheries (i.e., for both direct financial value and regional economic impact). Direct or indirect adverse effects to public resources (health and human safety, personal property and public facilities) would be similar to past conditions before the management feasibility studies and dissuasion research, which increased short-term dispersal of DCCOs, particularly to the Astoria Bridge. There would be no adverse effects to historic properties since there would be no ground disturbance on the island. Direct or indirect effects to threatened or endangered fish outside of the Lower Columbia River Basin and streaked horned larks in the Columbia River Estuary would be similar to past conditions before the management feasibility studies and dissuasion research. This alternative would have the greatest beneficial effects regarding existence and aesthetic value to individuals with positive perceptions of DCCOs and adverse effects to individuals with negative perceptions of DCCOs.

Alternative B - Non-Lethal Management Focus with Limited Egg Take

Because RPA action 46 requires a reduction in predation over such a large geographic area (172 river miles) and movement data from research indicates DCCOs are strongly committed to nesting on East Sand Island and roosting in the Lower Columbia River Basin when hazing has prevented that nesting, there is little to no evidence to suggest a non-lethal management strategy would be practicable or effective at achieving the purpose and need of the FEIS and resolving the depredation damage throughout the Columbia River Estuary. Feasibility of this approach is further reduced given the timeline of the FCRPS Biological Opinion and RPA 46 action and the need to minimize DCCO dispersal so that DCCO predation impacts are not pushed to other areas of concern. Other DCCO management programs have implemented non-lethal management at large geographic scales (although smaller than the Columbia River Estuary) and they provide no reason to suggest this would be an effective approach on the scale proposed under Alternative B. Additionally, state resource agencies in Oregon and Washington are particularly concerned of DCCO abundance increases in their respective states.

Of particular concern in implementing Alternative B is the likelihood of increased predation of ESA-listed juvenile salmonids from DCCO dispersal to the Columbia River Estuary. In evaluating potential benefits, the action alternatives assume the colony would be reduced to approximately 5,600 pairs at the end of Phase I, resulting in average annual survival increases for juvenile salmonids of 1 to 4 percent depending on the ESU or DPS. However, these are likely maximum benefits that would vary annually depending upon factors such as environmental conditions and dispersal of DCCOs upriver. Under Alternative B, the likelihood is very high that a large number of DCCOS would disperse and relocate in the Columbia River Estuary. When compared to Alternative A and proposed lethal removal and reductions in Phase I of Alternatives C, C-1, and D, predation rates of juvenile salmonids are more likely to increase under Alternative B and there is less certainty that DCCO abundance could be reduced throughout the Columbia River Estuary. Similarly, Alternative B could result in increases of annual direct financial value and regional economic impacts of 3.4 percent ($1.4 million) and 3.0 percent ($1.5 million), respectively, and $3.6 million savings in direct financial investment in hatchery production, but potential benefits are less certain to occur.

Even if hazing were effective at preventing DCCO from foraging and/or nesting in the Columbia River Estuary, there is potential for adverse effects in other areas frequently used by DCCOS, particularly along the Washington coast and Salish Sea. Bull trout susceptibility to DCCO predation may be greater for migratory fish compared with resident fish, especially for bull trout that utilize estuaries. Extended use of estuaries and nearshore marine environments by juvenile Puget Sound Chinook and juvenile Hood Canal chum suggests they would be more vulnerable to DCCO predation if DCCOs disperse to coastal estuaries in Washington. Puget Sound steelhead smolts may move offshore more quickly, as compared with Puget Sound Chinook and Hood Canal chum salmon (NOAA 2011), and this would likely lessen their susceptibility to DCCO predation. Impacts to Ozette Lake sockeye are unknown but the potential for conflict exists, especially if sockeye use estuary or nearshore habitats for extended periods of time.

Because Alternative B proposes to utilize primarily non-lethal methods to achieve the colony size on East Sand Island, adverse effects to the western population of DCCOs are less than alternatives that consider lethal take. Abundance of the western population of DCCOs is expected to remain similar to current levels in the near term but may decline to a greater extent than Alternative A due to the factors described plus additional loss of habitat at East Sand Island from the Phase II terrain modification and future limitation of the colony. Based on modeled results of long-term trend, a gradual decrease is predicted, with abundance stabilizing at approximately 46,000 breeding individual in years 13-20 after implementation (see Figure 4-5). Effects to vegetation could decrease over time as passive restoration occurs in areas DCCO are excluded from nesting.

In addition to concerns about effects to ESA-listed fish, there would likely be adverse effects to streaked horned larks with the larger scale hazing proposed in Alternative B. Dispersal of approximately 15,000 individual DCCOs under Alternative B is expected to increase the level of human disturbance on Rice Island, Miller Sands Spit, both historic colonies with relatively recent DCCO nesting attempts, and Pillar Rock Island. These islands support breeding pairs of streaked horned larks. Potential effects to streaked horned larks would be similar to effects to non-target species nesting on East Sand Island during management activities and could include flushing adults or young, increased exposure of eggs and juveniles to weather and predation, nest abandonment or destruction, and possible mortality of eggs or young (USFWS 2014c). Depending on the proximity, frequency, and duration of these activities, hazing efforts could result in reduced survival, and dissuasion measures could preclude the use of suitable nesting habitat, which would have indirect effects (USFWS 2014c). The Columbia River is particularly important to the conservation of streaked horned larks, given that the current range-wide population is estimated to only be about 1,170 to 1,610 individuals, with 150 to 170 breeding individuals at six sites in Oregon and Washington (Altman 2011; 78 FR 61452) and 45-60 breeding pairs in the Columbia River Estuary (Anderson 2013).

Indirect adverse effects to public resources, particularly to the Astoria-Megler Bridge, would be higher because of increased dispersal and DCCO use. This alternative would have adverse or beneficial effects (depending on the individual's values and perspective) regarding existence and aesthetic value and effects would likely be intermediate between the no action alternative and alternatives that proposed lethal take.

Alternative C - Culling with Integrated Non-Lethal Methods

Other large-scale culling efforts at DCCO breeding colonies have been documented (Bedard et al. 1997; Ontario Parks 2008). Results of these studies (summarized in Section 2.2.3) suggest Alternative C is technically feasible at meeting the purpose and need. The field techniques proposed for Alternative C would likely be as or more effective in lethally taking DCCOs than the studies cited (due to proposed timing of activities, night shooting, use of firearm suppressors, etc.); thus, feasibility of achieving potential take levels and doing so within a relatively short time period on-island is high. Adaptive management and methods to minimize dispersal would be taken to minimize environmental effects to other areas. All alternatives propose terrain modification and other habitat management and hazing presence to restrict colony expansion would function to restrict colony size and prevent future immigration of DCCO in the long-term.

Of the life stages on which lethal take could occur, take of adult individuals is likely the most direct approach to reducing the colony size to 5,380-5,939 breeding pairs within the timeframe of the 2014 FCRPS Biological Opinion (NOAA 2014). Lethal take of breeding adults has a greater impact on reducing abundance than removing eggs, chicks, or fledglings, as DCCOs are a long-lived species with high adult survival relative to other life stages and breed throughout their adult lives (Ludwig and Summer 1995; Hatch and Weseloh 1999; Blackwell et al. 2002; also see Appendix E). Ludwig and Summer (1995) estimated that culling adults had a 3- to 6-fold greater effect on the population than culling fledglings, chicks, or eggs. DCCOs typically breed in their third year (Hatch and Weseloh 1999), and, with egg take, there would be a multiple year delay before decreased recruitment affects the colony or population size (Bedard et al. 1997; Guillaumet et al. 2014).

Compared to all other alternatives, Alternative C would have the most direct and adverse impact to the abundance and future growth rate of the western population of DCCOs during Phase I. Abundance of the western population of DCCOs is projected to be approximately 35,000 breeding individuals after Phase I and increase to a long-term 20 year projected size of approximately 44,500 breeding individuals (see Figure 4-7). Due to the magnitude of proposed take and potential for misidentification during culling, the direct impacts to Brandt's and pelagic cormorants could be higher than Alternative C-1, but this would depend upon the effectiveness and amount of boat-based culling that takes place, an activity that has a greater potential to take Brandt's and pelagic cormorants. Up to 0.3 and 0.06 percent of the regional population of Brandt's and pelagic cormorants could be taken per year, respectively. Other birds nesting on East Sand Island would likely be affected (i.e., flushing, loss off eggs, etc.) from human disturbance, but this would likely be less than or similar to that of Alternative B.

Compared to Alternatives A and B (and Phase II of Alternative D), Alternative C has a greater certainty of reducing predation of juvenile salmonids within the Columbia River Estuary and minimizing potential adverse effects to listed fish species outside of the Columbia River Estuary. Thus, this alternative provides the greatest potential benefits to juvenile salmonids and economic benefits.

Because DCCO dispersal is expected to be least under this alternative, there is a much lower potential for adverse effects to other species or resources off of East Sand Island, as compared to Alternative B. Implementation of Alternative C is not expected to result in greater effects to streaked horned larks beyond what is currently planned for the Corps' navigation program. Effects to other resources in the affected environment would likely remain similar to existing conditions. This alternative would have adverse or beneficial effects (depending on the individual's values and perspective) regarding existence and aesthetic value and effects would likely be greater than the other alternatives because culling adults is the primary lethal strategy.

Alternative C-1 - Culling with Egg Oiling and Integrated Non-Lethal Methods *(Preferred Management Alternative)*

The results of studies cited in Alternative C and additional research that has documented greater effects of reducing colony abundance from an integrated culling and egg oiling program (Guillaumet et al. 2014) or similar or higher levels of egg oiling on a DCCO colony (e.g., Strickland 2011 and Russell et al. 2012) all suggest Alternative C-1 is technically feasible in achieving the purpose and need and could do so with lessened negative impact to the western population of DCCOs when compared to Alternative C. Adaptive management would also ensure minimal dispersal and that levels would be similar to Alternative C; however, greater dispersal could occur if there is additional dispersal between years due to nesting failure from egg oiling or increased incursion into the colony compared to Alternative C.

Compared to Alternative C, Alternative C-1 has a lesser effect on the western population because the number of individual DCCOs culled would be reduced by approximately 40 (i.e., take of approximately 11,000 versus 18,000 total breeding individuals). This reduction is expect to lessen the impacts to the western population, resulting in a higher abundance and a shorter period in which the projected abundance is predicted to fall below the ca. 1990 population level (4 years versus 9 years). Abundance of the western population of DCCOs is projected to be approximately 38,500 breeding individuals after Phase I and increase to a long-term 20 year projected size of approximately 45,000 breeding individuals (see Figure 4-10).

Because fewer DCCOs would be culled under Alternative C-1, as compared to Alternative C, there is less potential for take of Brandt's and pelagic cormorants. However, under Alternative C-1, a greater proportion of individuals could be culled over-water compared to Alternative C to reduce incursion and disturbance to the colony, which may reduce the difference in potential take levels between the two alternatives. Implementation of Alternative C-1 would likely occur later into the breeding season compared to Alternative C and this could have additional impacts to non-target nesting birds on East Sand Island due to egg oiling activities.

Overall, benefits to juvenile salmonids, economic benefits, and adverse effects to other resources would be similar to Alternative C; however, greater DCCO dispersal could occur under Alternative C-1 compared to Alternative C if additional disturbance events associated with combining culling and egg oiling occur on the colony and there is more dispersal between years, which would decrease similarity in expected effects. Effects to existence and aesthetic values would be similar to Alternative C, but the reduction in culling by 40 percent and the inclusion of egg oiling into the alternative could lessen the effects to individuals who have a high existence value for double-crested cormorants and who perceive egg oiling as a more humane method compared to culling adults.

Alternative D - Culling with Exclusion of DCCO Nesting on East Sand Island in Phase II

Alternative D in Phase I is the same as Alternative C-1. In Phase II, there would be a greater certainty in reducing predation of juvenile salmonids because DCCOs would no longer nest on East Sand Island; however, similar to Alternative B, predation impacts could increase, at least in the short-term when compared to Alternatives A, C, and C-1, as the full benefits would not be realized until dispersed DCCO are redistributed outside the Columbia River Estuary. Because Alternative D proposes to exclude all DCCO nesting on East Sand Island, economic increases to in-river Columbia River fisheries could be greater than Alternatives B, C, and C-1. Economic increases of up to 6.1 percent ($2.6 million; annual direct financial value) and 5.3 percent ($2.6 million; regional economic impact) and savings of $6.4 million in direct financial investment in hatchery production may be realized.

Alternative D has the greatest overall adverse impact to the western population of DCCOs because it reduces abundance via lethal take and prevents all DCCO nesting on East Sand Island. Abundance of the western population of DCCOs is projected to decrease to a low abundance of approximately 33,000 breeding individuals and remain below the ca. 1990 levels but slightly increase to a long-term 20 year projected size of approximately 37,500 breeding individuals (see Figure 4-12). DCCO dispersal and non-lethal management and hazing efforts on East Sand Island and in the Columbia River Estuary would be similar to Phase I of Alternative B. Thus, the expected benefits from additional DCCO abundance reduction would be less certain and the potential adverse effects to resources potentially affected by DCCO dispersal and hazing (e.g., streaked horned lark, Astoria-Megler bridge, ESA-listed fish within and outside the Columbia River Estuary) would similar to Phase I of Alternative B and greater than the other alternatives during Phase II.

TABLE 4-14. Summary of Environmental Consequences from Proposed Alternatives.

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
Vegetation and Soils on East Sand Island	Vegetation and soils over the 16 acres of the DCCO colony would continue to be impacted by guano. If colony increases potential for more vegetation to be impacted.	Phase I: Vegetation and soils could experience passive restoration if DCCO colony were reduced. Phase II: conversion of current bare sand to tidal mudflat or marsh areas could increase diversity of vegetation and soil complexity.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B. Greater restoration in Phase II since no DCCO colony.
Western Population of DCCOs	Remain similar to current estimate (62,400 breeding individuals) in the near term but may decline in the future; 20-year predicted abundance of 53,000 breeding individuals; approximately 40-50 percent of breeding population at East Sand Island colony.	Remain similar to current estimate in the near term but abundance and future growth may decline to a greater extent than Alternative A; predicted long-term gradual decreasing trend with a 20-year predicted abundance of approximately 46,000 breeding individuals; approximately 24 percent (11,200/46,000) of breeding population at East Sand Island.	Abundance reduced to approximately 35,000 breeding individuals after Phase I and then a gradual increasing trend to a 20-year predicted abundance of 44,500; approximately 32 percent (11,200/35,000) of breeding population at East Sand Island after Phase I and 25 percent (11,200/44,500) after Phase II.	Abundance reduced to approximately 38,500 breeding individuals after Phase I and then a gradual increasing trend to a 20-year predicted abundance of 45,000; approximately 29 (11,200/38,500) and 25 (11,200/45,000) percent of breeding population at East Sand Island after Phase 1 and Phase II, respectively.	Phase I: Same as Alternative C-1. Phase II: Abundance reduced to approximately 33,000 breeding individuals and then a gradual increasing trend to a 20-year predicted abundance of 37,500; approximately 29 and 0 percent of breeding population at East Sand Island after Phase I and II, respectively.
Other Birds on ESI	Abundance would remain similar to current estimates; spatial distribution of nesting species would remain similar;	Phase I: High potential for DCCO use and hazing outside designated nesting area throughout breeding season; potential for take from hazing activities; high potential to significantly reduce abundance or	Phase I: Low potential for overall DCCO use and hazing outside of designated nesting area; potential for take from hazing activities;	Phase I: Similar to Alternative C. Moderate to low impacts to other nesting species; potential for take of up to 0.1 percent of Brandt's	Phase I: Same as Alternative C-1. Phase II: High levels of hazing throughout island

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
	California brown pelican distribution more uniform with decrease in management activities.	exclude nesting of Brandt's cormorants; moderate to high potential to significantly reduce colony size of other nesting species (gulls and terns); low to moderate potential to reduce abundance of California brown pelicans or for species to abandon East Sand Island. Phase II: High potential for DCCO use and hazing on east side of island for both the short- and long-term; high potential to significantly reduce abundance or exclude nesting of Brandt's cormorants; moderate to high potential to significantly reduce colony size of other nesting species; low to moderate potential to reduce abundance of brown pelicans or for species to abandon East Sand Island. Beneficial effects to California brown pelicans and shorebirds from terrain modification.	potential for take of up to 0.3 percent of Brandt's cormorant regional population per year; moderate potential to significantly reduce colony size of Brandt's cormorants; low potential to exclude Brandt's cormorant from nesting; low to moderate potential to significantly reduce colony size of other nesting species; low potential to reduce abundance of California brown pelicans or for species to abandon East Sand Island. Phase II: Same as Alternative B.	cormorant regional population per year. Phase II: Same as Alternative B.	to exclude DCCOs in short-term but low thereafter; high potential to exclude nesting of Brandt's cormorants and reduce abundance or exclude other species.
Other Birds in Region	Abundance and distribution of other bird species would likely remain similar to current conditions in the near-term.	Phase I: High potential for DCCO dispersal; high potential for adverse effects to streaked horned larks from dispersal and DCCO hazing in estuary; potential for take from hazing activities; effects to other birds commensurate with dispersal levels to new areas and	Phase I: Low potential for DCCO dispersal; low potential for adverse effects to streaked horned larks from dispersal and subsequent DCCO hazing; potential for take from hazing activities; potential for	Phase I: Similar to Alternative C but dispersal levels may be slightly higher; potential for take of up to 0.04 percent of pelagic cormorant regional population per year. Phase II: Same as	Phase I: Same as alternative C-1. Phase II: High potential for DCCO dispersal in short-term and for on-going hazing in estuary (effects

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
		subsequent site-specific interactions. Phase II: Similar to Phase I; effects commensurate with dispersal levels.	take of up to 0.06 percent of pelagic cormorant regional population per year; effects to other birds commensurate with dispersal levels to new areas and subsequent site-specific interactions. Phase II: Similar to Phase II of Alternative B. Low potential for DCCO dispersal in short-term but could increase with time.	Alternative C.	similar to Phase I of Alternative B in short-term); no effects should all DCCOs be redistributed outside the estuary.
Lower Columbia River Basin ESA-listed Fish	DCCO predation remain similar to current estimates in the near-term; >11 million juvenile salmonids consumed annually on average, exceeding 20 million in some years.	Phase I and II: Average annual juvenile salmonid survival increases of 1 to 4 percent (depending on group); benefits less certain; likely to not fully realize juvenile salmonid survival benefits in the short-term because hazing is not expected to be 100 percent successful in keeping DCCO out of estuary. Discountable or adverse (impaction, water quality) effects from construction related to terrain modification. Long-term beneficial (increased nutrients and prey, improved habitat) and adverse (increased vulnerability to predators) effects from terrain	Phase I: Same as alternative B, but benefits more certain and expectation is to fully realize juvenile salmonid survival benefits in the short-term. Phase II: Same as alternative B, but benefits more certain and expectation is to fully realize juvenile salmonid survival benefits in the short-term; survival benefits could decrease with time. Same effects from	Phase I: Similar to Alternative C but dispersal levels may be slightly higher. Phase II: Same as Alternative C.	Phase I: Same as Alternative C-1. Phase II: Average annual juvenile salmonid survival increases of 2 to 8 percent (depending on ESU/DPS); but benefits less certain and may not realize these benefits in the short-term (similar to Alternative B).

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
		modification.	terrain modification as Alternative B.		
Other ESA-listed Fish in Region	DCCO predation would remain similar to current estimates in the near-term.	Phase I: High potential for DCCO dispersal; effects to ESA-listed fish commensurate with dispersal levels to new areas and subsequent site-specific interactions; potential effects would be greatest to salmonid species in freshwater and estuary habitats that occur within the foraging range of DCCO breeding colonies or high use areas within the sub-regions of the affected environment, particularly the Washington coast and Salish Sea. Potential impacts to Pacific eulachon are expected to be minimal because of little temporal overlap between spawning and DCCO nesting. Impacts to rockfish species are also expected to be minimal because of their large size at reproduction and use of deep water, although some impacts to juveniles and larvae could occur.	Phase I: Low potential for DCCO dispersal; effects to ESA-listed fish commensurate with dispersal levels to new areas and subsequent site-specific interactions. Phase II: Similar to Phase II of Alternative B. Low potential for DCCO dispersal in short-term but could increase with time.	Phase I: Similar to Alternative C but dispersal levels may be slightly higher. Phase II: Same as Alternative C.	Phase I: Same as Alternative C-1. Phase II: High potential for DCCO dispersal in short-term (effects similar to Phase I of Alternative B in short-term); no effects should all DCCOs be redistributed outside the estuary.

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
		Phase II: Similar to Phase I; effects commensurate with dispersal levels.			
Fisheries	Annual economic value of in-river Columbia River fisheries would likely remain similar to baseline in the near-term; annual direct financial value of $41.9 M (tribal commercial [3.8 M], non-Indian commercial [4.2 M]), and freshwater sport recreational [34.0 M]); annual regional economic impact of $49.0 M (tribal commercial [7.3 M], non-Indian commercial [7.1 M]), and freshwater sport recreational [34.6 M]). Predation by the DCCO colony on East Sand Island (compared to Alt D) would likely continue to result in annual loss of 3.7 percent ($0.1 million) direct financial value and 4.2 percent ($0.3 million) regional economic impact to tribal fisheries; annual	Phase I and II: Annual direct financial value increases of 3.4 percent ($1.4 M) for tribal commercial (2.1 percent [$0.1 M]), non-Indian commercial (1.9 percent [$0.1 M]), and freshwater sport recreational (3.8 percent [$1.3 M]); annual regional economic impact increases of 3.0 percent ($1.5 M) for tribal commercial (2.4 percent [$0.2 M]), non-Indian commercial (1.9 percent [$0.1 M]), and freshwater sport recreational (3.3 percent [$1.1 M]). Annual total hatchery investment cost savings (both tribal and non-tribal related) from DCCO consumption of 56 percent ($3.6 million); economic benefits less certain and would not be fully realized until DCCOs above the target size permanently emigrate away from the estuary.	Phase I and II: Same economic increases as Alternative B since end colony size is the same; benefits are more certain and expected to be realized more quickly because minimal dispersal is expected.	Phase I: Similar to Alternative C but dispersal levels may be slightly higher. Phase II: Same as Alternative C.	Phase I: Same as Alternative C-1. Phase II: Annual direct financial value increases of 6.1 percent ($2.6 M) for tribal commercial (3.7 percent [$0.1 M]), non-Indian commercial (3.3 percent [$0.1 M]), and freshwater sport recreational (6.8 percent [$2.3 M]); annual regional economic impact increases of 5.3 percent ($2.6 M) for tribal commercial (4.2 percent [$0.3 M]), non-Indian commercial (3.3 percent [$0.2 M]), and freshwater sport recreational (5.9 percent [$2.0 M]). Annual total hatchery

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
	loss of 6.8 percent ($2.3 million) direct financial value and 5.9 percent ($2.0 million) regional economic impact to freshwater sport recreational fisheries; annual loss of 3.3 percent ($0.1 million) direct financial value and 3.3 percent ($0.2 million) regional economic impact to non-Indian commercial fisheries. Total hatchery investment costs (both tribal and non-tribal related) curtailed by DCCO predation would likely remain similar to baseline conditions in the near-term at $6.4 million.				investment cost savings (both tribal and non-tribal-related) from DCCO consumption of 100 percent ($6.4 million); economic benefits less certain and would not be fully realized until all DCCOs permanently emigrate away from the estuary.
Public Resources	Direct or indirect adverse effects to public resources (public health and human safety, transportation facilities, dams, and hatcheries) would be similar to past conditions before management feasibility studies and dissuasion research on East Sand	Phase I: High potential for DCCO dispersal; high persistent DCCO use of the Astoria-Megler Bridge throughout the breeding season expected and high potential for adverse effects from DCCO guano corrosion. Effects to other transportation structures and dams and hatcheries commensurate with dispersal levels to new areas. No adverse effects to human health and	Phase I: Low potential for DCCO dispersal; short-term DCCO use of the Astoria-Megler Bridge during the primary time period of lethal take during Phase I could occur, but persistent use throughout the breeding season or adverse effects not expected; effects to	Phase I: Similar to Alternative C but dispersal levels may be slightly higher. Phase II: Same as Alternative C.	Phase I: Same as Alternative C. Phase II: High potential for DCCO dispersal in short-term (effects similar to Phase I of Alternative B in short-term); no effects should all DCCOs be

Affected Resource	No Action	Alternative B	Alternative C	Alternative C-1	Alternative D
	Island.	safety. With high nesting concentration on East Sand Island and high levels of dispersal, potential for disease transmission among DCCOs to be higher than prior levels, but adverse effects from disease to humans or other wildlife species not documented or low. Phase II: Similar to Phase I; effects commensurate with dispersal levels.	other transportation structures and dams and hatcheries commensurate with dispersal levels to new areas but assumed to be low. Risk to human safety from culling activities is low. Adverse effects from disease similar to Alternative B. Phase II: Similar to Phase II of Alternative B. Low potential for DCCO dispersal in short-term but could increase with time.		redistributed outside the estuary.
Historic Properties	No effect to historic properties.	Phase I: No adverse effects. Phase II: Terrain modification could adversely affect basalt rock armor because of removal of some rock and the World War II observation tower because of increased tidal inundation.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.

Chapter 5 Proposed Management Plan

Alternative C-1 is the Corps' preferred alternative. After evaluating the environmental consequences of each alternative when compared to the technical and logistical feasibility of achieving the FEIS purpose and need of reducing predation impacts throughout the Columbia River Estuary, adoption and implementation of the DCCO management plan described in Alternative C-1 best meets the Corps' statutory mission and responsibilities under the Endangered Species Act as identified by the 2014 FCRPS Supplemental Biological Opinion. Alternative C-1 also reduces effects to the western population of DCCOs.

Because Alternative C-1 proposes a reduction in colony size abundance through culling and egg oiling, there is more certainty this alternative would meet the need of reducing DCCO predation throughout the Columbia River Estuary than Alternative B and Alternative D in Phase II, which propose abundance reduction through dispersal. Minimal DCCO dispersal is expected under Alternative C-1 given proposed field techniques, use of boat-based shooting, and dispersal thresholds. However, the number of disturbance events associated with culling or egg oiling events could be higher compared to Alternative C if boat-based shooting is ineffective and thus more management occurs on the island.

Because response and dispersal of DCCOs will be monitored and activities on the island could cease if they are causing a substantial amount of dispersal, this alternative has more certainty in having few adverse effects to non-target species and resources off East Sand Island. Compared to Alternatives B and D, Alternative C-1 has a lower associated dollar cost for implementation and, given the breadth of the Columbia River Estuary, a greater certainty that indefinite commitment of resources would not be needed to achieve management goals of reduced predation in the Columbia River Estuary.

Implementation Plan

Phase I

The preferred management plan would have two phases. Phase I is expected to last approximately four years and is scheduled to begin in 2015, when the Corps proposes to begin culling individual DCCOs and oiling eggs in nests to achieve a colony size of 5,380–5,939 breeding pairs. Under a 4-year lethal strategy, 13.5 percent of the DCCO colony would be culled each year, resulting in a total take of 10,912 DCCOs in all years (3,489, 3,114, 2,408, and 1,902 DCCOs in years 1 to 4, respectively). The proposed individual take levels would include associated indirect nest loss that could occur from taking individuals with nests. In addition, total nest loss from both associated indirect loss and direct nest destruction via egg oiling would be implemented at a rate of 72.5 percent in years 1-3; the total number of nests oiled would be 15,184 (5,879, 5,247, and 4,058 nests in years 1 to 3, respectively).

A depredation permit application would be submitted to the USFWS each year and would need to be approved prior to implementing activities that involve take. The Corps would request technical assistance from USDA-WS in directly implementing the plan. Removal of individual DCCOs on and in the foraging range (25km) of East Sand Island would occur for 4 years, combined with the destruction of nests through egg oiling for 3 years using the proposed annual take levels in Table 5-1. Lethal take would occur in two generally defined areas in relation to East Sand Island: 1) over-water in the foraging area and 2) on-island. Culling would take place primarily on-island if boat-based culling is ineffective.

TABLE 5-1. Proposed Annual Take Levels.

Year	# individuals taken[10]	Associated nests lost through culling individuals[11]	Nests lost through egg oiling	Total nests lost
1	3,489	3,489	5,879	9,368
2	3,114	3,114	5,247	8,361
3	2,408	2,408	4,058	6,466
4	1,902	1,902	0	1,902
Total	10,912	10,912	15,184	26,096

[10] Increased take could also be considered above what is stated in the proposed take levels under adaptive management. This is described in Chapter 2 and Appendix E of the FEIS.

[11] "Active nests lost" values represent the upper bound of potential egg loss that could occur indirectly from taking individuals. The period of active nesting begins after eggs are laid, typically around March 27.

Once the management goal for colony size on East Sand Island is achieved in Phase I, Phase II would begin and includes non-lethal actions, primarily habitat modification, to ensure the number of DCCOs on East Sand Island does not exceed 5,380–5,939 breeding pairs. In Phase II no efforts would be made to maintain a minimum DCCO colony size on East Sand Island or to reduce DCCO abundance below 5,380 breeding pairs. The majority of management on East Sand Island would take place on the western portion of the island, where DCCOs nest (Figure 5-1).

FIGURE 5-1. East Sand Island DCCO nesting and use area.

Mobilization and Field Preparation

Field crew personnel would arrive on East Sand Island each year (prior to nesting season) to transport supplies and equipment and make any necessary preparations for management that year. Temporary housing (i.e., tents or weatherports) would be constructed and maintained, as personnel may be present 24 hours a day during the period of active hazing. Individuals would follow designated travel routes to minimize potential impacts on other wildlife. Travel by all-terrain vehicles (ATVs) would occur along compacted sand along the shore or on previously established ATV paths. Boat landing and loading points would be chosen to reduce potential disturbance. Protective fences would be used to conceal hazing activities from designated nesting areas. Established trails would be used to minimize human impacts on vegetation.

To facilitate management while minimizing impacts to non-target DCCOs and other nesting birds, additional silt fence installation and maintenance and modification of existing blinds would be conducted prior to birds nesting on the island (Figure 5-2). Silt fence would be installed to break up dense groups of DCCOs into smaller areas that would be targeted while minimizing disturbance to nesting birds in other nearby areas. Silt fence would connect the tunnels on the east side of the colony to the tunnels near the west tower to minimize human disturbance. Personnel would attempt to walk behind and stay below the top of the silt fence when moving across the island. The east privacy fence would be reinstalled as well to create a visual barrier when accessing the east tower.

FIGURE 5-2. Example of additional silt fence and existing structures that could be used to delineate lethal removal areas, and reduce disturbance to non-target birds on the DCCO breeding colony on East Sand Island.

Culling and Egg Oiling on East Sand Island

Culling on-island would initially be attempted as early in the year as possible and before active nests are present to determine the feasibility of lethally removing individuals without causing excessive DCCO dispersal and to minimize actions during the chick rearing phase. Culling on-island could occur during the day or night using night-vision optics. Take of individuals would occur by use of firearms with non-toxic ammunition. Preferred shooting distance would be between 25-75 yards but could extend to 100 yards or more depending on DCCO location and response to shooting. The number of shooting events on-island per year is estimated to be 6-8, but could be higher or lower depending upon the response of DCCO and efficacy of boat-based shooting. The number of egg oiling events is estimated to be 4-6 per year, but could be higher depending upon response of DCCOs.

Prior to management, field personnel would initially conduct surveys for DCCO abundance and activity at various points on the Oregon and Washington side of the Columbia River. Personnel may be deployed to observe birds on East Sand Island from the blinds or in a boat observing DCCOs foraging in the Columbia River Estuary, concentrating in areas downstream of the Astoria-Megler Bridge. On-island shooting would occur as personnel observe the colony from various blinds and identify optimal shooting locations based on suitable numbers of DCCOs and minimal presence of non-targets. A culling event would include multiple individuals shooting from observation points (ground or elevated) and existing structures on East Sand Island using rifles. Two shooters would likely operate from the same blind with an additional person assisting with observation and logistics. Personnel would monitor remaining DCCOs (likely from a different position opposite the direction of shooting) to determine responses and potential for dispersal or abandonment and would communicate via radio. During nighttime shooting, a thermal vision unit would be used to aid in observing DCCO response and to identify potential human activity in the vicinity of East Sand Island.

On-island culling and egg-oiling would occur in separate managed areas to the extent possible to reduce the potential effects on non-target nesting birds and reduce the number of incursions into a given management area (Figure 5-2). Take of nests through egg oiling or removal would occur during the day or night on East Sand Island. Field personnel would initially conduct surveys for DCCO and non-target species to determine the distribution of their nests. This would continue through the breeding season to determine species' use within areas designated for egg oiling. Personnel would identify DCCO and non-target nests from blinds prior to egg oiling. Egg oiling would occur in the area DCCOs have used in the past and likely on the western half of the DCCO nesting area (Figure 5-1). The egg oiling areas would be selected where the densities of non-target species is low and in areas not already identified as areas for culling individuals. Overlap could occur near the end of the breeding season if necessary to achieve the planned number of individuals culled.

Egg oiling could occur from approximately May through July, from peak incubation through peak fledging, and would likely be carried out in 2-3 week intervals. Personnel would use backpack sprayers with food grade corn oil. During active egg oiling activities, personnel would walk through the managed area and thoroughly coat each egg in a nest with oil and mark each nest with marking paint to ensure efficiency (reduce duplication) and accurate recording of number of nests oiled. Time on the colony and number of incursions would be minimized by using up to four people for each egg oiling event and by close observation of the nesting synchronicity. Fewer egg oiling events would be needed if the DCCOs nesting within an area have synchronized nesting.

Carcasses would be retrieved and removed immediately or as soon as feasible after the conclusion of lethal take with the intention to minimize disturbance to non-target nesting DCCOs and other non-target nesting species. Lights would be used to aid in carcass recovery at night. If this is not feasible, carcasses would be recovered the following day when DCCOs have left the island to forage. Carcass recovery would involve gathering DCCOs by hand and moving them to the north side of the tunnels. Wounded birds would be dispatched immediately using humane euthanasia techniques (see Chapter 2, Section 2.1.2) to minimize prolonged suffering of those individuals. Utility carts, small inflatable boats, and ATVs (using established trails along the northern shoreline) would be used to transport carcasses off island to nearby disposal locations. When possible, lethally removed birds or eggs would be donated to a public educational or scientific institution, Non-Eagle Feather Repositories, or other entities authorized to possess birds. Carcasses not donated for these purposes would be disposed of following standard conditions of 50 C.F.R. 21.41, which include burial and incineration, and any special conditions specified in a depredation permit.

Culling Over Water within Foraging Range of the DCCO Colony on East Sand Island

Boat-based culling could begin in early April and end when post-breeding dispersal is underway. Boat-based culling would be conducted a sufficient distance from East Sand Island so birds on the colony were not disturbed. Personnel would avoid shooting at large flocks to minimize sensitization to shooting. If DCCOs become wary to boat-based shooting from associated disturbance and noise, locations of culling could change within the foraging area (25km) to increase effectiveness.

Personnel would use shotguns and directly approach DCCOs with boats and shoot once in effective range or situate boats and individuals in the flight path of DCCOs. Pursuant to depredation regulations (50 C.F.R. § 21.41), shotguns would not be larger than 10-gauge and decoys and concealment would not be used to entice birds into gun range. Noise associated from boat-based shooting would also be used to deter DCCO foraging.

Culled birds would be retrieved soon after being shot and wounded birds would be dispatched immediately using humane euthanasia techniques (see Chapter 2, Section 2.1.2) and recovered. As with on-island shooting, carcasses would be collected and taken in the boat to a nearby disposal facility and off-loaded. For boat-based culling, where culled individuals would fall in open water, take activities would cease frequently enough in order to retrieve culled individuals while they are in the proximal area, or other boats and personnel would monitor or be positioned away from the site of culling to retrieve carcasses (i.e., downriver, along shorelines).

Minimizing the Potential for DCCO Dispersal or Colony Abandonment

Short-term and short-distance dispersal from management activities (Roby et al. 2012, 2013, 2014) and daily movements for foraging (foraging range typically < 25 km; Anderson et al. 2004a) are expected. An increase in DCCO dispersal from East Sand Island is suggested by 1) a large disparity between the expected colony abundance and the observed colony abundance, 2) increased DCCO abundance in the Columbia River Estuary upstream of the typical known foraging range of DCCOs from East Sand Island (i.e., 25 km; Anderson et al. 2004a), or 3) an increase of DCCO abundance in other monitored areas outside the Columbia River Estuary.

Both day and night shooting would be attempted and if one timeframe results in less dispersal, that would be the primary time on-island shooting would occur throughout the project. Silencers and sub-sonic (i.e., slower than the speed of sound) shot would be used to minimize noise disturbance. To further minimize the potential for dispersal and colony abandonment, the island would be left undisturbed after a culling event until another culling session occurs (likely the following week).

Shooting would cease if excessive dispersal of DCCOs occurs. Excessive dispersal would be determined by a dispersal threshold, which is identified as an observed abundance that is 70 percent or less than the expected post-take abundance one week after the culling event.[12] For example, if observed abundance was 5,000 breeding individuals at the time of the culling event and 500 breeding individuals were culled, expected abundance would be 4,500 breeding individuals. An abundance of 3,150 (0.7 x 4,500) breeding individuals would be the dispersal threshold. If observed abundance one week after the culling event is less than the dispersal threshold, culling on-island would temporarily cease until observed abundance returns to at least 90 percent of the expected post-take abundance. In the example provided, this would be 4,050 breeding individuals (0.9 x 4,500). Once observed abundance returns to at least 90 percent of the expected abundance, culling could continue.

Management actions (i.e., type, frequency, location, and duration) would be adjusted depending on effectiveness of technique and resulting dispersal levels in comparison to the dispersal threshold. Initially, culling would be attempted as early in the year as possible, but if the lower dispersal threshold is exceeded, culling would not occur until DCCO are observed building and attending active nests (late April). The same dispersal thresholds would be used for modifying the frequency of culling sessions on-island once active nests are present. Changes in management actions to reduce dispersal from egg oiling so as not to exceed the lower dispersal threshold include: changing the number of personnel conducting egg oiling to decrease time on colony site, or changing the number of disturbance points; changing locations in colony that may be less susceptible to dispersal; and/or decreasing the frequency and intensity of egg oiling.

Preventing DCCOs from Nesting in New Areas on East Sand Island

Hazing would be conducted on the eastern portion of East Sand Island to prevent DCCOs from nesting in new areas. Personnel would observe DCCOs from blinds or similar structures and the following observations or behaviors on the eastern portion of the island would trigger a hazing event: 1) DCCO breeding behavior (i.e., courtship, nest building, or copulation); 2) more than 50 DCCOs loafing in an area; and 3) DCCOs

[12] Dispersal threshold was chosen based upon cooperating agency input and was determined to be a level that would take into account variation in colony size and not create a management situation that is over- or under-reactive to natural changes in DCCO abundance. This threshold would be assessed based upon all relevant monitoring data available at the time of the assessment, including data from ground, aerial, and other surveys on East Sand Island and within and outside the Columbia River Estuary.

present at twilight (i.e., preparing to roost overnight). Hazing triggers would be adapted if they are ineffective at producing desired results. Other visual and noise deterrents could be used during hazing events as needed depending on effectiveness of human hazers and knowledge gained during implementation. Human hazers would begin to restrict DCCOs from nesting in areas outside the designated colony area. Any temporary habitat modification techniques would be removed when appropriate to reduce potential impacts to non-target species and to ensure materials are not damaged or lost over winter. Nest removal (up to 500 nests) would occur on East Sand Island in areas outside of the DCCO use area (Figure 5-1) to limit DCCO colony expansion. Hazing on East Sand Island would occur separate from or in conjunction with shooting.

Impact Avoidance and Minimization Measures

In addition to minimizing DCCO dispersal, efforts would be taken to minimize take of non-target species during culling by developing and establishing a shooting protocol prior to implementation. Shooters would receive species identification training and trained individual(s) or biologist(s) in species identification would be present when lethal take occurs to minimize take because of misidentification (i.e., Brandt's and pelagic cormorants). Areas that have a high concentration of non-target species present would be avoided. Species would be identified prior to shooting. If there is a high concentration of non-target species in the area, these areas would be avoided. Techniques and methods would also be modified to minimize take of non-target species if it should occur. These actions include increasing the amount of training for personnel, increasing the number of individuals in the field adequately trained in species identification, removing personnel unable to adequately perform duties, ceasing that particular lethal technique, or avoiding mixed species areas.

Personnel would also adhere to all safety standards of firearm operation and training as described in the USDA-WS Policy Manual, Directive 2.615 (Firearm Use and Safety) and Firearms Safety Training Manual. The use of firearms would be conducted in accordance with all applicable local, state, and federal regulations. Personnel would implement precautionary measures to reduce risk to public safety, such as positive identification before shooting, ensuring a backstop should the bullet miss, using rifles that fire single projectiles per shot, and using only specially trained personnel. To the extent possible, areas and times of public usage would be avoided when implementing management actions on-island and over water. Monitoring would occur before shooting to ensure people are not present within the management area or shooting direction. East Sand Island would be closed to the public during implementation and any violations of the closure or interference to management activities would be enforced as specified in 18 U.S.C. 111.

To prevent DCCOs from nesting in new areas on East Sand Island, preference would be given to visual deterrents first and noise deterrents second as a means to minimize impacts to non-target species. Monitoring to determine when hazing events are needed would be done via field crew observations from ground positions. For hazing and other management activities, DCCOs and other birds would be monitored from concealed areas or distances sufficient not to induce flushing. If monitoring or management within the colony is necessary, it would be kept to as short a time duration as possible and would be minimized during severe weather conditions or when higher than normal levels of predation might be expected. Egg take (outside of planned, direct management activities) would be minimized to the extent possible by: 1) implementing actions frequently enough so nest destruction and hazing occur before egg laying; 2) reducing or ceasing hazing and habitat modification techniques within a sufficient distance of an active nest (i.e., once an egg is laid); 3) removing nesting materials or destroying nests only if the nest does not have egg(s) in it; and 4) reducing or ceasing hazing if higher than normal levels of subsequent predation might be expected. Disturbance to species by personnel would be minimized by traveling in established routes and avoiding high concentrations of species when possible. Nests with provisioning chicks would be avoided to the extent possible and actions would occur outside the breeding season to the extent possible to reduce effects to nesting birds and chicks. The Adaptive Management Team would convene to evaluate the feasibility of continuing certain actions during the nesting season once chicks are observed. Boat-based shooting would be the preferred primary lethal strategy for take of individual DCCOs during the time of chick rearing until chicks have fledged.

Detecting DCCOs in the Columbia River Estuary

Surveys would be conducted in the Columbia River Estuary to determine if DCCOs dispersed from East Sand Island are relocating within the estuary. Monitoring would focus on the key locations identified in Table 5-2 and in upriver locations greater than the expected foraging range of DCCOs. Surveys would closely coincide to when culling sessions occur on East Sand Island. If necessary, subsequent hazing efforts would be integrated with ongoing avian predation management of dredge materials sites under the Corps' Channel and Harbors Program, which monitors dredged material placement sites for DCCOs and Caspian terns as needed to prevent their nesting. On dredge disposal islands, non-lethal methods to dissuade DCCOs could occur early in the nesting season and at a distant sufficient to minimize impacts to non-target species, especially streaked horned larks. The Corps would include take of up to 250 DCCO eggs on dredge material sites in their depredation permit application to ensure hazing efforts can continue after the nesting season has begun.

TABLE 5-2. Monitoring and Potential Hazing Locations in Columbia River Estuary and Associated Protocols.

Key Estuary Monitoring/Hazing Locations*	Monitoring and Hazing Protocols
Astoria-Megler Bridge	1) Begin surveys in April in areas where suitable nesting habitat is present to detect incipient nesting attempts before eggs are laid. Continue surveys through mid-June or until nest initiation has stopped. 2) Once DCCOs are detected on suitable nesting habitat, use binoculars and/or spotting scope to count the number of individuals and determine whether the birds are roosting or initiating nesting. 3) Coordinate with the landowner/state and federal resource agencies for access and regarding management activities where species of concern occur, such as occupied streaked horned lark critical habitat. 4) Use non-lethal methods to deter nesting, primarily by human hazing. 5) Collect eggs only under approved USFWS permit. Record and report any eggs collected.
Tongue Point Piers	
Trestle Bay	
Rice Island	
Miller Sands Spit	
Pillar Rock Island	
Lewis and Clark Bridge	
Troutdale Transmission Tower	
Willamette Falls/Oregon City	

*Additional locations for hazing would be determined from the results of surveys and monitoring.

Reporting

All individuals taken (DCCOs and non-target species) and associated active nests lost through egg oiling or unintended take would be recorded, and information would be submitted to USFWS for reporting requirements. Take of active nests is expected to occur indirectly from culling breeding adults that are actively nesting. Associated nests will be accounted for after nest initiation is observed. Active nesting typically occurs on East Sand Island beginning March 27 (Figure 5-3). For associated active nests lost, actual numbers would be recorded and reported when determination in the field can be made. If determination cannot be made in the field, associated nests will be accounted for after nest initiation is observed each year or March 27, if unknown. Informal reporting of field conditions and events could occur more frequently. DCCO carcasses would be examined for leg bands or other markers, and reported to the USGS Bird Banding Laboratory or other appropriate entity.

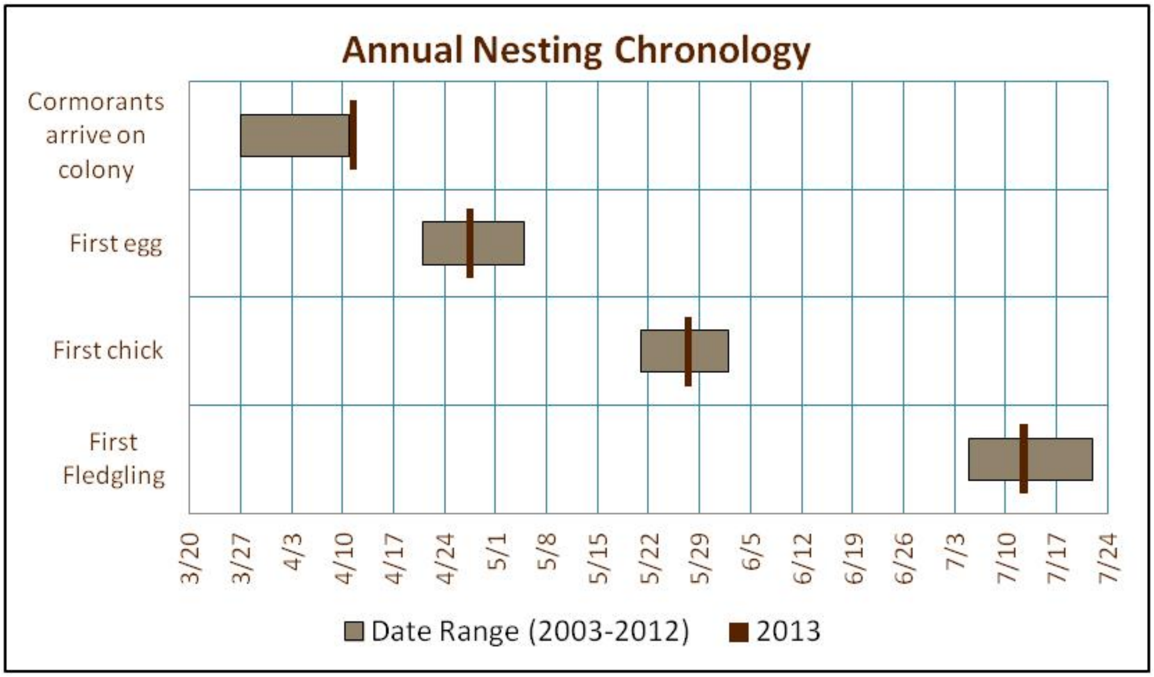

FIGURE 5-3. Nesting Chronology of DCCOs on East Sand Island during 2003-2013.

Monitoring and Adaptive Management

For this management plan, adaptive management is defined as evaluating the accuracy of the predicted environmental impacts, assessing the effectiveness of management actions, and modifying them as needed to ensure the purpose and need is met and levels of environmental effects predicted in the FEIS are not exceeded. The approaches taken in the alternatives follow the process described in the 2003 NEPA Task Force Report to the CEQ on Modernizing NEPA Implementation:

Predict → *Mitigate* → *Implement* → *Monitor* → *Adapt*

Results from prior dissuasion research, other avian predation management efforts, NOAA Fisheries' "survival gap" analysis, the fish and economic analyses, and the DCCO population model were used to *predict* potential outcomes. The management plan outlines various measures to *mitigate* impacts to non-target species and reduce potential for DCCO dispersal and identifies actions the Corps could *implement* to achieve management objectives. The Pacific Flyway Council *monitoring* strategy and other monitoring would be implemented annually to assist in the annual evaluation of management actions and in determining *adaptive* responses to proposed management. PIT tags would be recovered on the DCCO colony after the breeding season to assess predation rates. The Corps would convene an Adaptive Management Team, consisting of the cooperating agencies to the FEIS, NOAA Fisheries, and tribal entities, to meet as needed to assess the effectiveness of management actions and to guide future actions. The Corps would be the decision making body for the Adaptive Management Team but would consider input and recommendations from the team.

The primary goals of adaptive management would be to ensure that actions:

- Achieve baseline levels of predation as described in the FCRPS Biological Opinion (NOAA 2014)
- Reduce DCCO depredation of juvenile salmonids throughout the Columbia River Estuary
- Reduce the potential for shifting DCCO depredation impacts to areas outside the Columbia River Estuary
- Minimize adverse impacts to the western population of DCCO
- Minimize adverse impacts to non-target species during implementation
- Implement passive methods that are cost effective and require less human presence in the long-term

Adaptive management would allow for in-season and between-year adjustments in application of management techniques based on knowledge gained during implementation and in annual monitoring of the western population of DCCOs. This includes adjusting field methods, such as technique, timing of activities, and duration of actions, and monitoring frequency. When implementing non-lethal and lethal techniques and monitoring, impact avoidance measures (timing of activities to minimize impacts, use of field techniques that have least impacts to non-targets as identified in the alternatives) as identified would be used to reduce the potential for dispersal, colony abandonment, and impacts to non-target DCCOs and other species (see USDA-WS 1997; Steinkamp et al. 2003; USFWS 2003, 2008; Pacific Flyway Council 2013).

Passive Integrated Transponder (PIT) Tag Recovery

PIT tag recoveries on East Sand Island would occur after the breeding season. The average annual percentage of available PIT tags that are recovered in the DCCO nesting area would be evaluated in context of relevant factors to assess DCCO predation rates of juvenile salmonids. PIT tag data will be used to evaluate the effectiveness of management and in reporting per the FCRPS consultation requirements and to supplement information needed for a depredation permit application. PIT tag data would be used to inform future management actions and objectives if proposed actions do not achieve juvenile survival improvements as stated in the purpose and need. Due to annual variability in predation impacts, monitoring would likely need to occur over a longer period of time (5-10 years) to assess overall trends and effects accounting for yearly fluctuations.

Pacific Flyway Monitoring Strategy

The Corps, in coordination with the USFWS and states, would implement the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013) annually. Each year, the Corps would monitor all specified locations of the monitoring strategy, where and when there are not already established monitoring efforts and secure funding sources, supplement data processing of aerial photography, and assist in preparing an annual summary report of the Pacific Flyway Council and other collected monitoring data.

Adjusting Take Levels in Phase I

Adjusting the amount of take would be determined based on observed DCCO abundances on East Sand Island and within the western population and behavioral responses of DCCO and non-target species after implementation. Observed abundance on East Sand Island is the peak number of nesting DCCO pairs on the island after culling has taken place in a given year; the observed abundance of the western population will be the estimate of the nesting population following the annual population-wide monitoring, using methods described in the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013). The adjustments to take levels will be based upon the thresholds and descriptions in Table 5-3 and Table 5-4 (see Appendix E-2 for specific examples) and include a two-step evaluation process with regard to whether observed abundance is less than, greater than, or within one standard deviation of predicted abundances from the population models for both the western population of DCCOs and the DCCO colony on East Sand Island.

Take could increase if, for both the East Sand Island colony and the western population, the observed abundance is greater than one standard deviation of the predicted abundance. This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and thus, the predicted decline in the western population may not occur.

Increased take could also be considered in years 3–4 above what is stated in the proposed take levels described in the alternatives if authorized take the previous year was not fulfilled and if the observed abundance East Sand island is within one standard deviation above predicted while the observed abundance for the western population is within one standard deviation above predicted for that year. As described above, if this scenario occurs, it may indicate that the population model used to develop predictions may also be more conservative than actual conditions. However, if the observed abundance for the western population continues to decline, it would move evaluation and adaptive management into the next scenario described in Table 5-3.

Take could decrease or cease if observed abundance of the western population is lower than one standard deviation below predicted abundance, as this could be an indication that the East Sand Island colony is acting as an immigration sink, with DCCOs immigrating from other colonies within the western population. It could also be possible that the model could not adequately incorporate all the sources of fundamental uncertainty (see Tables 5-3 and 5-4 for additional detail of adaptive management thresholds and actions).

TABLE 5-3. Adaptive Management to Adjust Take Levels in Phase I.[13]

East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
 Observed colony abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is 20,450; 500 more than 19,950 (i.e. predicted by the model), and fewer than 21,594 individuals (1 standard deviation above predicted).	 Observed population abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	For years 1 and 2, stay with take as outlined in Alternative C-1; for years 3 and 4, if the target number of culled DCCOs and oiled nests was not achieved, and observed population abundances on East Sand Island and for the Western Population are above predicted, then consider increasing take in following year to include numbers not taken the previous year. The maximum increase would be the difference between the observed and predicted East Sand Island colony abundances. Example: Year 2, 1000 individuals were not culled that were authorized, consider adding up to 500 individuals to be culled in Year 3 implementation plan (i.e. the difference between observed and predicted East Sand Island colony abundances).
 Observed colony abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	 Observed population abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is above 56,235 individuals.	Consider increasing adult take and nest oiling on East Sand Island, or consider increasing take to authorize numbers not collected the previous year. The maximum increase would be one standard deviation. This would potentially bring the next year's observations closer to the predicted median colony abundance on East Sand Island. Example: Year 2 East Sand Island observed colony abundance is 23,000 individuals and 1,000 individuals were not culled the previous year as was planned; one standard deviation is 1,644. Therefore consider adding 1,644 (1,644 > 1,000) individuals to the Year 3 implementation plan. This scenario may indicate the population model is conservative.
 Observed colony abundance (after culling) is greater than one standard deviation above predicted.	 Observed population abundance (after culling) is within one standard deviation above predicted.	Consider increasing take on East Sand Island by a maximum of the difference between observed colony abundance and one SD above predicted colony abundance on East Sand Island, or consider increasing take to authorize numbers not collected the previous year, whichever is greater. The maximum increase would be one standard deviation. During last 2 years of management, consider doing habitat modification or dissuasion to limit colony size earlier.

[13] One standard deviation off of predicted population size dictates each threshold. Refer to predicted population modeled abundance (N, ASY Estimate After Culling) and standard deviation (SD) thresholds in Tables E-2 2 and E-2 3.

East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and/or this may indicate some immigration to East Sand Island from other colonies is occurring.
↑ Observed colony abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	↓ Observed population abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed population is below 45,927individuals.	Consider cessation of adult take and cessation/reduction of nest oiling. During last 2 years of management, consider doing habitat modification or dissuasion to limit colony size earlier. This scenario may indicate immigration to East Sand Island from other colonies is occurring.
↓ Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony size (after culling) is below 18,306 individuals.	↑ Observed population abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is above 56,235 individuals.	Stay with Modified Preferred Alternative but stop culling and egg oiling when East Sand Island management objective for colony size is achieved. Potentially speed up timeline for Phase II habitat modification or implement dissuasion to maintain lower colony abundance; will likely reach objective for colony size sooner than predicted. This scenario may indicate dispersal is taking place.
↓ Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony abundance (after culling) is below 18,306 individuals.	= Observed population abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	Stay with Modified Preferred Alternative but stop when East Sand Island management objective for colony size is achieved. Potentially speed up timeline for Phase II habitat modification or implement dissuasion to maintain lower colony size; will likely reach the management objective colony size sooner than predicted. This scenario would indicate that the population model used to develop predictions may be more liberal than actual conditions and/or this may indicate some dispersal is taking place

East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony size (after culling) is below 18,306 individuals.	Observed population abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed population abundance (after culling) is below 45,927 individuals.	Consider cessation of adult take and cessation/reduction of nest oiling. Consider decreasing adult take and nest oiling on East Sand Island by the difference between observed colony size and one SD below the predicted colony size on East Sand Island. During last 2 years of management, consider doing habitat modification or implement dissuasion to maintain lower colony size hazing earlier. This scenario may indicate the model is liberal.

TABLE 5-4. Predicted abundance after culling and adaptive management thresholds for the East Sand Island colony and western population of DCCOs under the Proposed Management Plan.

	East Sand Island Colony				Western Population			
Year	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD	Predicted Abundance	Standard Deviation	Lower Threshold Abundance - 1 SD	Upper Threshold Abundance + 1 SD
1	22,353	1,775	20,579	24,128	57,975	5,817	52,158	63,792
2	19,950	1,644	18,306	21,594	51,081	5,154	45,927	56,235
3	15,428	1,492	13,936	16,920	43,980	5,504	38,476	49,484
4*	12,185	1,293	10,891	13,478	39,034	5,312	33,722	44,345

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood of achieving the reduction in colony size on East Sand Island. Final evaluation of the management action would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population. For Alternative C-1 in year 5, the predicted abundance before culling was 11,259 (+/- 1 SD = 10,013–12,504) for East Sand Island and 38,365 (+/- 1 SD = 32,984–43,746) for the western population.

Phase II

Management Actions to Ensure Colony Size Goals are Retained

Continued non-lethal management on East Sand Island is expected to be necessary to slow or stop abundance increase of the colony. The goal of Phase II is to transition to lower maintenance non-lethal techniques and reduce the amount of human presence needed on the island while still ensuring colony size objectives are not exceeded. This would be accomplished through terrain modification and/or other habitat management supplemented with hazing as necessary. Hazing techniques would be the same as described in Phase I. Based on knowledge gained during Phase I, a limited amount of egg take (500 eggs) on East Sand Island would most likely be requested in a depredation permit application to ensure hazing efforts can continue during the nesting season.

Modification of the existing terrain (Figure 5-4) would occur through the excavation of sand (approximately 300,000 cubic yards on the western portion of the island) in order to inundate the DCCO nesting area. Sand would be excavated to an elevation that would be inundated at least once per week during April 1-July 15 (peak nesting season for DCCO on East Sand Island) and to a water depth of 6 inches to 1 foot to preclude nesting attempts. The shoreline would be armored with added rock (approximately 30,000 cubic yards of rip-rap) or other bio-engineering solutions such as use of logs, etc. on the northern shore to reinforce the island and maintain stability of the Columbia River Federal Navigation Channel. A re-vegetation and invasive species plan would be developed prior to implementation of terrain modification actions.

Excavation of sand would occur to create two “lagoon” type areas located on the western portion of the island (darker shaded green, Figure 5-4), designed with an elevation range of 1.7–2.2 m (NAVD88) and generally sloping downward from south to north. These lagoon areas would be open to tidal fluctuations via five channels on the north side of the island. Terrain modification was designed to encourage the establishment of mud flats, marshes, and other low-elevation herbaceous vegetation, and to be resilient to sea level rise over a 50-year planning horizon.

FIGURE 5-4. Proposed terrain modification, creating "lagoon" type areas in the DCCO nesting area on the western portion of East Sand Island.

The Corps would perform soil testing to determine potential contamination and nutrient load prior to selecting disposal locations for excavated sand. Disposal locations of excavated sand could be located on the designated Caspian tern colony to improve nesting habitat and in other upland areas on the eastern portion of the island and in upland areas where feasible. Disposal of sand could also be used for beach nourishment along the shoreline and/or placed between the pile dikes near the southern shoreline. Disposal locations would be selected to avoid and minimize impacts to delineated wetlands on the central portion of the island. Construction activities for terrain modification and associated work would likely take place within the in-water work window (November 15-February 15) to the extent possible but work below ordinary high tide could take place earlier in the fall, potentially September or October. Final time periods would be determined in consultation with NOAA Fisheries and USFWS.

After the terrain modification or similar habitat management has occurred, an upland area on the western portion of the island near the vegetation would remain and DCCO could nest in this area as they have attempted to in the past (Figure 5-1, DCCO use area). To augment the effectiveness of the terrain medication, non-lethal methods with limited egg take would be used to restrict DCCO nesting in other or new areas on East Sand Island. Privacy fences could be constructed to designate a DCCO nesting area prior to birds arriving on the island. Based on prior estimated maximum DCCO nesting density on East Sand Island (1.28 nests per square meter; BRNW unpublished data), the amount of available nesting habitat on East Sand Island may ultimately need to be reduced via habitat modification or hazing to 1.04–1.15 acres or less in order to retain colony size objectives. Efforts would be focused on restricting the nesting area and ensuring DCCO do not nest in new areas on East Sand Island (Figure 5-4).

Annual monitoring to estimate DCCO abundance, nesting density, and PIT tag recoveries on East Sand Island would continue as necessary. Peak breeding season colony size would be determined from counts during late incubation. An average 3-year peak breeding season colony size estimate would be used for evaluating observed colony size to management objectives. If personnel are on the island conducting hazing activities, DCCO counts and behavior and response of non-target species would be monitored and reported. PIT tag recoveries would be used to evaluate effectiveness of management actions in reducing predation of juvenile salmonids. Due to annual variability in predation impacts, monitoring would likely need to occur over a longer period of time (5-10 years) to assess overall trends and effects, accounting for yearly fluctuations.

Abundance surveys would continue as needed to determine DCCO abundance at other locations within the Columbia River Estuary. The same strategy as Phase I would be used to deter DCCO nesting and foraging in the Columbia River Estuary. Efforts would likely be less in Phase II if culling, egg oiling, and hazing efforts are successful in reducing the DCCO colony on East Sand Island and preventing increased abundance in other parts of the Columbia River Estuary. Monitoring would likely be less than during Phase I and would concentrate on known areas of concern or interest. Annual monitoring efforts outside of the Columbia River Estuary would be conducted as needed in Phase II.

Management actions could be adjusted to ensure the colony size and associated base period DCCO predation conditions are not exceeded. These actions would be conducted as necessary and would continually transition to methods that are most effective, least impactful to non-target species, and require least management effort and cost. Actions would be considered successful when the average 3-year peak colony size estimate does not exceed 5,380 to 5,939 nesting pairs while no management actions are conducted. The Adaptive Management Team would develop actions and appropriate monitoring based on Phase I and II results for long-term DCCO management in the Columbia River Estuary. Continuance of long-term monitoring and management would depend upon available appropriations and future management needs. Additional environmental review may be needed at that time.

TABLE 5-5. Proposed Methods for Phase II.

Action	When Used	Potential Adaptive Response
Restrict Nesting Area	Prior to nesting season. Habitat reduction is based on known nesting densities of 1.28 nests per square meter.	Augment terrain modification as necessary. Decrease available nesting area as needed, which may include reducing habitat to less than 1.1 acres if nesting densities become higher than observed in the past (i.e., 1.28 nests per square meter).
Hazing	Outside nesting area if breeding behavior observed, >50 DCCO observed loafing, or DCCOs observed at twilight about to roost.	Reduce threshold to 25 (or fewer) DCCOs loafing if greater hazing intensity needed. If DCCO habituate to human hazing, apply visual deterrents to increase effectiveness in hazing. Dogs could be used selectively if human hazing is not effective.
Visual/ Noise Deterrents (per Section 2.1.2 of FEIS)	If DCCO habituate to human hazing.	If DCCO habituate to visual deterrents, apply noise deterrents. If DCCO habituate to noise deterrents, combine additional methods.
Habitat Modification	Concurrent with hazing.	Increase amount and area.
Egg Take (collect up to 500 DCCO eggs)	Concurrent with hazing.	Take numbers adjusted in subsequent years based on take during the prior year.
Aerial Surveys to Determine Peak Colony Size on East Sand Island	During peak breeding season (mid-April to mid-June).	If 3 year average DCCO colony size is greater than 5,939 breeding pairs, implement non-lethal methods with limited egg take to reduce colony. Management actions could be scaled back or techniques changed to avoid impacts to non-target species.
Monitor western population of DCCOs	During peak breeding season (timeframes vary based on location, see Pacific Flyway Council Monitoring Strategy).	Coordinate with Corps' Channels and Harbors Program to document potential increases of DCCOs on dredged material islands. Increase frequency of surveys if needed. Coordinate with USFWS and Pacific Flyway Council to determine effectiveness of survey methodologies.
Collect PIT Tags and Assess Predation Rates	Post-breeding season for Adaptive Management Team.	Evaluate predation rates in context of other environmental factors. Coordinate with Adaptive Management Team to evaluate potential changes to management actions and objectives if proposed actions do not achieve juvenile survival improvements stated in the EIS purpose and need.

Chapter 6 Consultation and Coordination

In addition to the cooperating agencies, the Corps coordinated with the following agencies and groups during the development of this document: NOAA Fisheries and the US Geological Survey's Oregon Cooperative Fish and Wildlife Research Unit Department of Fisheries and Wildlife.

6.1 List of Primary Preparers

Name and Affiliation	Position and Contribution to EIS	Education	Years of Experience
U.S. Army Corps of Engineers Elisa Carlsen	Social Scientist Technical writer/editor - all sections, affected environment - public resources	B.A. Cultural Anthropology	11
U.S. Fish and Wildlife Service Michelle McDowell	Wildlife Biologist Population Modeling, QA/QC Review Technical assistance to minimize impacts to DCCO and other migratory birds	B.A. Biology M.S. Wildlife Science	19
U.S. Department of Agriculture - Wildlife Services Kevin Christensen	Wildlife Biologist, Assistant State Director Chapter 2 – Alternatives Chapter 4 – Effects	B.S. Fisheries and Wildlife Management	17
U.S. Department of Agriculture - Wildlife Services Matt Alex	Wildlife Specialist Chapter 2 – Alternatives Chapter 4 – Effects	B.S. Fisheries and Wildlife Science	8
Harris Environmental Group Josh Dooley	Environmental Planner Technical writer/editor - all sections - Affected Environment - Environmental Consequences DCCO, other Birds, Population Modeling	B.S. Env. Biology M.S. Wildlife Management	10
Harris Environmental Group Lirain Urreiztieta	Graphics / GIS	B.A. Anthropology M.S. GIS	13
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Pacific Northwest National Laboratory Andre Coleman	Geospatial Engineer Climate Change Effects Review/Analysis, ATIIM Modeling, Affected Environment - Inundation, Environmental Consequences - Inundation, Phase II - Terrain Modification	B.S. Geography & Earth Resources M.S. Geoinformatics	20
Pacific Northwest National Laboratory Nichole Sather	Fisheries Scientist Climate Change Effects Review/Analysis	A.A. General Studies B.S. Environmental Science M.S. Fisheries Science	13
Pacific Northwest National Laboratory Amy Borde	Wetlands Ecologist Climate Change Effects Review/Analysis, Phase II -Terrain Modification	B.S. Biology B.S. Env. Pol. & Management	20
The Research Group Shannon Davis	Econometrician Chapter 3 and 4 - Appendix I salmonid adult return and fisheries economic contribution simulation modeling	M.S. Quantitative Studies	30
The Research Group Hans Radtke	Natural Resource Economist Chapter 3 and 4 - Appendix I economic effects write-up	Ph.D. Economics	40
The Research Group Christopher Carter	Natural Resource Economist Chapter 3 and 4 - Appendix I economic effects write-up	Ph.D. Economics	35

6.2 List of Agencies, Organizations, and Persons to Whom Copies of the Environmental Impact Statement Were Sent

An email distribution list was created with over 150 interested parties, non-governmental organizations, federal, state, and local agencies, and other private individuals. The DEIS and link to the Federal Register notice was sent electronically to this email list. Notice of the public meetings to be held in Astoria, Oregon and Portland, Oregon was also sent to this email distribution list and a press release was issued to media groups in the region.

NON-GOVERNMENTAL ORGANIZATIONS (NGOs) - Portland Audubon Society, Seattle Audubon Society, Audubon Society of Lower Columbia Basin, Audubon Society of Willapa Hills, National Audubon Society, American Bird Conservancy, American Welfare Institute, American Society for the Prevention of Cruelty to Animals, Cascadia Wildlands, Center for Biological Diversity, Coastal Conservation Association, Columbia Basin Fish and Wildlife Authority, Columbia River Estuary Study Taskforce, Cormorant Defenders International, Defenders of Wildlife, Endangered Species Coalition, Federation of Fly Fishers, The Freshwater Fund, Friends of Animals, Humane Society of the U.S., Lower Columbia River Fish Enhancement Group, National Pest Management Association, National Wildlife Control Operators Association, National Wildlife Federation, Native Fish Society, Nature Conservancy, Northwest Environmental Advocates, Ocean Conservancy, Oregon Wild, Ornithological Societies of North America, Pacific Coast Federation of Fisherman's Association, Pacific Seabird Group, People for the Ethical Treatment of Animals, Salmon for All, Seabird Restoration Program, Sierra Club, Washington Ornithological Society, Western Environmental Law Center, Wild Fish Conservancy, Wild Salmon Center, Wild Fish Conservancy, Wild Earth Guardians, Wildlife Center of the North Coast, Wildlife Watch

ACADEMIC INSTITUTIONS - Oregon State University, Slater Museum of Natural History-University of Puget Sound

BUSINESSES - Alsea Sportsman's Association, National Aquaculture Association, Northwest Guides and Anglers Association, Northwest Sportfishing Industry and Association, Real Time Research, Washington State Coastal Trollers Association

CITY AGENCIES & GROUPS - The Cities and Ports of Astoria, Portland, Illwaco, Long Beach, Warrenton

COUNTY AGENCIES & GROUPS - Clatsop County, Clatsop County Fisheries Project, Hood River County, Pacific County, Wahkiukum County

STATE AGENCIES & GROUPS - Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Transportation, Oregon Fish and Wildlife Commission, Idaho Fish and Game, Washington Department of Fish and Wildlife, Washington Department of Transportation

FEDERAL AGENCIES - Bonneville Power Administration, Bureau of Reclamation, NOAA Fisheries, USFWS, USDA-WS, Environmental Protection Agency

COUNCILS & COMMISSIONS - Columbia River Inter-Tribal Fish Commission, Northwest Power and Planning Council, Pacific Fishery Management Council, Pacific Flyway Council, Pacific States Marine Fish Commission, Northwest Indian Fisheries Commission, Natural Resources Defense Council

TRIBAL GOVERNMENTS & STAFFS - The Tribal Leadership and/or Natural Resource Management Programs of: Burns Paiute Tribe, Chinook Indian Nation, Confederated Tribes of Coos, Lower Umpqua and Suislaw Indians, Confederated Tribes of the Colville Reservation, Confederated Tribes of the Grand Ronde, Confederated Tribes of the Stiletz, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation, Coquille Indian Tribe, Cow Creek Band of Umpqua Indians, Cowlitz Indian Tribe, Jamestown S'Klallam Tribe, Klamath Tribes, Nez Perce, Port Gamble S'Klallam Tribe, Skokomish Nation, Spokane Tribe of Indians, Yakama Nation

Appendix A: References

Literature Citations

Abatzoglou, J. T. 2011. Development of gridded surface meteorological data for ecological applications and modeling. International Journal of Climatology. doi: 10.1002/joc.3413

Abatzoglou, J. T. and T. J. Brown. 2012. A comparison of statistical downscaling methods suited for wildfire applications. International Journal of Climatology. doi: 10.1002/joc.2312

Adamus, Paul, Ph.D., Adamus Resource Assessment, Inc. 2006. Hydrogeomorphic (HGM) Assessment Guidebook for Tidal Wetlands of the Oregon Coast Part 1: Rapid Assessment Method. Produced by Coos Watershed Association.

Adamus, P. R. and D. Field. 2001. Guidebook for Hydrogeomorphic (HGM)–based Assessment of Oregon Wetland and Riparian Sites. I. Willamette Valley Ecoregion, Riverine Impounding and Slope/Flats Subclasses. Volume IA: Assessment Methods. Oregon Division of State Lands, Salem, OR.

Adkins, J. Y. and D. D. Roby. 2010. A status assessment of the double-crested cormorants (*Phalacrocorax auritus*) in western North America: 1998-2009. Final Report to the U.S. Army Corps of Engineers. Available on-line at www.birdresearchnw.org.

Adkins, J. Y., D. D. Roby, D. E. Lyons, K. N. Courtot, K. Collis, H. R. Carter, W. D. Shuford, and P. J. Capitolo. 2014. Recent population size, trends, and limiting factors for the double-crested cormorant in western North America. Journal of Wildlife Management 78(7): 1131–1142. doi:10.1002/jwmg.737

Adrean, L. 2013. Avian Predation Program: 2012 Final Report. Oregon Department of Fish and Wildlife. Tillamook, Oregon.

Ainley, D. and D.W. Anderson. 1981. Feeding ecology of marine cormorants in southwestern North American. Condor 83:120-131.

Alder, J. R. and S. W. Hostetler, 2013. USGS National Climate Change Viewer. US Geological Survey. Available at: http://www.usgs.gov/climate_landuse/clu_rd/nccv.asp doi:10.5066/F7W9575T

Altman, B. 2011. Historical and Current Distribution and Populations of Bird Species in Prairie-Oak Habitats in the Pacific Northwest. Northwest Science 85:194-222.

Anderson, C. D., D. D. Roby, and K. Collis. 2004a. Foraging patterns of male and female double-crested cormorants nesting in the Columbia River Estuary. Canadian Journal of Zoology-Revue Canadienne De Zoologie 82:541-554.

Anderson, C. D., D. D. Roby, K. Collis. 2004b. Conservation implications of the large colony of double-crested cormorants on East Sand Island, Columbia River Estuary, Oregon, U.S.A. Waterbirds 27(2):155-164.

Anderson, H. 2013. Streaked Horned Lark Habitat Analysis and Dredged Material Deposition Recommendations for the Lower Columbia River. Report from the Center for Natural Lands Management to the U.S. Fish and Wildlife Service, Lacey, Washington. 47 pp.

Anthony, R. G., R. W. Frenzel, F. B. Isaacs, and M. G. Garrett. 1994. Probable causes of nesting failures in Oregon’s bald eagle population. Wildlife Society Bulletin 22:576-582.

Antolos, M., D. D. Roby, D. E. Lyons, K. Collis, A. F. Evans, M. Hawbecker, and B. A Ryan. 2005. Caspian tern predation on juvenile salmonids in the mid-Columbia River. Transactions of the American Fisheries Society 134: 466-480.

Badzinski, S. S., R. J. Cannings, T. E. Armenta, et al. 2008. Monitoring coastal bird population in B.C. The first five years of the Coastal Waterbird Survey (1999-2004). British Columbia Birds 17:1–36.

B. C. Conservation Data Centre. 2011. B.C. Species and Ecosystems Explorer. B.C. Minist. Of Environ. Victoria, B.C. Available at: http://a100.gov.bc.ca/pub/eswp/

Bedard, J., A. Nadeau, and M. Lepage. 1997. "Double-Crested Cormorant Culling in the St. Lawrence River Estuary: Results of a 5-Year Program.” *Symposium on Double-Crested Cormorants: Population Status and Management Issues in the Midwest.* Paper 15. http://digitalcommons.unl.edu/nwrccormorants/15.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Press, P. Roni, J. Kimball, J. Stanford, P. Kiffney, and N. Mantua. 2012. Restoring salmon habitat for a changing climate. River Res. Applic.

Blackwell, B. F., M. A. Stapanian, and D. C. Weseloh. 2002. Dynamics of the double-crested cormorant population on Lake Ontario. Wildl. Soc. Bull. 30:345–353.

Borde, A. B., S. A. Zimmerman, R. M. Kaufmann, H. L. Diefenderfer, N. K. Sather, and R. M. Thom. 2011. Lower Columbia River and Estuary Restoration Reference Site Study: 2010 Final Report and Site Summaries. PNWD-4262, prepared for the Lower Columbia River Estuary Partnership and the Bonneville Power Administration by Pacific Northwest National Laboratory, Marine Sciences Laboratory, Sequim, WA.

Borde, A. B., V. I. Cullinan, H. L. Diefenderfer, R. M. Thom, R. M. Kaufmann, J. Sagar, and C. Corbett. 2012a. Lower Columbia River and Estuary Ecosystem Restoration Program Reference Site Study: 2011 Restoration Analysis. PNNL-21433, prepared for the Lower Columbia River Estuary Partnership by Pacific Northwest National Laboratory, Richland, Washington.

Borde, A. B., R. M. Kaufmann, V. I. Cullinan, S. A. Zimmerman, and C. L. Wright. 2012b. Lower Columbia River and Estuary Habitat Monitoring 2011 Annual Report. PNNL-21128, prepared for the Lower Columbia River Estuary Partnership by Pacific Northwest National Laboratory, Richland, Washington.

Borde, A. B., S. A. Zimmerman, R. M. Kaufmann, R. M. Thom, and C. L. Wright. 2013. Lower Columbia River and Estuary Habitat Monitoring Study, 2012 Annual Report. PNNL-22410, prepared for the Lower Columbia River Estuary Partnership by Pacific Northwest National Laboratory, Richland, Washington.

Bottom, D. and K. Jones. 1990. Species composition, distribution and invertebrate prey of fish assemblages in the Columbia River Estuary. Progress in Oceanography 25: 243-270.

Bower, J. L. 2009. Changes in marine bird abundance in the Salish Sea: 1975 to 2007. Marine Ornithology 37:9–17.

Bregnballe, T. and J. Eskildsen. 2009. Forvaltende indgreb i danske skarvkolonier i Danmark 1994-2008. – Omfang og effekter af oliering af æg, bortskræmning og beskydning. Danmarks Miljøundersøgelser, Aarhus Universitet. 46 s. – Arbejdsrapport fra DMU nr. 249. Available at: http://www.dmu.dk/Pub/AR249.pdf

Breuning-Madsen, H., Ehlers-Koch, C., Gregersen, J., and C. L. Løjtnant. 2010. Influence of perennial colonies of piscivorous birds on soil nutrient contents in a temperate humid climate. Danish Journal of Geography 110(1): 25-35.

Brinker, D. F., J. M. McCann, B. Williams, and B. D. Watts. 2007. Colonial-nesting seabirds in the Chesapeake Bay region: where have we been and where are we going? Waterbirds 30(sp1):91-104.

BRNW (Bird Research Northwest). 2013a. Implementation and effects of double crested cormorant dissuasion research at East Sand Island, Columbia River Estuary: 2008-2012. Draft Technical Memorandum submitted to the U.S Army Corps of Engineers – Portland District, Portland, Oregon.

BRNW (Bird Research Northwest). 2013b. East Sand Island Biological Assessment: 2010-2012. Draft Technical Memorandum submitted to the U.S Army Corps of Engineers – Portland District, Portland, Oregon.

Bruskotter, J. T., J. J. Vaske, and R. H. Schmidt. 2009. Social and cognitive correlates of Utah resident's acceptance of the lethal control of wolves. Human Dimensions Wildlife 14,119–132.

Carney, K. M. and W. J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbird Society 22: 68-79.

Carter, H. R., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends, and conservation problems of the double-crested cormorants on the Pacific coast of North America. Colonial Waterbirds 18:189-215.

Carter, J. A., G. A. McMichael, I. D. Welch, R. A. Harnish, and B. J. Bellgraph. 2009. Seasonal Juvenile Salmonid Presence and Migratory Behavior in the Lower Columbia River. PNNL-18246, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18246.pdf.

CEQ (Council on Environmental Quality). 2011a. Federal agency climate change adaptation planning: Implementing instructions. 4 March 2011. President's Council on Environmental Quality, Office of the White House, Washington, DC. http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.

CEQ (Council on Environmental Quality). 2011b. Federal agency climate change adaptation planning: Support Document. 4 March 2011. President's Council on Environmental Quality, Office of the White House, Washington, DC. http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_support_document_3_3.pdf.

CEQ (Council on Environmental Quality). 2013a. Principles and requirements for Federal investments in water resources. Chapters I and II. Final Draft, March 2013. President's Council on Environmental Quality, Office of the White House, Washington, DC. http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG.

CEQ (Council on Environmental Quality). 2013b. Interagency guidelines for Federal investments in water resources. Chapter III. Draft, March 2013. President's Council on Environmental Quality, Office of the White House, Washington, DC. http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG.

Chatwin, T. A., M. H. Mather, and T. D. Giesbrecht. 2002. Changes in pelagic and double-crested nesting populations in the Strait of Georgia, British Columbia. Northwestern Naturalist (Vancouver) 83:109-117.

Chaves, F. P., J. Ryan, S. E. Lluch-Cota, and M. Niquen. 2003. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. Science 299: 217-221.

Clark, A. C., T. M. Kollasch, and D. A. Williamson. 2006. Movements of double-crested cormorants fledged on the Columbia River Estuary. Northwestern Naturalist 87:150-152.

Clements, S., T. Stahl, and C. B. Schreck. 2012. A comparison of the behavior and survival of coho salmon (*Onchorhynchus kisutch*) and steelhead trout (*O. mykiss*) in a small estuary system. Aquaculture 362-363:148-157.

Coleman, A. M, H. L. Diefenderfer, D. L. Ward, and A. B. Borde. 2014. A Spatially Based Area-Time Inundation Index Model for Tidal Wetlands and Restoration Sites of the Lower Columbia River Floodplain and Estuary, Environmental Modelling and Software, in review.

Collis, K. D., D. D. Roby, D. P. Craig, B. A. Ryan, and R. D. Ledgerwood. 2001. Colonial waterbird predation on juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary: vulnerability of different salmonid species, stocks, and rearing types. Trans. Am. Fish. Soc., 130:385-396.

Collis, K., D. D. Roby, D. P. Craig, S. Adamany, J. Adkins, and D. E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: Implications for losses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society 131:537–550.

Collis, K., D. D. Roby, K. W. Larson, L. J. Adrean, K. Nelson, A. F. Evans, D. Battaglia, D. E. Lyons, T. Marcella, and A. Patterson. 2012. Trends in Caspian tern nesting and diet in San Francisco Bay: Conservation implications for terns and salmonids. Waterbirds 35:25-34.

Conover, M. R. 2002. Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management. Lewis Publishers, Boca Raton, Florida, USA.

COSEWIC. 2008. COSEWIC assessment and update status report on the Great Blue Heron fannini subspecies Ardea herodias fannini in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 39 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Courtot, K. N., D. D. Roby, J. Y. Adkins, D. E. Lyons, D. T. King, and R. S. Larsen. 2012. Colony Connectivity of Pacific Coast Double-Crested Cormorants Based on Post-Breeding Dispersal from the Region's Largest Colony. Journal of Wildlife Management 76:1462–1471.

Cowardin, L. M., V. Carter, F. C. Golet and E. T LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-79/31. December 1979. Reprinted 1992.

Craig, E. C., S. B. Elbin, J. A. Danoff-Burg, and M. I. Palmer. 2012. Impacts of Double-crested Cormorants (*Phalacrocorax auritus*) and Other Colonial Waterbirds on Plant and Arthropod Communities on Islands in an Urban Estuary. Waterbirds 35:4-12.

Crewe, T., K. Barry, P. Davidson, and D. Lepage. 2012. Coastal waterbird population trends in the Strait of Georgia 1999–2011. Results from the first 12 years of the British Columbia Coastal Waterbird Survey. British Columbia Birds 22:8–35.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. Evolutionary Applications 1:252-270.

Crozier, L. 2011. Literature review for 2010 citations for BIOP: Biological effects of climate change. In: Endangered Species Act Federal Columbia River Power System 2010 Annual ESA Progress Report: Section 2, Attachment 1. p. 148ff.

Cuthbert, F. J., L. R. Wires, and J. E. McKeranan. 2002. Potential impacts of nesting double-crested cormorants on great blue herons and black-crowned night-herons in the U.S. Great Lakes Region. Journal of Great Lakes Research 28(2): 145-154.

Darby, M. 2014. Cultural Resources Survey of East Sand Island, Clatsop County. Draft report submitted to the U.S. Army Corps of Engineers – Portland District, Portland, Oregon.

DeBruyne, R. L., J. T. H. Coleman, J.R. Jackson, L. G. Rudstam and A. J. VanDeValk. 2013. Analysis of prey selection by double-crested cormorants: A 15-year diet study in Oneida Lake, New York. Transactions of the American Fisheries Society 142: 430–446.

Decker, D. J., T. L. Brown, and W. F. Siemer. 2001. Human dimensions of wildlife management in North America. Bethesda, MD: The Wildlife Society.

DeVault, T. L., R. B. Chipman, S. C. Barras, J. D. Taylor, C. P. Cranker III, E. M. Cranker, and J. F. Farquhar. 2012. Reducing impacts of double-crested cormorants to natural resources in central New York: a review of a collaborative research, management, and monitoring program. Waterbirds 35: 50–55.

Dey, D. B. 2012. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2011. National Marine Fisheries Service, Northwest Fisheries Science Center, March 6, 2012, memo to James H. Lecky.

Diamond, P.A., and J.A. Hausman. 1994. Contingent Valuation: Is some number better than no number? J Econ Perspect 8(4): 45-64.

Dias, E., P. Morais, M. Leopold, J. Campos, and C. Antunes. 2012. Natural born indicators: great cormorant *Phalacrocorax carbo* (Aves: Phalacrocoracidae) as monitors of river discharge influence on estuarine ichthyofauna. Journal of Sea Research 73:101-108.

Diefenderfer, H. L., A. M. Coleman, A. B. Borde, and I. A. Sinks. 2008. Hydraulic geometry and microtopography of tidal freshwater forested wetlands and implications for restoration, Columbia River, U.S.A. Ecohydrology and Hydrobiology 8:339-361. doi: 10.2478/v10104-009-0027-7.

Dorr, B. S., T. Aderman, P. H. Butchko, and S. C. Barras. 2010. Management effects on breeding and foraging numbers and movements of double-crested cormorants in the Les Cheneaux Islands, Lake Huron, Michigan. Journal of Great Lakes Research 36:224–331.

Duerr, A. E., T. M. Donovan, and D. E. Capen. 2007. Management-induced reproductive failure and breeding dispersal in double-crested cormorants on Lake Champlain. Journal of wildlife Management 71:2565-2574.

Ellison, L. N. and L. Cleary. 1978. Effects of human disturbance on breeding of Double-crested Cormorants. Auk 95:510-517.

Evans, A. F., N. J. Hostetter, D. D. Roby, K. Collis, D. E. Lyons, B. P. Sandford, and R. D. Ledgerwood. 2012. Systemwide evaluation of avian predation on juvenile salmonids from the Columbia River based on recoveries of Passive Integrated Transponder tags. Transactions of the American Fisheries Society 141:975-989.

FPC (Fish Passage Center). 2013. Fish passage center 2012 annual report. FPC of the Columbia Basin Fish and Wildlife Authority, BPA Project 1994-033-00, Portland, Oregon. Available: http://www.fpc.org/documents/annual_FPC_report/FPC%202012%20Annual%20Report-Final2.pdf.

FPC (Fish Passage Center). 2014. Fish Passage Center Adult Passage Data. Available on-line at www.fpc.org.

Fox, D. S., S. Bell, W. Nehlsen, and J. Damron. 1984. The Columbia River Estuary: Atlas of Physical and Biological Characteristics. Columbia River Estuary Data Development Program, Astoria, Oregon.

Fresh, K. L., E. Casillas, L. L. Johnson, and D. L. Bottom. 2005. Role of the estuary in the recovery of Columbia River basin salmon and steelhead: an evaluation of the effects of selected factors on salmonid population viability. U.S. Dept. Commer. NOAA Tech. Memo. NMFS-NWFSC-69, 105 pp.

Furness, R. W. 1978. Energy requirements of seabird communities: A bioenergetics model. Journal of Animal Ecology 47: 39-53.

Galbraith H., R. Jones, R. Park, J. Clough, S. Herrod-Julius, B. Harrington, and G. Page. 2002. Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. Waterbirds 20(2): 173-183.

GAO (General Accounting Office). 2002. Columbia River Basin Salmon and Steelhead: Federal Agencies' Recovery Responsibilities, Expenditures and Actions. GAO-02-612.

Gill, R. E., Jr. and L. R. Mewaldt. 1983. Pacific Coast Caspian terns: dynamics of an expanding population. Auk 100:369-381.

Gowing, D. J. and G. Spoor. 1998. United Kingdom Floodplains, eds. R. Bailey, P. Jose, and B. Sherwood, 185-196. Otley, United Kingdom, Westbury.

Green Banks LLC. 2014a. *Wetland Delineation Report, East Sand Island, Clatsop County, OR.* Prepared in cooperation with Allegiance Group LLC for U.S. Army Corps of Engineers, Portland District.

Green Banks LLC. 2014b. ORWAP Functional Assessment Memo for East Sand Island, Clatsop County, OR. Prepared in cooperation with Allegiance Group LLC for U.S. Army Corps of Engineers, Portland District.

Gremillit, D. and T. Boulinier. 2009. Spatial ecology and conservation of seabirds facing global climate change: a review. Marine Ecology Progress Series. 391: 121-137.

Gresh, T., J. A. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. *Fisheries* 25(1): 15-21.

Gress, F., R. W. Risebrough, D. W. Anderson, L. F. Kiff and J. R. Jehl, Jr. 1973. Reproductive failures of double-crested cormorants in southern California and Baja California. Wilson Bulletin 85:197-208.

Groot, C. and L.Margolis (Eds.). 1991. Pacific Salmon Life Histories. UBC, Press, University of British Columbia, Vancouver, Canada.

Guillaumet, A., B. Dorr, G. Wang, and T. Doyle. 2014. The cumulative effects of management on the population dynamics of the Double-crested Cormorant *Phalacrocorax auritus* in the Great Lakes. Ibis 156:141-152.

Gustafson, R. G., M. J. Ford, D. Teel, and J. S. Drake. 2010. Status review of eulachon (Thaleichthys pacificus) in Washington, Oregon, and California. U.S. Department of Commerce.

Harnish, R. A., G. E. Johnson, G. A. McMichael, M. S. Hughes, and B. D. Ebberts. 2012. "Effect of Migration Pathway on Travel Time and Survival of Acoustic-Tagged Juvenile Salmonids in the Columbia River Estuary." Transactions of the American Fisheries Society 141:507–519.

Hatch, J. J. 1995. Changing populations of double-crested cormorants. Colonial Waterbirds 18:8-24.

Hatch, J. J. and D. V. Weseloh. 1999. Double-crested cormorant (*Phalacrocorax auritus*), the birds of North America online (A. Poole, Ed.). Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/441/articles/introduction.

Hipner, J. M., L. K. Blight, R. W. Lowe, S. I. Wilhelm, G. J. Robertson, R. T. Barrett, T. Anker-Nilssen, and T. P. Good. 2012. Unintended consequences: How the recovery of sea eagle Haliaeetus spp. populations in the northern hemisphere is affecting seabirds. Marine Ornithology 40:39-52.

Hobara, S., T. Osono, K. Koba, N. Tokuchi, S. Fujiwara, and K. Kameda. 2001. Forest floor quality and N transformations in a temperate forest affected by avian-derived N deposition. Water Air Soil Pollution 130: 679-684.

Hogg, E. H. and J. K. Morton. 1983. The effects of nesting gulls on the vegetation and soils of islands in the Great Lakes. Can. J. Biol. 61:3240-3254.

Hostetter, N. J., E. F. Evans, D. D. Roby, and K. Collis. 2012. Susceptibility of Juvenile Steelhead to Avian Predation: the Influence of Individual Fish Characteristics and River Conditions. Transactions of the American Fisheries Society 141:1586–1599.

Howell, M. D., M. D. Romano, and T. A. Rien. 2001. Outmigration timing and distribution of larval eulachon, Thaleichthys pacificus, in the lower Columbia River, spring 2001. Washington Dept. Fish and Wildlife, Vancouver, and Oregon Dept. Fish and Wildlife, Clackamas.

HSRG (Hatchery Scientific Review Group). 2009. Columbia River Hatchery Reform System-Wide Report. Available at: http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action.

IPCC (Intergovernmental Panel on Climate Change). 2001. The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson, eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/ipccreports/tar/wg1/index.htm.

IPCC (Intergovernmental Panel on Climate Change). 2007a. Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, eds.). Cambridge, United Kingdom, and New York, NY: Cambridge University Press. http://ipcc-wg1.ucar.edu/wg1/wg1-report.html.

IPCC (Intergovernmental Panel on Climate Change). 2007b. IPCC Fourth Assessment Report Annex 1: Glossary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, eds.). Cambridge, United Kingdom and New York, NY: Cambridge University Press. http://ipccwg1.ucar.edu/wg1/Report/AR4WG1_Print_Annexes.pdf.

Isaacs, F.B., and R.G. Anthony. 2011 Bald eagles (Haliaeetus leucocephalus) nesting in Oregon and along the lower Columbia River, 1978-2007. Final Report, 18 March 2011. Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA.

ISAB (Independent Scientific Advisory Board). 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. ISAB 2007-2. May 11, 2007. Northwest Power and Conservation Council, Portland, Oregon.

Ishida, A. 1996. Changes of soil properties in the colonies of the common cormorant, *Phalacrocorax carbo*. Journal of Forest Research 1: 31-35.

IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Jay, D. A., K. Leffler, H. L. Diefenderfer, and A. B. Borde. *In revision*. Tidal-fluvial and estuarine processes in the lower Columbia River, I. Along-channel water level variations, Pacific Ocean to Bonneville Dam. Estuaries and Coasts.

Johnson, F. A., B. K. Williams, and P. R. Schmidt. 1996. Adaptive decision-making in waterfowl harvest and habitat management. Proceedings of the International Waterfowl Symposium 7:26-33.

Johnson, G. E., et al. 2011. Evaluation of Cumulative Ecosystem Response to Restoration Projects in the Lower Columbia River and Estuary. PNNL-20296, Pacific Northwest National Laboratory, Richland, WA.

Karl, T. R., J. M. Melillo, and T. C. Peterson (eds.). 2009. Global Climate Change Impacts on the United States. Cambridge University Press, Cambridge.

Keefer, M. L and C. A. Peery. 2008. A literature review relevant to juvenile fall Chinook salmon habitat use, migration behavior, and survival in the lower Snake River. A technical report for Contract W912EF-08-D-005. Available at: http://www.webpages.uidaho.edu/uiferl/pdf%20reports/UI%20Snake%20River%20Fall%20Chinook%20review%20_FINAL_.pdf.

King, D. T. 1996. Movements of Double-crested Cormorants among winter roosts in the delta region of Mississippi. Journal of Field Ornithology 67: 205-211.

Kuentzel, W. F., D. E. Capen, Z. L. Richards, and B.R. Higgins. 2012 Attitude strength and social acceptability of cormorant control programs on Lake Champlain. Journal of the Great Lakes, 38, 141-149.

Kuiken, T. 1999. Review of Newcastle disease in double-crested cormorants. Waterbirds 22:333-347.

Kury, C. R. and M. Gochfeld. 1975. Human interference and gull predation in cormorant colonies. Biol. Conserv 8:23-34.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC, USA, 78 pp.

Kushlan, J. A. 2012. A history of conserving colonial waterbirds in the United States. Waterbirds 35:608-625.

Lemmon, C. R., G. Bugbee, and G. R. Stephens. 1994. Tree damage by nesting double-crested cormorants in Connecticut. The Connecticut Warbler 14(1): 27-30.

Lewis, H. F. 1929. The natural history of the double-crested cormorant (Phalacrocorax auritus (Lesson)). Ru-Mi-Lou Books, Ottawa, Ontario.

Lichatowich, J. 2001. Salmon without rivers: a history of the Pacific salmon crisis. Island Press, Washington, D.C.

Ligeza, S. and H. Smal. 2003. Accumulation of nutrients in soils affected by perennial colonies of piscivorous birds with reference to biogeochemical cycles of elements. Chemosphere 52(2003): 595-602.

Loeffler, W. E. 1996. Dietary overlap and its implications for coexistence in a recently established assemblage of nesting seabirds at the Bolsa Chica Ecological Reserve. M.S. Thesis. California State Univ. Fullerton.

Ludwig, J. P. and C. L. Summer. 1995. Final report of the SERE Group Ltd. study to: Model the population of Double-crested Cormorants in the Les Cheneaux region of Lake Huron, and to collect data relevant to fish species utilization by cormorants and other waterbirds from the northern Great Lakes. The SERE Group, Ltd., Eureka, MI.

Lyons, D. E., D. D. Roby, and K. Collis. 2007. Foraging patterns of Caspian terns and double-crested cormorants in the Columbia River Estuary. Northwest Science 81(2): 91-103.

Lyons, D. E. 2010. Bioenergetics-based predator-prey relationships between piscivorous birds and juvenile salmonids in the Columbia River Estuary. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. 331pp. Available at: www.birdresearchnw.org.

Lyons, D. E., D. D. Roby, A. F. Evans, N. J. Hostetter, and K. Collis. 2014. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony: A report to the U.S. Army Corps of Engineers Portland District. Bird Research Northwest. Available on-line at www.birdresearchnw.org.

Manfredo, M. J., 2008. Who cares about wildlife? Social Science Concepts for Exploring Human-Wildlife Relationships and Conservation Issues. Springer, New York.

Mann, Roger. 2004. The Yakima Basin Regional Economy and the Contribution of Fish and Wildlife. Yakima County Public Services. November, 2004.

Maranto, C. J., T. P. Good, F. K. Wiese, and J. K. Parish. 2010. Impact of the Potholes Reservoir Caspian tern breeding colony on out-migrating juvenile salmonids in the mid-Columbia River. Transactions of the American Fisheries Society 139:362-381.

Marsh, D. M., W. D. Muir, B. P. Sandford, S. G. Smith, and D. Elliot. 2012. Alternative Barging Strategies to Improve Survival of Salmonids Transported from Lower Granite Dam: Final Report from the 2006–2008 Spring/Summer Chinook and Steelhead Juvenile Migrations. Draft report to U.S. Army Corps of Engineers, Walla Walla District. National Marine Fisheries Service and U.S. Geological Survey. February 2012.

Marshall, D. B., M. G. Hunter, and A. L. Contreras. 2006. Birds of Oregon: A general reference. Oregon State University Press, Corvallis, Oregon. 640 pp.

Matier, P. and A. Ross. (2014, April 7). Caltrans scramble to lure cormorants to new Bay Bridge span. *San Francisco Gate.* Available at: http://www.sfgate.com/bayarea/matier-ross/article/Caltrans-scrambles-to-lure-cormorants-to-new-Bay-5381205.php.

McArthur, L. A. 1915 The Pacific Coast Survey of 1849 and 1850. Oregon Historical Quarterly, Portland, Oregon. The Ivy Press.

McCarter, P. B., and D. E. Hay. 1999. Distribution of spawning eulachon stocks in the central coast of British Columbia as indicated by larval surveys. Canadian Stock Assessment Secretariat research document 99/177. DFO, Ottawa, Ontario.

McGowan, J. A., D. R. Cayan, and L. M. Dorman. 1998. Climate-Ocean Variability and Ecosystem Response in the Northeast Pacific. Science. 281: 210-217.

McMichael, G. A., J. A. Vucelick, B. A. Ryan, L. Gilbreath, R. L. McComas, D. Elliot, T. Murray, L. Applegate, and C. McKibben. 2006. Alternative barging strategies to improve survival of transported juvenile salmonids 2005. PNWD-3702, Battelle Pacific Northwest Division, Richland, WA.

McMichael, G. A., R. A. Harnish, B. J. Bellgraph, J. A. Carter, K. D. Ham, P. S. Titzler, and M. S. Hughes. 2010. Migratory behavior and survival of juvenile salmonids in the lower Columbia River and estuary in 2009. Pacific Northwest National Laboratory, PNNL-19545, Richland, Washington. Available: jsats.pnl.gov/Results/Publications.aspx.

Mercer, D. M. 2008. Phylogeography and population genetic structure of double-crested cormorants (*Phalacrocorax auritus*). M.S. thesis, Oregon State University, Corvallis, Oregon.

Mercer, D. M., S. M. Haig, and D. D. Roby. 2013. Phylogeography and population genetic structure of double-crested cormorants (Phalacrocorax auritus). Conservation Genetics 14(4):823-836.

Miller, I. M., C. Shishido, L. Antrim, and C. E. Bowlby. 2013. Climate Change and the Olympic Coast National Marine Sanctuary: Interpreting Potential Futures. Marine Sanctuaries Conservation Series ONMS-13-01. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. 238 pp.

Mizota, C. 2009. Temporal variations in the concentration and isotopic signature of ammonium- and nitrate-nitrogen in soils under breeding colony of black-tailed gulls (Larus crassirostris) on Kabushima Island, northeastern Japan. Applied Geochemistry 24(2009): 328-332.

Moser, M. L. and S. T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:281-295.

Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX.

Mott, D. F., J. F. Glahn, P. L. Smith, D. S. Reinhold, K. J. Bruce and C. A. Sloan. 1998. An evaluation of dispersing Double-crested Cormorants from winter roosts for reducing predation on catfish in Mississippi. Wildlife Society Bulletin 26: 584-591.

Moul, I. E. and M. B. Gebauer. 2002. Status of the double-crested cormorant in British Columbia. Wildlife Working Report WR-105: i-viii, 31 pp.

Naughton, M. B., D. S. Pitkin, R. W. Lowe, K. J. So and C. S. Strong. 2007. Catalog of Oregon seabird colonies. U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication FWS/BTP-R1009-2007, Washington, D.C.

Nichols, J. D., F. A. Johnson, and B. K. Williams. 1995a. Managing North American waterfowl in the face of uncertainty. Annual Review of Ecology and Systematics 26:177-199.

NMFS (National Marine Fisheries Service). 2011. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. NMFS Northwest Region. Portland, OR. January. Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc., subcontractor.

NOAA (NOAA Fisheries). 2008. Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE [D. Oregon]). National Marine Fisheries Service, Northwest Region 137 pp.

NOAA (NOAA Fisheries). 2008a. Supplemental Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and other Tributary Actions. May 5, 2008.

NOAA (NOAA Fisheries). 2008b. Endangered Species Act Section 7(a) (2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin Subject to the 2008-2017 US v. Oregon Management Agreement. May 5, 2008.

NOAA (NOAA Fisheries). 2010. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a) (I) (A) Permit for Juvenile Fish Transportation Program. National Marine Fisheries Service, Northwest Region 246 pp.

NOAA (NOAA Fisheries). 2011a. 5-Year Salmon and Steelhead ESA Status Reviews. National Marine Fisheries Service, Northwest Region. Portland, Oregon. Available at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/salmon_steelhead_esa_status_reviews.html.

NOAA (NOAA Fisheries). 2011b. Endangered and threatened species; designation of critical habitat for southern distinct population segment of eulachon. Federal Register. Available at: https://www.federalregister.gov/articles/2011/10/20/2011-26950/endangered-and-threatened-species-designation-of-critical-habitat-for-the-southern-distinct.

NOAA (NOAA Fisheries). 2012. Biological Opinion for the Reinitiation of Columbia River Navigation Channel Operations and Maintenance Mouth of the Columbia River to Bonneville Dam, Oregon and Washington. NFMS Consultation Number 2011/02095, Northwest Region 196 pp.

NOAA (NOAA Fisheries). 2013. Endangered and threatened species; designation of critical habitat for yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound/Georgia Basin. Federal Register. Available at: https://www.federalregister.gov/articles/2013/08/06/2013-18832/endangered-and-threatened-species-designation-of-critical-habitat-for-yelloweye-rockfish-canary.

NOAA (NOAA Fisheries). 2013a. Endangered Species Act Section 7 Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Stream Restoration and Fish Passage Improvement Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES V Restoration). (March 19, 2013) (Refer to: NMFS No.: 2013-9717). National Marine Fisheries Service, Northwest Region. Portland, Oregon.

NOAA (NOAA Fisheries). 2014. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a) (I) (A) Permit for Juvenile Fish Transportation Program. National Marine Fisheries Service, Northwest Region 246 pp.

NOAA (NOAA Fisheries). 2014a. Office of Protected Resources. Overview of Endangered Species Act Listed Marine and Anadromous Fish. Available at: http://www.nmfs.noaa.gov/pr/species/fish/.

NOAA (NOAA Fisheries). 2014b. Reinitiation of the Endangered Species Act Section 7 Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Stormwater, Transportation or Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES for Stormwater, Transportation or Utilities). (March 14, 2014) (Refer to: NMFS No.: NWR-2013-10411). National Marine Fisheries Service, Northwest Region. Portland, Oregon.

North American Bird Conservation Initiative, U.S. Committee. 2012. North American Bird Conservation Initiative – United States. Advancing Integrated Bird Conservation in North America. http://www.nabci-us.org.

NRC (National Research Council). 1987. Responding to Changes in Sea Level: Engineering Implications. Committee on Engineering Implications of Changes in Relative Mean Sea Level, Marine Board, National Research Council. National Academies Press, Washington, DC. ISBN: 0-309-59575-4, 160 pp.

NRC (National Research Council). 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present and Future. National Academies Press, Washington, DC. ISBN: 978-0-309-25594-3, 201 pp.

NRDC (Natural Resources Defense Council). 2014 Environmental News Media Center Press Release http://www.nrdc.org/media/2014/140211.asp.

OCCRI (Oregon Climate Change Research Institute). 2010. Oregon Climate Assessment Report. K.D. Dello and P.W. Mote (eds). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR. Available at: www.occri.net/OCAR.

ODSL (Oregon Department of State Lands). 2010. P. Adamus, J. Morlan, and K. Verble. Manual for the Oregon Rapid Assessment Protocol (ORWAP), Version 2.0.2.

Ontario Parks. 2008. Presqu'ile Cormorant Management Strategy Assessment 2003-2006. Ontario Ministry of Natural Resources. Peterborough, Ontario. 68 pp.

Opperman, H. 2003. A birder's guide to Washington. American Birding Association, Inc. Colorado Springs, Colorado.

Osterback, A. K., D. M. Frechette, A. O. Shelton, S. A. Hayes, M. H. Bond, S. A. Shaffer and J. W. Moore. 2013. High predation on small populations: avian predation on imperiled salmonids. Ecosphere 4(9):116. http://dx.doi.org/10.1890/ES13-00100.1

Pacific Biodiversity Institute. 2008. Bald Eagle species profile for Washington, Oregon, and Idaho. Accessed at: http://www.pacificbio.org/initiatives/ESIN/Birds/BaldEagle/baldeaglepg.html.

Pacific Flyway Council (PFC). 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55 pp.

Pacific Flyway Council. 2012a. Pacific Flyway Plan: A Framework for the Management of American White Pelican Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 49 pp.

Pacific Flyway Council (PFC). 2013. A Monitoring Strategy for the Western Population of Double-crested Cormorants within the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 37pp.

Palmer, R. S., ed. 1962. Handbook of North American birds, Vol. 1. Yale University Press, New Haven, CT.

Parkhurst, J. A., R. P. Brooks and D. E. Arnold. 1987. A survey of wildlife depredations and control techniques at fish-rearing facilities. Wildl. Soc. Bull. 15:386-394.

Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1. 37 pp.

Pearson, S. F. and B. Altman. 2005. Range-wide Streaked Horned Lark (*Eremophila Alpestris strigata*) Assessment and Preliminary Conservation Strategy. Washington Department of Fish and Wildlife, Olympia, WA. 25pp.

Pearson, S. F., M. Hopey, W. D. Robinson, and R. Moore. 2005. Range, Abundance and Movement Patterns of Wintering Streaked Horned Larks (*Eremophila alpestris strigata*) in Oregon and Washington. Natural Areas Program Report 2005-2. Olympia, WA. 13 pp.

Pearson, S. F., P. J. Hodum, T. P. Good, M. Schrimpf, and S. Knapp. 2013. A model approach for estimating colony size, trends, and habitat associations of burrow-nesting seabirds. Condor 115(2):356-365.

Petersen, J. H. and J. F. Kitchell. 2001. Climate regimes and water temperature changes in the Columbia River: Bioenergetic implications for predators of juvenile salmon. Canadian Journal of Fisheries and Aquatic Sciences, 58:1831–1841.

Peterson, W. and F. Schwing. 2008. California Current Ecosystem. In Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. Edited by K. E. Osgood. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-89. Available at http://spo.nmfs.noaa.gov/tm/TM%20SPO%2089.pdf (Accessed February 2014).

Pevey, K. C., G. Savant, H. R. Moritz, and E. O. Childs. 2012. Draft Letter Report: Lower Columbia River Adaptive Hydraulics (AdH) Model. ERDC/CERL TR-XX-DRAFT, May 2012. USACE Construction Engineering Research Laboratory, Vicksburg, Mississippi.

Portney, P.R. 1994. The contingent valuation debate: why economists should care. Journal of Economic Perspectives 8(4):3-17.

Purcell, M., G. Mackey, E. LaHood, H. Huber, and L. Park. 2004. Molecular methods for the genetic identification of salmonid prey from Pacific harbor seal (*Phoca vitulina richardsi*) scat. Fishery Bulletin 102: 213-220.

Rechisky, E. L., D. W. Welch, A. D. Porter, M. C. Jacobs-Scott, and P. M. Winchell. 2013. Influence of Multiple Dam Passage on Survival of Juvenile Chinook Salmon in the Columbia River Estuary and Coastal Ocean. PNAS 110(17). Available at: http://www.pnas.org/content/110/17/6883.full.pdf.

Ridgeway, M. S., T. A. Middel, J. B. Pollard. 2012. Response of Double-Crested Cormorants to a Large-Scale Egg Oiling Experiment on Lake Huron. Journal of Wildlife Management 76(4):740–749.

Roby, D. D., D. E. Lyons, D. P. Craig, K. Collis, and G. H. Visser. 2003. Quantifying the effect of predators on endangered species using a bioenergetics approach: Caspian terns and juvenile salmonids in the Columbia River estuary. Canadian Journal of Zoology 81:250-265.

Roby, D. D., K. Collis, D. E. Lyons, J. Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, E. Dykstra, J. Harms, W. Mashburn, J. Tennyson, N. Ventolini, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, R. Ledgerwood, and S. Sebring. 2012. Research, monitoring, and evaluation of avian predation on Salmonid smolts in the Lower and Mid-Columbia River. Draft 2011 annual report. Bird Research Northwest. Available at: www.birdresearchnw.org.

Roby, D. D., K. Collis, and 22 co-authors. 2013. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2012 Annual Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 103 pp. Available at: www.birdresearchnw.org.

Roby, D. D., K. Collis, and 27 co-authors. 2014. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2013 Annual Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 102 pp. Available at: www.birdresearchnw.org.

Rush, S. A., S. Verkoeyen, T. Dobbie, S. Dobbyn, C. E. Herbert, J. Gagnon, and A. T. Fisk. 2011. Influence of increasing populations of double-crested cormorants on soil nutrient characteristics of nesting islands in western Lake Erie. Journal of Great Lakes Research. 37(2011): 305-309.

Russell, I., B. Broughton, T. Keller, and D. N. Carss. 2012. The INTERCAFE Cormorant Management Toolbox— Methods for reducing Cormorant problems at European fisheries. COST Action 635 Final Report III, ISBN 978-1-906698-09-6.

Ryan, B. A., J. W. Ferguson, R. D. Ledgerwood, and E. P. Nunnallee. 2001. Detection of passive integrated transponder tags from juvenile salmonids on piscivorous bird colonies in the Columbia River basin. North American Journal of Fisheries Management 21: 417-421.

Ryan, B. A., S. G. Smith, J. M. Butzerin, and J. W. Ferguson. 2003. Relative vulnerability to avian predation of juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary, 1998-2000. Transactions of the American Fisheries Society 132: 275-288.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. *The North American Breeding Bird Survey, Results and Analysis 1966–2009. Version 3.23.2011.* USGS Patuxent Wildlife Research Center, Laurel, Maryland.

Savant, G. and T. O. McAlpin. 2014. Tidal hydrodynamics in the lower Columbia River Estuary through depth averaged adaptive hydraulics modeling. Journal of Engineering. Article ID 416914. http://dx.doi.org/10.1155/2014/416914.

Seattle Audubon Society. 2005. Brown pelican. BirdWeb: Seattle Audubon's online guide to the birds of Washington State. Available at: http://www.birdweb.org/birdweb/bird_details.aspx?value=search&id=34.

Sebring, S. H., M. C. Carper, R. D. Ledgerwood, B. P. Sandford, G. M. Matthews, and A. F. Evans. 2013. Relative vulnerability of PIT-tagged subyearling fall Chinook salmon to predation by Caspian terns and double-crested cormorants in the Columbia River Estuary. Transactions of the American Fisheries Society 142:1321-1334.

Sherwood, C. R., D. A. Jay, R. B. Harvey, P. Hamilton, and C. A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25:299-352.

Shuford, W. D. and T. Gardali, ed. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Shuford, W. D. 2010. Inland-breeding pelicans, cormorants, gulls, and terns in California: A catalogue, digital atlas, and conservation tool. Wildlife Branch, Nongame Wildlife Program Report 2010-01. California Department of Fish and Game, Sacramento. Available at: www.dfg.ca.gov/wildlife/nongame/waterbirdcatalogue.

Siegel-Causey, D. and G. L. Hunt. 1981. Colonial defense behavior in double-crested and pelagic cormorants. Auk 98:522-531.

Skalski J. R., R. L. Townsend, A. Seaburg, G. R. Ploskey, and T. J. Carlson. 2012. Compliance Monitoring of Yearling Chinook Salmon and Juvenile Steelhead Survival and Passage at Bonneville Dam, Spring 2011. PNNL-21175, Final Report, Pacific Northwest National Laboratory, Richland, Washington.

Steinkamp, M., B. Peterjohn, V. Byrd, H. Carter, and R. Lowe. 2003. Breeding season survey techniques for seabirds and colonial waterbirds throughout North America. Waterbird Monitoring Partnership of the Waterbirds for Americas Initiative. Available at: http://www.waterbirdconservation.org/pubs/PSGManual03.PDF.

Strickland, B., B. Dorr, F. Pogmore, G. Nohrenberg, S. Barras, J. McConnell, and J. Gobeille. 2011. Effect of management on Double-crested Cormorant nesting fidelity. Journal of Wildlife Management 75:1012-1021.

Stinson, D. W., J. W. Watson, and K. R. McAllister. 2007. Washington state status report for the bald eagle. Washington Department of Fish and Wildlife, Olympia, Washington. 86 pp.

Sullivan, K. L., P. D. Curtis, R. B. Chipman, and R. D. McCullough. 2006. The Double-crested Cormorant: Issues and Management. Cornell University Cooperative Extension. Dept. of Nat. Res., Fernow Hall, Cornell University. Available at: http://wildlifecontrol.info/pubs/Documents/Cormorant/Cormorant.pdf.

Suzuki, Y. 2012 Piscivorous Colonial Waterbirds in the Columbia River Estuary: Demography, Dietary Contaminants and Management. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. 183pp. Available at: www.birdresearchnw.org.

Sydeman, W. J., M. M. Hester, J. A. Thayer, F. Gress, P. Martin, and J. Buffa. 2001. Climate change, reproductive performance and diet composition of marine birds in the southern California Current system, 1969-1997. Progress in Oceanography. 49: 309-329.

Tebaldi, C., B. H. Strauss, and C. E. Zervas. 2012. Modeling sea level rise impacts on storm surges along US coasts. *Environmental Research Letters* 7(2012): 014032. doi:10.1088/1748-9326/7/1/014032.

Tessler, D. F., J. A. Johnson, B. A. Andres, S. Thomas, and R. B. Lanctot. 2010. Black Oystercatcher (*Haematopus bachmani*) Conservation Action Plan. Version 1.1. International Black Oystercatcher Working Group, Alaska Department of Fish and Game, Anchorage, Alaska, U.S. Fish and Wildlife Service, Anchorage, Alaska, and Manomet Center for Conservation Sciences, Manomet, Massachusetts. 115 pp.

Thomas, D. W. 1983. Changes in the Columbia River Estuary habitat types over the past century. Report of the Columbia River Estuary Data Development Program. Columbia River Estuary Study Taskforce, Astoria, Oregon.

Thompson, D. R. and K. C. Hamer. 2000. Stress in seabirds: causes, consequences and diagnostic value. Journal of Aquatic Ecosystem Stress and Recovery. 7:91-110.

Tillmann, P. and D. Siemann. 2011. Climate change effects and adaptation approaches in marine and coastal ecosystems of the North Pacific Landscape Conservation Cooperative region - a compilation of scientific literature. Phase 1 Draft Final Report. National Wildlife Federation. Available at: http://northpacificlcc.org/documents/NPLCC_Marine_Climate%20Effects_Draft%20Fina.pdf.

Tobin, M. E., D. T. King, B. S. Dorr, S. J. Werner, and D. S. Reinhold. 2002. Effect of Roost Harassment on Cormorant Movements and Roosting in the Delta Region of Mississippi. Waterbirds 25(1):44-51.

TRG (The Research Group, LLC). 2009. Mitchell Act Hatchery EIS, Preliminary 2.1, Economic and Social Analysis Sections. Prepared for NOAA Fisheries, Northwest Regional Office Salmon Recovery Division, Portland, Oregon. January 2009.

TRG (The Research Group, LLC). 2014. Economic Effects and Social Implications Section for the Double Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. Version 2.7. Submitted to the U.S Army Corps of Engineers – Portland District, Portland, Oregon. November 2014.

Tyson, L. A., J. L. Belant, F. J. Cuthbert, and D. V. Weseloh. 1997. Nesting populations of double-crested cormorants in the United States and Canada. Pages 17-25 In Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest. USDA-APHIS Tech. Bull. No. 1879.

USACE (U.S. Army Corps of Engineers). 1992. HTRW Initial Assessment for Real Estate Acquisitions/Disposals. Vertical File, USACE, Portland, OR.

USACE (U.S. Army Corps of Engineers). 2009. Engineering Circular: Incorporating sea-level change considerations in Civil Works programs. EC 1165-2-211. 1 July 2009. U.S. Army Corps of Engineers, Washington, DC.

USACE (U.S. Army Corps of Engineers). 2010. Merged Light Detection and Ranging (LiDAR) and Bathymetry Dataset for the Lower Columbia River and Estuary. United States Army Corps of Engineers, Portland District, Portland, Oregon.

USACE (U.S. Army Corps of Engineers). 2011a. USACE Climate Change Adaptation Policy Statement. 3 June 2011. Office of the Assistant Secretary of the Army for Civil Works, Washington, DC. http://www.corpsclimate.us/docs/USACEAdaptationPolicy3June2011.pdf.

USACE (U.S. Army Corps of Engineers). 2011b. EC 1165-2-212. Engineering Circular: Sea-level change considerations for Civil Works programs. Updated 1 October 2011. Previously EC 1165-2-211, 1 July 2009. U.S. Army Corps of Engineers, Washington, DC. http://140.194.76.129/publications/eng-circulars/index.html.

USACE (U.S. Army Corps of Engineers). 2012. USACE 2012 Climate Change Adaptation Plan and Report. 23 June, 2012. https://corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf.

USACE (U.S. Army Corps of Engineers). 2013a. 2013 Strategic Sustainability Performance Plan. 28 June 2013. Office of the Assistant Secretary of the Army for Civil Works, Washington, DC. http://www.usace.army.mil/missions/sustainability/strategicsustainabilityperformanceplans.aspx.

USACE (U.S. Army Corps of Engineers). 2013b. ER 1100-2-8162. Engineering Regulation: Incorporating sea-level change in Civil Works programs. U.S. Army Corps of Engineers, Washington, DC. http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1100-2-8162.pdf.

USACE (U.S. Army Corps of Engineers). 2013c. Columbia River LiDAR Project. CENWP, U.S. Army Corps of Engineers, Portland District, contract No. W9127N-10-D-0002 / 0001 and W9127N-09-D-0009 / 0006. Report and metadata available online: ftp://csc.noaa.gov/pub/DigitalCoast/lidar1_z/geoid12a/data/1122/supplemental/ColumbiaRiverLiDARProject_FinalSummaryReport.doc and http://csc.noaa.gov/dataviewer/webfiles/metadata/or2010_usace_columbia_river_template.html.

USACE (U.S. Army Corps of Engineers). 2013d. Mouth of the Columbia River South Jetty Dune Stabilization, Fort Stevens, Oregon. Interim-Final Design Documentation Report. April, 2013. Portland District, Portland, Oregon.

USACE (U.S. Army Corps of Engineers). 2014. Inland Avian Predation Management Plan Environmental Assessment. U.S. Army Corps of Engineers, Walla Walla District. January 2014. Available at: http://www.nww.usace.army.mil/Missions/Projects/InlandAvianPredationManagementPlan.aspx

USDA-WS (U. S. Department of Agriculture, Wildlife Services). 1997, revised. Animal damage control program, final environmental impact statement. United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control [Wildlife Services'], Operational Support Staff, Riverdale, Maryland, USA.

USDA-WS (U. S. Department of Agriculture, Wildlife Services). 2009. Final Environmental Assessment: Reducing Double-crested Cormorant Damage Management in Wisconsin. Available at: http://www.aphis.usda.gov/regulations/pdfs/nepa/WI%20DCCO%20EA%20Public%20Draft%20Final%20rev.pdf.

USDA-WS (U. S. Department of Agriculture, Wildlife Services). 2011a. Final Environmental Assessment: Bird Damage Management in Washington. Available at: http://www.aphis.usda.gov/regulations/pdfs/nepa.

USDA-WS (U. S. Department of Agriculture, Wildlife Services). 2011b. Final Environmental Assessment: Double-crested Cormorant Damage Management in Michigan. Available at: http://www.aphis.usda.gov/regulations/pdfs/nepa/MI_2011_Final_DCCO_EA.pdf.

USDC (U.S. Department of Commerce). 2009. Endangered and threatened wildlife and plants: Final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351. October 9, 2009.

USFWS (U. S. Fish and Wildlife Service). 2003. Final Environmental Impact Statement: Double-crested Cormorant Management. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, VA.

USFWS (U. S. Fish and Wildlife Service). 2005a. Caspian tern management to reduce predation of juvenile salmonids in the Columbia River Estuary, Final Environmental Impact Statement. Portland, OR.

USFWS (U. S. Fish and Wildlife Service). 2005b. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, OR.

USFWS (U. S. Fish and Wildlife Service). 2008. Western Colonial Waterbird Survey Protocols. U.S. Fish and Wildlife Service, Portland, Oregon. Available at: http://www.fws.gov/mountain-prairie/species/birds/western_colonial/Phase%20I%20western%20waterbird%20protocols%2025%20Sept.pdf.

USFWS (U. S. Fish and Wildlife Service). 2009. Final Environmental Assessment: Extended Management of Double-crested Cormorants under 50 C.F.R. § 21.47 and 21.48. U.S. Dept. of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203.

USFWS (U. S. Fish and Wildlife Service). 2014. Final Environmental Assessment: Management of Double-crested Cormorants under 50 C.F.R. § 21.47 and 21.48. U.S. Dept. of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203.

USFWS (U. S. Fish and Wildlife Service). 2014a. Species Profile and links, Bull Trout (Salvelinus confluentus). Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E065#crithab.

USFWS (U. S. Fish and Wildlife Service). 2014b. Oregon Seabird Colony Catalog computer database and Colony Status Record archives. U.S. Fish and Wildlife Service, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon 99567.

USFWS (U. S. Fish and Wildlife Service). 2014c. Endangered Species Act - Section 7 Consultation Biological Opinion: Consultation for U.S. Army Corps of Engineers Continued Operations and Maintenance Dredging Program for the Columbia River Federal Navigation Channel in Oregon and Washington (2014-2018). 47 pp.

USFWS (U.S. Fish and Wildlife Service) and USCB (U.S. Census Bureau). 2014. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Oregon. FHW/11-OR (RV).

USGS (US Geological Survey). 2010. Wildlife Health Bulletin 2010-06. Available at http://www.nwhc.usgs.gov/publications/wildlife_health_bulletins/WHB_2010-06_Newcastle.pdf.

Van Der Veen, H. E. 1973. Some aspects of the breeding biology and demography of the Double-crested Cormorants (Phalacrocorax auritus) of Mandarte Island. Ph.D. thesis. Zoologisch Laboratorium der Rijksuniversiteit te Groningen, Groningen.

Wait D. A., D. P. Aubrey, and W. B. Anderson. 2005. Seabird guano influences on desert islands: soil chemistry and herbaceous species richness and productivity. Journal of Arid Environments 60(2005): 681- 695.

Waterbird Conservation for the Americas. 2012. Waterbird Conservation for the Americas. http://www.waterbirdconservation.org.

Watson, W. J., M. G. Garrett, and R. G. Anthony. 1991. Foraging ecology of bald eagles in the Columbia River Estuary. Journal of Wildlife Management 55(3):492-499.

Watson, J. W., D. W. Stinson, K. R. McAllister, and T. E. Owens. 2002. Population status of bald eagles in Washington at the end of the 20th century. Journal of Raptor Research. 36:161-169.

WDFW (Washington Department of Fish and Wildlife). 2012. Candidate species 2012 annual report: Tufted Puffin. Available at: http://wdfw.wa.gov/conservation/endangered/species/tufted_puffin.pdf.

Weber, W. J. 1979. Health Hazards from pigeons, European starlings, and English sparrows. Thompson Publ. Fresno, Calif. 138 pp.

Weitkamp, L. A., P. J. Bentley, and M. Litz. 2012. Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River Estuary. Fish. Bull. 110:426-450.

Welch, D. W., E. L. Rechisky, M. C. Melnychuk, A. D. Porter, C. J. Walters, S. Clements, B. J. Clemens, R. S. McKinley, and C. Schreck. 2008. Survival of Migrating Salmon Smolts in Large Rivers With and Without Dams. PLoS Biol 6(10):e265. Available at: doi:10.1371/journal.pbio.0060265.

Weseloh, D. V. C. and P. J. Ewins. 1994. Characteristics of a rapidly increasing colony of double-crested cormorants (*Phalacrocorax auritus*) in Lake Ontario: Population size, reproductive parameters and band recoveries. Journal of Great Lakes Research 20(2): 443-456.

Whittaker, D., J. J. Vaske, M. J. Manfredo. 2006. Specificity and the cognitive hierarchy: Value orientations and the acceptability of urban wildlife management actions. Soc. Nat. Resour. 19, 515–530.

Wiese, F. K., J. K. Parrish, C. W. Thompson, and C. Maranto. 2008. Ecosystem-based management of predator-prey relationships: Piscivorous birds and salmonids in the mid-Columbia River. Ecological Applications 18: 681-700.

Williams, B. K., F. A. Johnson, and K. Wilkins. 1996. Uncertainty and the adaptive management of waterfowl harvests. Journal of Wildlife Management 60:223-232.

Wilson, U. W. 1991. Responses of three seabird species to El Niño events and other warm episodes on the Washington coast, 1979-1990. Condor 93:853-858.

Wires, L. R., F. J. Cuthbert, D. R. Trexel and A. R. Joshi. 2001. Status of the double-crested cormorant (*Phalacrocorax auritus*) in North America. Final Report to U.S. Fish and Wildlife Service.

Wires, L. R. and F. J. Cuthbert. 2006. Historic populations of the double-crested cormorant (*Phalacrocorax auritus*): Implications for conservation and management in the 21st century. Waterbirds 29:9-37.

Wright, S. K. 2005. Disturbance and roosting ecology of California brown pelicans (*Pelecanus occidentalis californicus*) on East Sand Island in the Columbia River Estuary. M.S. Thesis, Oregon State University, Corvallis, OR. 106 pp.

Wright, S. K., D. D. Roby, and R. G. Anthony. 2007. Responses of California brown pelicans to disturbances at large Oregon roost. Waterbirds 30:479-487.

Zabel, R. W. 2013. Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2012. Memorandum for James H. Lecky, Northwest Fisheries Science Center. Available at: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/2012-estimation-memo.pdf.

Zabel, R. W. 2014. Preliminary survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2014. Memorandum for Ritchie Graves, Northwest Fisheries Science Center. Available at: http://www.nwd-wc.usace.army.mil/tmt/agendas/2014/1015_2014_Preliminary_Survival_Estimates_Memo.pdf.

Zamon, J. E., T. A. Cross, B. P. Sandford, A. F. Evans, and B. Cramer. 2013. Measuring estuary avian predation impacts on juvenile salmon by electronic recovery of ISO-PIT tags from bird colonies on East Sand Island, Oregon, 2012. Draft Report by Northwest Fisheries Science Center to the Portland District of U.S. Army Corps of Engineers.

PERSONAL COMMUNICATION

Dan Roby, Oregon State University (telephone conversation held 4 April 2014 with Terry Frederick, Harris Environmental Group, Portland, Oregon).

Diane Winterboure, USDA Wildlife Services'- liaison to Oregon Department of Transportation (email correspondence with Corps. April- August 2013).

Don Lyons, Oregon State University (email and telephone conversations with Corps. November 2013).

Greg Smith, Oregon State University (telephone conversation with Terry Frederick, Harris Environmental Group. 22 April 2014).

Mark Bagdovitz, USFWS Regional Fisheries Resources Office (email and telephone conversations with Corps. February-May 2013).

Niels Jepsen, Senior Researcher, PhD, DTU-Aqua Section for Freshwater Fisheries Ecology-Denmark (email and telephone conversations with Corps. June-October 2014).

Scott Patterson, ODFW Fish Propagation Program Manager (email and telephone conversations with Corps. February-May 2013).

Shawn Stephensen, USFWS Refuge Wildlife Biologist, Oregon Coast National Wildlife Refuge Complex (phone conversation with Michelle McDowell, USFWS DMBM. May 22, 2014).

Tom Anderson, Wildlife Biologist, Sonny Bono Salton Sea National Wildlife Refuge (email to Michelle McDowell, USFWS DMBM. April 4, 2014; telephone conversation. January 28, 2015).

Appendix B: Applicable Laws and Executive Orders

Law, Regulation, or Guideline	Description and Assessment of Compliance
Migratory Bird Treaty Act of 1918 (MBTA), as amended, (16 U.S.C. 703-711)	The MBTA implements treaties with Canada, Mexico, Japan, and Russia; the act imposes obligations on the U.S. for the conservation of migratory birds, including the responsibilities to conserve and manage migratory birds internationally; sustain healthy migratory bird populations for consumptive and non-consumptive uses; and restore depleted populations of migratory birds. *USFWS is a cooperating agency to this EIS. Any action requiring permits under MBTA will be coordinated with USFWS.*
Endangered Species Act of 1973 (ESA), as amended (7 U.S.C. 136; 16 U.S.C.1531-1544)	It is Federal policy, under the ESA, that all Federal agencies seek to conserve threatened and endangered species and utilize their authorities in furtherance of the purposes of the Act (Sec. 2(c). *NOAA Fisheries listed species-* Consultation with NOAA Fisheries for species under its jurisdiction for Phase I of the proposed action was completed in the 2014 FCRPS Biological Opinion; thus, no Section 7 consultation is required for Phase 1 for NOAA Fisheries species. A BA will be prepared and section 7 consultation completed for the proposed terrain modification in Phase II prior to implementing that action. *USFWS listed species-* A BA was developed to address all listed species in the project area under the jurisdiction of USFWS from the preferred management plan for both Phase I and Phase II actions. The BA includes streaked horned larks and an assessment of potential effects to other listed species. The Corps' Channels and Harbors Program has completed consultation on the continued operation and maintenance dredging program for the Columbia River Federal Navigation Channel (USFWS 2014c). Hazing Caspian terns and DCCOs on dredged material islands that are critical habitat for streaked horned larks occurs under this program. Consultation with the USFWS on the effects of the proposed management plan will be completed prior to implementation.
National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321-4347)	NEPA requires Federal agencies to evaluate the potential environmental impacts when planning a major Federal action and ensures that environmental information is available to the public before decisions are made and actions are taken. *This EIS is the process for demonstrating compliance with NEPA.*
National Historic Preservation Act (NHPA) of 1966 (16 USC 470(f))	Requires the effects of a “federal undertaking” to be assessed for their potential to affect historic properties on, or eligible for listing on the National Register of Historic Places, and to consult with the State Historic Preservation Officers. *Historic properties are identified in Chapter 3 effects to those properties are discussed in Chapter 4. The Corps will be initiating consultation with SHPO on the effects of the*

Law, Regulation, or Guideline	Description and Assessment of Compliance
	proposed actions.
Coastal Zone Management Act (CZMA) of 1972, as amended (16 U.S.C. 1451-1464)	Protects environmental quality of coastal areas. *A consistency determination will be submitted to OCDCL. No off island effects would occur under Phase I that would affect a coastal resource as described in the relevant planning documents.*
Federal Water Pollution Control Act of 1948, as amended in 1972 as the Clean Water Act (CWA)	CWA contains a number of provisions to restore and maintain the quality of the nation's water resources. Provides for protection of water quality. Section 404 of the Clean Water Act (CWA) of 1977, as amended, requires that all projects involving the discharge of dredged or fill material into Waters of the United States be evaluated for water quality and other effects prior to making the discharge. Federal regulations, at 33 C.F.R. § 336.1, provide that a Section 404 permit will not be issued for such fill material by the Corps to itself; however, the Corps shall apply the Section 404(b) (1) guidelines to the project. *See Section 404(b) (1) evaluation following this table.*
Bald and Golden Eagle Protection Act of 1940 (16 U.S.C. 668-668c)	This Act provides further protection for bald and golden eagles. The Act defines take as "to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturbance" relates to activities that affect the viability of eagle populations (e.g., from nest or chick abandonment), which would result from otherwise normal, lawful business practices. *Take as defined by the BGEPA would not occur as part of the proposed FEIS alternatives. Although there could be some impacts to eagles from implementation of the alternatives, these impacts would be minor (flushing and potential to reduce foraging opportunities on the island which only makes up a small portion of the diet) these impacts would not result in "take" as defined by the Act.*
Executive Order 13112 on Invasive Species (February 3, 1999)	This Executive Order established the National Invasive Species Council and required federal agencies (to the extent practicable) to identify actions that may spread invasive species and use relevant programs and authorities to prevent the introduction of invasive species; to research, monitor and otherwise control invasive species; to restore native species and habitat conditions in ecosystems that have been invaded; and promote public education on invasive species. *A revegetation and invasive species plan will be developed prior to implementation of the action and strategies would be employed to minimize the effect of field personnel and construction equipment impacting vegetation or unintentionally spreading invasive or unintended plant species on the island.*
Executive Order 13186-	This Order identifies federal agency responsibilities to protect migratory birds and their habitats, and directs executive departments and agencies to undertake actions that will further implement the MBTA. The Order encouraged each agency to immediately begin

Law, Regulation, or Guideline	Description and Assessment of Compliance
Responsibilities of Federal Agencies to Protect Migratory Birds (January 10, 2001)	implementing the fifteen identified conservation measures, as appropriate and practicable. These conservation measures include avoiding or minimizing adverse impacts on migratory bird resources, lessen the amount of unintentional take, restoring and enhancing the habitat of migratory birds, promote research and information exchange related to the conservation of migratory birds including coordinated inventorying and monitoring. It also directs federal agencies to develop a Memorandum of Understanding (MOU) with the USFWS to promote the conservation of migratory bird populations, including their habitats, when their actions have, or are likely to have, a measurable negative effect on migratory bird populations. This Order also directs the Secretary of the Interior to establish The Council for the Conservation of Migratory Birds (Council) to oversee the implementation of this order. The Council serves to enhance coordination and communication among Federal agencies regarding their responsibilities under the four bilateral treaties on the conservation of migratory birds. (Canada - 1916, Mexico - 1936, Japan - 1972, Russia - 1978) and also builds upon the progress that has been made in recent years on conservation of migratory birds. *The Department of Defense (DoD) signed an MOU with the USFWS, 31 July 2006, to comply with this executive order http://www.dodpif.org/plans/migratory/mbtadod.php The MOU states the DoD shall, among other things, "encourage incorporation of comprehensive migratory bird management objectives in the preparation of DoD planning documents (…including NEPA analyses)." The NEPA process allows for much of the coordination with USFWS and consideration of measures to minimize impacts to migratory birds where feasible. Measures to minimize impacts to migratory birds were integrated into the proposed action and alternatives and will be implemented to the extent practicable.*
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Provides a mechanism for establishing regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications. *The Corps sent out letters to tribes in the region initiating consultation soon after the Notice of Intent was published. Coordination with tribal governments has been ongoing through the regional programs and groups (SRWG, RIOG) that meet to discuss implementation of all FCRPS RPA actions. The Confederated Tribes of the Colville Reservation and Confederated Tribes of the Umatilla Indian Reservation accepted the invitation for government to government consultation and delegated staff to work with the Corps in development of the EIS.*
Executive Order 12898 (EO), Federal Actions to	The overall purpose of the order is to avoid disproportionately high imposition of any adverse environmental or economic impact on minority or low-income populations. All NEPA environmental analyses must include an evaluation of effects on minority and low

Law, Regulation, or Guideline	Description and Assessment of Compliance
Address Environmental Justice in Minority and Low-Income Populations, 11 February 1994	income communities. *No subsistence, low-income or minority communities would be affected by the alternatives under consideration as none currently access or utilize East Sand Island. The alternatives under consideration would not cause disproportionately high and/or adverse effects on any minority or low-income populations and is compliant with the Order.*

Clean Water Act Section 404 Evaluation

Regulatory Authority

Section 404 of the Clean Water Act (CWA) of 1977, as amended, requires all activities involving the discharge of dredged or fill material into waters of the U.S. be evaluated for water quality and other effects prior to making the discharge. Federal regulations at 33 C.F.R. § 336.1 (a), provide that a Section 404 permit is not issued by the Corps to itself; however, the Corps shall applying all applicable substantive legal requirements, including public notice, opportunity for public hearing, and application of the Section 404 (b) (1) guidelines.

Under 33 C.F.R. § 230.13, the Corps applies Engineering Regulations (ER) 1105-2-11 in development of NEPA documents. ER 1105-2-100 C.6 (h) *Water Quality and Related Requirements* specifies the evaluation of the effects of the discharge of dredged or fill material, including consideration of the Section 404(b)(1) guidelines shall be included in the NEPA document where the plan or project involves the discharge of dredged or fill material into waters of the U.S. Full compliance with the CWA, and 404(b)(1) guidelines must be completed prior to the initiation of project construction (ER 1105-2-100 C.6 (e)).

In consideration of the Section 404(b)(1) guidelines, this evaluation assesses the effects of proposed terrain modification actions (described in Chapter 5) utilizing guidelines established by the EPA and described at 40 C.F.R. Part 230 1-12 and in ER 1150-2-100, Appendix C. A public notice, describing the proposed action and fill under Section 404 has been issued for 45-day public review and comment. Coordination with other agencies has occurred (see Chapter 6).

Jurisdictional Waters of the U.S. on East Sand Island

The Corps' jurisdiction over tidal waters is outlined in Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Section 10 defines jurisdiction to the "mean high water line" which is the average of all high tides of navigable water ways. Section 404 defines jurisdiction to the "high tide line" which is the maximum height of a rising tide, not including storm surges (33 C.F.R. § 328.3(d)). Since the high tide line would be higher in elevation than the mean high water line, the high tide line was delineated to determine the federal jurisdictional limit.

Eight wetlands have been delineated on East Sand Island. Four are non-tidal freshwater wetlands with a mix of Cowardin classifications of palustrine scrub-shrub (PSS) and palustrine emergent (PEM). Four are tidal estuarine wetlands located entirely below the delineated tidal waters boundary. The Cowardin class of the tidal estuarine wetlands is estuarine emergent (EEM). No wetlands were identified on the western portion of the island where the proposed excavation of approximately 300,000 cubic yards of sand would occur. Placement of a portion of the approximately 30,000 cubic yards of rip-rap material would occur below delineated high tide line and would constitute a fill under the CWA.

Project Description

The FEIS describes the proposed action (Chapters 2 and 5), location and need for the action. In summary the terrain modification to East Sand Island would occur as part of long-term management plan and involve excavation of approximately 300,000 cubic yards of sand on the western most portion of East Sand Island (see Figure 2-4) to create inlet channels and lagoon type areas to inundate the island and preclude nesting by DCCOs in that location. To stabilize the island and ensure there would be no adverse effect to the Columbia River Federal Navigation Channel placement of approximately 30,000 cubic yards of rip-rap would be placed on the northern shoreline.

Temporary impacts to waters of the U.S. could occur as a result of construction and staging activities. These impacts would be short in duration (construction activities and placement would occur during in-water work period Nov 15-Feb 15 to the extent possible). Permanent impacts to waters of the U.S. would occur from the placement of rock armor below high tide line and potential disposal of excavated sand below high tide line and/or in wetlands on the eastern portion of the island. Disposal locations have not been fully identified and would be selected to minimize impacts where possible when confirmed as designs are finalized. Preference would be given to place material in upland areas and to supplement the designated Caspian tern colony area.

General Description of the Dredged Material

Due to the history of disturbance and the dynamic nature of the fluvial system, soils on the island are very young and poorly developed. Soils on East Sand Island are mapped in the Clatsop County, Oregon (OR007) Soil Survey as Tropopsamments, 0 to 15 percent slopes. Soils have been built up by repeated alluvial deposition, evidenced by the thin contrasting layers in exposed profiles from the northwestern shore of the island. They are very deep, excessively drained, and very low in organic matter and fines (silts and clays). Although guano from DCCO has accumulated on the western portion where excavation would occur, due to high porosity of sandy soils it is unlikely that any chemical contamination is present in the dredged material (see Chapter 4, Section 4.2.1.)

Effects on the physical, chemical, and biological components of the aquatic environment

Physical substrate determinations.

Soils on East Sand Island are similar across the island and predominantly sandy with some silt and loam (see Chapter 3, Section 3.2.1). Field personnel have noted the excrement of DCCO guano is toxic to the species of plants upon which DCCO nest on East Sand Island, and former nesting sites of DCCO on the island, where there was previously vegetation, are now bare of all vegetation and no longer used for nesting. Compaction is occurring on the Caspian tern colony where disposal would occur and disposal could affect the water table. However long-term disposal on the designated tern colony would provide benefits to nesting Caspian terns by creating more suitable habitat. East Sand Island is exposed to a high degree of wind and wave erosive forces and substantial amount of erosion has occurred and is likely to continue. Soils observable in some beach exposures on the northern and northeastern shore of East Sand Island are higher in silt (predominantly silt loam textures). This is likely the Coquille soil in Map Unit 11A (Fluvaquentic Edoaquepts) that is mapped along the northern and eastern shores of adjacent Sand Island. This soil profile has common redox features throughout, as a result of its proximity to the water table and its higher water holding capacity. This inclusion may be capped with disposal of sand and occur as a buried soil further inland, likely perching and retaining water.

Water circulation, fluctuation, and salinity determinations.
East Sand Island is located near the mouth of the Columbia River and exposed to highly erosive wave action and wind. Placement of rock armor has been designed to stabilize the island and maintain current water circulation patterns. Disposal of excavated sand on the island and placement of rock armor would have little or no effect on water circulation or fluctuation, or salinity of the Columbia River and would maintain current conditions.

Suspended particulate/turbidity determinations.
The Mouth of the Columbia River is a high energy environment, with naturally occurring fluctuations of turbidity. Short-term turbidity increases are expected during disposal when this occurs near shoreline or below delineated high tide line. However, due to the high sand content of the disposal material, the dredged material is expected to settle out of the water column quickly and the turbidity plume resulting from the activity would be intermittent and temporary. In comparison to the natural fluctuations in the turbidity regime in the Mouth of the Columbia River, disposal-induced turbidity would be a minor contributor to the water column.

Contaminant determinations.
Disposal of excavated sand contains nutrients from DCCO guano. DCCO can contribute to higher levels of soil nitrogen, phosphorus, carbon, potassium and calcium (See Chapter 4, section 4.2.1). However, nutrient accumulation is likely less pronounced (or less persistent) in high-

rainfall environments with sandy-textured soils, such as East Sand Island. Because sandy soils have a low water-holding capacity and high infiltration rate, rainwater mobilizes deposited guano and rapidly leaches it through the soil profile. In addition, sandy-textured soils that are low in organic matter have a low cation exchange capacity, so nutrients in solution are not retained on soil particle surfaces. Most nutrients and contaminants deposited in seabird guano likely have a short residence time in the soil profile before being flushed through and into the river system. Based on this there would be little to no effect from chemical contaminants to the Columbia River.

Aquatic ecosystem and organism determinations.
Adverse impacts of fill and discharge to the structure and function of the aquatic ecosystem and organisms are expected to be short-term and minor. Some organisms could be buried or temporarily displaced by the fill below delineated high tide line. This work would be done in approved in-water work periods determined in consultation with NOAA Fisheries and USFWS. Disposal could temporarily disrupt feeding and food sources of organisms present within the site. Aquatic ecosystem functions would essentially remain unchanged in the long-term within the high-energy environment of the Mouth of the Columbia River.

The proposed terrain modification has the potential to provide additional direct and indirect beneficial effects for juvenile salmonids. The ability to create tidal wetlands to indirectly support juveniles through the production and export of macrodetritus and prey is possible. More intertidal mudflats and marsh areas could support shallow water rearing habitat for juveniles. Biological assessments are being prepared for consultation with USFWS and NOAA Fisheries to address the potential effects to listed threatened or endangered species and their critical habitat for the proposed action.

Proposed disposal site determinations.
Disposal sites on the island would be selected in upland locations wherever possible. Should disposal sites be located on the eastern portion of the island, it is possible that two delineated tidal estuarine wetlands, approximately 0.6 acre could be permanently filled. Potential mitigation for this impact could be enhancing other tidal estuarine wetlands present on the island or use of mitigation banks. Permanent disposal of materials in wetlands would be minimal. Temporary impacts to waters of the U.S. could occur during construction could affect wetlands. However, the area impacted would be relatively small and is unlikely to cause large-scale or long-term effects to aquatic habitat features in the Mouth of the Columbia River.

Determination of secondary and cumulative effects on the aquatic ecosystem.

Complete cumulative effects associated with the project are described in Chapter 4, Section 4.4. In summary, terrain modification would likely reduce overall nesting waterbird use of East Sand Island, but would benefit and increase usage of species that require marsh, mudflat, and inundated beach habitat. Species diversity on East Sand Island would likely increase. Less nutrient loading into the Columbia River Estuary would occur with decreased nesting waterbird abundance on East Sand Island. No change or adverse effect in the aquatic ecosystem from the cumulative placement of fill in nearshore environments along the Columbia River is expected. When combined with other disposal events in the Columbia River, disposal of sand on East Sand Island would likely mirror natural erosive processes. Because disposal of excavated sand is native material, no invasive material is being filled that would change the Mouth of the Columbia River's aquatic ecosystem.

Appendix C: Retrospective Analysis of Factors Influencing Predation on Juvenile Salmonids by Double-crested Cormorants in the Columbia River Estuary with Summaries of Bioenergetic-Based Consumption Estimates and PIT Tag Predation Probabilities

Factors Influencing Predation on Juvenile Salmonids by Double-crested Cormorants in the Columbia River Estuary: A Retrospective Analysis

November 7, 2014

This report has been prepared for the U.S. Army Corps of Engineers – Portland District.

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ABSTRACT

Enhancing the survival of juvenile salmonid (*Oncorhynchus* spp.) is a priority objective to recover populations of Columbia River salmonids listed under the U.S. Endangered Species Act (ESA). In the Columbia River estuary, a significant mortality factor for juvenile salmonids is predation by double-crested cormorants (*Phalacrocorax auritus*) nesting at East Sand Island. The U.S. Army Corps of Engineers is considering management alternatives to reduce this mortality. Understanding the factors that influence cormorant predation is important to understanding the potential consequences of various management strategies. We used principal components regression (PCR) to evaluate the relationship between several annual measures of cormorant predation and a combination of colony size and environmental covariates. The environmental factors considered included large-scale climate indices (Pacific Decadal Oscillation, El Nino/Southern Oscillation Index, North Pacific Gyre Oscillation, Pacific Northwest Index), regional climate measures (sea surface temperature, upwelling strength, upwelling timing), and variables describing conditions during freshwater and estuarine outmigration (river discharge, spill at hydroelectric dams, measures of salmonid smolt survival to the estuary). These covariates potentially influenced both the susceptibility of salmonids to cormorant predation and the abundance and distribution of marine forage fish and their availability as alternative prey for cormorants nesting in the estuary. Measures of cormorant predation spanned a 15-year period (1999 – 2013) and included (1) predation probabilities for multiple steelhead (*O. mykiss*) and Chinook salmon (*O. tshawytscha*) populations derived from recoveries of salmonid passive integrated transponder (PIT) tags at the cormorant colony, (2) estimates of annual consumption of steelhead and yearling Chinook by cormorants derived using bioenergetics modeling, and (3) the observed percentage of the cormorant diet that consisted of salmonids. We also related cormorant diet composition to purse seine catches in the estuary during 2007 – 2012 to assess how predation on salmonids is related to availability of alternative, non-salmonid prey and to examine cormorant selectivity of salmonids relative to other available prey.

PCR analyses indicated that environmental factors explain a substantial proportion of the annual variability seen in several measures of cormorant predation on Columbia River juvenile salmonids. Cormorant colony size was an important explanatory factor in most regressions; however, it never explained more than 17% of the variability in any annual measure of cormorant predation on salmonids. In aggregate, environmental factors explained a greater proportion of the annual variability in cormorant predation than did colony size; in particular, river discharge and the North Pacific Gyre Oscillation (NPGO) were prominent environmental explanatory factors. Based on comparisons to estuary purse seine catches, cormorants appeared to take salmonids in proportion to their relative availability in the Columbia River estuary, not their absolute abundance. Conversely, changes in absolute abundance of alternative prey, both marine and freshwater/estuarine forage fishes, did influence how much cormorants relied on salmonids as prey. While colony size is an important determinant of cormorant impacts on salmonid populations, environmental conditions that regulate the availability of alternative prey might outweigh the effects of changing colony size in any given year. Potential management efforts to reduce the size of the double-crested cormorant colony on East Sand Island to benefit ESA-listed salmonids would best be evaluated in the context of environmental conditions, particularly if evaluation occurs on an annual basis, with special attention given to river discharge and the NPGO. Multiyear data sets following any implementation of management would likely be more useful to evaluate potential benefits.

INTRODUCTION

Increasing salmonid (*Oncorhynchus* spp.) survival at the juvenile life history stage has been proposed as a priority objective to recover Columbia River basin salmonid populations listed under the U.S. Endangered Species Act (ESA; NOAA 2014). In the Columbia River estuary, a significant mortality factor for juvenile salmonids is predation by piscivorous colonial waterbirds (Lyons 2010, Evans et al. 2012). In particular, average annual predation rates on ESA-listed salmonid populations by double-crested cormorants (*Phalacrocorax auritus*) nesting at East Sand Island (river km 8) ranged from 1.9% to 9.8% by population during 2007 – 2012 (Lyons et al. 2014). Total annual salmonid consumption by double-crested cormorants ranged from 9.2 million to 20.5 million smolts during the same interval (BRNW 2014).

While levels of cormorant predation on some populations of juvenile salmonids have been high on average, there has been substantial inter-annual variability. Coefficients of variation (CVs; calculated as the standard deviation divided by the mean value for a given parameter) of annual predation rates (proportion of available smolts that were consumed by cormorants) during 2007 – 2012 ranged from 35% to 89% for Chinook salmon (*O. tshawytscha*) populations and 37% to 63% for steelhead (*O. mykiss*) populations (Lyons et al. 2014). For the total numbers of steelhead and yearling Chinook smolts consumed, CVs were 47% and 50%, respectively, during 2004 – 2012. Similarly, the annual percentage of the cormorant diet that consisted of salmonids varied over an order of magnitude since 2004, ranging from 2% to 20% (CV = 45%) of the diet. While change in the size of the double-crested cormorant colony on East Sand Island may explain some of the annual variability in cormorant predation on salmonids, colony size was relatively stable during 2004 – 2012 (10,950 – 13,800 breeding pairs; CV = 7%).

It is well documented that environmental conditions can play an important role in the survival of juvenile salmonids during outmigration to the ocean and after ocean entry (e.g., Petrosky and Schaller 2010, Burke et al. 2013, Peterson and Burke 2013). Large scale climate indices such as the Pacific Decadal Oscillation (PDO; Mantua et al. 1997), the El Nino/Southern Oscillation (quantified as the Multivariate ENSO Index, or MEI; Wolter and Timlin 1993, 1998), the North Pacific Gyre Oscillation (NPGO; Di Lorenzo et al. 2008, Miller et al. 2013), and the Pacific Northwest Index (PNI; Ebbesmeyer and Strickland 1995, Williams et al. 2014), have all been found to relate to juvenile salmonid survival, presumably through the regulation of predators, competitors, and/or food resources (Emmett et al. 2006, Scheuerell et al. 2009, Lyons 2010).

At the regional scale, important factors related to survival of juvenile salmonids include local sea surface temperature (SST; Brosnan et al. 2014) and the strength (Greene et al. 2005) and timing (Logerwell et al. 2003) of coastal upwelling, among others. These conditions probably only weakly regulate conditions in the Columbia River estuary but may play a strong role in the abundance and distribution of marine forage fish and their availability to cormorants nesting in the estuary (Litz et al. 2012). In the estuary, river discharge has been shown to be a factor significantly affecting the composition of the local forage fish community (Weitkamp et al. 2012), presumably by altering salinity distributions, and has been shown to regulate predation on juvenile salmonids by Caspian terns (*Hydroprogne caspia*) nesting at East Sand Island (Lyons 2010).

The conditions that juvenile salmonids experience during their freshwater migration, prior to arrival in the estuary, may also affect their survival in the estuary. The proportion of water passing a dam that flows over the spillway, often the most benign route for a smolt to move past a dam (Muir et al. 2001), can be related to subsequent survival in the estuary or near-shore ocean environments (Petrosky and Schaller 2010, Haeseker et al. 2012). In addition, river flows experienced by smolts can influence travel times and survival rates during migration through the hydropower system (Scheuerell et al. 2009). Ultimate survival rates of smolts migrating through the Columbia River hydropower system have also been a useful predictor of survival in the estuary and near-shore ocean (Haeseker et al. 2012). Less spill, reduced flows, and/or lower survival through the hydropower system may indicate a rigorous or stressful migration, which may leave smolts more vulnerable to predation in the estuary (the "delayed-mortality hypothesis"; Budy et al. 2002, Schaller and Petrosky 2007).

As a component of a comprehensive strategy for salmonid recovery in the Columbia Basin, management has been proposed to reduce the impacts of East Sand Island double-crested cormorants on juvenile survival of ESA-listed salmonid populations (NOAA 2014). One possible management objective is to reduce the size of the cormorant colony through culling or dispersal of cormorants to areas outside the Columbia River basin. The primary goal of analyses presented here were to provide context for this potential management strategy by assessing the relationship between cormorant colony size and measures of cormorant predation, and identifying important environmental factors that may confound that relationship. The large variability observed in multiple measures of cormorant predation (diet composition, total smolt consumption, and predation rates) that occurred during a period of relatively stable colony size suggests that evaluating the efficacy of colony size reductions requires an understanding of how environmental conditions also influence cormorant predation on juvenile salmonids in the Columbia River estuary.

METHODS

The double-crested cormorant colony on East Sand Island (river km 8) was the largest in western North America during 1998-2013 (Adkins et al. 2014), ranging from 6,300 to 14,900 breeding pairs annually (Appendix C-1, Table C-1.2). We examined predation on juvenile salmonids by cormorants nesting on East Sand Island in the Columbia River estuary using several techniques and datasets during this period, namely by Principal Component Regression (PCR) analysis and by investigating the relationships between the availability of alternative prey and cormorant diet composition.

Principal Components Regression Analysis

To assess the relative importance of colony size and other environmental factors on salmonid predation by cormorants, we used PCR analysis (Koslow et al. 2002, Burke et al. 2013). With this technique, the effects of multiple, sometimes related (i.e., correlated) explanatory factors can be assessed on a given response variable by first transforming the raw explanatory factor data into a set of orthogonal principal components (PCs). Those PCs can then be regressed on the response variable(s) of interest. We conducted this analysis using annual values for both explanatory factors and response variables.

Measures of Cormorant Predation (Response Variables): Two primary measures have been used to assess predation on Columbia River juvenile salmonids by piscivorous waterbirds nesting at colonies in the Columbia River basin: (1) the number of smolts consumed and (2) the percentage of smolts consumed. Each measure is derived using independent techniques.

The number of smolts consumed or *smolt consumption* is estimated using demand-based bioenergetics models, incorporating estimates of waterbird numbers (adults and chicks), energy requirements of individual waterbirds (adults and chicks), diet composition, and energetic content of each prey type (Roby et al. 2003, Antolos et al. 2005, Lyons 2010, Maranto et al. 2010). The taxonomic resolution of smolt consumption estimates are dictated by the achievable resolution in the data on diet composition. The diet composition of double-crested cormorants nesting on East Sand Island was quantified using identifiable soft tissue from the stomach contents of cormorants collected as they returned to the colony after foraging, with partitioning among prey types by relative identifiable biomass (Collis et al. 2002). In partnership with NOAA Fisheries (D. Kuligowski, Northwest Fisheries Science Center), salmonids from cormorant stomach contents were identified to species using genetic techniques (Lyons 2010, BRNW 2014). In recent years, identification of salmonids to the level of evolutionarily significant unit (ESU) or distinct population segment (DPS) level has been possible due to advancements in genetic stock identification. Sample sizes for each ESU/DPS group have been too small, however, to accurately partition the diet below the level of species on an annual basis. Consequently, estimates of smolt consumption are performed at the species level, with a partition by age class for Chinook salmon. A summary of annual cormorant diet composition (the percentage of the diet that was salmonids) is presented in Appendix C-1 (Table C-1.2) along with smolt consumption results from Lyons (2010) and BRNW (2014; Table C-1.3).

An alternative, and complimentary, measure of cormorant predation is the percent of smolts consumed or *predation probability*, which is the probability of locally available juvenile salmonids being consumed by birds from a particular nesting colony. This measure has been based on detections of smolts tagged with passive integrated transponder (PIT) tags at a point in the river (e.g., a dam) and the subsequent recovery of a portion of those tags at nearby colonies of fish-eating birds (Collis et al. 2001, Ryan et al. 2001, Ryan et al. 2003, Antolos et al. 2005, Good et al. 2007, Evans et al. 2012, Hostetter et al. in-press). Estimates of this measure have been labeled *predation rates* previously in the literature, but *predation probability* is more precise terminology given recent probabilistic modeling approaches to estimation (Appendix C-2; Evans et al. 2012, Osterback et al. 2013, Hostetter et al. in-press). Predation probabilities can be specific to any group of smolts for which there is a representative sample of tagged fish; analyses presented here are conducted at the level of evolutionary significant units (ESUs) or discrete populations segments (DPSs) of smolts following past efforts (Antolos et al. 2005, Good et al. 2007, Evans et al. 2012). We used predation probability estimates for East Sand Island double-crested cormorants that incorporated two significant enhancements over previously available estimates: (1) estimates were calculated using models that accounted for PIT tag detection and deposition probabilities and (2) predation probabilities included the most up to date data available (studies completed in 2013). Further details on predation probability calculations are presented in Appendix C-2 and Hostetter et al. (in-press). The resulting annual estimates of cormorant predation probabilities for all ESA-listed Columbia River DPSs/ESUs originating upstream of Bonneville Dam on the Columbia River and upstream of Sullivan Dam on the Willamette River, where representative samples of PIT-tagged smolts were available, are also presented in Appendix C-2 (Table C-2.1).

A large and diverse number of measures of double-crested cormorant predation on Columbia River salmonids were available for potential analysis during 1998-2013 (see Appendices C-1 and C-2); for simplicity, we focused on a reasonable, prioritized subset of possible measures. For population-specific measures, we prioritized predation probabilities for ESA-listed populations from the Snake and Upper Columbia rivers that experienced lengthy migrations through the Federal Columbia River Power System (FCRPS). The recovery of these populations was the impetus for management actions, including reductions in cormorant predation, prescribed in the 2014 FRCPS Biological Opinion (NOAA 2014). We also prioritized steelhead and spring/summer (yearling) Chinook salmon, as they were more heavily impacted species/runs and were consistently PIT-tagged during 1999-2013. Estimates of smolt consumption (total numbers consumed) at the species/age-class level were included and offered a more general measure of impacts, complementing the focus on predation probabilities for a few select populations.

By including responses from both methodologies (ESU/DPS-specific predation probabilities and species-specific smolt consumption) our aim was to improve our ability to derive robust results. These criteria resulted in the selection of smolt consumption estimates for steelhead and yearling Chinook (see Appendix C-1), and the predation probabilities for the Snake River (SR) and Upper Columbia River (UCR) steelhead distinct population segments, and the Snake River spring-summer ($SR_{sp/su}$) and Upper Columbia River spring (UCR_{sp}) Chinook salmon evolutionarily significant units as the response variables (see Appendix C-1).

Finally, because it was an important component of the bioenergetics-based smolt consumption estimates and highly variable across the study period, we also included the annual percentage of salmonids in the cormorant diet (% of identifiable prey biomass; see Appendix C-1) as a response measure. We averaged the percent salmonids in the diet across mid-April to mid-June – the major outmigration period for steelhead and yearling Chinook smolts – for each year.

Measures of Biotic and Abiotic Variability (Explanatory Variables): Our analysis focused on explanatory factors that might influence predation on juvenile salmonids by double-crested cormorants in the estuary via four primary mechanisms: (1) by variability in cormorant abundance, (2) by affecting smolt abundance and/or susceptibility to cormorant predation as smolts enter the foraging range of cormorants in the estuary, (3) by influencing the physical environment of the estuary while smolts are migrating through to the ocean, or (4) by affecting the abundance of alternative, non-salmonid prey for cormorants in the estuary. We selected factors demonstrated in the literature to influence smolt survival in the estuary and/or near ocean environment and for which data were likely to be readily available in the future.

Abundance of double-crested cormorants was quantified as the peak colony size observed on East Sand Island each year. High resolution aerial photography was taken at the approximate time of peak colony activity (late May or early June) and three independent counts of cormorant nests in photography were averaged to estimate the number of cormorant breeding pairs present. Because the cormorant breeding colony on East Sand Island is a mixed-species colony, including both double-crested cormorants and Brandt's cormorants (*P. penicillatus*), the number of double-crested cormorant breeding pairs was obtained by subtracting the number of Brandt's cormorant nests from the total number of cormorant nests. Colony size was an input variable in the generation of two response variables, the bioenergetics-based estimates of steelhead and yearling Chinook consumption, so a relationship between these variables was expected; of interest was how much variability was explained by other factors.

We used average monthly values (Jan. – Apr.) of the PDO obtained from the University of Washington Joint Institute for the Study of the Atmosphere and Ocean (http://jisao.washington.edu/pdo). This seasonal metric has been shown to correlate with Caspian tern consumption of smolts in the Columbia River estuary (Lyons 2010). We similarly used average monthly values of the MEI obtained from the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (http://www.cdc.noaa.gov), and the NPGO obtained from Emanuele Di Lorenzo (http://www.o3d.org/npgo). Annual values for the PNI were obtained from the Columbia Basin Research website maintained by the University of Washington (http://www.cbr.washington.edu).
Regional climate conditions were described in three ways. The average daily optimal-interpolated sea surface temperature (SST) was obtained from the International Comprehensive Ocean-Atmospheric Data Set maintained by the University Corporation for Atmospheric Research (http://rda.ucar.edu) and averaged across May and June of each year. Daily upwelling indices were downloaded from NOAA's Pacific Fisheries Environmental Laboratory (http://www.pfeg.noaa.gov); daily values were averaged

across April through June to describe the strength of upwelling during the period in which steelhead and yearling Chinook salmon smolts were migrating through the estuary. The date of the spring transition to upwelling along the Oregon and Washington coast was obtained from NOAA's Northwest Fisheries Science Center (http://www.nwfsc.noaa.gov).

Several explanatory factors related to physical conditions in the estuary and the freshwater migration conditions that smolts experience prior to arrival in the estuary were evaluated. Values for river discharge at river km 87 (Beaver Army Terminal, site number 14246900) were obtained from the U.S. Geological Survey (http://waterdata.usgs.gov); daily values in May were averaged to represent annual flow, corresponding to the peak outmigration period for steelhead and yearling Chinook (Fish Passage Center 2013). May flows were also highly correlated to the rest of the smolt outmigration period. Annual survival estimates for steelhead and yearling Chinook smolts migrating from Lower Granite Dam on the Snake River to Bonneville Dam on the lower Columbia River were obtained from the Fish Passage Center (http://fpc.org). Daily estimates of spill (% of total water passing through a given dam) were downloaded from the Columbia Basin Research website, averaged over the multiple dams encountered, and temporally averaged across April through June, after Haeseker et al. (2012).
Annual values of all explanatory variables used in the PCR analyses are provided in Appendix C-3 (Table C-3.1).

PCR Analyses: Each explanatory factor was evaluated for normality using Anderson-Darling tests; if data were found to be non-normal or had extreme outliers, a log transformation was performed. For a few variables, outliers were irreconcilable using transformations (normality tests still failed) or the time series included one or more missing values. We consequently conducted two PCR analyses for each response variable. The first PCR included only those variables for which there was a complete (1999-2013) and normally distributed data set (i.e., PDO, MEI, NPGO, SST, upwelling strength, spring transition date to upwelling, river discharge, and colony size). The second PCR included all explanatory variables but excluded years having missing or outlying values for any variable (i.e., PNI, steelhead survival through the hydropower system, Chinook salmon survival through the hydropower system, and average spill). For the second PCR the sample size was reduced from 15 years to 11 years for steelhead and to 13 years for Chinook salmon. In both analyses, all data were scaled to have a mean of zero and a standard deviation of one. A principal component analysis (PCA) was then performed using PC-ORD (MjM Software, Gleneden Beach, Oregon) to transform the explanatory variables into orthogonal principal components (PCs), eliminating the multicolinearity present in the original explanatory variable dataset (Appendix C-3, Table C-3.2).

Response variables were tested for normality and, if found to be non-normal, log-transformed. Multiple linear regression was performed for each response variable initially using the first six principal components generated in the explanatory factor PCA analysis. Model reduction from that initial, full model was performed using backwards stepwise selection and applying Akaike's Information Criterion corrected for small sample sizes (AICc) to prioritize PCs for possible elimination from intermediate models. Model reduction decisions were based on goodness-of-fit F-tests. Model fit was accepted at the level of $P < 0.10$. For responses with acceptable models (i.e. where models including one or more principal components outperformed the null model), we quantified the relative contribution of each of the explanatory factors to the regression by taking the squared loadings of a given factor onto the PCs that remained in the best regression model and multiplying them by the semi-partial correlation coefficient for each remaining PC, then summing across PCs (Burke et al. 2013).

Relationships between Estuary Purse Seine Catches and Cormorant Diet Composition

To assess the relationship between prey availability and cormorant predation on juvenile salmonids, we related the percentage of the cormorant diet (% biomass) identified as salmonids to purse seine catches of both juvenile salmonids and alternative prey. Purse seine sampling was conducted during 2007-2012 as described in Weitkamp et al. (2012). In brief, sampling cruises were conducted approximately every two weeks across the spring and summer at two sites in the estuarine mixing region. Seining was performed during daylight hours on days with early morning low tides using a fine mesh net measuring 10.6 m deep by 155 m long. Sampling was conducted in areas where water depths were approximately 8-10m deep, allowing the net to fish the entire water column. It was possible to estimate catch per unit effort by following a systematic round haul protocol. Using length-weight relationships, purse seine catches were identified as total biomass and the percentage of total biomass for each prey type.

Purse seine catches conducted between 13 April and 21 July overlapped with the collection of data on cormorant diet composition for six to seven sampling cruises per year. Cormorant diet data were partitioned into approximate two-week periods centered on each cruise date. Purse seine and cormorant diet data were averaged across cruises in each year to generate an annual estimate of prey abundance in seine catches and cormorant diet composition. To understand the relationship between cormorant diet and the availability of salmonids and alternative prey, the percentage of the cormorant diet that was observed to be salmonids was related to salmonid biomass in the purse seines, as well as the biomass of marine forage fishes (anchovy, herring, sandlance, and smelts; biomass was log transformed) and freshwater/estuarine resident fish (minnows, flatfish, lamprey, sculpin, stickleback, surfperch, and others). Relationships were evaluated using simple linear regression.

To explore whether double-crested cormorants were feeding selectively on specific types of fish (i.e., eating fish prey types either with greater or lesser frequency than found locally in the estuary), we compared the percent biomass of each prey type in the observed diet with the percent biomass of that fish prey type in the purse seine hauls conducted over the same time period. The selectivity metric we used was the $\log_{10}$ of the odds ratio (LOR; Schabetsberger et al. 2003). The LOR is symmetrical around zero (LOR = 0 indicated no selectivity, or prey eaten in the same proportion as it occurred in the estuary), where positive values mean positive prey selection (prey type found at a higher percentage in the cormorant diet than observed in the purse seine catch) and negative values mean negative prey selection (prey type found at higher percentage in the purse seine catch than in the diet):

$$LOR = log_{10}\left[\frac{d_i(100-e_i)}{e_i(100-d_i)}\right],$$

as calculated from the numerical percentages of fish taxon i in the predator diet (d_i) and local surroundings (e_i). The LOR values were calculated from percent biomass of each prey type in purse seine sampling and cormorant diet over several time periods (April-May, June-July, and April-July). Logarithms to the base 10 of the odds ratios were taken so that odds ratios of + 1 and +2 indicate prey types occurring 10 times or 100 times, respectively, more frequently in the cormorant diet than would be expected given its relative abundance in the estuary as reflected in purse seine catches. Values of - 1 and -2, however, indicate potential prey types avoided by the predator because the species' relative abundance in the purse seine catch was 10 or 100 times greater than its frequency in the diet (Tollitt et al. 1997). This measure of predator selectivity assumes that the purse seine is catching all prey fish species with equal efficiency and accurately represents the prey community from which the cormorants are selecting.

RESULTS

PCR Analyses

The first three principal components explained at least 75% of the variability in the environmental explanatory factors in all iterations of the principal components analysis. Ordination plots of the first two principal component axes for all analyses indicated similar dispersion of the study years, with early years segregated from later years of the study (Figure 1). Cormorant colony size and river discharge (flow) were important drivers of this segregation of years. Interesting outlying years included 2001 (low river discharge), 2005 (delayed spring transition), 2008 (cool and wet spring conditions) and 2011 (high river discharge).

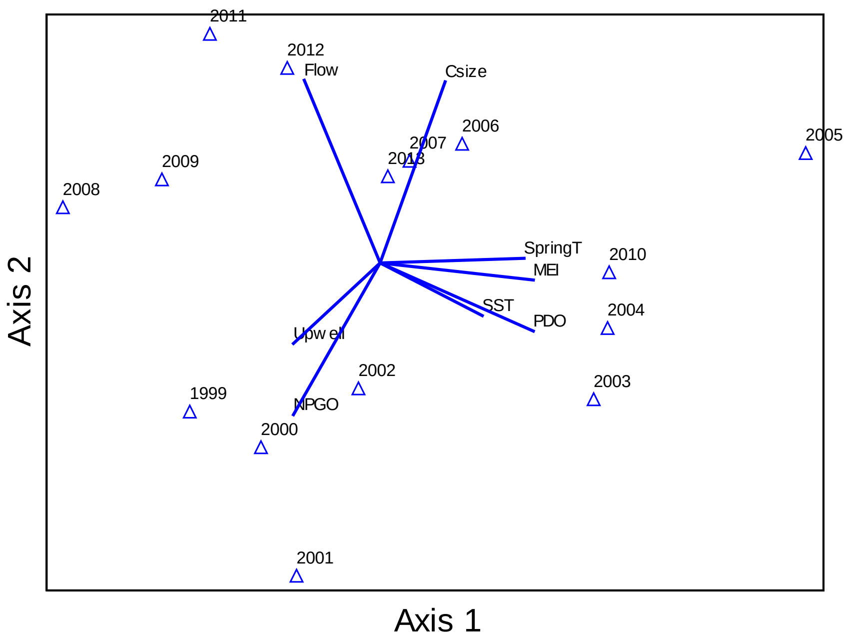


Figure 1. Ordination plot for a principal components analysis of explanatory factors from 1999 to 2013 (all years of the study). Factors included the Pacific Decadal Oscillation (PDO), Multivariate El Nino/Southern Oscillation Index (MEI), North Pacific Gyre Oscillation (NPGO), sea surface temperature (SST), strength of upwelling (Upwell), upwelling spring transition (SpringT), river discharge (Flow), and cormorant colony size (Csize). Outlying years included 2001 (low river discharge), 2005 (delayed spring transition), 2008 (cool and wet spring conditions), and 2011 (high river discharge). The first and second principal components explained 40.3% and 23.3% of the variability in the explanatory factors, respectively.

Reverse stepwise selection of regression models resulted in best fit models that incorporated one or two principal components for most responses; however, in a few cases no model was significantly better than the null model (Tables 1 and 2). For regressions having a model with a good fit, 25-60% of the variability in the response was explained (Table 1 and 2).

Table 1. Best fit Principal Component Regression models resulting from reverse stepwise model selection for the analysis incorporating data from all years of the study period (1999-2013) but a reduced set of explanatory factors. Response variables include

cormorant predation on spring (sp) and summer (su) run Chinook salmon and steelhead and Chinook salmon originating from the Snake River (SR) and Upper Columbia River (UCR).

Response Variable	# of Principal Components in best model	F Test P-Value	R^2
Steelhead Consumed	2	0.04	0.42
SR Steelhead Predation Probability	No good fit	NA	NA
UCR Steelhead Predation Probability	2	0.04	0.44
Yearling Chinook Consumed	2	0.04	0.39
$SR_{sp/su}$ Chinook Predation Probability	1	0.06	0.25
UCR_{sp} Chinook Predation Probability	No good fit	NA	NA
Percent Salmonids in Cormorant Diet	2	0.01	0.52

Table 2. Best fit Principal Component Regression models resulting from reverse stepwise model selection for the analysis incorporating data from the complete set of explanatory variables but omitting years with data gaps or extreme outliers. Response variables include cormorant predation on spring (sp) and summer (su) run Chinook salmon and steelhead and Chinook salmon originating from the Snake River (SR) and Upper Columbia River (UCR).

Response Variables	# of Principal Components in best model	F Test P-Value	R^2
Steelhead Consumed	No good fit	NA	NA
SR Steelhead Predation Probability	No good fit	NA	NA
UCR Steelhead Predation Probability	1	0.01	0.50
Yearling Chinook Consumed	2	0.08	0.43
$SR_{sp/su}$ Chinook Predation Probability	No good fit	NA	NA
UCR_{sp} Chinook Predation Probability	2	0.01	0.60
Percent Salmonids in Cormorant Diet	1	0.01	0.52

For the PCR that included a subset of explanatory factors and data from all years of the study, the relative importance of the explanatory factors was consistent across several response variables (Figure 2). Colony size, river discharge, and the NPGO explained more of the variability in each of the predation probability and smolt consumption estimates for which well-fitting PCR models were derived. Cormorant colony size and river discharge explained a similar amount of variability (12-17% and 13-15%, respectively) across these four responses, with the NPGO explaining 6-10%. Large scale (PDO, MEI) and regional (spring transition date, SST) climate factors explained more variability in cormorant diet, with colony size not strongly related to this metric.

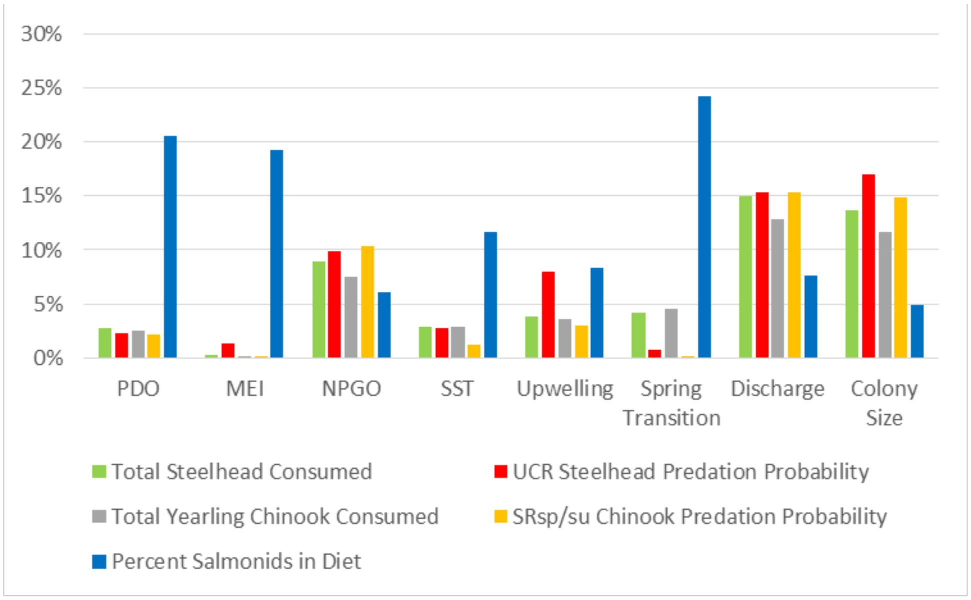


Figure 2. Relative ability of environmental factors to explain inter-annual variability in measures of cormorant predation on juvenile salmonids. Percentages indicate how much of the variability explained by the Principal Component Regression models can be attributed to each particular factor. This analysis included data from the entire study period 1999-2013. Population-specific response variables included cormorant predation probabilities for Upper Columbia River (UCR) steelhead and Snake River spring/summer ($SR_{sp/su}$) Chinook salmon.

In the second set of PCR models, which included the complete set of environmental factors, the effect of individual factors was more dilute (Figure 3). The only prominent exception to this trend was the NPGO, which explained relatively large amounts of variability in both the UCR steelhead and UCR_S Chinook salmon predation probabilities (35% and 22%, respectively). Notably, none of the additional explanatory factors included in this analysis (i.e., PNI, steelhead or Chinook survival through the hydropower system, or average spill conditions) had substantial ability to explain variation in any of the well-modeled responses.

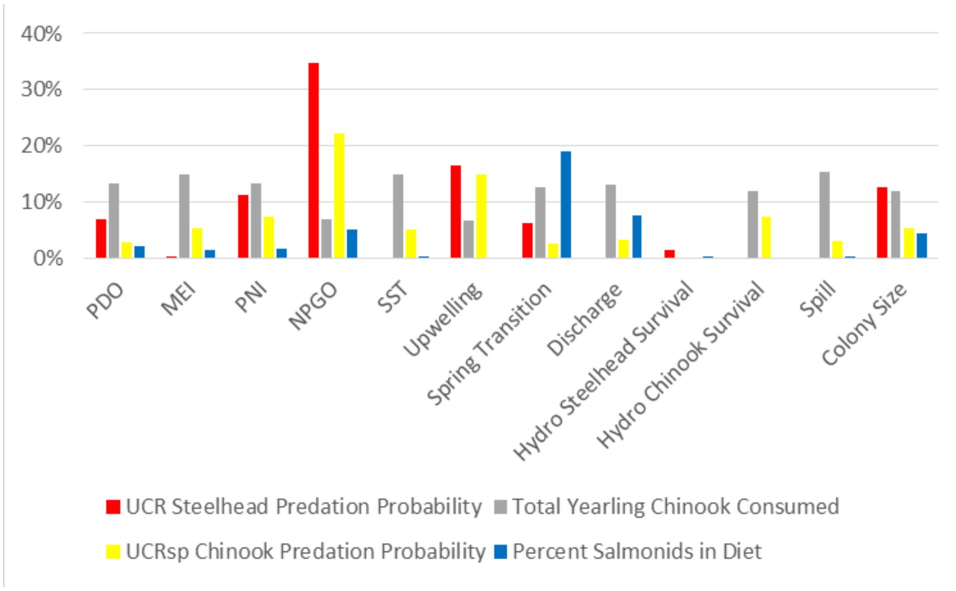


Figure 3. Relative ability of environmental factors to explain inter-annual variability in measures of cormorant predation on juvenile salmonids. Percentages indicate how much of the variability explained by the Principal Component Regression models can be attributed to each particular factor. This analysis omitted data from years when data were unavailable or extreme outliers occurred. Population-specific response variables include cormorant predation probabilities for steelhead and spring (sp) run Chinook salmon originating from the Upper Columbia River (UCR).

Purse Seine Analyses

We found that the annual percentage of salmonids (biomass) in the diet of cormorants was significantly related to the annual percentage of salmonids (biomass) in estuary purse seine (EPS) catches, but not the total annual biomass of salmonids in EPS catches (Figure 4). Consistent with this result, we found that when a greater biomass of alternative forage fish was caught in EPS hauls, the salmonid proportion of the cormorant diet was smaller. This was true for both pooled marine forage fishes and pooled freshwater/estuarine forage fishes (Figure 5).

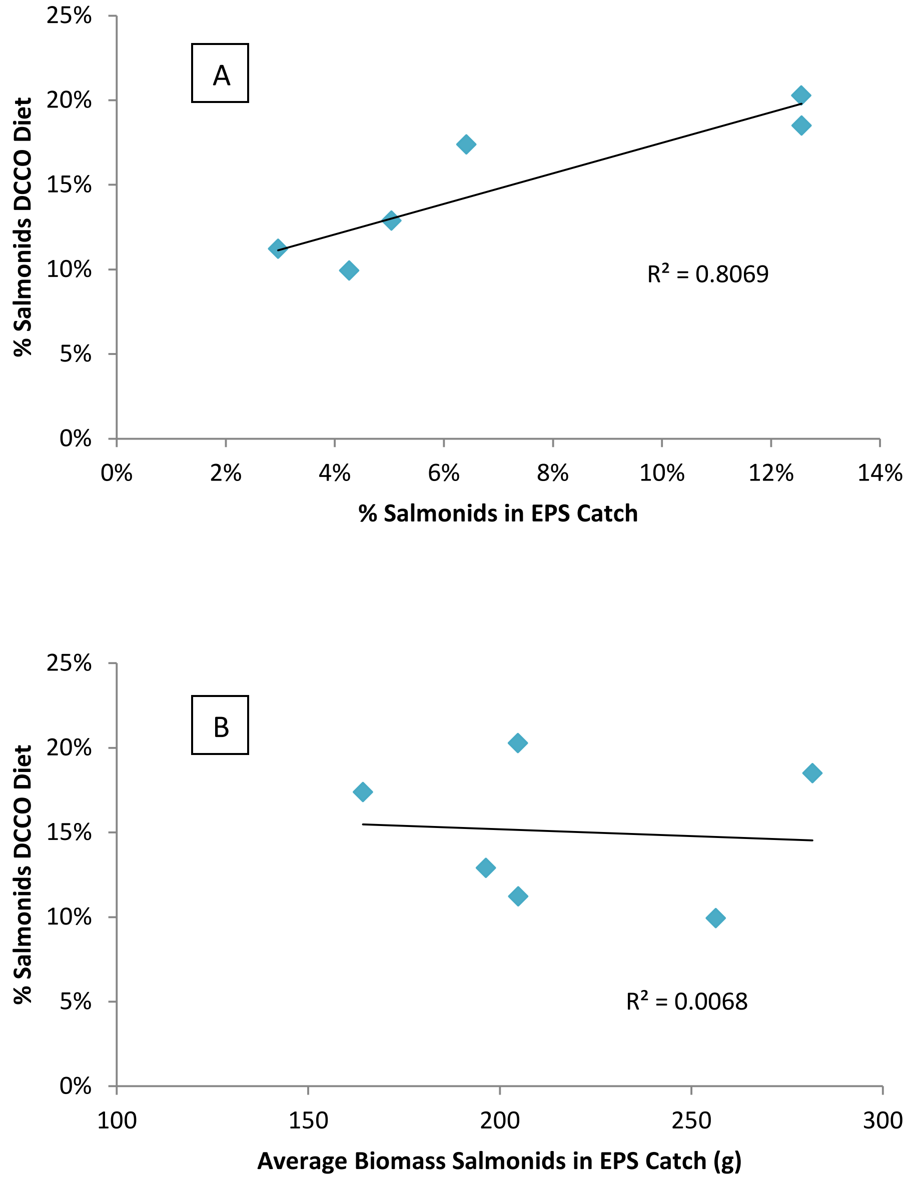
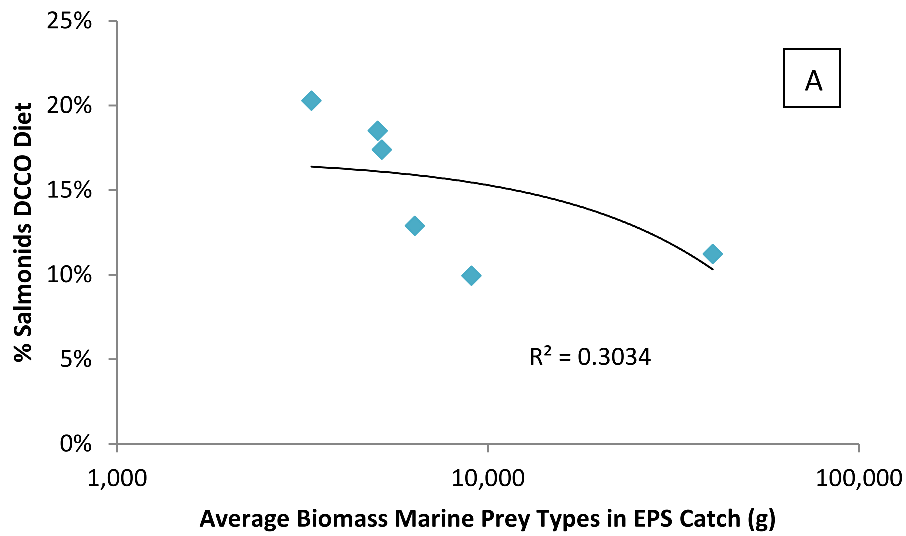


Figure 4. Relationships between the proportion of salmonids (biomass) in the diet of double-crested cormorants (DCCO) nesting on East Sand Island and (A) the proportion of salmonids (biomass) in estuary purse seine (EPS) catches and (B) the average biomass of salmonids caught in EPS hauls. Each data point represents one year of study during 2007-2012. Cormorants appeared to respond to the relative abundance, but not the absolute abundance, of salmonids in the estuary.



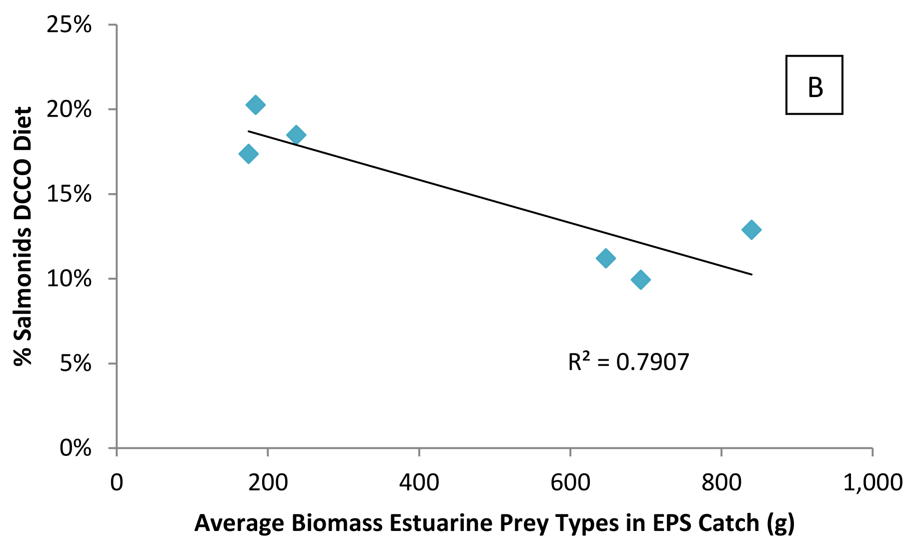


Figure 5. Relationships between the proportion of salmonids in the diet of double-crested cormorants (DCCO) nesting on East Sand Island and (A) average total biomass of marine forage fishes in estuary purse seine (EPS) catches and (B) the average total biomass of estuarine forage fishes in EPS catches. Each data point represents one year of study during 2007-2012. Greater absolute availability of alternative prey was associated with reduced cormorant reliance on juvenile salmonids.

Little evidence of cormorant preference for salmonids was found using log odds ratios of the percent salmonids in the cormorant diet to that in the estuary purse seine catches (Figure 6). Other prey types appeared to be more strongly selected for (anchovy or flatfish) or selected against (clupeids, smelt) by cormorants, but results varied by year and fish family.

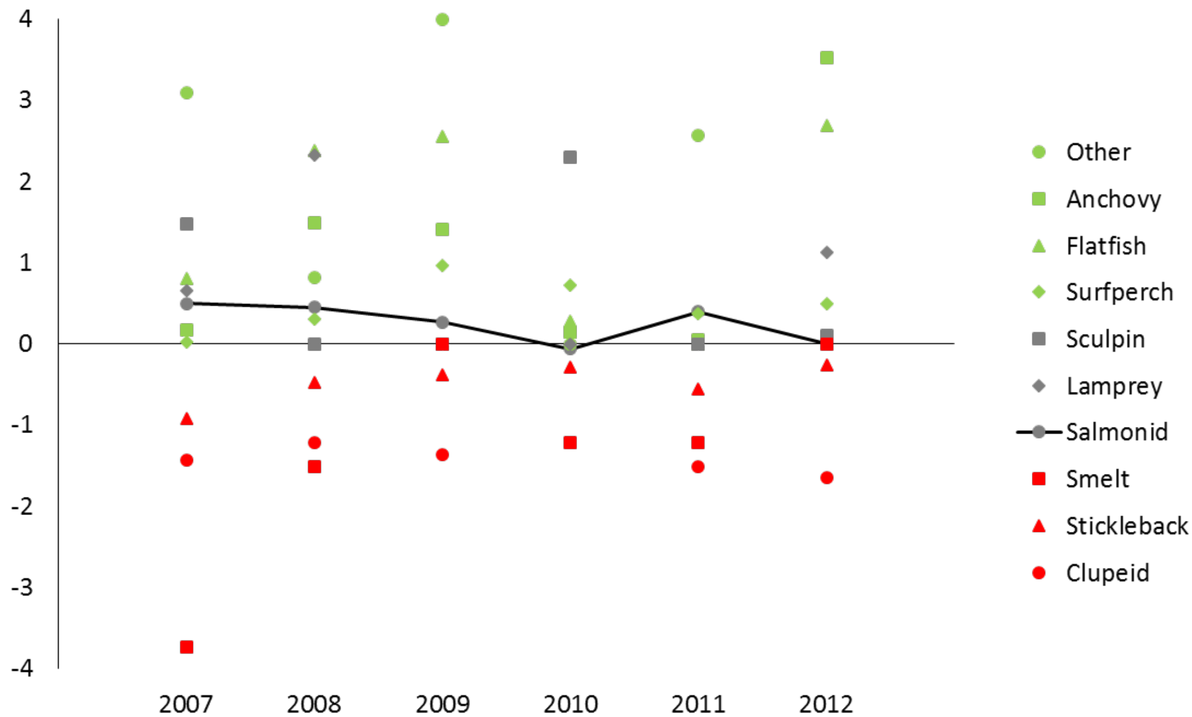


Figure 6. Log odds ratio of the percent of prey types in the diet of double-crested cormorants to the percent of prey types in estuary purse seine catches during April-May. Positive values indicate greater prevalence in the cormorant diet than in seine catches. Compared to values for anchovy, flatfish, and surfperch, selectivity by double-crested cormorants for salmonids (black circles and line) was minimal. The "other" prey type category included several types that were uncommon in both cormorant diets and purse seine catches – gunnels, suckers, gadids, pricklebacks, greenlings, mackerels, lingcod, and crustaceans.

DISCUSSION

Annual measures of cormorant predation impacts on Columbia River juvenile salmonids by double-crested cormorants nesting on East Sand Island derived using two independent methodologies varied substantially across 1999 – 2013. Previous summaries of shorter time periods (2007 – 2012; Evans et al. 2012, Lyons et al. 2014) had indicated substantial inter-annual variation in both smolt consumption and predation probability measures, and that variability was present across the entire extended time period of data summarized for this analysis.

We found that environmental factors explained some of the variability seen in several measures of cormorant predation on salmonids. Many of these same environmental factors have previously been related to variability in survival of juvenile salmonids during freshwater migration, travel through the estuary, or early ocean residency (Petrosky and Schaller 2010, Haeseker et al. 2012). Given the number of potential factors and our relatively short time series (with regards to regression analyses), principal components regression was an effective technique to evaluate the potential importance of many factors simultaneously (Koslow et al. 2002, Burke et al. 2013).

When using all 15 years of our response data sets, the PCR analysis identified a similar set of important explanatory factors, including colony size, river discharge, and the NPGO, for four of the six direct measures of cormorant predation on salmonids. These responses included the number of steelhead and yearling Chinook smolts consumed by cormorants derived using bioenergetics modeling (see Appendix C-1) and predation probabilities derived from PIT tag recoveries (see Appendix C-2) for two ESA-listed populations.

Compared with smolt consumption and predation probabilities, the percentage of salmonids in the cormorant diet was best explained by an alternative set of environmental variables. More variability was explained by the date of spring transition to upwelling and the large-scale climate indices PDO and MEI than by any other factors. The percentage of salmonids in cormorant diets describes predation by cormorants on all species and populations of juvenile salmonids, including coho salmon (*O. kisutch*) and sub-yearling Chinook salmon. In most years, coho salmon have been the salmonid species most frequently consumed by cormorants during the spring outmigration period that was the focus of this analysis (mid-April through mid-June). Often bioenergetics estimates of coho salmon consumption by double-crested cormorants have been greater than those for steelhead and yearling Chinook combined (Appendix C-1, Table C-1.3). This predation on coho salmon masks the contribution of steelhead and yearling Chinook to the percentage of salmonids in the cormorant diet. If the annual susceptibility of coho salmon to cormorant predation responds to a somewhat different set of environmental factors than that of steelhead and yearling Chinook salmon, it would explain the inter-annual differences observed in cormorant diets. Sub-yearling Chinook salmon are typically the smolt type most frequently consumed by cormorants on an annual basis, but most of that predation occurs after mid-June, so is less likely a confounding factor in the analysis presented herein.

When using a subset of our response data set, but including a complete list of environmental factors of interest, the PCR analysis did not reveal strong relationships between any response and the four additional factors added. The NPGO was strongly related to predation probabilities for the UCR steelhead and UCRs Chinook populations, supporting the conclusion from the first PCR that this large scale climate index is an important explanatory factor.

The PCR models sought to explain variability in both predation probabilities derived from PIT tag recoveries and estimates of smolt consumption derived from bioenergetics models. These two independent measures of cormorant predation on salmonids are not directly comparable, but each offers useful and complimentary information about cormorant impacts on survival of juvenile salmonids. Predation probabilities offer a direct measure of cormorant impacts on specific salmonid conservation units: ESA-listed ESUs and DPSs. In addition, predation probability is more easily interpreted in the context of juvenile salmonid survival, a priority metric of broader salmon recovery efforts in the Columbia River Basin (NOAA 2014). Smolt consumption estimates, conducted at the species level (and age-class level for Chinook salmon), offer a more general or inclusive measure of cormorant predation, and do not rely on representative PIT tag sampling of smolts but rather a representative sample of the birds diet. Demand-based bioenergetics calculations of smolts consumed also offer a cormorant-centric mechanistic understanding of factors influencing smolt consumption levels – factors such as cormorant colony size, diet, and productivity (number of young produced), as well as prey fish nutritional quality (energy content) – all of which are important input parameters in the estimation process. Species-specific estimates of salmonid consumption integrate consumption of all Columbia River populations, both ESA-listed and non-listed. Such integrated measures are useful to interpret large-scale salmonid conservation and management issues; however, they cannot be directly related to specific population recovery objectives under the ESA.

Another measure of predation impact is *consumption rate* (the analog of predation probability) at the species level, which can be estimated by dividing species-specific smolt consumption estimates by estimates of the species-specific number of smolts available to cormorants in the estuary (e.g., see Appendix E of NOAA [2014]). We did not choose to calculate consumption rates in this manner for our analyses because our objective was to explore the ability of colony size and environmental factors to explain variability in cormorant predation. Uncertainty in annual estimates of smolt availability in the estuary (Burke et al. 2013) could confound such relationships. Furthermore, consumption rates, are not directly comparable to ESU/DPS-specific predation probabilities, as they describe predation on multiple ESUs/DPSs. Significant differences between predation probabilities on different ESUs/DPSs of the same species (see Appendix C-2, Table C-2.1) indicate that an integrated measure of consumption rate at the species level may be substantially different from the predation probability for any particular component ESU/DPS.

River discharge and the large scale climate index, the North Pacific Gyre Oscillation, were the most important environmental factors in PCR models. Varying levels of river discharge significantly influences the distribution of freshwater within the estuary, particularly at the surface and in shallower areas (Fox et al. 1984). At high flows, saltwater intrusion into the estuary is greatly reduced and marine forage fish are substantially less abundant (Weitkamp et al. 2012). In such cases, alternative prey for cormorants are reduced and reliance on salmonids may be greater. High discharge may also speed the arrival of juvenile salmonids into the estuary, perhaps before some are physiologically ready to enter saltwater, thereby increasing the residence time of juvenile salmonids in the estuary. These extended estuary residence times presumably prolong exposure to predation by cormorants nesting on East Sand Island (Schreck et al. 2006). Our results suggest that predation impacts on salmonids by cormorants were elevated during high flow years. Smolt survival through the FCRPS is typically highest in years of high river flow, however (Petrosky and Schaller 2010, Haeseker et al. 2012). Thus the benefits of higher smolt survival to the estuary in years having higher river flows may be offset to some degree by increased predation by double-crested cormorants in the estuary.

The NPGO is calculated monthly as the second principal component of sea surface height across the Northeast Pacific Ocean. This derived index of climate variability has tracked well with salinity, chlorophyll, nitrates, and upwelling winds in the California Current along the North American Pacific Coast (Di Lorenzo et al. 2008). Our result that cormorant predation in the estuary was related to the NPGO is consistent with recent studies that have seen relationships between the NPGO and, for example, Snake River spring/summer Chinook salmon smolt-to-adult return rates (Miller et al. 2013). Exact mechanisms of how large scale climate indices influence survival of Columbia Basin salmonids at specific life history stages are challenging to identify; however, cormorant predation in the estuary is one possible mechanism. Presumably the NPGO regulates cormorant predation on smolts indirectly by regulating alternative prey that may enter the estuary and be available for cormorants to consume instead of salmonids.

Both cormorant diets and estuary purse seine catches were highly variable within seasons and between sampling cruises, suggesting that prey resources in the estuary are highly dynamic on short time scales (e.g., tidal cycles, daily, weekly, and monthly time scales). Relationships between purse seine catches and cormorant diets were more consistent at annual scales, so we focused on those comparisons. Correlations at the annual scale, however, rely on a small sample size of purse seine catch data (n = 6 years), so results should be viewed as suggestive.

Based on the comparisons to the purse seine catches, double-crested cormorants nesting on East Sand Island appeared to take salmonids (all species combined) in proportion to their relative availability in the Columbia River estuary, not their absolute abundance. In years when more salmonids were caught in purse seine hauls, cormorants did not necessarily respond by consuming a higher proportion of salmonids in the diet. Instead, when salmonids were a greater proportion of the total catch (greater proportion of biomass caught), salmonids made up a greater proportion of cormorant diets as well. Changes in absolute abundance of alternative prey, both marine and freshwater/estuarine forage fishes, did influence how much cormorants relied on salmonids as prey. This provided strong evidence that double-crested cormorants respond to changes in the availability of alternative prey within the estuary, and suggests that in years when alternative prey (marine and estuarine forage fishes) are relatively abundant, cormorant predation on salmonids will be reduced. The log odds ratio calculations also suggested that cormorants did not exhibit selectivity for salmonids relative to their relative availability in the estuary. Taken together, these results suggest that cormorants are foraging on smolts opportunistically in the Columbia River estuary. The degree to which cormorants make use of salmonids as prey is thus very likely dependent on environmental factors that influence the availability of alternative prey.

In summary, double-crested cormorants consumed a substantial number and percentage of juvenile salmonids in the Columbia River estuary during 1999-2013, and colony size was an important explanatory factor in most models. Environmental factors were as or more important in explaining the variability in cormorant predation than colony size, however. In aggregate, environmental factors explained a greater portion of variability in cormorant predation, and at least one other factor (river discharge) appears to be as important as colony size in determining levels of cormorant predation on smolts. While colony size is an important determinant of cormorant impacts on salmonid populations, environmental conditions that regulate the availability of alternative prey could outweigh the effects of changes in colony size in any given year. Consequently, management efforts to reduce the size of the East Sand Island cormorant colony to benefit ESA-listed salmonids would best be evaluated in the context of environmental conditions, particularly if evaluation occurs on an annual basis, and with specific attention given to river discharge and the NPGO. Multiyear data sets following any implementation of management would likely be more useful to evaluate potential benefits.

REFERENCES

Adkins, J.Y., D.D. Roby, D.E. Lyons, K.N. Courtot, K. Collis, H.R. Carter, W.D. Shuford, and P.J. Capitolo. 2014. Recent population size, trends, and limiting factors for the double-crested cormorant in Western North America. Journal of Wildlife Management 78: 1131-1142.

Antolos, M., D.D. Roby, D.E. Lyons, K. Collis, A.F. Evans, M. Hawbecker, and B.A Ryan. 2005. Caspian tern predation on juvenile salmonids in the mid-Columbia River. Transactions of the American Fisheries Society 134: 466-480.

Bird Research Northwest (BRNW). 2005-2013. Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River, Final 2005-2012 Annual Reports. Submitted to the Bonneville Power Administration, U.S. Army Corps of Engineers – Walla Walla District, and the U.S Army Corps of Engineers – Portland District. Available on line at www.birdresearchnw.org.

Bird Research Northwest (BRNW). 2014. Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River: 2013 Final Annual Report. Real Time Research, Bend, OR and Oregon State University, Corvallis, OR. Available on line at www.birdresearchnw.org.

Boström, M. K., S.-G. Lunneryd, L. Karlsson, and B. Ragnarsson. 2009. Cormorant impact on trout (*Salmo trutta*) and salmon (*Salmo salar*) migrating from the river Dalälven emerging in the Baltic Sea. Fisheries Research 98:16–21.

Brosnan, I.G., D.W. Welch, E.L. Rechisky, and A.D. Porter. 2014. Evaluating the influence of environmental factors on yearling Chinook salmon survival in the Columbia River plume. Marine Ecology Progress Series 496: 181-196.

Budy, P., G.P. Thiede, N. Bouwes, C.E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22:35-51.

Burke B.J, W.T. Peterson, B.R. Beckman, C. Morgan, E.A. Daly, and M. Litz. 2013. Multivariate models of adult Pacific salmon returns. PLOS ONE 8: e54134

Collis, K., D.D. Roby, D.P. Craig, B.A. Ryan, and R.D. Ledgerwood. 2001. Colonial waterbird predation on juvenile salmonids tagged with passive integrated transponders in the Columbia River estuary: Vulnerability of different salmonid species, stocks, and rearing types. Transactions of the American Fisheries Society 130: 385-396.

Collis, K., D.D. Roby, D.P. Craig, S. Adamany, J.Y. Adkins, and D.E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: implications for losses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society 131:537-550.

Di Lorenzo E., N. Schneider, K.M. Cobb, K. Chhak, P.J.S. Franks, A.J. Miller, J.C. McWilliams, S.J. Bograd, H. Arango, E. Curchister, T.M. Powell, and P. Rivere. 2008. North Pacific Gyre Oscillation links ocean climate and ecosystem change. Geophysical Research Letters, 35: L08607.

Dunn, E.H. 1975. Caloric intake of nestling double-crested cormorants. Auk 92: 553-565.

Ebbesmeyer, C.C. and R.M. Strickland. 1995. Oyster Condition and Climate: Evidence from Willapa Bay. Publication WSG-MR 95-02, Washington Sea Grant Program, University of Washington, Seattle, WA. 11p.

Emmett, R.L., G.K. Krutzikowsky, and P. Bentley. (2006) Abundance and distribution of pelagic piscivorous fishes in the Columbia River plume during spring ⁄ early summer 1998-2003: relationship to oceanographic conditions, forage fishes, and juvenile salmonids. Progress in Oceanography, 68:1-26.

Evans, A.F., N.J. Hostetter, D.D. Roby, K. Collis, D.E. Lyons, B.P. Sandford, R.D. Ledgerwood, and S. Sebring. 2012. Systemwide evaluation of avian predation on juvenile salmonids from the Columbia River based on recoveries of passive integrated transponder tags. Transactions of the American Fisheries Society 141: 975-989.

Fish Passage Center (FPC). 2013. Smolt Monitoring Program. Available on line at www.fpc.org.

Fox, D.S., S. Bell, W. Nehlsen, and J. Damron. 1984. The Columbia River estuary: atlas of physical and biological characteristics. Columbia River Estuary Data Development Program, Astoria, OR.

Furness, R.W. 1978. Energy requirements of seabird communities: A bioenergetics model. Journal of Animal Ecology 47: 39-53.

Gelman, A., J.B. Carlin, H.S. Stern, and D.B. Rubin. 2004. Bayesian data analysis, second edition. CRC/Chapman and Hall, Boca Raton, Florida, USA.

Good, T.P., M.M. McClure, B.P. Sanford, K.A. Barnas, D.M. Marsh, B.A. Ryan, and E. Casillas. 2007. Quantifying the effect of Caspian tern predation on threatened and endangered Pacific salmon in the Columbia River estuary. Endangered Species Research 3: 11-21.

Greene, C.M., D.W. Jensen, G.R. Pess, E.A. Steel, and E. Beamer. 2005. Effects of environmental conditions during stream, estuary, and ocean residency on Chinook salmon return rates in the Skagit River, Washington. Transactions of the American Fisheries Society 134: 1562-1581.

Gremillet, D., Storch, S., and Peters, G. 2000. Determining food requirements in marine top predators: A comparison of three independent techniques in great cormorants, *Phalacrocorax carbo*. Canadian Journal of Zoology 78: 1567-1579.

Gremillet, D., Wright, G., Lauder, A., Carss, D.N., and Wanless, S. 2003. Modelling the daily food requirements of wintering great cormorants: A bioenergetics tool for wildlife management. Journal of Applied Ecology 40: 266-277.

Haeseker, S.L., J.A. McCann, J. Tuomikoski, and B. Chockley. 2012. Assessing freshwater and marine environmental influences on life-stage-specific survival rates of Snake River spring-summer Chinook salmon and steelhead. Transactions of the American Fisheries Society 141: 121-138.

Hostetter, N.J., A.F. Evans, D.D. Roby, K. Collis, B. Cramer, and D.E. Lyons. In-press. Avian predation on fish populations: Estimating predator specific predation probabilities in tag-recovery models.

Jepsen, N., R. Klenke, P. Sonnesen, and T. Bregnballe. 2010. The use of coded wire tags to estimate cormorant predation on fish stocks in an estuary. Marine and Freshwater Research 61:320–329.

Koslow, J.A., A.J. Hobday, and G.W. Boehlert. 2002. Climate variability and marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon production area. Fisheries Oceanography 11: 65-77.

Litz, M.N.C., R.D. Brodeur, R.C. Emmett, S. Heppell, R.S. Rassmussen, L. O'Higgins, and M.S. Morris. 2010. The effects of variable oceanographic conditions on forage fish lipid content and fatty acid composition in the northern California Current. Marine Ecology Progress Series 405: 71-85.

Litz, M.N.C., R.L. Emmett, P.J. Bentley, A.M. Claiborne, and C. Barcelo. 2013. Biotic and abiotic factors influencing forage fish and pelagic nekton community in the Columbia River plume (USA) throughout the upwelling season 1999 – 2009. ICES Journal of Marine Science. doi:10.1093/icesjms/fst082.

Logerwell, E.A., N. Mantua, P.W. Lawson, R.C. Francis, and V.N. Agostini. 2003. Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (*Oncorhynchus kisutch*) marine survival. Fisheries Oceanography 12: 554-568.

Lyons, D.E. 2010. Bioenergetics-based predator-prey relationships between piscivorous birds and juvenile salmonids in the Columbia River estuary. Unpubl. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. Available on-line at www.birdresearchnw.org.

Lyons, D.E., D.D. Roby, A.F. Evans, N.J. Hostetter, and K. Collis. 2014. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony in the Columbia River estuary. Report to the U.S. Army Corps of Engineers, Portland District, Portland, OR. Available on-line at www.birdresearchnw.org.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78: 1069-1079.

Maranto, C.J., T.P. Good, F.K. Wiese, and J.K. Parish. 2010. Impact of the Potholes Reservoir Caspian tern breeding colony on out-migrating juvenile salmonids in the mid-Columbia River. Transactions of the American Fisheries Society 139:362-381.

Miller, J.A., D. Teel, W.T. Peterson, and A. Baptista. 2013. Assessing the relative importance of local and regional processes on the survival of Snake River spring/summer Chinook salmon. North Pacific Anadromous Fish Commission Technical Report 9: 191-194.

Muir, W.D., S.G. Smith, J.G. Williams, and B.P. Sandford. 2001. Survival of juvenile salmonids passing through bypass systems, turbines, and spillways with and without flow deflectors at Snake River Dams. North American Journal of Fisheries Management 21:135–146.

National Atmospheric and Oceanic Administration (NOAA). 2014. Endangered Species Act Section 7(a)(2) Supplemental Biological Opinion: Consultation on Remand for Operation of the Federal Columbia River Power System. NOAA's National Marine Fisheries Service Northwest Region. 610 pp.

Osterback, A.-M.K., D.M. Frechette, A.O. Shelton, S.A. Hayes, M.H. Bond, S.A. Shaffer and J.W. Moore. 2013. High predation on small populations: avian predation on imperiled salmonids. Ecosphere 4(9):116. http://dx.doi.org/10.1890/ES13-00100.1

Peterson, W.T., and B.B. Burke. 2013. Oceanographic and ecological indicators for salmon returns in the northern California Current. North Pacific Anadromous Fish Commission Technical Report No. 9: 71-75.

Petrosky, C.E., and H.A. Schaller. 2010. Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook salmon and steelhead. Ecology of Freshwater Fish 19:520–536.

Plummer, M. 2003. JAGS: A program for analysis of Bayesian graphical models using Gibbs sampling. Proceedings of the 3rd International Workshop on Distributed Statistical Computing (DSC 2003), March 20–22, Vienna, Austria. ISSN 1609-395X.

Purcell, M., G. Mackey, E. LaHood, H. Huber, and L. Park. 2004. Molecular methods for the genetic identification of salmonid prey from Pacific harbor seal (Phoca vitulina richardsi) scat. Fishery Bulletin 102: 213-220.

Roby, D.D., D.E. Lyons, D.P. Craig, K. Collis, and G.H. Visser. 2003. Quantifying the effect of predators on endangered species using a bioenergetics approach: Caspian terns and juvenile salmonids in the Columbia River estuary. Canadian Journal of Zoology 81:250-265.

Ryan, B.A., J.W. Ferguson, R.D. Ledgerwood, and E.P. Nunnallee. 2001. Detection of passive integrated transponder tags from juvenile salmonids on piscivorous bird colonies in the Columbia River basin. North American Journal of Fisheries Management 21: 417-421.

Ryan, B.A. J.H. Glabek, J.W. Ferguson, E.P. Nunnalle, and R. D. Ledgerwood. 2002. Detection of passive integrated transponder (PIT) tags on piscivorous bird colonies in the Columbia River Basin, 2000. Report submitted to the U.S. Army Corps of Engineers – Walla Walla District by the National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, Washington.

Ryan, B.A., S.G. Smith, J.M. Butzerin, and J.W. Ferguson. 2003. Relative vulnerability to avian predation of juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary, 1998-2000. Transactions of the American Fisheries Society 132: 275-288.

Sebring, S.H., M.C. Carper, R.D. Ledgerwood, B.P. Sandford, G.M. Matthews, and A.F. Evans. 2013. Relative vulnerability of PIT-tagged subyearling fall Chinook salmon to predation by Caspian terns and double-crested cormorants in the Columbia River estuary. Transactions of the American Fisheries Society 142:1321-1334.

Schabetsberger, R., C.A. Morgan, R.D. Brodeur, C.L. Potts, W.T. Peterson, and R.L. Emmett. 2003. Prey selectivity and diel feeding chronology of juvenile Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Columbia River plume. Fisheries Oceanography 12: 523-540.

Schaller, H.A., and C.E. Petrosky. 2007. Assessing hydrosystem influence on delayed mortality of Snake River stream-type Chinook salmon. North American Journal of Fisheries Management 27: 810-824.

Scheuerell, M.D., R.W. Zabel, and B.P. Sandford. 2009. Relating juvenile migration timing and survival to adulthood in two species of threatened Pacific salmon (*Oncorhynchus* spp.). Journal of Applied Ecology 46:983–990.

Schreck, C.B., T.P. Stahl, L.E. Davis, D.D. Roby, and B.J. Clemens. 2006. Mortality estimates of juvenile spring-summer Chinook salmon in the lower Columbia River and Estuary, 2992-1998: Evidence of delayed mortality? Transactions of the American Fisheries Society 135:457-475.

Tollit, D.J., S.P.R. Greenstreet, and P.M. Thompson. 1997. Prey selection by harbour seals, *Phoca vitulina*, in relation to variations in prey abundance. Canadian Journal of Zoology 75: 1508-1518.

Weathers, W.W. 1992. Scaling nestling energy requirements. Ibis 134: 142-153.

Weitkamp, L.A., P.J. Bentley, and M.N.C. Litz. 2012. Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River estuary. Fishery Bulletin 110: 426-450.

Williams, J.G., S.G. Smith, J.K. Fryer, M.D. Scheuerell, W.D. Muir, T.A. Flagg, R.W. Zabel, J.W. Ferguson, and E. Casillas. 2014. Influence of ocean and freshwater conditions on Columbia River sockeye salmon *Oncorhynchus nerka* adult return rates. Fisheries Oceanography 23: 210-224.

Wolter, K., and M.S. Timlin. 1993. Monitoring ENSO in COADS with a seasonally adjusted principal component index. Pp. 52-57 *in* Proceedings of the 17th Climate Diagnostics Workshop, Norman, OK.

Wolter, K., and M.S. Timlin. 1998. Measuring the strength of ENSO events - how does 1997/98 rank? Weather 53: 315-324.

APPENDIX C-1: Estimates of colony size, diet composition, and smolt consumption of East Sand Island double-crested cormorants.

Estimates of colony size, diet composition, and smolt consumption used in this report are based on methods previously developed by Collis et al. (2002), Roby et al. (2003), and Lyons (2010).
Colony Size: The number of adults breeding at each colony during late incubation (peak colony size usually occurred in late May or early June) was precisely estimated using high-resolution aerial photographs (see Collis et al. 2002). Counts of occupied nests in aerial photographs were interpreted as the peak number of breeding pairs for a given colony in a given year. Multiple counts of occupied nests by independent observers varied with a SE ≤ 3% of the mean count.

Diet Composition: Cormorant diet data were obtained from stomach contents of cormorants collected during the breeding season. Five to fifteen samples per week were collected for approximately 10 weeks from late April until the end of July; 125 – 140 samples were available for analysis in each year (Collis et al. 2002). Diet composition, in percent biomass, was taken from the identification to prey family (or genus and species, when possible) of all undigested soft tissue present in the fore-gut. Stomachs lacking any soft tissue (but possibly containing bones), and portions of gastro-intestinal tracts lacking any undigested soft tissue (e.g., bones in intestines), were excluded from the quantitative diet composition analysis. Soft tissue was identified to family using external features when possible or, when necessary, using diagnostic bones following artificial digestion of soft tissue. Unidentifiable soft tissue lacking diagnostic bones was excluded from analysis. From 21 – 25 kg of prey soft tissue biomass was identified in diet analyses each year, which represented >90% of total prey soft tissue mass. Salmonids were identified to species using morphology of external soft tissue when possible or, more frequently; using PCR amplified genetic material (extracted from intact soft tissue or bone) after Purcell et al. (2004).

Smolt Consumption: Smolt consumption estimates were derived using a bioenergetics model based on cormorant abundance, diet composition, energy requirements, and prey energy content (Roby et al. 2003, Lyons 2010, Figure C-1.1). Calculations were performed using a Monte Carlo technique to produce "best" estimates and corresponding 95% confidence intervals (after Furness 1978).
Cormorant Abundance: Peak colony size during each breeding season was estimated as described above. Data were collected on the abundance of cormorants across each breeding season using a combination of aerial photographs and direct counts from boats or blinds within the cormorant colony. Counts of nests in aerial photographs were used to estimate colony size from mid-May until early July during 2008 – 2013. These colony size estimates excluded any non-breeding cormorants using East Sand Island during this period. Counts from boats or blinds conducted at other times (early season, late season, and years prior to 2008) included all birds using East Sand Island and included any non-breeding cormorants present.

For simplicity, chicks were assumed to hatch synchronously in early June and achieve independence eight weeks later. The initial number of chicks present was taken to be the average initial brood size observed in representative focal nests (in sample plots monitored from observation blinds) multiplied by the peak colony size (measured as the number of breeding pairs). The number of chicks present 28 days later was taken to be the average brood size at 28 days post-hatch seen in focal nests, again multiplied by the peak colony size. To quantify the number of chicks present at other times during the chick rearing period an exponential decay function was fit to these two data points (total number of chicks present 1 day and 28 days post-hatch). The number of chicks present following the chick rearing period (i.e. > 8 weeks following the early June hatch date) were directly enumerated in counts from boats or blinds.

Diet Composition: Diet samples were pooled across 4-week periods spanning the period when cormorant nesting overlapped with smolt outmigration (mid-April through the end of July). For periods before and after this sampling period, the diet was assumed to be equivalent to the nearest period sampled. If a prey type was not detected during any given period, it was presumed to be absent from the diet during that time and was not incorporated into the consumption calculations for the given period.

Because the cormorant stomach sample is the independent sampling unit for diet composition, multiple salmonid samples identified from the same stomach are not independent samples of salmonid composition. The breakdown of each stomach sample containing salmonids identified to species is compiled by frequency (e.g., 100% coho salmon, 50% yearling Chinook salmon and 50% steelhead, etc.), averaged across the available samples, and then translated into proportional biomass using the average masses of each salmonid species/type. Because of limited clean tissue samples in any given year, samples are pooled across years. Data through 2013 are summarized in Table C-1.1. Seasonal trends in salmonid species breakdown data are consistent with nearby purse seine sampling of salmonids in the Columbia River estuary (Weitkamp et al. 2012) and salmonid species identified in the diet of Caspian terns also nesting on East Sand Island (Lyons 2010).

Sensitivity analysis has shown that for cormorants, the uncertainty in characterizing diet composition due to small sample sizes was the leading factor causing uncertainty in the subsequent smolt consumption estimates (Lyons 2010). Diet sampling of cormorants was constrained by practical and ethical considerations, however. Non-lethal sampling (e.g., collection of regurgitated stomach samples from adults and/or chicks) was not feasible on a larger scale without inducing significant disturbance to a large portion of the breeding colony, which might have had significant impacts to reproductive success or fidelity to the breeding site. Larger scale lethal sampling (greater collection of adult cormorants) could have caused a reduction in the East Sand Island adult breeding population. Either of these results would have been an inappropriate outcome of scientific research and counter to protections offered cormorants under the Migratory Bird Treaty Act. Consequently, diet sample sizes were limited to levels that would avoid a colony-level impact. Use of the Monte Carlo calculation technique described below allows for estimation of uncertainty in consumption irrespective of sample size for estimating the input parameter distributions.

Energy Requirements: Adult energy expenditures were measured using the doubly-labeled water technique during chick-rearing and chick energy requirements were derived from published values for cormorants and other birds (Lyons 2010). Measurements on breeding adults were conducted in 2001, 2003, and 2006 (total n = 10). A mean daily energy expenditure (DEE) for the adult population was derived by averaging the measured DEE for males and females, each calculated separately. This value was used during the chick rearing period. During other portions of the breeding season (pre-breeding, incubation, and post-breeding), DEE was scaled using data on daily activity budgets after Gremillet et al. (2000, 2003).

Chick energy expenditures were derived from allometric predictions of total energy requirements during the entire chick rearing period (Weathers 1992). Total energy requirements were partitioned into daily requirements using the trend in daily chick requirements observed by Dunn (1975) for developing double-crested cormorant chicks. Energy requirements for chicks following the rearing period were assumed to be equivalent to post-breeding adults.

Assimilation efficiencies of consumed food were assumed to be 77.3% after Brugger (1993), for both adults and chicks.

Prey Energy Content: Prey energy densities were obtained from a parallel study on the bioenergetics of Caspian terns in the Columbia River estuary (Roby et al. 2003, Lyons 2010), where energy densities were measured using proximate composition analysis. Energy densities were assumed to be constant across seasons and years. Prey mass data were obtained from whole fish captured by terns and, for larger prey types, from minimally digested samples removed from the stomachs of collected cormorants. Prey masses were assumed to be constant across seasons, but were varied across years if significant differences were observed (tested using Kruskal-Wallace one-way ANOVA, $\alpha = 0.05$).
Monte Carlo Calculation Technique: Estimates of prey consumption were calculated for discrete 2-week periods across each cormorant breeding season and summed to get annual totals. A Monte Carlo process was used to generate a "best estimate" of smolt consumption for each salmonid species/type and to describe the uncertainty in those estimates (after Furness 1978). The calculations were performed 1000 times using a routine written in Visual Basic 6.0 (Microsoft Corporation, Redmond, WA). In each iteration, a "random" value was drawn from the empirically measured or assumed (obtained from published literature) sampling distribution of each input parameter and used collectively in the calculations. For parameters other than diet proportions, random values were drawn from a normal distribution with the measured (or assumed) mean and standard error. Sampling errors in these input parameters were assumed to be uncorrelated. For diet proportions, random values were drawn from a normal distribution with a mean equal to the empirically measured value and a standard error determined using the proportional standard deviation and diet sample size. If the random value generated was < 0, the diet proportion for that prey type and simulation were set to 0, thus truncating the distribution of values used. This truncated normal distribution effectively approximated a one-sided distribution for small diet proportions, avoiding false negatives, which was appropriate given positive detection of a particular prey type, even if in small proportions. Each diet proportion was generated from an assumed normal or truncated normal distribution without constraint initially, but after proportions were generated for all detected prey types in a given period, the values were normalized to sum to a value of 1. This approach was taken because diet proportions are not entirely independent - if cormorants consume more of any given prey type, they will inevitably consume less of all other prey types combined.

The median of the 1000 calculated values of smolts consumed was used to describe the most likely or central value. A 95% confidence interval for that "best estimate" was defined by the 2.5^{th} percentile value as the lower confidence limit and the 97.5^{th} percentile value as the upper confidence limit.

Key assumptions of the bioenergetics methodology include:
A1. There are relatively few non-breeding cormorants associated with East Sand Island during the peak breeding period (mid-May to early July).
A2. Chick abundance is well estimated by assuming complete hatching synchrony in early June.
A3. The seasonal pattern in salmonid breakdown in the cormorant diet is consistent across years.
A4. The energy expenditure of adult cormorants is consistent across years.
A5. Energy requirements of independent (post-fledging) cormorant chicks is equivalent to post-breeding adults.
A6. Annual differences in prey energy content are adequately represented by differences in prey mass. Energy density is assumed to be similar across seasons and years. Prey mass is assumed to be constant across seasons.

Observations of cormorants on East Sand Island during the peak breeding season suggest that a strong majority (>95%) of cormorants have active nests during the period of peak breeding (A1). Additionally, observations of cormorants throughout the Columbia River estuary at these times have never suggested a surplus of individuals significantly greater than the number of cormorants nesting at East Sand Island. While cormorant chick hatching synchrony vary to some extent from one year to the next, in most years median hatch date of nests in observation plots has been within 1-2 weeks of June 1st (A2). No independent measure of smolt availability in the estuary is available to test assumption A3, that the seasonal pattern in the salmonid breakdown of cormorant diets is consistent across years (A3). There are likely differences in arrival times of naturally-spawned groups/species of smolts between years, but hatchery production may dampen this variability. The seasonal pattern of salmonid breakdown in the diet of Caspian terns nesting at East Sand Island has been characterized with sufficient sample sizes to test for interannual differences in some years. Differences have been detected in a few years, but for most, no difference from the overall pattern is detectable. Adult cormorant energy expenditure may vary between years of high and low prey availability, or cormorants may put forth a consistent energy expenditure in order to maximize productivity (i.e. the number of chicks fledged) in good years. In either case, the interannual variability in energy expenditure is likely less than the individual variability characterized by studies of cormorants at East Sand and Rice islands (A4). There are no studies that characterize the energy expenditure of recently fledged cormorants, so an empirical comparison to adult energy expenditures is not possible (A5). Body mass and daily activity budgets of recent fledglings and post-breeding adults are similar; however, suggesting energy expenditures may also be similar. Annual differences in the energy (lipid) content of marine forage fish have been observed in the California Current ecosystem (Litz et al. 2010); however, differences in total energy content have not (A6). Differences in fish mass have been characterized, and are likely a good surrogate measure of total prey energy content. Additional information on assumptions and caveats for these bioenergetics methods can be found in Roby et al. (2003) and Lyons (2010).

Elasticity analysis performed for the cormorant bioenergetics model in Lyons (2010) indicated that colony size across the season and the salmonid proportion of the diet were the two input variables with the most potential to influence the estimates of the number of smolts consumed. Since the time of that analysis, colony size has been more precisely quantified by counting active nests or individual cormorants in a series of aerial photographs of the East Sand Island colony taken across the breeding season. This methodological improvement left diet composition – the proportion of the diet that is salmonids – as the factor having the most leverage on the calculated smolt consumption. Because sample sizes were relatively small for cormorant diet, the uncertainty in that proportion salmonids parameter propagates into substantial uncertainty in the estimated number of smolts consumed. Other factors contributing to uncertainty in smolt consumption estimates were (in rank order beginning with the most influential after the salmonid proportion of the diet) the total energy required by chicks, energy densities of non-salmonid prey types, average mass of salmonid prey types, average mass of non-salmonid prey types, daily energy expenditure of adult cormorants, and the assimilation efficiency.

Table C-1.1: Proportional breakdown (by frequency) of salmonids by species/type in stomachs of double-crested cormorants collected near East Sand Island, during 2000 – 2013.

Species/type	Time Period			
	3/27 – 5/7	5/8 – 6/4	6/5 – 7/2	7/3 – 7/30
Chinook, sub-yearling	0.03	0.18	0.87	0.91
Chinook, yearling	0.10	0.19	0.03	0.00
Coho	0.54	0.32	0.83	0.01
Sockeye	0.00	0.02	0.00	0.00
Steelhead	0.33	0.29	0.07	0.08
N	68	94	35	25

Table C-1.2: Estimated peak colony size (95% confidence interval) and the percentage of salmonids (% salmonids) in diet samples of double-crested cormorants nesting on East Sand Island in the Columbia River estuary during 1998-2013 (Lyons 2010, BRNW 2014, Adkins et al. 2014).

Year	Peak Colony Size (breeding pairs)	% Salmonids (all species)	
		April-June	April-July
1998	6,300 (5,900 - 6,700)	12%	15%
1999	6,600 (6,200 - 7,000)	33%	28%
2000	7,200 (6,700 - 7,600)	21%	17%
2001	8,100 (7,600 - 8,600)	12%	9%
2002	10,200 (9,600 - 10,800)	6%	5%
2003	10,600 (10,000 - 11,300)	10%	8%
2004	12,500 (11,700 - 13,200)	7%	6%
2005	12,300 (11,500 - 13,000)	2%	2%
2006	13,700 (12,900 - 14,600)	19%	14%
2007	13,800 (12,900 - 14,600)	14%	11%
2008	11,000 (10,600 - 11,300)	15%	12%
2009	12,100 (11.900 - 12,200)	12%	9%
2010	13,600 (13,100 - 14,100)	22%	17%
2011	13,000 (12,900 - 13,200)	22%	18%
2012	12,300 (11,900 - 12,700)	27%	20%
2013	14,900 (14,500 - 15,300)	14%	11%

Table C-1.3: Estimated annual consumption numbers (95% confidence interval) of juvenile salmonid smolts by double-crested cormorants nesting on East Sand Island in the Columbia River estuary during 1998-2013. Smolt consumption estimates are based on the percentage of salmonids (% salmonids) found in cormorant diet samples and bioenergetics modeling (Lyons 2010, BRNW 2014).

	Consumption Estimates (millions)				
Year	Yearling Chinook	Sub-yearling Chinook	Coho	Sockeye	Steelhead
1998	0.5 (0.1 – 1.2)	10.3 (5.7 – 19.8)	0.9 (0.3 – 2.0)	<0.1 (0.0 - 0.2)	0.6 (0.2 – 1.2)
1999	0.9 (0.3 – 2.1)	8.3 (4.3 – 16.4)	1.6 (0.8 – 3.5)	<0.1 (0.0 - 0.3)	1.0 (0.5 – 2.1)
2000	0.8 (0.2 – 2.1)	4.4 (2.2 – 9.4)	1.3 (0.5 - 2.9)	<0.1 (0.0 - 0.3)	0.9 (0.4 – 2.2)
2001	0.4 (0.1 – 1.3)	5.0 (2.3 – 11.1)	0.8 (0.2 – 2.1)	<0.1 (0.0 - 0.2)	0.5 (0.2 – 1.3)
2002	0.1 (0.0 - 0.3)	4.1 (1.6 – 8.9)	0.3 (0.1 - 0.8)	<0.1 (0.0 - 0.0)	0.1 (0.0 - 0.4)
2003	0.7 (0.1 – 2.2)	1.4 (0.4 – 3.9)	0.9 (0.3 – 2.5)	<0.1 (0.0 - 0.4)	0.7 (0.2 - 1.7)
2004	0.5 (0.1 – 1.4)	5.3 (1.9 – 11.8)	1.0 (0.3 – 2.4)	<0.1 (0.0 - 0.3)	0.6 (0.2 – 1.4)
2005	0.1 (0.0 - 0.4)	2.2 (0.5 – 6.3)	0.4 (0.1 – 1.0)	<0.1 (0.0 - 0.1)	0.2 (0.0 - 0.6)
2006	1.6 (0.5 – 4.1)	2.7 (0.9 – 6.3)	3.3 (1.6 – 7.0)	<0.1 (0.0 - 0.6)	1.7 (0.8 – 3.7)
2007	1.0 (0.3 – 2.7)	5.0 (1.7 – 11.9)	2.5 (1.2 – 5.6)	<0.1 (0.0 - 0.4)	1.3 (0.5 - 2.9)
2008	0.9 (0.3 - 1.8)	5.8 (2.6 – 10.7)	1.8 (0.9 - 2.8)	<0.1 (0.0 - 0.3)	0.9 (0.4 - 1.6)
2009	0.7 (0.1 – 1.4)	8.7 (3.7 – 17.0)	1.4 (0.6 – 2.6)	<0.1 (0.0 - 0.3)	0.8 (0.3 – 1.4)
2010	1.2 (0.3 – 2.4)	13.8 (6.8 – 24.2)	3.0 (1.6 – 4.6)	<0.1 (0.0 - 0.4)	1.5 (0.7 – 2.4)
2011	0.9 (0.2 - 1.6)	15.7 (9.1 – 25.5)	2.9 (1.5 – 4.3)	0.1 (0.0 - 0.9)	1.3 (0.6 – 2.1)
2012	1.5 (0.5 – 2.7)	11.1 (5.9 – 17.4)	4.8 (3.0 – 7.2)	0.2 (0.0 – 1.1)	1.8 (1.0 - 2.7)
2013	1.0 (0.3 – 2.0)	11.9 (6.0 – 21.3)	2.8 (1.3 – 4.6)	0.3 (0.0 – 1.2)	1.1 (0.5 – 1.9)

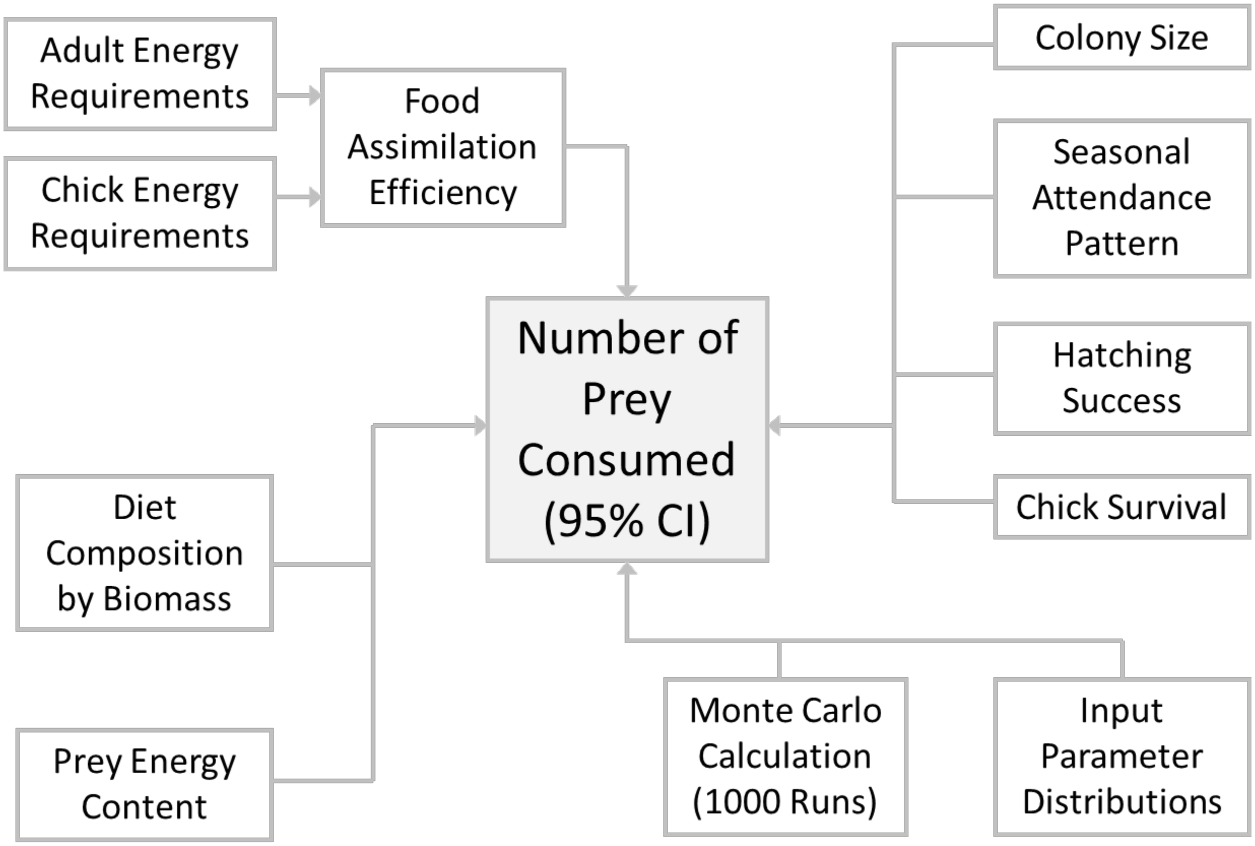


Figure C-1.1. Conceptual framework of the bioenergetics model used to estimate smolt consumption by East Sand Island double-crested cormorants after Lyons (2010), showing important input variables and methodology.

APPENDIX C-2: Estimates of Smolt Predation Probabilities by East Sand Island Double-crested Cormorants

Capture-recapture methods are commonly used to estimate fish mortality due to avian predation (Ryan et al. 2001; Boström et al. 2009; Jepsen et al. 2010; Evans et al. 2012; Sebring et al. 2013; Hostetter et al. in-press). In these studies samples of fish are captured and tagged to identify individuals or groups, and then returned to mix with the rest of the population of interest. Nearby bird colonies are then searched to detect tags from fish consumed by birds that were subsequently deposited at the bird colony. The recovery of tags on bird colonies, however, is not a direct measure of predation impacts because some proportion of consumed tags are deposited off-colony or damaged during digestion (deposition probability; Hostetter et al. in-press) or the tag is deposited on-colony but missed during the recovery process (detection probability; Evans et al. 2012). Statistical models have been applied to address the challenge of imperfect recovery of PIT tags deposited on bird colonies (Evans et al. 2012; Osterback et al. 2013; Hostetter et al. in-press). These models can then be used to generate best or absolute measures of predation on groups of tagged fish. PIT tag predation probabilities presented herein and those presented in the Double-crested Cormorant Management Plan to Reduce Predation on Juvenile Salmonids in the Columbia River Estuary were derived using modeling techniques published in Evans et al. (2012) and Hostetter et al. (in-press) and are summarized below, with results presented in Table C-2.1.

Availability of PIT-tagged Smolts to Double-crested Cormorants Nesting on East Sand Island: Following the methods of Evans et al. (2012) and Hostetter et al. (in-press), PIT-tagged salmonid smolts last detected passing Bonneville Dam on the lower Columbia River or Sullivan Dam on the lower Willamette River during March-August provide data on the number of smolts available to cormorants nesting on East Sand Island each year (1999-2013). PIT-tagged fish were grouped by evolutionary significant unit (ESU) or distinct population segment (DPS), with each ESU/DPS representing a unique combination of species (Chinook salmon, sockeye salmon, or steelhead trout), run-type (spring, summer, fall, or winter), and river-of-origin (Columbia, Snake, or Willamette). The designation of ESU/DPSs follows that of NOAA (2011), which includes both wild and hatchery-reared fish, depending on the ESU/DPS.
PIT tag Recovery on East Sand Island: Recovery of smolt PIT tags on the East Sand Island double-crested cormorant colony following methods of Ryan et al. (2001) and Evans et al. (2012). Briefly, scanning for PIT tags was conducted after birds dispersed from the breeding colony following the nesting season (September - November). The colony areas was scanned using pole-mounted PIT tag antennas. The area scanned was determined based on year-specific aerial photography and colony visits during the nesting season.

PIT tag Detection Probability on East Sand Island: The probability that a PIT tag was detected by researchers given that the tag was deposited on-colony (i.e., detection probability) required surveys of tags known to have been deposited on-colony (see Evans et al. 2012). Studies estimating PIT tag detection probability at the East Sand Island cormorant colony were conducted during 2000-2013, with detection probability data provided by NOAA fisheries (Ryan et al. 2002, Sebring et al. 2013) and BRNW

(BRNW 2005-2007; Evans et al. 2012, Hostetter et al. in-press). Briefly, PIT tags with known tag codes were sown on the East Sand Island cormorant colony during 1-2 occasions prior to and after the nesting season (hereafter "test tags") and the proportion subsequently recovered after the nesting season was used to model detection efficiency during the nesting season via logistic regression per Evans et al. (2012). In years when zero (1999) or just one (2000-2006) release of test tags occurred, release and recovery values for the missing occasion were averaged across the nearest years with adequate data.
PIT Tag Deposition Probability on East Sand Island: Studies estimating PIT tag deposition probability (i.e., the probability a tag was deposited on-colony after it was consumed) were conducted on the East Sand Island cormorant colony in 2012 and 2013 (Hostetter et al. in-press). Briefly, fish with known tag codes were consumed by double-crested cormorant nesting on East Sand Island at different times of the day (morning, evening) and throughout the nesting season. The proportion of consumed tags subsequently deposited on-colony was then used to estimate deposition probability. The distribution of the mean deposition probability derived from these studies (0.51; 95% confidence interval 0.34-0.70; Hostetter et al. in-press) was applied across all years (1999-2013). This distribution was used as (i) data on cormorant deposition probabilities in other years (1999-2011) were unavailable and (ii) results from 2012-2013 indicated cormorant deposition probabilities did not significantly differ by consumption time, consumption day, or year.

Cormorant Predation probability: Predation probabilities were modeled independently for each year and each salmonid ESU/DPS. The probability of recovering a PIT-tagged smolt on the cormorant colony was the product of the three probabilities described above: the probability that the fish was consumed (θ), deposited (μ_ϕ), and detected (ψ) on-colony:

$$k_i \sim Binomial(n_i, \theta_i * \mu_\phi * \psi_i)$$

where k_i is the number of smolt PIT tags recovered from the number available (n_i) in week *i*. Detection probability (ψ_i) was modeled as a logistic function as described above, the distribution of the mean cormorant deposition probability (μ_ϕ) was applied across all weeks, and θ_i is the predation probability for week *i*. We used an informative prior (beta [15.98, 15.29]; Hostetter et al. in-press) for the mean deposition probability as deposition probability data were not available in all years. We ascribed a hyperdistribution for weekly predation probabilities ($\boldsymbol{\theta}$):

$$logit(\theta_i) \sim Normal(\mu_\theta, \sigma_\theta^2)$$

This allowed each week (*i*) to have a unique predation probability (θ_i), but information was shared among weeks (*i*) to improve precision. Annual predation probabilities were derived as the sum of the estimated number of PIT-tagged smolts consumed each week divided by the total number of individuals last detected passing Bonneville or Sullivan dams that year.

$$\sum_{all\ i} (\theta_i * n_i) \Big/ \sum_{all\ i} (n_i)$$

The derived annual predation probability constitutes the estimated proportion of available PIT-tagged smolts consumed by DCCO nesting at East Sand Island in a given year.

We implemented all predation probability models in a Bayesian framework using the software JAGS (Plummer 2003) accessed through R version 3.0.1 (R Core Team 2014). We ran three parallel chains for 50,000 iterations each and a burn-in of 5,000 iterations. Chains were thinned by 20 to reduce autocorrelation of successive Markov chain Monte Carlo samples, resulting in 6750 saved iterations. Chain convergence was tested using the Gelman-Rubin statistic ($\hat{R}$; Gelman et al. 2004). We report results as posterior medians as well as 2.5 and 97.5 percentiles, which represent the Bayesian equivalent to 95% Confidence Intervals (95CRI). Predation probabilities were only calculated for ESUs/DPSs when ≥ 500 PIT-tagged salmonids were interrogated passing Bonneville or Sullivan dams in a given year to control for imprecise results that might arise from small annual sample sizes of available PIT-tagged smolts (Evans et al. 2012).

Results from this predation modeling procedure were based on the following assumptions:

A1. PIT-tag salmonid release and interrogation information obtained from Bonneville and Sullivan dams were complete and accurate.

A2. PIT-tagged smolts last detected passing Bonneville and Sullivan dams were available to cormorants nesting downstream on East Sand Island.

A3. The detection probabilities of test PIT tags sown on-colony was equal to that of PIT tags naturally deposited by cormorants on-colony in each study year.

A4. The deposition probabilities of PIT tags (those used in deposition studies; see Hostetter et al. in-press) during 2012-2013 were equal to that of fish consumed and deposited by birds in all years (1999-2013).

A5. PIT tags from consumed fish were deposited on a bird colony within a short time period (weeks) of the fish being detected passing an upstream dam.

A6. PIT-tagged fish, by species, ESU, rear-type, and detection site (dam), were representative of non-tagged fish.

To verify the first assumption (A1), irregular entries were either validated by the respective coordinator of the PIT-tagging effort or eliminated from the analysis. Detections of PIT-tagged salmonids at dams upstream of bird colonies were deemed the most appropriate measure of fish availability given the downstream movement of juvenile salmonids, the ability to standardize data across sites, and the ability to define unique groups of salmonids by a known location and passage date (Assumption A2). Assumption A2 assumes all PIT tagged fish last detected passing Bonneville or Sullivan dams were alive and available to cormorant predation in the estuary. If large numbers of fish died immediately following passage and prior to reaching the foraging range of cormorants, however, predation probabilities would underestimate impacts. Detection efficiency estimates (A3) were generally high (ca. 70%, depending on year; see Evans et al. 2012 and Hostetter et al. in-press), suggesting possible violations of assumption A3 would have little effect on estimates of predation. Data collected during 2012-2013 (where multiple measures of deposition were estimated in each year) showed no evidence of a within season temporal trend in deposition probabilities (Assumption A4). Assumption A5 relates to the use of the last date of live detection as a proxy for the date a PIT tag was deposited on a bird colony and needs to be only roughly true because detection efficiency did not change dramatically on a weekly bases (see Evans et al. 2012; Hostetter et al. in-press). Assumption A6 relates to inference regarding the consumption of PIT-tagged fish last detected passing Bonneville and Sullivan dams to all fish (tagged and untagged) of the same ESU/DPS susceptible to cormorant predation in the estuary. There are few empirical data to support or refute assumption A6, other than to note that the run-timing and abundance of PIT-tagged fish is often in agreement with the run-timing and abundance of non-tagged fish passing dams on the

Columbia and Willamette rivers and that differences in fish vulnerability to cormorant predation based on a fish's passage route or migration history (in-river or transported) tend to be small and inconsistent from year-to-year (Ryan et al. 2003; Lyons et al. 2014). Finally, sample sizes of PIT-tagged fish varied considerably by year and ESU/DPS but were generally in the thousands, minimizing the potential risk for bias or spurious results that could emerge with small numbers of tagged fish. These and other assumptions, caveats, and discussion points are presented in more detail in Evans et al. (2012), Lyons et al. (2014), and Hostetter et al. (in-press).

Table C-2.1: Estimated annual predation probabilities (95% credible interval) of PIT-tagged, ESA-listed salmonid smolts by double-crested cormorants nesting on East Sand Island in the Columbia River estuary during 1999-2013. Predation probabilities are based on numbers of PIT-tagged fish (N) interrogated passing Bonneville Dam on the Columbia River or Sullivan Dam on the Willamette River, and subsequently consumed by cormorants in the estuary. Only salmonid populations with ≥ 500 PIT-tagged smolts interrogated passing a dam were evaluated in any given year. Dashes denote populations with < 500 PIT-tagged fish available. Salmonid populations originating from the Snake River (SR), Upper Columbia River (UCR), Middle Columbia River (MCR) and Upper Willamette River (UWR) were evaluated, with runs of spring (Sp), summer (Su), and fall (Fa) fish included, where applicable.

	ESU/DPS-specific Predation Probabilities							
Year	SR Sp/Su Chinook (Threatened)	SR Fa Chinook (Threatened)	UCR Sp Chinook (Endangered)	UWR Sp Chinook (Threatened)	SR Sockeye (Endangered)	MCR Steelhead (Threatened)	SR Steelhead (Threatened)	UCR Steelhead (Threatened)
1999	.009 (.006-.015)	.015 (.006-.030)	.007 (.002-.020)	-	-	.010 (.001-.035)	.024 (.017-.039)	.020 (.013-.032)
	N=18,558	N=1,987	N=1,325			N=632	N=12,287	N=12,123
2000	.033 (.023-.053)	.051 (.029-.093)	.034 (.016-.068)	-	-	-	.106 (.075-0.168)	.060 (.039-.100)
	N=11,810	N=1,323	N=1,123				N=10,356	N=3,100
2001	.022 (.014-.035)	.055 (.029-.104)	.033 (.017-.063)	-	-	.025 (.010-.057)	.028 (.011-.061)	-
	N=8,845	N=807	N=1,230			N=872	N=774	
2002	.018 (.013-.030)	.014 (.008-.026)	.022 (.016-.036)	-	-	-	.031 (.020-.051)	.037 (.014-.086)
	N=30,617	N=4,899	N=20,493				N=7,331	N=561
2003	.017 (.012-.027)	.011 (.007-.020)	.014 (.009-.021)	-	-	-	.019 (.012-.030)	.015 (.010-.024)
	N=28,150	N=6,234	N=30,723				N=8,553	N=27,918
2004	.051 (.033-.085)	.019 (.006-.047)	.047 (.032-.076)	-	-	-	.036 (.014-.080)	.074 (.051-.118)
	N=4,816	N=929	N=9,533				N=803	N=6,040
2005	.048 (.032-.079)	.036 (.018-.069)	.045 (.028-.078)	-	-	-	.043 (.020-.086)	.055 (.037-.088)
	N=5,935	N=1,121	N=2,518				N=753	N=5610
2006	.052 (.035-.085)	.027 (.016-.046)	.047 (.022-.095)	-	-	-	.131 (.082-.227)	.047 (.028-.082)
	N=5,570	N=4,057	N=731				N=1,100	N=2,064
2007	.017 (.011-.027)	.016 (.007-.033)	.027 (.015-.051)	.010 (.003-.026)	-	.028 (.015-.052)	.035 (.023-.058)	.034 (.021-.061)
	N=23,830	N=2,005	N=2,268	N=1,505		N=2,234	N=6,391	N=3,042
2008	.035 (.024-.055)	.026 (.019-.042)	.036 (.020-.066)	.033 (.019-.058)	-	.140 (.095-.232)	.147 (.106-.232)	.062 (.040-.104)
	N=11,425	N=24,136	N=1,662	N=2,509		N=2,291	N=19,572	N=2,513
2009	.068 (.049-.107)	.045 (.032-.071)	.027 (.015-.049)	.014 (.008-.024)	.057 (.035-.098)	.149 (.103-.238)	.166 (.120-.257)	.072 (.047-.120)
	N=17,396	N=16,314	N=2,064	N=5,573	N=1,845	N=2,700	N=23,311	N=2,265
2010	.053 (.039-.084)	.039 (.027-.061)	.033 (.023-.054)	.042 (.016-.092)	.026 (.013-	.082 (.058-.131)	.075 (.055-0.121)	.068 (.049-.106)

					.049)			
	N=38,441	N=17,974	N=5,972	N=510	N=1,382	N=8,515	N=40,024	N=12,284
2011	.043 (.029-.069)	.019 (.013-.031)	.056 (.029-.108)	.004 (.001-.015)	.048 (.024-.091)	.078 (.046-.140)	.053 (.037-.085)	.114 (.078-.186)
	N=6,557	N=12,327	N=704	N=1,119	N=826	N=865	N=7,028	N=2,419
2012	.037 (.026-.060)	.026 (.018-.042)	.021 (.012-.037)	.006 (.003-.013)	.037 (.020-.069)	.033 (.017-.064)	.049 (.032-.081)	.065 (.043-.108)
	N=17,929	N=10,742	N=3,227	N=3,731	N=1,457	N=1,084	N=4,768	N=3,357
2013	.036 (.025-.057)	.022 (.013-.037)	.030 (.018-.053)	.010 (.004-.020)	.033 (.018-.062)	.021 (.010-.041)	.025 (.017-.040)	.034 (.022-.057)
	N=16,167	N=4,465	N=3,112	N=2,629	N=1,454	N=1,865	N=8,516	N=4,473

APPENDIX C-3: Summary of explanatory factors used in Principal Components Regression analysis.

Table C-3.1: Annual values of explanatory variables used in the Principal Components Regression analysis. Variables included the Pacific Decadal Oscillation (PDO; Mantua et al. 1997), the El Nino/Southern Oscillation (MEI; Wolter and Timlin 1993, 1998), the Pacific Northwest Index (PNI; Ebbesmeyer and Strickland 1995), the North Pacific Gyre Oscillation (NPGO; Di Lorenzo et al. 2008), local sea surface temperature (SST; Brosnan et al. 2014), the strength (Upwelling; Greene et al. 2005) and timing (Spring Transition; Logerwell et al. 2003) of coastal upwelling, river discharge (Scheuerell et al. 2009), survival of Snake River spring-summer (sp/su) Chinook and steelhead through the hydropower system (Hydro Chinook Survival, Hydro Steelhead Survival; Haeseker et al. 2012), the proportion of water passing through a dam that passes over the spillway (Spill; Muir et al. 2001), and the size of the East Sand Island double-crested cormorant colony (BRNW 2014, Adkins et al. 2014).

Year	PDO	MEI	PNI	NPGO	SST (°C)	Upwelling	Spring Transition (Julian Day)	River Discharge (cfm/day)	Hydro Chinook Survival	Hydro Steelhead Survival	Spill	Colony Size (breeding pairs)
1999	-0.43	-1.11	-0.54	1.75	12.4	33	134	361355	0.52	0.40	0.34	6561
2000	-0.55	-0.97	0.45	2.01	14.2	19	97	305871	0.45	0.38	0.35	7162
2001	0.26	-0.49	0.88	2.60	12.7	23	79	174742	0.27	0.04	0.03	8120
2002	-0.28	-0.02	0.10	1.71	13.1	23	108	271903	0.55	0.23	0.34	10230
2003	1.63	0.68	0.77	1.39	13.4	22	156	300613	0.53	0.29	0.32	10646
2004	0.52	0.14	0.96	0.36	15.6	18	132	253452	0.35	NA	0.26	12480
2005	0.91	0.79	0.92	-1.48	14.5	-2	230	295000	0.53	NA	0.27	12287
2006	0.54	-0.58	-0.70	-0.59	13.2	37	180	388645	0.61	0.42	0.36	13738
2007	-0.04	0.18	0.10	-0.13	12.3	19	81	309258	0.56	0.37	0.38	13771
2008	-1.00	-1.33	-0.98	1.21	11.4	30	64	390226	0.46	0.48	0.40	10950
2009	-1.55	-0.53	-0.08	0.61	12.3	27	65	354065	0.53	0.68	0.34	12087
2010	0.72	1.26	0.60	1.75	12.0	8	177	285871	0.55	0.62	0.39	13596
2011	-0.72	-1.54	0.05	0.73	12.8	9	82	474161	0.48	0.59	0.44	13045
2012	-0.89	-0.36	0.18	1.30	11.4	4	126	453516	0.59	0.60	0.40	12301
2013	-0.34	-0.11	NA	1.13	13.9	22	91	358226	0.52	0.50	0.39	14916
Mean	0.01	-0.08	0.20	0.96	13.1	20	129	334185	0.50	0.43	0.33	11136
St. Dev.	0.87	1.04	0.58	1.00	1.1	10	57	72963	0.09	0.16	0.09	2664

Table C-3.2: Correlations between transformed and normalized explanatory variables used in the Principal Components Regression analysis. Variables included the Pacific Decadal Oscillation (PDO; Mantua et al. 1997), the El Nino/Southern Oscillation (MEI; Wolter and Timlin 1993, 1998), the Pacific Northwest Index (PNI; Ebbesmeyer and Strickland 1995), the North Pacific Gyre Oscillation (NPGO; Di Lorenzo et al. 2008), local sea surface temperature (SST; Brosnan et al. 2014), the strength (Upwelling; Greene et al. 2005) and timing (Spring Transition; Logerwell et al. 2003) of coastal upwelling, river discharge (Scheuerell et al. 2009), survival of Snake River spring-summer (sp/su) Chinook and steelhead through the hydropower system (Hydro Chinook Survival, Hydro Steelhead Survival; Haeseker et al. 2012), the proportion of water passing through a dam that passes over the spillway (Spill; Muir et al. 2001), and the size of the East Sand Island double-crested cormorant colony (BRNW 2014, Adkins et al. 2014).

	PDO	MEI	PNI	NPGO	SST	Upwelling	Spring Transition	River Discharge	Hydro Chinook Survival	Hydro Steelhead Survival	Spill	Colony Size
PDO	1.00											
MEI	0.75	1.00										
PNI	0.53	0.50	1.00									
NPGO	-0.19	-0.16	0.04	1.00								
SST	0.50	0.35	0.56	-0.30	1.00							
Upwelling	-0.07	-0.15	-0.59	0.22	-0.06	1.00						
Spring Transition	0.77	0.77	0.29	-0.38	0.42	-0.14	1.00					
River Discharge	-0.40	-0.27	-0.61	-0.23	-0.35	-0.02	-0.02	1.00				
Hydro Chinook Survival	-0.05	0.20	-0.42	-0.40	-0.32	-0.05	0.35	0.56	1.00			
Hydro Steelhead Survival	-0.38	0.00	-0.32	-0.40	-0.27	-0.32	0.06	0.73	0.56	1.00		
Spill	-0.31	-0.11	-0.53	-0.21	-0.29	-0.07	-0.04	0.77	0.76	0.76	1.00	
Colony Size	-0.11	-0.09	-0.03	-0.52	-0.11	-0.36	-0.18	0.22	0.42	0.45	0.39	1.00

Appendix D: NOAA Fisheries per Capita Analysis

UNITED STATES DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232

December 9, 2013

MEMORANDUM FOR: Bruce Suzumoto and Ritchie Graves
FROM: Gary Fredricks
SUBJECT: Double-crested Cormorant Estuary Smolt Consumption BiOp Analysis

The primary goal for addressing double-crested cormorant (DCCO) smolt consumption in the 2013 BiOp is to determine the smolt survival "gap" that has resulted from the dramatic increase in cormorant population and smolt consumption between the base and current years that was not captured in the 2008 BiOp analysis.

Once the 2008 BiOp was completed it became apparent that the analysis did not completely address the full impact of rapidly increasing cormorant populations in the estuary on the current salmon ESU productivity estimates. The BiOp had to assess the likely effect of hydro/mitigation actions (i.e., continuing and future actions) on population/ESU productivity. The BiOp considers three periods of time.

- Base (roughly Brood Year 1981 to 2000 or Migration Year 1983 to 2002)
- Current (roughly Brood Year 2001 – 2006 or Migration Year 2003 to 2009)
- Prospective (2018 – after the implementation of all BiOp actions)

Base-to-Current and Current-to-Prospective multipliers were estimated for many factors (including Hydro) in order to estimate effects on listed stock productivity. "Current" estimates include all measured sources of mortality in the estuary and ocean attributable to birds, harvest, etc. Since the 2008 BiOp did not consider the dramatic estuary cormorant population increase in its analysis, the estimate of the current period productivity was somewhat less than it should have been. Because of this, a partitioning of this impact will be a negative multiplier. While this shortfall (or gap) can be addressed with any actions that improve productivity, it is logical that cormorant management objectives assist in this goal. This analysis calculates the size of the productivity gap for steelhead and yearling Chinook.

Sockeye are a special case in this analysis since this species was not included in the original 2008 BiOp Base to Current analysis, primarily due to a lack of information. In order to at least get an idea of the relative effect of cormorant predation on these fish, this analysis includes an estimate of consumption rate of sockeye compared to steelhead and yearling Chinook.

Analytical Approach

The gap analysis consists of a Microsoft Excel workbook that was completed primarily to calculate the negative multiplier for steelhead and yearling Chinook salmon. The analysis also uses a per capita (per bird) consumption level to calculate the number of cormorants that will likely need to be removed to zero the multiplier (fill the gap).

The analysis first presents the gap analysis for each species (steelhead and Chinook worksheet pages). The analysis uses annual cormorant species specific smolt consumption levels and the annual estimated estuary smolt population levels to calculate annual species specific smolt consumption rates. The resultant annual survival rates are then used to calculate average base and current period survival rates depending on what years are in the two periods. The average current period survival estimate divided by the average base period survival estimate provides the base-to-current survival estimate. The difference between this and 100 percent is considered as the base to current survival gap.

The key data sets for this analysis are the estimates of smolt consumption, estimates of cormorant population and estimates of smolt population.

Estuary double-crested cormorant smolt consumption estimates were based on bioenergetics modeling conducted by the avian researchers at Oregon State University and Real Time Research. Species-specific smolt consumption levels (numbers of smolt consumed) for the years 1998 to 2009 were provided by Collis (2010) and are presented in the data worksheet in the gap analysis. Consumption levels for 2010 through 2012 were found in the individual annual research reports for those years (Roby et al. 2011, 2012 and 2013). Consumption levels for years before 1998 were not available. Consumption and survival rates for these years were calculated based on the average current period consumption rates (approximately 2003-2009) adjusted for the cormorant population for the year or years in question and the area where those birds lived at that time. Birds nesting on Rice Island had a higher smolt consumption rate than birds nesting on East Sand Island. Collis et al. (2002) reported that cormorants nesting on Rice Island consumed approximately three times more salmon per bird than birds nesting on East Sand Island. No adjustment was made for the years 1980 through 1987 since birds were dispersed in the lower estuary (primarily Trestle Bay) during this time frame (Carter et al. 1995). The literature did provide Rice/East Sand population breakouts for the years 1988, 1991, 1992 and 1997 (Carter et al. 1995, Roby et al. 1998).

Estuary double-crested cormorant population estimates were determined for the year's 1980 to2012, which encompasses all the base to current years. The early year population estimates were presented in the literature only for the years 1980, 1987, 1988, 1991-92 and 1997. The data were extended approximately equally between these years for years where no estimates exist. For example, the estimates for 1980 to 1994 were based on information provided by Carter et al 1995. The 1980 to 1987 rough estimate of <150 pairs was based on Carter's report of 262 birds nesting on structures in Trestle Bay and "other small colonies that may have been present" in 1980. The 1988 and 1989 estimate of 1,847 pairs was based on Carter's estimate of 3,694 individual birds in 1988. The 1990 to 1994 estimate of 3,364 pairs was based on an aggregate estimate from 1990 to 1992 of 6,728 birds surveyed in various locations in the Columbia River Estuary (Carter et al. 1995, Appendix 1). The 1995 to 1997 estimate of 6,104 pairs was based on Roby et al. 1998 (page 16). For the years 1998 through 2009, cormorant population estimates were provided in the western North America cormorant status assessment (Adkins et al. 2010). For 2010 to 2012, the estimates were provided in the annual research reports (Roby et al. 2011, 2012, 2013).

All smolt population data (1998-2012) are from annual smolt population estimate memos issued by the NOAA Northwest Fisheries Science Center (Schiewe 1998 - 2002, Ferguson 2003-2010, Day 2011, Zabel 2012). Appendix 3 lists the specific data used for this analysis for each year. The species-specific population data were derived from the estimated smolt population arriving at Tongue Point in the estuary. These numbers are provided in the memos for full transport and spill with transport scenarios, thus the conditions that occurred for the year in question had to be determined before the best estimate was chosen.

A per capita consumption analysis was added to the gap analysis to determine how many cormorants might have to be removed from the estuary to achieve the steelhead survival levels that will eliminate the estimated negative productivity multiplier or gap. This analysis used the 1998 through 2012 cormorant consumption and population estimates to determine an average per capita consumption level for the East Sand Island cormorant colony. This fifteen year data set encompasses a fairly wide variation in cormorant salmonid consumption levels and river conditions and therefore likely serves as a decent predictor of per capita cormorant consumption rates in the near future, as long as the birds remain on or in the vicinity of East Sand Island. Also in support of this is the fact that East Sand Island cormorant population has remained fairly stable at about 10,500 to 13,500 pairs for the past ten years.

Analysis Results and Discussion

The results of the gap analysis indicate a 3.6 percent survival gap for steelhead exists between the average base period survival (migration years1983-2002) and the average current period survival (2003-2009). For yearling Chinook, a 1.1 percent gap exists between the base period survival (1982-2001) and current period survival (2002-2009). Table 1 presents the average survivals calculated by the analysis and the resultant gap for each species. The specific data used for each year are presented in Appendix 1.

Table 1. Results of the gap analysis (MY= Migration Year).	
Steelhead	
Ave Base Survival(MY1983-2002)	0.971
Ave Current Survival(MY2003-2009)	0.935
Current/Base	0.964
Base to Current Gap	0.036
Yearling Chinook	
Ave Base Survival(MY1982-2001)	0.988
Ave Current Survival(MY2002-2009)	0.978
Current/Base	0.989
Base to Current Gap	0.011

The results of the per capita analysis indicated a fifteen year average annual total consumption rate of 6.7 percent and 2.7 percent for steelhead and yearling Chinook, respectively, for a fifteen year average annual cormorant population of 10,378 pairs. These respective values for the current period were 6.5 percent and 2.5 percent for an average current period (for steelhead) cormorant population of 12,024 pairs. The base period consumption rate values were 2.9 percent and 1.2 percent for steelhead and Chinook, respectively. Since steelhead consumption rates are higher, a larger number of birds will need to be removed to achieve elimination of the negative multiplier or gap. Because of this, the steelhead portion of the analysis will likely drive the management actions. The per capita consumption rates for steelhead translate to a needed reduction of the cormorant colony size to a range of between 5,380 and 5,939 pairs in order to achieve the base (2.9 percent) consumption rate value. The range in the colony size reflects the average 95 percent confidence interval for the East Sand Island cormorant population estimates.

The results of the comparison of the fifteen year period average consumption rates for smolts of each salmonid species are presented in table 2. Sockeye were consumed at somewhat lower rates than either steelhead or yearling Chinook.

Table 2. Consumption rate comparison (average for 1998 – 2012).	
Yearling Chinook	2.7%
Steelhead	6.7%
Sockeye	1.3%

A couple of issues have arisen regarding the application of these results. The issue of hatchery vs. wild susceptibility was investigated by Collis et al. (2001) and Ryan et al. (2003 and 2008). These investigators found through PIT tag analysis that, at least for steelhead, there was no consistent indication of a cormorant preference for prey based on rearing type. Another issue is the idea of compensatory predation mortality, which would argue that at least some portion of the fish consumed by predators would have died from other factors subsequent to the predation event. There is evidence that fish condition, size and rearing history may affect the vulnerability of fish to double-crested cormorant predation (Hostetter et al. 2012) and it is likely that predation losses to avian predators is compensated somewhat due to these vulnerabilities. This argument is not, however, particularly important to the treatment of cormorant predation in the supplemental BiOp. The analysis presented here considers only that double-crested cormorant population in the lower Columbia River Estuary has increased dramatically between the base and current periods. It is therefore, our assumption that the vulnerabilities are likely equal on both sides of the base and current periods in the analysis. The ultimate difference between these two periods is still the difference in the effect the increase in cormorant population has had on the populations of listed salmon. As an example for steelhead, if we assume that compensation is 50 percent and this was applied to the analysis equally during both periods, the resulting difference would be half of the calculated 3.6 percent, or 1.8 percent. However, the number of cormorants that would need to be reduced to get back to the base period consumption rate will still be between 5,380 and 5,939 pairs.

Literature Cited:

Adkins, J. Y. and D. D. Roby. 2010. A status assessment of the double-crested cormorant (Phalacrocorax auritus) in western North America: 1998-2009. Final Report to U. S. Army Corps of Engineers, Portland District. 59 pp. plus appendices.

Carter, H. R., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends, and conservation problems of the double-crested cormorant on the Pacific Coast of North America. In: Nettleship DN, Duffy DC, editors. The double-crested cormorant: biology, conservation and management. Colonial Waterbirds 18 (Special Publication 1). p 189–207.

Collis, K. D., D. D. Roby, D. P. Craig, B. A. Ryan, and R. D. Ledgerwood. 2001. Colonial waterbird predation on juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary: vulnerability of different salmonid species, stocks, and rearing types. Trans. Am. Fish. Soc., 130:385-396.

Collis, 2002 Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: implications for losses of juvenile salmonids to avian predation. Trans Am. Fish. Soc. 131:537-550.

Collis, K. 2010. Email (Subject: RE: Cormorant Consumption Data) to Gary.Fredricks@noaa.gov dated 3/30/10.

Dey, D. B. 2012. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2011. National Marine Fisheries Service, Northwest Fisheries Science Center, March 6, 2012, memo to James H. Lecky.

Ferguson, J. W. 2010. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2010. National Marine Fisheries Service, Northwest Fisheries Science Center, November 9, 2010, memo to James H. Lecky.

Ferguson, J. W. 2009. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2009. National Marine Fisheries Service, Northwest Fisheries Science Center, October 15, 2009, memo to James H. Lecky.

Ferguson, J. W. 2008. Final estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2008. National Marine Fisheries Service, Northwest Fisheries Science Center, December 4, 2008, memo to James H. Lecky.

Ferguson, J. W. 2007. Revised estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2007. National Marine Fisheries Service, Northwest Fisheries Science Center, September 11, 2007, memo to James H. Lecky.

Ferguson, J. W. 2006. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2006. National Marine Fisheries Service, Northwest Fisheries Science Center, April 10, 2006, memo to James H. Lecky.

Ferguson, J. W. 2005. Revised estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2005 based on June 2005 changes in listing status. National Marine Fisheries Service, Northwest Fisheries Science Center August 24, 2005, memo to James H. Lecky.

Ferguson, J. W. 2004. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2004. National Marine Fisheries Service, Northwest Fisheries Science Center, March 29, 2004, memo to Laurie Allen.

Ferguson, J. W. 2003. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River Basin in 2003. National Marine Fisheries Service, Northwest Fisheries Science Center, March 20, 2003, memo to Laurie Allen.

Hostetter, N. J., A. F Evans, D. D. Roby and K. Collis. 2012. Susceptibility of juvenile steelhead to avian predation: the influence of individual fish characteristics and river conditions. Trans. Am. Fish. Soc. 141:1586-1599.

Marsh, D. 2013. March 12, 2013 email to Gary Fredricks. 1998 steelhead population estimates. Roby, D. D., and 19 co-authors. 2012. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2011 Annual Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 88 pp plus figures and tables.

Roby, D. D. and 20 co-authors. 2011. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2010 Final Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 81 pp plus figures and tables.

Roby, D. D., K. Collis and 22 co-authors. 2013. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. DRAFT 2012 Annual Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 103 pp plus figures and tables.

Roby, D. D., D. P. Craig, K. Collis, and S. L. Adamany. 1998 Avian predation on juvenile salmonids in the lower Columbia River. 1997 Annual Report to the Bonneville Power Administration and the U. S. Army Corps of Engineers. 32 pp plus figures and tables.

Ryan, B. A., S. G. Smith, J. M. Butzerin, and J. W. Ferguson. 2003. Relative vulnerability to avian predation of juvenile salmonids tagged with passive integrated transponders in the Columbia River Estuary, 1998-2000. Trans. Am. Fish. Soc. 132:275-288.

Appendix 1. Gap analysis tables.
Table 1. Estuary Cormorant Consumption - Steelhead

Year	Cormorant Population (pairs)	Sthd Consumption (Millions)	Sthd Population (Millions)	Consumption Rate	Survival Rate
1980	150			0.001	0.999
1981	150			0.001	0.999
1982	150			0.001	0.999
1983	150			0.001	0.999
1084	150			0.001	0.999
1985	150			0.001	0.999
1986	150			0.001	0.999
1987	150			0.001	0.999
1988	1847			0.017	0.983
1989	1847			0.017	0.983
1990	3364			0.031	0.969
1991	3364			0.031	0.969
1992	3364			0.031	0.969
1993	3364			0.031	0.969
1994	3364			0.031	0.969
1995	6104			0.045	0.955
1996	6104			0.045	0.955
1997	6104			0.045	0.955
1998	6285	0.817	13.0	0.063	0.937
1999	6561	1.092	13.9	0.079	0.921
2000	7162	0.966	14.0	0.069	0.931
2001	8120	0.516	14.9	0.035	0.965
2002	10230	0.119	13.9	0.009	0.991
2003	10646	0.701	14.5	0.048	0.952
2004	12480	0.605	13.7	0.044	0.956
2005	12287	0.166	13.7	0.012	0.988
2006	13738	1.855	14.3	0.130	0.870
2007	13771	1.311	13.9	0.094	0.906
2008	10950	0.931	14.1	0.066	0.934
2009	12087	0.796	13.8	0.058	0.942
2010	13596	1.500	14.1	0.106	0.894
2011	13045	1.200	15.7	0.076	0.924
2012	12300	1.700	14.3	0.119	0.881

Table 2. Estuary Cormorant Consumption - Yearling Chinook

Year	Cormorant Population (pairs)	YrCH Consumption (Millions)	YrCH Population (Millions)	Consumption Rate	Survival Rate
1980	150			0.000	1.000
1981	150			0.000	1.000
1982	150			0.000	1.000
1983	150			0.000	1.000
1084	150			0.000	1.000
1985	150			0.000	1.000
1986	150			0.000	1.000
1987	150			0.000	1.000
1988	1847			0.006	0.994
1989	1847			0.006	0.994
1990	3364			0.011	0.989
1991	3364			0.011	0.989
1992	3364			0.011	0.989
1993	3364			0.011	0.989
1994	3364			0.011	0.989
1995	6104			0.016	0.984
1996	6104			0.016	0.984
1997	6104			0.016	0.984
1998	6285	0.687	18.4	0.037	0.963
1999	6561	0.937	26.9	0.035	0.965
2000	7162	0.874	30.6	0.029	0.971
2001	8120	0.430	23.7	0.018	0.982
2002	10230	0.089	34.3	0.003	0.997
2003	10646	0.704	36.9	0.019	0.981
2004	12480	0.515	33.8	0.015	0.985
2005	12287	0.080	38.5	0.002	0.998
2006	13738	1.723	38.8	0.044	0.956
2007	13771	1.091	28.7	0.038	0.962
2008	10950	0.934	29.5	0.032	0.968
2009	12087	0.668	26.9	0.025	0.975
2010	13596	1.300	37.5	0.035	0.965
2011	13045	0.900	32.8	0.027	0.973
2012	12300	1.500	33.5	0.045	0.955

Table 3. Per capita analysis for steelhead

Steelhead							
Per Capita consumption analysis to estimate a cormorant colony size (pairs) that would close the							
Year	% Consumption		DCCO Population (pairs)			Per Capita	
		<95%CI	Best	>95%CI	<95%CI	Best	>95%CI
1998	6.3%	5908	6285	6662	0.0000106	0.000010	0.000009
1999	7.9%	6167	6561	6955	0.0000128	0.000012	0.000011
2000	6.9%	6732	7162	7592	0.0000103	0.000009	0.000009
2001	3.5%	7633	8120	8607	0.0000045	0.000004	0.000004
2002	0.9%	9616	10230	10844	0.0000009	0.000000	0.000000
2003	4.8%	10007	10646	11285	0.0000048	0.000004	0.000004
2004	4.4%	11731	12480	13229	0.0000038	0.000003	0.000003
2005	1.2%	11550	12287	13024	0.0000011	0.000001	0.000000
2006	13.0%	12914	13738	14562	0.0000101	0.000009	0.000008
2007	9.4%	12945	13770	14597	0.0000073	0.000006	0.000006
2008	6.6%	10585	10950	11315	0.0000063	0.000006	0.000005
2009	5.8%	11929	12087	12245	0.0000048	0.000004	0.000004
2010	10.6%	13130	13596	14062	0.0000081	0.000007	0.000007
2011	7.6%	12781	13045	13309	0.0000060	0.000005	0.000005
2012	11.9%	12035	12300	12567	0.0000099	0.000009	0.000009
Average	6.7%	10378	10884	11390	0.000007	0.00000	0.00000
Ave "Current" (03-09)	6.5%	11666	12280	12894	0.000005	0.00000	0.00000
An average colony size (pairs) of:					5380	5661	5939
Would achieve the Base Period consumption rate of:						2.9%	

Table 4. Per capita analysis for yearling Chinook.

Yearling Chinook			
Per Capita consumption analysis to estimate a cormorant colony size (pairs) that would close the Base to Current gap in juvenile Yr Chinook survival.			
Columbia River Estuary			
Year	% Consumption	DCCO Population	Per Capita Consumption
1998	3.7%	6285	0.0000059
1999	3.5%	6561	0.0000053
2000	2.9%	7162	0.0000040
2001	1.8%	8120	0.0000022
2002	0.3%	10230	0.0000003
2003	1.9%	10646	0.0000018
2004	1.5%	12480	0.0000012
2005	0.2%	12287	0.0000002
2006	4.4%	13738	0.0000032
2007	3.8%	13771	0.0000028
2008	3.2%	10950	0.0000029
2009	2.5%	12087	0.0000021
2010	3.5%	13596	0.0000025
2011	2.7%	13045	0.0000021
2012	4.5%	12300	0.0000036
Average	2.7%	10884	0.000003
Need to reduce DCCO colony size by:			3965
To achieve a yearling Chinook consumption reduction of:			1.1%
Which would be a reduction in average colony size of:			36%
Or an allowable average colony size of:			6919

Appendix 2. Data sources for the Columbia River Estuary double-crested cormorant consumption rate analysis for the 2013 BiOp.

1980-1997 All data from Fredricks 2008 and 2010 BiOp memos.

1997 Cormorant population estimates and Rice Island vs. East Sand Island proportions from Roby et al 1998 (1997 Annual Report).

1998 Cormorant population estimates from Collis et al. 2000 (1998 Annual Report). Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Doug Marsh 3/12/13 email – 98sthdest with LCR fish.xls.

1999 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Schiewe 3/3/99 Population estimate memo.

2000 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Schiewe 3/16/00 Population estimate memo.

2001 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Schiewe 5/2/01 Population estimate memo.

2002 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Schiewe 3/28/02 Population estimate memo.

2003 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Ferguson 3/20/03 Population estimate memo.

2004 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Ferguson 3/29/04 Population estimate memo.

2005 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Ferguson 8/24/05 Population estimate memo.

2006 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Ferguson 4/10/06 Population estimate memo.

2007 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead estuary population estimate from Ferguson 9/11/07 Population estimate memo.

2008 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead and Chinook estuary population estimate from Ferguson 12/4/08 Population estimate memo.

2009 Cormorant population estimates from Adkins and Roby 2010. Steelhead consumption rates from Collis 3/30/2010 email attachment: V3 98-09 Estuary DCCO Consumption.xls. Steelhead and Chinook estuary population estimate from Ferguson 10/15/09 Population estimate memo.

2010 Cormorant population estimates from Roby et al 2011 (2010 Annual Report). Steelhead consumption rates from Roby et al. 2011. Steelhead and Chinook estuary population estimate from Ferguson 11/9/10 Population estimate memo.

2011 Cormorant population estimates from Roby et al 2012 (2011 Annual Report). Steelhead and Chinook consumption rates also from Roby et al 2012. Steelhead and Chinook estuary population estimate from Dey 3/6/12 Population estimate memo.

2012 Cormorant population estimates from Roby et al. 2013 (Draft 2012 Annual Report). Steelhead consumption rates from Annual Report. Steelhead and Chinook estuary population estimate from Zabel 1/23/13 Population estimate memo.

Appendix 3. Smolt population data summary memo.

July 29, 2013 F/NWR-5

FILE MEMORANDUM
FROM: Gary Fredricks
SUBJECT: Smolt Population Estimates for Estuary Cormorant Consumption Analysis

The data for steelhead and yearling Chinook estuary (Tongue Point) population estimates for the double crested cormorant analysis came from the following NOAA Science Center memos and correspondence for each year from 1998 to 2012. These data were used to estimate consumption rates for these species of fish by cormorants feeding in the lower estuary. Since the consumption rates are total number of fish eaten by species, the population estimate has to be based on the total number of fish available (not just listed fish available).

1998 – Steelhead: 3/12/13 email from Doug Marsh No page number, Table 12. Added wild (813,901) and hatchery (12,173,677) estimates at Tongue Point for a total steelhead estimate of **12,987,578**. Yearling Chinook: Schiewe 1998, February 11, 1998. Table 5, full transport with spill scenario - **18,397,190**. Sockeye: Schiewe 1998, Table 5 with spill **- 1,291,687**.

1999 – Schiewe 1999, March 3, 1999. Steelhead: Table 12, transport with spill. Added wild (983,624) and hatchery (12,865,635) estimates at Tongue Point for a total steelhead estimate of **13,849,259**. Yearling Chinook: Table 6, transport with spill. Added wild (2,059,807) and hatchery (24,816,940) estimates at Tongue Point for a total yearling Chinook estimate of
26,876,747. Sockeye: Table 5, transport with spill **– 1,283,905**.

2000 - Schiewe 2000, March 16, 2000. Steelhead: Table 6, transport with spill. Added wild (1,792,916) and hatchery (12,184,824) estimates at Tongue Point for a total steelhead estimate of
13,977,740. Yearling Chinook: Table 6, transport with spill. Added wild (8,733,906) and hatchery (21,831,929) estimates at Tongue Point for a total yearling Chinook estimate of
30,565,835. Sub Chinook: Table 5, transport with spill **– 47,345104**. Sockeye: Table 5, transport with spill **– 3, 257, 494**.

2001 - Schiewe 2001, May 2, 2001. Steelhead: Table 9, Full transportation at Tongue Point -

14,923,748. Yearling Chinook: Table 7, Full transportation at Tongue Point **– 23,704,323**. Sub Chinook: Same table **– 38,571,680**. Sockeye: Table 7, full transport **– 2,122,764**.

2002 - Schiewe 2002, March 28, 2002. Steelhead: Table 10, transport with spill. Added wild (2,165,789) and hatchery (11,700,319) estimates at Tongue Point for a total steelhead estimate of **13,866,108**. Yearling Chinook: Table 8, transport with spill. Added wild (10,771,077) and hatchery (23,531,162) estimates at Tongue Point for a total yearling Chinook estimate of **34,302,239**. Sub Chinook: Table 7, transportation with spill **– 47,139,165**. Sockeye: Table 7, transport with spill **– 2,081,468**.

2003 - Ferguson 2003, March 20, 2003 memo. Steelhead: Table 10, Transportation with spill - Added wild (2,702,533) and hatchery (11,781,527) estimates at Tongue Point for a total steelhead estimate of **14,484,060**. Yearling Chinook: Table 8, transport with spill. Added wild (12,651,681) and hatchery (24,200,009) estimates at Tongue Point for a total yearling Chinook estimate of **36,851,690**. Sub Chinook: Table 7, full transportation **– 59,463,290**. Sockeye: Table 7, with spill **– 1,781,584**.

2004 - Ferguson 2004, March 29, 2004 memo. Steelhead: Table 10, Full transportation - Added wild (2,602,246) and hatchery (11,060,851) estimates at Tongue Point for a total steelhead estimate of **13,663,097**. Yearling Chinook: Table 8, full transportation - Added wild (12,142,606) and hatchery (21,683,696) estimates at Tongue Point for a total yearling Chinook estimate of **33,826,302**. Sub Chinook: Table 7, full transportation **– 60,475.322**. Sockeye: Table 7, full transport - **1,850,321**.

2005 - Ferguson 2005, August 24, 2005 memo. Steelhead: page 45, Table 9, Full Transportation **-13,692,289**. Yearling Chinook: page 36, Table 7a, Full Transportation **– 38,509,029**. Sub Chinook: page 38, Table 7b (transport with spill) **– 81,247,508**. Sockeye: Table 7c, full transport **– 1,781,663**.

2006 - Ferguson 2006, April 10, 2006 memo. Steelhead: page 51, Table 9, Transportation with spill **-14,278,819**. Yearling Chinook: page 44, Table 7b, Transportation with spill – **38,832,655**. Sub Chinook: same page and table **– 89,791,172**. Sockeye: Table 7c, with spill – **1,368,440**.

2007 - Ferguson 2007, September 11, 2007 memo. Steelhead: page 52, Table 9, Transportation with spill **-13,922,277**. Yearling Chinook: page 45, Table 7b, Transportation with spill –
28,719,701. Sub Chinook: same page and table **– 90,003,337**. Sockeye: Table 7c, with spill **– 1,663,764**.

2008 - Ferguson 2008, December 4, 2008 memo. Steelhead: page 52, Table 9, Transportation with spill **-14,046,231**. Yearling Chinook: page 45, Table 7b, Transportation with spill –
29,538,756. Sub Chinook: same page and table **– 81,940,043**. Sockeye: Table 7c, with spill **– 1,650,027**.

2009 – Ferguson 2009, October 15, 2009 memo. Steelhead: page 53, Table 9, Transportation with spill **-13,800,640**. Yearling Chinook: page 46, Table 7b, Transportation with spill –
26,902,885. Sub Chinook: same page and table **– 87,612,607**. Sockeye: Table 7c, with spill **– 1,489,029**.

2010 – Ferguson 2010, November 9, 2010 memo. Steelhead: page 56, Table 9, Transportation with spill **-14,091,647**. Yearling Chinook: page 49, Table 7b, Transportation with spill –
35,517,282. Sub Chinook: same page and table **– 80,208,807**. Sockeye: Table 7c, with spill **– 1,492,268**.

2011 – Dey 2012, March 6, 2012 memo. Steelhead: page 56, Table 9, Transportation with spill - **15,706,982**. Yearling Chinook: page 49, Table 7b, Transportation with spill **– 32,807,329**. Sub Chinook: same page and table **– 88,555,553**. Sockeye: Table 7c, with spill **– 1,489,406**.

2012 – Zabel et al, January 23, 2013 memo. Steelhead: page 56, Table 9, Transportation with spill **-14,282,359**. Yearling Chinook: page 49, Table 7b, Transportation with spill **– 33,476,396**. Sub Chinook: same page and table **– 82,710,393**. Sockeye: Table 7c, with spill **– 1,657,481**.

Data from Ken Collis' spreadsheet: Copy of v3 98-09 estuary DCCO consumption.xls (sheet: Consumption Data with 95 percent CI).

scenario	date of	model	total salmonids			Chinook, sub-yearling			Chinook, yearling			coho			sockeye			steelhead		
	estimate	revision	min	best	max	min	best	max	min	best	max	min	best	max	min	best	max	min	best	max
1998 Total	39304	3	7.972538	14.99552	22.01851	6.04632	12.11229	18.17826	0.345553	0.686643	1.027732	0.694745	1.35783	2.020914	0.006254	0.021446	0.036638	0.437698	0.817314	1.19693
1999 Total			5.914695	12.36584	18.81698	3.95545	8.556197	13.15694	0.305362	0.937002	1.568641	0.620176	1.750721	2.881266	-0.0002	0.030401	0.061003	0.425491	1.091518	1.757545
2000 Total			3.768665	7.862304	11.95594	2.130427	4.585188	7.039949	0.324045	0.87426	1.424474	0.586009	1.405932	2.225856	0.000866	0.031405	0.061944	0.418328	0.965519	1.51271
2001 ES	39304	3	3.241129	6.778788	10.31645	2.326869	5.003389	7.67991	0.16876	0.429913	0.691066	0.326893	0.815697	1.304501	0.000834	0.01398	0.027126	0.211946	0.515809	0.819672
2002 ES	39304	3	2.004261	4.637369	7.270477	1.727224	4.094756	6.462288	0.014227	0.089318	0.164408	0.060313	0.333841	0.607369	6.35E-06	0.000164	0.000322	0.01938	0.11929	0.2192
2003 ES	39304	3	1.532003	3.409985	5.287966	0.443927	0.974876	1.505824	0.23442	0.703683	1.172947	0.374034	1.005018	1.636002	-0.00028	0.025485	0.051248	0.254959	0.700922	1.146885
2004 ES	39304	3	3.496283	7.34712	11.19796	2.372198	5.214959	8.057721	0.188358	0.514915	0.841471	0.380753	0.996701	1.612649	0.001327	0.01591	0.030494	0.230124	0.604634	0.979144
2005 ES	39304	3	1.082384	2.408425	3.734466	0.81047	1.893767	2.977064	0.029429	0.079764	0.1301	0.109716	0.266637	0.423558	9.16E-05	0.001999	0.003906	0.070572	0.166258	0.261944
2006 ES	39304	3	4.060271	9.137534	14.2148	0.86507	1.945474	3.025877	0.672846	1.722527	2.772209	1.431976	3.566875	5.701773	-0.00413	0.047702	0.099538	0.776325	1.854957	2.933588
2007 ES	39414	3	4.302968	9.156402	14.00984	1.845794	4.073863	6.301932	0.431452	1.090545	1.749639	1.040227	2.65604	4.271853	0.002184	0.024908	0.047633	0.549902	1.311046	2.072189
2008 ES	40140	4	7.105007	9.289814	11.47462	3.713252	5.62834	7.543428	0.684605	0.933507	1.182409	1.33029	1.769495	2.2087	0.00976	0.027402	0.045044	0.72447	0.93107	1.13767
2009 ES	40140	4	7.740189	11.13764	14.5351	5.079365	8.256174	11.43298	0.489313	0.667771	0.846229	1.048515	1.397404	1.746294	0.005849	0.020302	0.034755	0.616623	0.795992	0.97536

FILE MEMORANDUM
FROM: Gary Fredricks
SUBJECT: 2014 FCRPS BiOp Cormorant Analysis

During the development of the 2014 Supplemental FCRPS Biological Opinion it became apparent that NOAA and the Action Agencies would have to address an oversight in the 2008 FCRPS BiOp baseline analysis due to the dramatic increase in double-crested cormorants in the lower Columbia River Estuary. I was given the task of developing an analysis that would assess the difference in average salmonid consumption rates due to cormorant predation that occurred between the BiOp jeopardy analysis base period (roughly migration years 1983 to 2002) and the current period (roughly migration years 2003 to 2009). Two types of cormorant smolt consumption data existed based on either PIT tag recovery data or bioenergetics modeling data. After considering both approaches, I chose to go with the bioenergetics approach for the following reasons:

1.) Data history. The bioenergetics based smolt consumption data in the literature extended back to 1997, providing a continuous annual estimate for a fifteen year block of time which partially spanned both the base and current periods. It was my opinion that this extensive dataset would work better for extrapolating smolt consumption back into the base period when consumption data (of any kind) were not available. The PIT tag consumption data set was simply not as robust and did not extend back into the base period.

2.) Representativeness. To use the bioenergetics approach to determine predation rates, it was necessary to estimate the smolt populations available to cormorants in the estuary. Determining this rate via PIT tags would have been easier since the analysis would have simply relied on tags detected at Bonneville Dam. However, it was my opinion that the use of NOAA smolt population estimates in the estuary better represented the smolt population as a whole since they were not subject to the erratic tagging rates and stocks the characterized the PIT tag database.

3.) Simplicity/availability. While the OSU bioenergetics model and the NOAA smolt population estimates are far from simple, they were readily available in the literature and were easily adapted to the need and timeframe of the BiOp analysis. The PIT tag data that would fit the smolt population as a whole were not readily available in the literature and an ESU by ESU analysis was tainted by the complications of tagging rates per ESU and the ultimate issue of how one would manage birds for any particular fish stock.

4.) Error. Both approaches have error associated with them. The bioenergetics consumption and cormorant population estimates had errors reported in the literature, while the smolt population estimates did not. The PIT tag consumption estimates had good precision owing to the known starting populations, however, there were significant uncertainties associated with tag deposition and detection rates as well as the issue erratic tagging per species and ESU.

In summary, there is nothing inappropriate or incorrect about either approach, however it was my opinion that the bioenergetics/smolt population approach was a better fit for the supplemental Biological Opinion. This approach was discussed with the bird researchers prior to the development of the final BiOp and they did not believe that it was inappropriate for the intended use. Regardless of which approach was used in the 2014 Supplemental BiOp, it is appropriate to use all lines of evidence when developing and assessing the cormorant management plan.

DRAFT October 17, 2014

FILE MEMORANDUM

FROM: Gary Fredricks

SUBJECT: Revised Cormorant Gap Analysis

The review of the Corps' Draft Cormorant EIS revealed an error in the bird researcher's analytical methods used to generate bioenergetics based smolt consumption estimates for double-crested cormorants in the Columbia River estuary. As a result, Don Lyons (Oregon State University) revised the smolt consumption estimates for the years 1998 through 2013 and transmitted those to me in an October 10, 2014, email. These estimates, along with smolt population estimates were the main inputs for the base-to-current period gap analysis used in the 2014 Supplemental FCRPS Biological Opinion. For reference, this analysis is presented in Appendix E of that document.

The original BiOp gap analysis using the researchers "best" estimates of annual cormorant consumption indicated that there was a difference of 3.65% in consumption rate of juvenile steelhead between the base and current periods used in the BiOp. Re-running the gap analysis with the revised consumption data indicates a slightly lower gap of 3.54% between the base and current periods. The researchers indicated two important points regarding the revised consumption estimates. First, the error found in the modeling approach would not significantly affect the "best" consumption level estimates (the error was only associated with the confidence interval calculations) and second, there will be slight differences in the "best" estimates due to the Monte Carlo method used in the bioenergetics model. Repeat estimates using this method are unlikely to ever be exactly the same. Thus, the slight change in this gap estimate would not change the conclusions in the supplemental BiOp.

Several reviewers of the Corps' draft EIS inquired about the range of data or confidence intervals associated with the cormorant consumption estimates and how this would affect the gap estimate. I ran the gap analysis spreadsheet with both the lower and upper revised estimates for each year. The following tables illustrate the results for steelhead and yearling Chinook along with the original BiOp consumption data gap estimates for comparison.

Table 1. Base to Current Period gap estimates for juvenile **steelhead** with lower and upper 95% confidence intervals for the original and revised cormorant consumption data.			
	Lower 95% CI	Best Estimate %	Upper 95% CI
Original Gap Estimate	Not Calculated	3.65	Not Calculated
Revised Gap Estimate	1.34	3.54	7.90

Table 2. Base to Current Period gap estimates for juvenile yearling **Chinook** with lower and upper 95% confidence intervals for the original and revised cormorant consumption data.			
	Lower 95% CI	Best Estimate %	Upper 95% CI
Original Gap Estimate	Not Calculated	1.06	Not Calculated
Revised Gap Estimate	0.26	1.04	2.60

Appendix E-1: Population Model to Assess Take Levels of the Western Population of Double-crested Cormorants and the Double-crested Cormorant Colony on East Sand Island

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*on U.S. Fish and Wildlife Service contract to develop model and simulation program for subsequent agency use

INTRODUCTION

The U.S. Fish and Wildlife Service developed this population model to assist in assessing potential effects of different annual scenarios and rates of individual and egg take on the western population of double-crested cormorants (*Phalacrocorax auritus*, DCCO Western Population Model). In 2011 the Pacific Flyway Council (Council) identified the need to develop an approach to manage DCCOs, coordinated among the 12 western states comprising the flyway. In 2012 the Council developed *A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway* (Framework; Pacific Flyway Council 2012) to assist managers in developing management strategies to address conflicts with DCCOs. The Framework identified priority management strategies, including the exploration of population modeling options to assess sustainable levels of take while ensuring the conservation of DCCOs. The Council then developed the *Potential Biological Removal (PBR) Model for Assessing Allowable Take Levels* (Dooley 2012). The DCCO Western Population Model was developed subsequent to this, extending to include density dependence, egg take, age structure, and the calculation of population growth as a function of recruitment and adult survival. The DCCO Western Population Model projects population levels through time (trajectories), and could be used to assess the effects of take levels on the western population of DCCOs.

METHODS

The following 2-age class model was used to estimate abundance trajectories of the western population of DCCOs (see Table E-1 1 for model input parameters):

(1) $$N_{SY(t+1)} = N_{ASY(t)}\left(1 - p_t\right)\left(a + bN_{ASY(t)}\right)$$

(2) $$N_{ASY(t+1)} = (N_{SY(t)} * S_{SY}) + N_{ASY(t)}(S_{ASY} - c_{ASY(t)})$$

where;

$N_{SY(t)}$	= number of second year (SY) individuals in year *t*,
$N_{ASY(t)}$	= number of after second year (ASY; breeding individuals) individuals in year *t*,
c_t	= individual culling rate in year *t,*
p_t	= nest/egg take rate in year *t*;
a	= annual recruitment rate (this implicitly incorporates hatch-year survival rate)
b	= density dependence parameter,
S_{SY}	= annual survival rate of second year (SY) individuals in the absence of culling, and
S_{ASY}	= annual survival rate of after second year (ASY) individuals in the absence of culling

Further details of the modeling approach can be found in the Final Environmental Assessment to Extend Management of Double-crested Cormorants (USFWS 2009) and the Final Environmental Assessment (USFWS 2014). The model is an age-structured extension of the population models used in the Potential Biological Removal and Prescribed Take Level models (Wade 1998, Runge et al. 2004, 2009) and most similar to the logistic growth model with harvest (Williams et al. 2002:140):

(3)
$$N_{t+1} = N_t + r_{max}\, N_t \left[1 - \frac{N_t}{K}\right] - h_t N_t$$

where,

N	= number of individuals at time t,
K	= carrying capacity,
r_{max}	= maximum growth rate, and
h_t	= harvest rate at time t

This modeling approach (equations 1 and 2) incorporates aspects of density-dependent population models and harvest models, and replaces $r_{max,}$ with its underlying components, namely survival and recruitment. We used a 2-age class model (SY and ASY), where SY do not breed but transition to ASY in the subsequent year at the SY annual survival rate. We assumed all ASY breed at the beginning of their 3rd year after birth and all years thereafter and culling would occur only on ASY. Limited information for DCCOs exists about the percentage of each age class that returns to breed. Referenced values (see Hatch and Weseloh 1999) come primarily from a single, small sample size study on Mandarte Island, British Columbia (Van der

Veen 1973), which reported that <5, 17, 78, and 98 percent of first, second, third, and greater than third year old individuals breed, respectively. From preliminary banding data on East Sand Island, <0.1 percent of banded chicks were confirmed first year breeders (Y. Sazuki, OSU, unpublished data). Although our modeling approach does not incorporate this potential age-class complexity, including the very small percentage SY breeders and a lower percentage of third year breeders likely would have a small effect overall and is likely offset or countered by incorporating all ASY breeding in their third year. We assumed all individuals within an age class have the same parameter values, and nest/egg take directly correlates to take of density-dependent recruitment. In this final assumption, we did not attempt to include additional compensatory effects of life stages later than nest/egg stage (i.e., chick, fledgling, hatch-year) in affecting recruitment (e.g., fledgling survival increases or decreases at particular thresholds of nest/egg take) because no data was available to model the direction or magnitude of this effect.

Abundance (N) estimates for a given year are a pre-breeding estimate (i.e., potential number of individuals available in the population before the beginning of the breeding season). SY and ASY survival span from the beginning of the breeding season to the subsequent beginning of the next breeding season. The interval for hatch-year survival and recruitment (*a*) spans from the time of birth of new individuals to the beginning of the following breeding season. Thus, the recruitment parameter is estimating recruitment into the SY age class and covers the birth process and survival process of hatch-year individuals. The interval between the beginning of breeding seasons includes the processes of ASY loss from take, nest/egg loss from take, recruitment of new SYs into the population, and SY (i.e., recruited into the population from the previous time period) and ASY survival.

To estimate the density dependence parameter (*b*), we adjusted *b* under a deterministic scenario (i.e., no variance) under no individual and nest/egg take to find the value that maximized the R-squared value of model predicted estimates compared to observed past data. R-squared was calculated using the equation:

$$R^2 = 1 - \frac{\sum_i^N (y_i - \hat{y}_i)^2}{\sum_i^N (y_i - \bar{y})^2}$$

where,

y_i	= observed abundance in year i,
$\hat{y}_i$	= model predicted abundance in year i, and
$\bar{y}_i$	= average observed abundance from year i to N

The density dependence parameter value estimated from past observed data and reported coefficient of variation (CV) for this parameter (Table E-1 1) was then used in the simulation process described below for estimating future abundance trajectories.

We conducted a Monte Carlo simulation in Program R (R Development Core Team 2008) using equations 1 and 2 to estimate annual abundance of ASY (i.e., breeding individuals) for each time period. Using the parameter values, CV, and sampling distribution described in Table E1-1, sampling distributions were created for each parameter, which represent the parametric uncertainty surrounding that model input value, and 10,000 random samples were drawn from each parameter distribution at each time period to create a distribution of SY and ASY abundance for each time period. This process was repeated for the number of years desired for a given simulation, randomly sampling from the abundance distribution in a given time period (along with the other model parameters) to create the next time period abundance distributions. Because SY time period 1 abundance was not directly estimated or reported (i.e., only the number of ASYs were reported), we estimated this value as the number of SYs produced from the number of ASYs in time period 1 under no individual and nest/egg take. For annual abundance estimates, we calculated and reported median values to describe the central tendency of the simulated parameter and 95 percent lower and upper credibility limits (LCL and UCL) as the 97.5 percent and 2.5 percent quantiles of the 10,000 simulations. We also report the standard deviation (SD) of the estimate. For model output, we refer to year 1 as the initial, pre-breeding abundance estimate for year 1 (i.e., the first year of management). Year 2 is the initial, pre-breeding abundance estimate for year 2 (i.e. similar nomenclature for subsequent years).

As an example of this modeling approach, we evaluated the effect of continued, annual individual take rates of 0–10 percent and annual nest take rates of 0–40 percent on the western population of DCCOs (*this example differs from the Appendix E-2 analysis for FEIS actions, where take is occurring over a short (4 year) interval and different parameter values were used).

Points of Discussion Concerning Model

Because DCCOs have delayed breeding, there is a time lag between when nest/egg take occurs and when effects will be realized on the breeding population. Our modeling approach includes this time lag, with ASY abundance being affected by nest/egg take at time $t + 2$ from the time of management action. We acknowledge that effects from nest/egg take would likely not occur as simplistically as modeled; however, we feel this is the best approximation given available data.

Take levels should be considered within the context of the parameter values chosen. Carrying capacity, modeled with the density dependence parameter (*b*; assuming all other parameters are held constant), largely influences how take will affect the population. A choice has to be made about which values to use for future projections. Choice should incorporate past estimates and data, to the extent possible, or a range of potential values should be used if there is uncertainty. Additionally, choice of initial population size will determine the level of take necessary to achieve a particular target size. Multiple year averages should be used when available, rather than extreme values, prior-year estimates, or single-year estimates, as averages are more representative of the central tendency of the population or colony.

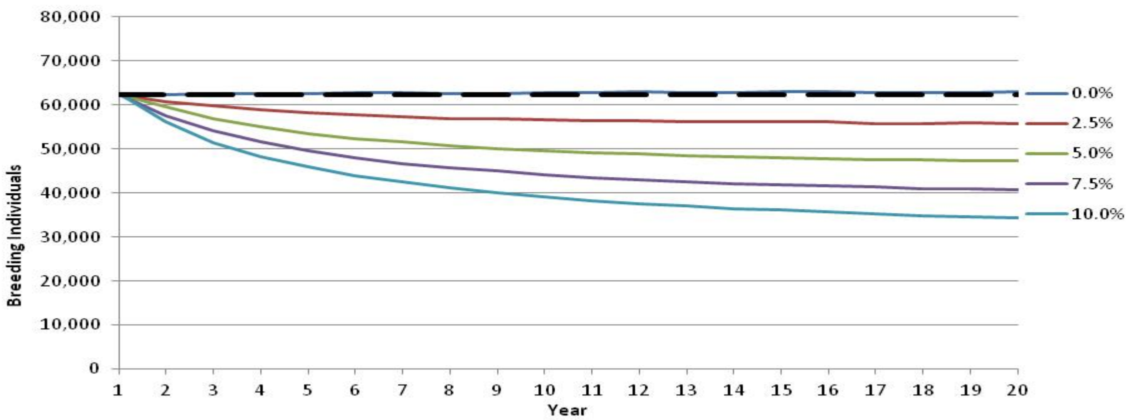
Additional knowledge concerning factors affecting growth, response, and density dependence would improve the ability to model these dynamics. The density-dependent parameter can be thought of as general constraint on underlying growth (i.e., when abundance is close to carrying capacity, growth is nil). The input parameters (i.e., recruitment and survival) capture the growth potential of the species, but levels of intrinsic (i.e., recruitment) versus extrinsic (i.e., immigration) growth at a colony or within a given population cannot be distinguished from abundance data alone; thus, the modeled growth rate includes both intrinsic and extrinsic growth. We modeled the effect of culling of an ASY breeding individual as equal across sex and different ages. We did this because: 1) we wanted to take a generalized approach; 2) determination of age, sex, and breeding status in the field during culling is typically not possible; and 3) the data required to incorporate these additional factors into the model do not exist; for example, existing population abundance and growth data is based upon breeding individuals, and extrapolation to the non-breeding segment of the population is tenuous and would not change observed growth rates. Model performance would likely improve if the following parameters were appropriately monitored for the western population of DCCOs and then incorporated into the current model: density-dependent relationships among parameters; extrinsic versus intrinsic growth and differences between past and future growth potential; and age, sex, and breeding status.

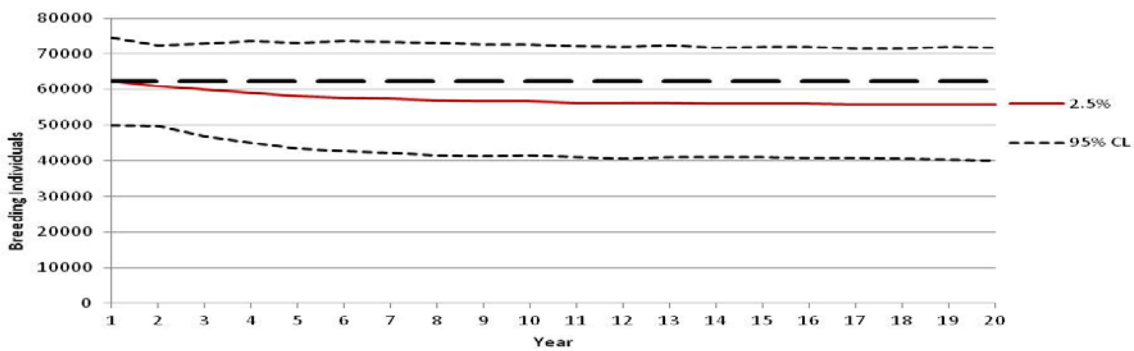
Table E-1 1. Description, mean value, coefficient of variation (CV) of parameters used in the DCCO western population model simulations.

Parameter	Description	Distribution (Mean, CV) N=Normal; ß=Beta	Reference
$N_{WP\_int\_future}$	initial number of breeding individuals in the western population (ca. 2009) for modeling future abundance	N [62,400, 0.10]	Adkins et al. 2014 (no CV reported)
a	recruitment parameter	N [0.471, 0.09]	USFWS 2014, ancillary data
b_{WP}	density dependence parameter that maximizes R-square value of observed data of western population (41,660 breeding individuals in 1990 to final population size of 62,400 breeding individuals in ca. 2009); also value used for future projections.	N [-0.0000043131, 0.25]	Mean from this analysis; CV estimate from USFWS 2014, ancillary data
S_{SY}	second year survival	ß [0.75, 0.05]	Hatch and Wesoloh 1999 = 0.74 (no CV reported) USFWS 2014, ancillary data = 0.778, SE 0.02
S_{ASY}	after second year survival	ß [0.85, 0.05]	Hatch and Wesoloh 1999 = 0.85 (no CV reported) USFWS 2014, ancillary data = 0.884; SE 0.02

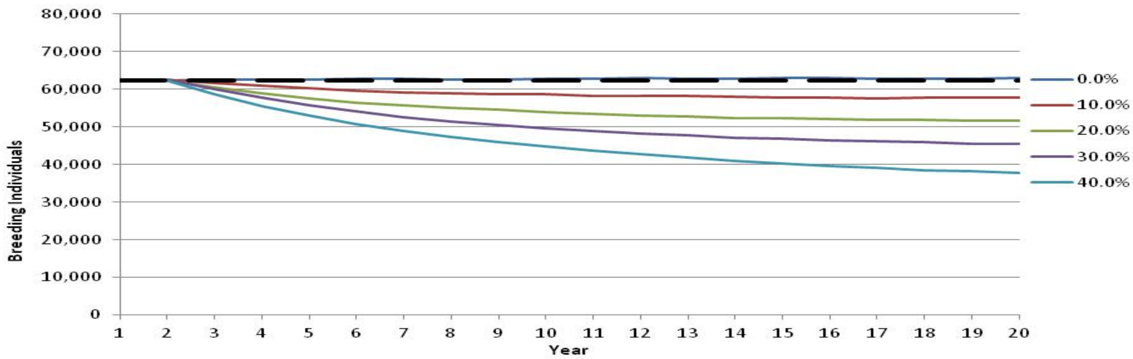
Figure E-1 1. Population trajectories for the western population of DCCOs under different annual take scenarios: I) Percent of breeding individuals culled every year, II) Percent of nests/eggs taken every year. Simulation parameter values are provided in Table E-1 1. The horizontal dashed black line shows initial population size (i.e., static population). The left panel shows the median population trajectories for a range of take values. The right panel shows the median trajectory (with 95 percent credibility limits [CL]) for the scenarios of smallest non-zero take.

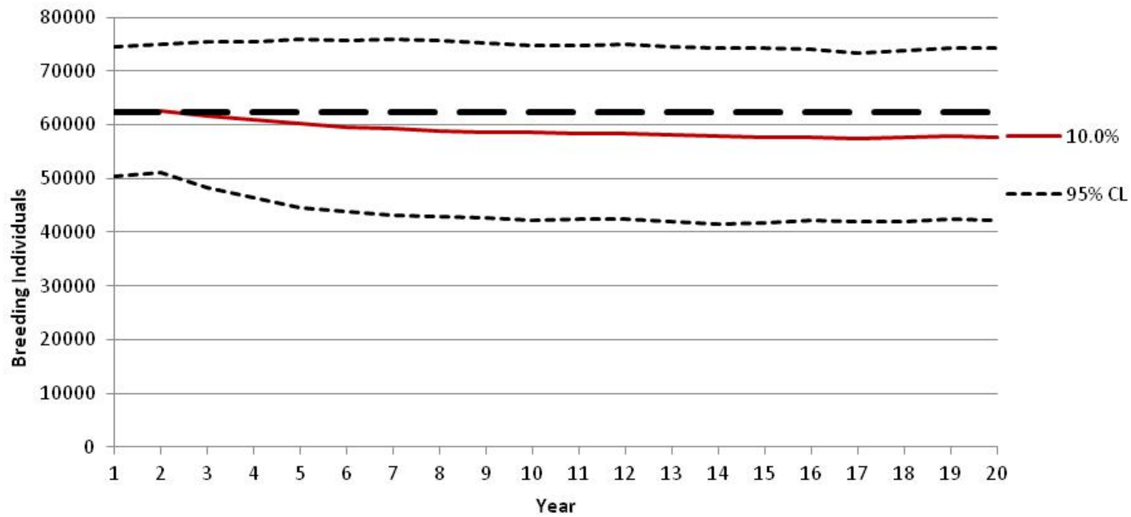
I) Percent of breeding individuals culled every year





II) Percent of nests/eggs taken every year





Literature Cited

Adkins, J. Y., D. D. Roby, D. E. Lyons, K. N. Courtot, K. Collis, H. R. Carter, W. D Shuford, and P. J. Capitolo. 2014. Estimated population size, trends, and limiting factors for the Double-crested Cormorant in western North America. Journal of Wildlife Management 78: 1131–1142.

Dooley, J. 2012. Use of the Potential Biological Removal (PBR) Model for Assessing Allowable Take Levels: Applicability for the Issuance of USFWS Permits. Presentation at U.S. Fish and Wildlife Service, Migratory Bird Habitat Programs Coordination Meeting, September 25, 2012.

Hatch, J. J. and D. V. Weseloh. 1999. Double-crested Cormorant (Phalacrocorax auritus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online.

Pacific Flyway Council (PFC). 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55pg.

R Development Core Team. 2008. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. Available at: http://www.R-project.org.

Runge, M. C., W. L. Kendall, J. D. Nichols. 2004. Exploitation. Pages 303–328 in Sutherland W. J., I. Newton, and R. E. Green, eds. Bird Ecology and Conservation: A Handbook of Techniques. Oxford University Press, Oxford, UK.

Runge, M. C., J. R. Sauer, M. L. Avery, B. F. Blackwell, and M. D. Koneff. 2009. Assessing allowable take of migratory birds. Journal of Wildlife Management 73(4):556–565.

USFWS (U. S. Fish and Wildlife Service). 2009. Final Environmental Assessment: Extended Management of Double-crested Cormorants under 50 CFR 21.47 and 21.48. U.S. Dept. of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203.

USFWS (U. S. Fish and Wildlife Service). 2014. Draft Environmental Assessment: Management of Double-crested Cormorants under 50 CFR 21.47 and 21.48. U.S. Dept. of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203; in cooperation with U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services.

Van Der Veen, H. E. 1973. Some aspects of the breeding biology and demography of the Double-crested Cormorants (Phalacrocorax auritus) of Mandarte Island. Ph.D. thesis. Zoologisch Laboratorium der Rijksuniversiteit te Groningen, Groningen.

Williams, B. K., J. D. Nichols, and M. J. Conroy. 2001. Analysis and management of animal populations. Academic Press, San Diego, CA.

Appendix E-2: Population Model Analyses to Assess Proposed Take Levels on East Sand Island and the Western Population of Double-crested Cormorants

Background and Methods

The model described in Appendix E-1 was used to develop take levels described in Phase I of Alternatives C and C-1 (Alternative D would be the same as Alternative C-1 during Phase I and is implicitly incorporated herein); these alternatives have objectives to reduce the East Sand Island double-crested cormorant (DCCO) colony to the target size of 5,380 to 5,939 breeding pairs by the end of the 2018 timeline of the 2014 FCRPS Biological Opinion (NOAA Fisheries 2014, see Chapter 1, Section 1.1.5) using primarily lethal techniques. The model was then used to assess the potential effects of the take levels and management strategies proposed in Alternatives C and C-1 on the DCCO colony on East Sand Island and how those take levels would affect, consequently, the western population of DCCOs. Alternative C includes take of individuals as the primary lethal method of take. Aside from limited egg take to support implementation of non-lethal methods (i.e., up to 500 eggs on East Sand Island and 250 eggs in the Columbia River Estuary), nest/egg take is not proposed as a primary lethal method in this alternative. In contrast, Alternative C-1 includes both take of individuals and nest/egg oiling as primary lethal methods. Appendix E-2 includes a description of Alternative C and C-1 take levels and how they were derived. Appendix E-3 includes graphical representations and a short description of all alternatives considered in the FEIS.

To determine take levels for the East Sand Island colony, the model was fit to observed DCCO abundance on East Sand Island and Rice Island from 1989–2013 to determine the density dependent parameter value that maximized R-square (see Appendix E-1 for description); observed abundance data came from NOAA (2014) (see Appendix D) and Roby et al. (2014). DCCOs nested on both East Sand Island and Rice Island before 1999, and then exclusively on East Sand Island thereafter (see Table E-2 1 for model input parameters). For future growth trajectories, annual take percentages (i.e., percentage of the colony taken) were identified for Phase I of Alternatives C and C-1 to reduce the DCCO colony on East Sand Island from 25,834 breeding individuals (i.e., 10-year average) to the colony target size of 11,319 breeding individuals, as required under reasonable and prudent alternative 46 of the 2014 FCRPS Biological Opinion (stated as 5,380 to 5,939 nesting pairs; NOAA 2014). If lethal take is initiated in 2015 and management actions are implemented for four years, the target colony size on East Sand Island would be achieved by the end of 2018 (lethal control taking place in 2015, 2016, 2017, and 2018), with final evaluation of the management action in achieving the target size based on the pre-breeding estimate for the following year (i.e., 2019) to account for recruitment (or lack of recruitment) into the population the following year. The Corps would undertake a 4-year lethal strategy to achieve the target colony size and adaptive management thresholds and actions described below would be used to adjust take levels between years based upon response of the East Sand Island colony and the western population of DCCOs.

Future East Sand Island population trajectories were modeled using the density dependence value estimated from past observed data for years 1 to 4, then density dependence was increased (carrying capacity reduced) to the RPA 46 action target range in years thereafter when terrain modification and other non-lethal measures will be implemented to ensure that the East Sand Island DCCO colony does not exceed the target size. An abundance of 25,834 breeding individuals, the 10-year average during 2004–2013, was used as the initial colony abundance for the pre-breeding estimate in year 1 (i.e., the first year of management). For Alternative C, we calculated the individual take percentage that was equal among the 4 years of management and achieved the colony target size after the 4th year of management (i.e., year 5 in model output; pre-breeding estimate the following year). The lethal take scenario modeled included equal individual take and associated active nest loss percentages per year. For Alternative C-1, we calculated a lower individual take percentage (compared to Alternative C) with an increased percentage of nest/egg take that achieved the colony target size after the 4th year of management (i.e., year 5 in model output; pre-breeding estimate the following year). This lethal take scenario included equal individual take percentages in years 1 to 4, greater and equal nest/egg take percentages in years 1 to 3, and then nest/egg take percentage in year 4 being equal to the individual take percentage in year 4. Take percentages were evaluated at 0.5 percent intervals.

For determining take numbers in a given year, we calculated the number of individuals taken and associated active nests lost each year as the modeled individual take percentage for that year multiplied by the estimated initial number of breeding individuals for that year. We estimated the number of individuals after culling in a given year as the estimated initial number of individuals for that year minus the number of individuals taken. We calculated the number of nests oiled as:

$$N_{NestOil(t)} = \frac{N_{ASY(t)}}{2} * \left(\%TotalNestTake_{(t)} - \%AssociatedNestLoss_{(t)}\right)$$

where,

$N_{NestOil(t)}$ = number of nests oiled in time t,

$N_{ASY(t)}$ = number of ASY (breeding individuals) in time t

$\%TotalNestTake_{(t)}$ = total percentage of modeled nest take in time t, and

$\%AssociatedNestLoss_{(t)}$ = percentage of associated nest loss in time t

To assess potential effects to the western population of DCCOs from the proposed management actions, estimated take levels on East Sand Island were added to potential take levels that could occur elsewhere in the western population of DCCOs to estimate the total annual take percentages of the western population of DCCOs. From 1998 to 2014, the number of DCCOs authorized to be taken under depredation permits, scientific collecting permits, and special purpose permits ranged from 1,670 (in 1999) to 2,525 (in 2004) for the western population. Approximately 2,300 DCCOs per year are currently authorized to be lethally taken under these permit types within the western population, but only 1,364 per year were taken on average (range = 682–1,994) from 1998-2008 (USFWS, unpublished data). This level of take (1,364 DCCOs) was accounted for in model parameters (i.e., abundance estimates used for deriving the density dependence value come from Adkins et al. (2014), which include abundance estimates through ca. 2009); the potential additional take of 936 DCCOs (2,300 – 1,364 = 936) was included for future population trajectories; thus take of approximately 2,300 DCCOs within the western population was either included implicitly (i.e., in model parameters) or explicitly. Total annual take for the entire western population includes the proposed annual individual and nest take levels on East Sand Island identified in Phase I of Alternatives C and C-1 and an additional 936 individuals per year in both Phase I and Phase II.

Simulations using the western population of DCCO take percentages were conducted using the model described in Appendix E-1 to estimate annual abundance and 20-year trajectories of the western population of DCCOs. To calculate annual take levels as a percentage of the western population, individual take was calculated as the total annual individual take (i.e., annual number of individuals taken on East Sand Island plus 936 individuals) for that year divided by the estimated number of breeding individuals (i.e., ASY) of the western population for that year. Nest take as a percentage of the western population was calculated as the total annual nest take (annual number of associated nests loss and oiled on East Sand Island) divided by the estimated number of nests of the western population (i.e., ASY abundance/2; assuming each breeding pair has one nest). In the simulations, once the targeted colony size of East Sand Island was reached (i.e., year 5 in the model output), take levels for year 5 were changed to reflect the end of lethal removal of individuals and nests on East Sand Island. Annual take of 936 DCCOs was still included every year, as this take throughout the western population of DCCOs would most likely continue in the future. The density dependence parameter value was estimated that maximized the R-square value from past observed data (i.e., an initial abundance of 41,660 breeding individuals ca. 1990 [Tyson et al. 1997] and current estimated abundance of 62,400 breeding individuals ca. 2009 [Adkins et al. 2014]). For future 20-year population trajectories, an estimate of 62,400 breeding individuals (i.e., Adkins et al. 2014) was used for the initial abundance and a reduced value (compared to past observed data) was used to account for potential reduction in carrying capacity that could occur from terrain modification on East Sand Island and potential loss of habitat from cumulative adverse effects, such as drought caused by climate change, increasing depredation by an expanding bald eagle population, and other regional impacts. Specifically, future 20-year modeled population trajectories include a carrying capacity value of 50,958 breeding individuals, or an approximate

18% decrease from current estimated abundance (i.e., 62,400 breeding individuals). This was derived by subtracting approximately half the loss of the DCCO numbers associated with Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals; Adkins et al. 2014) and approximately half of the colony size reduction proposed on East Sand Island (i.e., 7,258 individuals) from the current estimated abundance (62,400 – 4,184 – 7,258 = 50,958) to account for potential habitat loss in the future. Half of potential maximum loss was used for determining the reduced carrying capacity value because we assumed that there would be sufficient habitat in the region for approximately 50 percent of the DCCOs displaced from Salton Sea and East Sand Island.

Results

For the DCCO colony on East Sand Island, the density dependence value that maximized the R-squared value (i.e., 85%) for observed DCCO abundance data during 1989–2013 was -0.0000081932 (Table E-2 1). East Sand Island model results for Phase I of Alternatives C and C-1 are provided in Table E-2 2 and Figure E-2 1. Annual take is a percentage of the colony; thus, as a percentage of a population is removed, the next year's starting population would be smaller, resulting in a smaller number of individuals removed under the same take percentage. Western population model results are provided in Table E-2 3 and Figure E-2 2.

For Alternative C, annual individual take and associated active nest loss rates of 24 percent in years 1 to 4 projected a predicted DCCO abundance on East Sand Island approaching the population target after the 4th year of management (i.e., year 5 in model output; Table E-2 2 and Figure E-2 1). This corresponded to 18,185 total individuals taken and 18,185 associated nests lost during all 4 years (i.e., 6,202, 4,887, 3,881, and 3,214 in years 1-4, respectively; Table E-2 2). Annual individual and associated active nest loss levels on East Sand Island plus the additional estimated take with the western population (i.e., 936 individuals) were converted into western population take percentages (see Table E-2 3). For Alternative C, annual take percentages of the western population of DCCOS ranged from 10.8–11.4 percent for individuals and 16.7–19.9 percent for associated active nests. These take percentages projected a reduction in abundance of the western population from 62,400 breeding individuals to 34,979 ((+/- 1 SD =29,899–40,058) breeding individuals after the 4th year of management (i.e., year 5 in model output), or a 44 percent reduction, with an increase to a long-term 20 year projected median population size of 44,349 (+/- 1 SD =38,586–50,113) breeding individuals (Table E-2 3 and Figure E-2 2).

For Alternative C-1, annual individual take of 13.5 percent in years 1 to 4 and associated nest loss and nest oiling rates of 72.5 percent in years 1 to 3 and 13.5 percent in year 4 projected a predicted DCCO abundance on East Sand Island approaching the population target after the 4th

year of management (i.e., year 5 in model output; Table E-2 2 and Figure E-2 1). This corresponded to 10,912 total individuals taken, 10,912 associated nests lost, 15,184 nests oiled, and 26,096 total nests lost during all 4 years (i.e., individual take = 3,489, 3,114, 2,408, and 1,902 in years 1-4, respectively; associated nests lost = 3,489, 3,114, 2,408, and 1,902; nests oiled = 5,879, 5,247, 4,058, and 0; total nests lost = 9,368, 8,361, 6,466, and 1,902; Table E-2 2). For Alternative C-1, annual take percentages of the western population of DCCOS ranged from 6.8–7.3 percent for individuals and 9.1–30.3 percent for nests. These take percentages projected a reduction in abundance of the western population from 62,400 breeding individuals to 38,365 (+/- 1 SD=32,984–43,746) breeding individuals after the 4th year of management (i.e., year 5 in model output), or a 39 percent reduction, with an increase to a long-term 20 year projected median population size of approximately 44,903 (+/- 1 SD=38,900–50,906) breeding individuals (Table E-2 3 and Figure E-2 2).

Discussion
A depredation permit application would be submitted annually by the Corps for approval by the USFWS prior to any lethal take. The proposed take levels on East Sand Island (Table E-2 2) would be the initial strategy the Corps would use to achieve the target colony size under Phase I of Alternatives C and C-1. Growth rate data and input parameter values used in the model were specific to the western population and East Sand Island or are demographic parameters intrinsic to the species. Take levels from the modeling approach account for expected density-dependent effects and growth or decreases for both the western population of DCCOs and the DCCO colony on East Sand Island. The difference between the 10-year average colony size on East Sand Island (25,834 breeding individuals) and the value of the target population size (11,319 breeding individuals) is 14,515 breeding individuals. Total proposed individual take levels on East Sand Island were 18,185 breeding individuals (and 18,185 associated nests lost) for Alternative C, and 10,912 breeding individuals and 26,096 total nests lost for Alternative C-1 (Table E-2 2). The difference in abundance between the ca. 2009 estimated size of the western population of DCCOs (62,400 breeding individuals; Adkins et al. 2014) and the predicted population abundance after implementation of Phase I of Alternatives C (34,979 breeding individuals) and C-1 (38,365 breeding individuals) is approximately 27,421 and 24,035 breeding individuals, respectively.

Conservative modeling approaches were used with regard to carrying capacity of the western population, the initial East Sand Island colony size, associated active nest loss, and incorporation of additional take within the western population of DCCOs (see below). This could result in proposed take levels that underestimate the level of take needed to achieve the target colony size on East Sand Island. Similarly, observed abundance for the western population of DCCOs and the East Sand Island colony could be greater than predicted.

Disparities between model predictions and future observed abundance will be addressed by the adaptive management measures outlined below. These measures provide an approach that allows for achievement of the East Sand Island target colony size within the context of measures to ensure the conservation of the western population of DCCOs.

An Adaptive Management Approach

An adaptive management approach is needed due to uncertainties in predicting future outcomes. Adaptive management will be used to adjust proposed take levels in future years, if needed. The predictions of effects on the DCCO colony on East Sand Island and the western population were developed from the DCCO western population model. Four fundamental sources of uncertainty may cause observations to not match the predictions (Nichols et al. 1995a, Johnson et al. 1996, Williams et al. 1996): environmental variation, partial controllability of culling/egg oiling, partial observability of estimating population attributes, and structural uncertainty with an incomplete understanding of underlying biological processes.

Adjusting the amount of take would be determined based on observed DCCO abundances on East Sand Island and within the western population and behavioral responses of DCCO and non-target species after implementation. Observed abundance on East Sand Island is the peak number of nesting DCCO pairs on the island after culling has taken place in a given year; the observed abundance of the western population will be the estimate of the nesting population following the annual population-wide monitoring, using methods described in the Pacific Flyway Council Monitoring Strategy (Pacific Flyway Council 2013). The adjustments to take levels will be based upon the thresholds and descriptions included in Tables E-2 2, E-2 3, E-2 4, and Figure E-2 3 and include a two-step evaluation process with regard to whether observed abundance is less than, greater than, or within 1 standard deviation of predicted abundances from the population models for both the western population of DCCOs and the DCCO colony on East Sand Island.

Take could increase if, for both the East Sand Island colony and the western population, the observed abundance is greater than one standard deviation of the predicted abundance. This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and thus, the predicted decline in the western population may not occur.

Increased take could also be considered in years 3–4 above what is stated in the proposed take levels described in the alternatives if authorized take the previous year was not fulfilled and if the observed abundance East Sand island is within one standard deviation above predicted while the observed abundance for the western population is within one standard deviation above predicted for that year. As described above, if this scenario occurs, it may indicate that the population model used to develop predictions may also be more conservative than actual conditions. However, if the observed abundance for the western population continues to decline, it would move evaluation and adaptive management into the next scenario described in Table E-2 4.

Take could decrease or cease if observed abundance of the western population is lower than one standard deviation below predicted abundance, as this could be an indication that the East Sand Island colony is acting as an immigration sink, with DCCOs immigrating from other colonies within the western population. It could also be possible that the model could not adequately incorporate all the sources of fundamental uncertainty (as stated above; see Table E-2 4 for additional adaptive management scenarios).

We provide a more explicit example below, to demonstrate how this adaptive approach might be implemented, using the predicted abundances and proposed take levels and adaptive management thresholds in Tables E-2 2, E-2 3, E-2 4, and Figure E-2 3 and hypothetical observed abundances in future years.

Under the proposed Alternative C-1, in year 1, 3,489 individuals would be taken and 5,879 nests oiled (Table E-2 2). If, after year 1 management is completed, the observed abundance after culling for East Sand Island was 24,000 breeding individuals and 60,000 breeding individuals for the western population, the following would be considered by the Adaptive Management Team using the adaptive management strategy: since both of these values fall within one standard deviation above predicted abundances after culling for Year 1 (ESI = 22,353–24,128; WP = 57,975–63,792), Year 2 proposed take levels (3,114 individuals and 5,247 nests oiled) would be implemented as planned. Now consider, after year 2 management is completed, the observed abundance after culling for East Sand Island is 23,000 breeding individuals and 57,000 breeding individuals for the western population. In this case, the observed Year 2 abundance after culling for the western population is greater than one standard deviation above predicted abundance for the western population (i.e., 56,235) and the observed abundance after culling for East Sand Island is greater than one standard deviation of predicted abundance for East Sand Island (i.e., 21,594) and is 1,406 breeding individuals greater than one standard deviation above predicted abundance. Thus, the Adaptive Management Team would consider adding 1,406 breeding individuals to the take levels planned for year 3 (i.e., 2,408 + 1,406 = 3,814 breeding individuals and 4,058 nests oiled). If these take levels were implemented in year 3, consider hypothetically that the observed abundance at East Sand Island after culling was 16,500 breeding individuals on East Sand Island and 44,000 breeding individuals for the western population. Since both of these values fall within one standard deviation of Year 3 predicted abundance after culling (i.e.

ESI = 15,428-16,920; WP = 43,980-49,484), the year 4 proposed take levels (1,902 individuals and 0 nests oiled) would be considered for Year 4. Full evaluation of the four years of management would occur during Year 5. If at any time during implementation the East Sand Island target colony size is achieved or observed abundance of the western population of DCCOs falls below one standard deviation of predicted abundance, take on East Sand Island would likely cease.

It should be noted that abundance monitoring will take place before and after management and throughout the breeding season on East Sand Island. Western population abundance would be monitored typically during the mid-breeding season (Pacific Flyway Council 2013). Data from a given breeding season will be summarized in time to inform management for the following breeding season. Adjustments in authorized take would not occur during the breeding season. Additionally, western population data collected in 2014 (before management begins), by the Corps, USFWS and States within the Pacific Flyway, may be considered as part of the adaptive management approach by the Corps and USFWS prior to initiating actions at East Sand Island in 2015.

Modeling Approach

There is uncertainty when choosing parameters for modeling future effects. For example, density dependence/carrying capacity cannot be empirically known, and these values in the future could be similar, lower, or higher compared to present conditions. For the western population of DCCOs analysis, the density dependence/carrying capacity value used for future population trajectories (with no take on East Sand Island) resulted in a greater than an 18% reduction in abundance in 20 years compared to current estimated abundance. This reduction in carrying capacity assumes the potential reduction in range-wide habitat (i.e., loss of Salton Sea and East Sand Island, see above) would be lost indefinitely with a reduced number of alternative sites that could serve as compensation for this loss; thus, in the future, it is assumed the western United States could only support 82% of the current estimated DCCO abundance.

The 10-year average abundance was used as the initial East Sand Island colony size, and proposed take levels are derived from this initial colony size. However, the 2013 abundance estimate (largest recorded) was approximately 4,000 breeding individuals greater than the 10-year average; thus, the actual East Sand Island colony size at the time of implementation of Phase I of Alternative C and C-1 may be greater than the abundance estimate used in the model. The size of the East Sand Island colony fluctuates naturally year to year. For example, during 2004 to 2013, the average percentage change in colony size between consecutive years was 11 percent; the greatest percent change was 21 percent between 2012 and 2013 (see

Figure 1-2 of the FEIS). Thus, using the 10-year average was believed to be more representative of the central tendency of the colony size rather than using a particular year estimate.

Loss of active nests could occur indirectly from take of breeding adults that are actively nesting when culled, if culling sessions are not completed prior to the onset of nesting. The loss of nests associated with breeding adults that are culled will be accounted for after nest initiation is observed, which from past data has been approximately March 27. The actual amount of associated active nest loss from individual take is unknown, whereas with nest oiling, this amount is known with certainty. In the modeling approach when calculating the number of associated nests lost, this effect was modeled as one nest per one individual taken, which represents the most extreme associated active nest loss scenario possible (i.e., each adult taken is assumed to have an associated active nest that would subsequently fail; thus, if number of individuals taken was 13%, the number of associated nests lost was 26%). Lower associated active nest loss is expected since a proportion of the proposed take would occur prior to the initiation of nesting (some culled individuals would have no associated nest), and some pairs, associated with the same nest, would be taken (one active nest lost per two individuals). Thus, the model likely overestimates the potential loss of nests associated with culled adults. For determining the number of nests to oil, the annual percentage of associated nest loss was first subtracted from the annual total percentage of nest take modeled. This formulation ensured that total nest take would not exceed the modeled total nest take percentage for a given year (or result in estimates of nest loss that exceed the number of nests expected to be present on the colony, assuming one nest per two breeding individuals). Future abundance trajectories included the effect of all annual modeled nest take, but the modeled effect of nest take may be greater than observed because associated nest loss is likely modeled as a maximum effect.

Lastly, the 936 DCCOs each year included in the western population take levels in addition to the annual take on East Sand Island represent potential, authorized take that could occur in the future. Actual take levels from this potentially authorized amount could be lower.

Also, of note, in Phase II, terrain modification and other non-lethal techniques will be implemented to ensure that the East Sand Island DCCO colony does exceed the target size. This effect was modeled as occurring definitively (i.e., mainly for visual purposes of graphs); however, the actual extent that terrain modification and non-lethal management will achieve this effect is less certain than modeled.

Table E-2 1. Description, mean value, coefficient of variation (CV), and sampling distribution of parameters used in the DCCO population model simulations.

Parameter	Description	Distribution (Mean, CV) N=Normal; ß=Beta	Reference
$N_{WP\_int\_future}$	initial number of breeding individuals in the western population (ca. 2009) for modeling future abundance	N [62,400, 0.10]	Adkins et al. 2014 (no CV reported)
$N_{ESI\_int\_model\ fit}$	initial number of breeding individuals on East Sand Island in 1989 for assessing model fit to observed data	N [3,694, 0.10]	NOAA 2014 (no CV reported)
N_{ESI_future}	initial number of breeding individuals on East Sand Island (2004–2013 average) for modeling future abundance	N [25,834, 0.08]	Roby et al. 2014
a	recruitment parameter	N [0.471, 0.09]	USFWS 2014, ancillary data
$b_{WP\_model\_fit}$	density dependence parameter that maximizes R-square value of observed data of western population (41,660 breeding individuals in 1990 to final population size of 62,400 breeding individuals in ca. 2009)	N [-0.0000043131, 0.25]	Mean from this analysis; CV estimate from USFWS 2014, ancillary data
b_{WP_future}	density dependence parameter for future projections of western population (62,400 breeding individuals in ca. 2009 to final size of 50,958 breeding individuals in 20 years; 18% reduction from current estimated abundance)	N [-0.0000053257, 0.25]	Mean from this analysis; CV estimate from USFWS 2014, ancillary data
b_{ESI}	density dependence parameter that maximizes R-square value of observed data of East Sand Island (3,694 breeding individuals in 1989 to final population size of 29,832 breeding individuals in 2013)	N [-0.0000081932, 0.25]	Mean from this analysis; CV estimate from USFWS 2014, ancillary data
S_{SY}	second year survival	ß [0.75, 0.05]	Hatch and Wesoloh 1999 = 0.74 (no CV reported) USFWS 2014, ancillary data = 0.778, SE 0.02
S_{ASY}	after second year survival	ß [0.85, 0.05]	Hatch and Wesoloh 1999 = 0.85 (no CV reported) USFWS 2014, ancillary data = 0.884; SE 0.02

Table E-2 2. Estimated take levels that resulted in the DCCO colony on East Sand Island approaching the 2014 FCRPS Biological Opinion population target of 11,319 breeding individuals after the 4th year of management (i.e., year 5 in model output; pre-breeding estimate the following year) under the lethal strategies proposed in Phase I of Alternatives C and C-1. Shown are predicted annual colony abundance (N) estimates before and after culling for a given management year, standard deviation (SD) and +/- 1 SD (used for adaptive management thresholds), and the number of individuals (Ind) taken, associated active nests lost, nests oiled, and total nests lost (i.e., proposed take levels for a given year). For years 1 to 4, the density dependence value modeled was the value estimated from past observed data, then density dependence was increased (carrying capacity reduced) to the population target range in years thereafter when terrain modification and other non-lethal measures will be implemented (See Figure E-2 1).

Alternative C

Ind (24% yr 1-4) + nest (24% yr 1-4) on East Sand Island

	ASY Estimate Before Culling								ASY Estimate After Culling			
Year	N	SD	-1 SD	+ 1 SD	# Ind Taken	# Associated Active Nests Lost	# Nest Oiled	Total Nest Lost	N	SD	-1 SD	+ 1 SD
1	25,842	2,051	23,790	27,893	6,202	6,202	0	6,202	19,640	1,559	17,588	21,691
2	20,365	1,740	18,625	22,104	4,887	4,887	0	4,887	15,477	1,322	13,737	17,217
3	16,171	1,738	14,433	17,909	3,881	3,881	0	3,881	12,290	1,321	10,552	14,028
4	13,392	1,506	11,886	14,897	3,214	3,214	0	3,214	10,178	1,144	8,672	11,683
5	11,278	1,244	10,034	12,522								
6	10,927	1,370	9,558	12,297								
7	11,139	1,437	9,702	12,576								
8	11,365	1,485	9,880	12,850								
9	11,508	1,549	9,958	13,057								
10	11,662	1,593	10,069	13,255								
11	11,804	1,621	10,183	13,424								
12	11,882	1,666	10,217	13,548								
13	11,969	1,716	10,253	13,685								
14	12,012	1,763	10,249	13,775								
15	12,037	1,804	10,233	13,840								
16	12,064	1,828	10,236	13,892								
17	12,115	1,843	10,271	13,958								
18	12,138	1,878	10,260	14,016								
19	12,173	1,909	10,264	14,082								
20	12,149	1,931	10,218	14,080								
Total					18,185	18,185	0	18,185				

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood of achieving the target size on East Sand Island. Final evaluation of the management action in achieving the target size would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population.

Alternative C-1

Ind (13.5% yr 1-4) + nest (72.5,72.5,72.5,13.5%) on East Sand Island

	ASY Estimate Before Culling								ASY Estimate After Culling			
Year	N	SD	-1 SD	+ 1 SD	# Ind Taken	# Associated Active Nests Lost	# Nest Oiled	Total Nest Lost	N	SD	-1 SD	+ 1 SD
1	25,842	2,051	23,790	27,893	3,489	3,489	5,879	9,368	22,353	1,775	20,579	24,128
2	23,064	1,901	21,163	24,965	3,114	3,114	5,247	8,361	19,950	1,644	18,306	21,594
3	17,836	1,725	16,111	19,561	2,408	2,408	4,058	6,466	15,428	1,492	13,936	16,920
4	14,086	1,495	12,591	15,582	1,902	1,902	0	1,902	12,185	1,293	10,891	13,478
5	11,259	1,245	10,013	12,504								
6	11,036	1,464	9,572	12,501								
7	11,236	1,503	9,733	12,739								
8	11,439	1,542	9,897	12,981								
9	11,569	1,599	9,970	13,168								
10	11,715	1,635	10,080	13,350								
11	11,846	1,656	10,190	13,503								
12	11,916	1,696	10,220	13,612								
13	11,998	1,742	10,256	13,740								
14	12,033	1,785	10,248	13,818								
15	12,054	1,823	10,230	13,877								
16	12,079	1,845	10,234	13,923								
17	12,123	1,857	10,266	13,980								
18	12,148	1,890	10,258	14,038								
19	12,180	1,919	10,261	14,099								
20	12,154	1,940	10,214	14,094								
Total					10,912	10,912	15,184	26,096				

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood of achieving the target size on East Sand Island. Final evaluation of the management action in achieving the target size would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population.

Table E-2 3. Predicted abundance of the western population of DCCOs and associated take levels under the lethal strategies proposed in Phase I of Alternatives C and C-1. Shown are predicted annual abundance estimates of the western population (WP N) before and after culling for a given management year, standard deviation (SD) and +/- 1 SD (used for adaptive management thresholds) and the number of individuals (Ind) taken, associated active nests lost, nests oiled, and total nests lost on East Sand Island (ESI). Western Population take levels include East Sand Island take plus 936 additional individuals taken per year in other areas of the western population, which were not included in modeled parameters. See Methods for description of how take levels and percentages were derived. The density dependence value modeled for future population trajectories was an 18% reduction (in 20 years) from current estimated abundance (see Figure E-2 2).

Alternative C

Ind (24% yr 1-4) + nest (24% yr 1-4) on East Sand Island

	ASY Estimate Before Culling												ASY Estimate After Culling			
Year	WP N	WP SD	WP -1 SD	WP + 1 SD	ESI Ind Take	Additional Ind Take in WP	Total Ind Take	% Ind Take of WP	ESI Associated Active Nests Lost	ESI Nest Oiled	Total Nests Lost/Oiled	% Associated Active Nest Loss/Oiled of WP	WP N	WP SD	WP -1 SD	WP + 1 SD
1	62400	6261	56139	68661	6202	936	7138	11.4%	6202	0	6202	19.9%	55,262	5,545	49,717	60,807
2	52413	5331	47082	57744	4887	936	5823	11.1%	4887	0	4887	18.6%	46,589	4,739	41,850	51,328
3	43930	5897	38033	49827	3881	936	4817	11.0%	3881	0	3881	17.7%	39,113	5,250	33,863	44,363
4*	38508	5547	32961	44054	3214	936	4150	10.8%	3214	0	3214	16.7%	34,358	4,949	29,409	39,307
5	34979	5080	29899	40058	0	936	936	2.7%	0	0	0	0%				
6	35069	4903	30166	39972	0	936	936	2.7%	0	0	0	0%				
7	36546	4848	31698	41394	0	936	936	2.6%	0	0	0	0%				
8	37506	4760	32746	42266	0	936	936	2.5%	0	0	0	0%				
9	38574	4774	33800	43348	0	936	936	2.4%	0	0	0	0%				
10	39440	4814	34627	44254	0	936	936	2.4%	0	0	0	0%				
11	40223	4893	35331	45116	0	936	936	2.3%	0	0	0	0%				
12	40943	5041	35902	45984	0	936	936	2.3%	0	0	0	0%				
13	41537	5051	36486	46589	0	936	936	2.3%	0	0	0	0%				
14	42097	5180	36917	47277	0	936	936	2.2%	0	0	0	0%				
15	42679	5313	37366	47991	0	936	936	2.2%	0	0	0	0%				
16	43181	5418	37764	48599	0	936	936	2.2%	0	0	0	0%				
17	43655	5495	38160	49149	0	936	936	2.1%	0	0	0	0%				
18	43766	5658	38108	49424	0	936	936	2.1%	0	0	0	0%				
19	44024	5710	38314	49734	0	936	936	2.1%	0	0	0	0%				
20	44349	5763	38586	50113	0	936	936	2.1%	0	0	0	0%				

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood that the predicted abundance would be observed. Final evaluation of the management action would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population.

Alternative C-1

Ind (13.5% yr 1-4) + nest (72.5,72.5,72.5,13.5%) on East Sand Island

	ASY Estimate Before Culling													ASY Estimate After Culling			
Year	WP N	WP SD	WP -1 SD	WP + 1 SD	ESI Ind Take	Additional Ind Take in WP	Total Ind Take	% Ind Take of WP	ESI Associated Active Nests Lost	ESI Nest Oiled	Total Nests Lost/Oiled	% Associated Active Nest Loss/Oiled of WP	WP N	WP SD	WP -1 SD	WP + 1 SD
1	62400	6261	56139	68661	3489	936	4425	7.1%	3489	5879	9368	30.0%	57,975	5,817	52,158	63,792
2	55130	5563	49568	60693	3114	936	4050	7.3%	3114	5247	8361	30.3%	51,081	5,154	45,927	56,235
3	47324	5923	41402	53247	2408	936	3344	7.1%	2408	4058	6466	27.3%	43,980	5,504	38,476	49,484
4*	41871	5698	36174	47569	1902	936	2838	6.8%	1902	0	1902	9.1%	39,034	5,312	33,722	44,345
5	38365	5381	32984	43746	0	936	936	2.4%	0	0	0	0%				
6	38616	5344	33272	43960	0	936	936	2.4%	0	0	0	0%				
7	39807	5324	34482	45131	0	936	936	2.4%	0	0	0	0%				
8	40456	5263	35193	45719	0	936	936	2.3%	0	0	0	0%				
9	41230	5291	35938	46521	0	936	936	2.3%	0	0	0	0%				
10	41828	5331	36497	47158	0	936	936	2.2%	0	0	0	0%				
11	42321	5399	36922	47720	0	936	936	2.2%	0	0	0	0%				
12	42791	5533	37258	48325	0	936	936	2.2%	0	0	0	0%				
13	43163	5510	37653	48672	0	936	936	2.2%	0	0	0	0%				
14	43519	5609	37910	49128	0	936	936	2.2%	0	0	0	0%				
15	43906	5713	38193	49620	0	936	936	2.1%	0	0	0	0%				
16	44247	5784	38463	50031	0	936	936	2.1%	0	0	0	0%				
17	44566	5826	38740	50393	0	936	936	2.1%	0	0	0	0%				
18	44528	5961	38567	50489	0	936	936	2.1%	0	0	0	0%				
19	44685	5980	38706	50665	0	936	936	2.1%	0	0	0	0%				
20	44903	6003	38900	50906	0	936	936	2.1%	0	0	0	0%				

*Post-culling predicted abundance in year 4 would be after the final year of management (i.e., 4 years of management) and would be used in assessing the following year's likelihood that the predicted abundance would be observed. Final evaluation of the management action would be based on the predicted abundance before culling the following year (year 5) to account for recruitment (or lack of recruitment) into the population.

Table E-2 4. Adaptive management thresholds and descriptions for adjusting proposed take levels. One standard deviation off of predicted population size dictates each threshold. Refer to predicted population modeled abundance (N, ASY estimate after culling) and standard deviation (SD) thresholds in Tables E-2 2 and E-2 3.

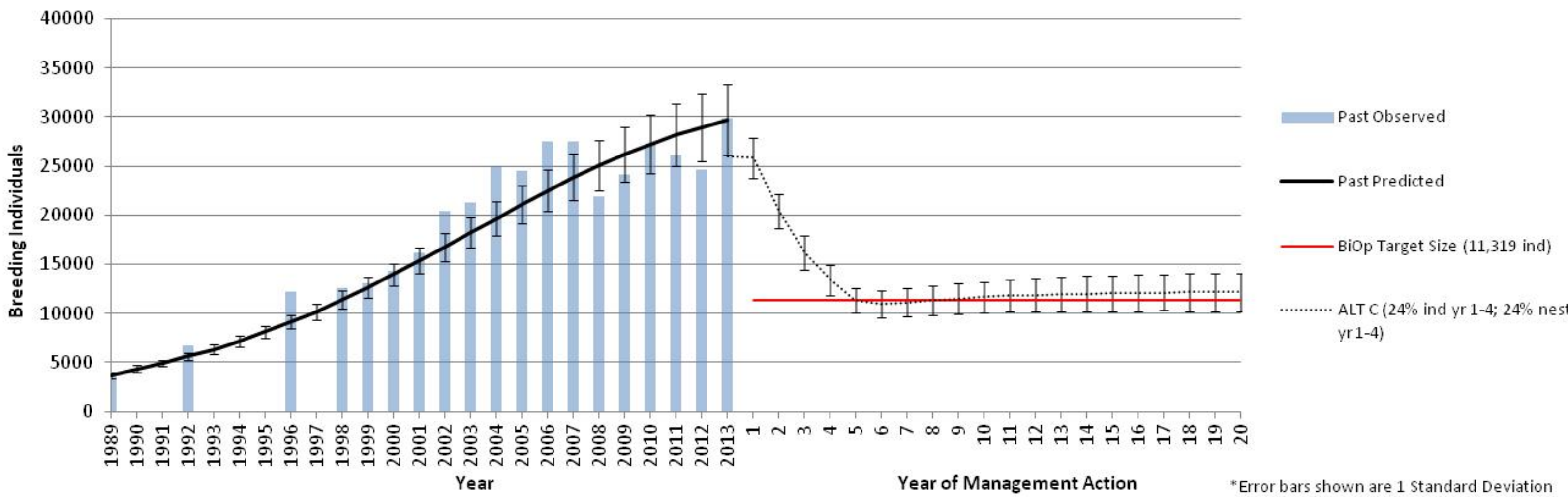
East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
 Observed colony abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is 20,450; 500 more than 19,950 (i.e. predicted by the model), and fewer than 21,594 individuals (1 standard deviation above predicted).	 Observed population abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	For years 1 and 2, stay with take as outlined in Alternative C-1; for years 3 and 4, if the target number of culled DCCOs and oiled nests was not achieved, and observed population abundances on East Sand Island and for the Western Population are above predicted, then consider increasing take in following year to include numbers not taken the previous year. The maximum increase would be the difference between the observed and predicted East Sand Island colony abundances. Example: Year 2, 1000 individuals were not culled that were authorized, consider adding up to 500 individuals to be culled in Year 3 implementation plan (i.e. the difference between observed and predicted East Sand Island colony abundances).
 Observed colony abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	 Observed population abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is above 56,235 individuals.	Consider increasing adult take and nest oiling on East Sand Island, or consider increasing take to authorize numbers not collected the previous year. The maximum increase would be one standard deviation. This would potentially bring the next year's observations closer to the predicted median colony abundance on East Sand Island. Example: Year 2 East Sand Island observed colony abundance is 23,000 individuals and 1,000 individuals were not culled the previous year as was planned; one standard deviation is 1,644. Therefore consider adding 1,644 (1,644 > 1,000) individuals to the Year 3 implementation plan. This scenario may indicate the population model is conservative.

East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
Observed colony abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	Observed population abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	Consider increasing take on East Sand Island by a maximum of the difference between observed colony abundance and one SD above predicted colony abundance on East Sand Island, or consider increasing take to authorize numbers not collected the previous year, whichever is greater. The maximum increase would be one standard deviation. During last 2 years of management, consider doing habitat modification or dissuasion to limit colony size earlier. This scenario would indicate that the population model used to develop predictions may be more conservative than actual conditions and/or this may indicate some immigration to East Sand Island from other colonies is occurring.
Observed colony abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed colony abundance (after culling) is above 21,594 individuals.	Observed population abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed population is below 45,927individuals.	Consider cessation of adult take and cessation/reduction of nest oiling. During last 2 years of management, consider doing habitat modification or dissuasion to limit colony size earlier. This scenario may indicate immigration to East Sand Island from other colonies is occurring.
Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony size (after culling) is below 18,306 individuals.	Observed population abundance (after culling) is greater than one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is above 56,235 individuals.	Stay with Modified Preferred Alternative but stop culling and egg oiling when East Sand Island management objective for colony size is achieved. Potentially speed up timeline for Phase II habitat modification or implement dissuasion to maintain lower colony abundance; will likely reach objective for colony size sooner than predicted. This scenario may indicate dispersal is taking place.

East Sand Island Colony Abundance (N)	Western Population Abundance (WP N)	Potential Adaptive Decision
Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony abundance (after culling) is below 18,306 individuals.	Observed population abundance (after culling) is within one standard deviation above predicted. Example: Year 2 observed population abundance (after culling) is between 51,081 and 56,235 individuals.	Stay with Modified Preferred Alternative but stop when East Sand Island management objective for colony size is achieved. Potentially speed up timeline for Phase II habitat modification or implement dissuasion to maintain lower colony size; will likely reach the management objective for colony size sooner than predicted. This scenario would indicate that the population model used to develop predictions may be more liberal than actual conditions and/or this may indicate some dispersal is taking place.
Observed colony abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed colony size (after culling) is below 18,306 individuals.	Observed population abundance (after culling) is lower than one standard deviation below predicted. Example: Year 2 observed population abundance (after culling) is below 45,927 individuals.	Consider cessation of adult take and cessation/reduction of nest oiling. Consider decreasing adult take and nest oiling on East Sand Island by the difference between observed colony size and one SD below the predicted colony size on East Sand Island. During last 2 years of management, consider doing habitat modification or implement dissuasion to maintain lower colony size hazing earlier. This scenario may indicate the model is liberal.

Figure E-2 1. Observed and predicted DCCO abundance on Rice and East Sand Island during 1989–2013 and 20-year trajectories for the estimated take levels that resulted in the DCCO colony on East Sand Island approaching the 2014 FCRPS Biological Opinion population target of 11,319 breeding individuals after the 4th year of management (i.e., year 5 in model output; pre-breeding estimate the following year) under the lethal strategies proposed in Phase I of Alternatives C and C-1. Population trajectories include both the annual level of individual take and nest loss given in parenthesis. For years 1 to 4, the density dependence value modeled was the value estimated from past observed data, then density dependence was increased (carrying capacity reduced) to the population target range in years thereafter when terrain modification and other non-lethal measures will be implemented (See Table E-2 1).

Alternative C



Alternative C-1

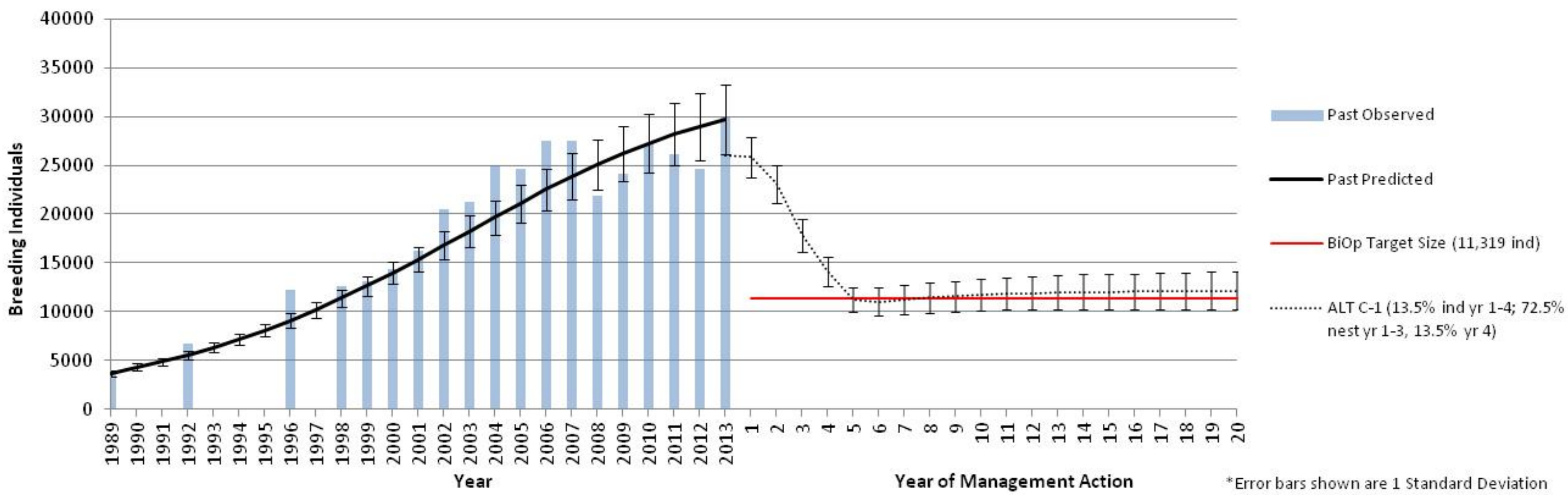
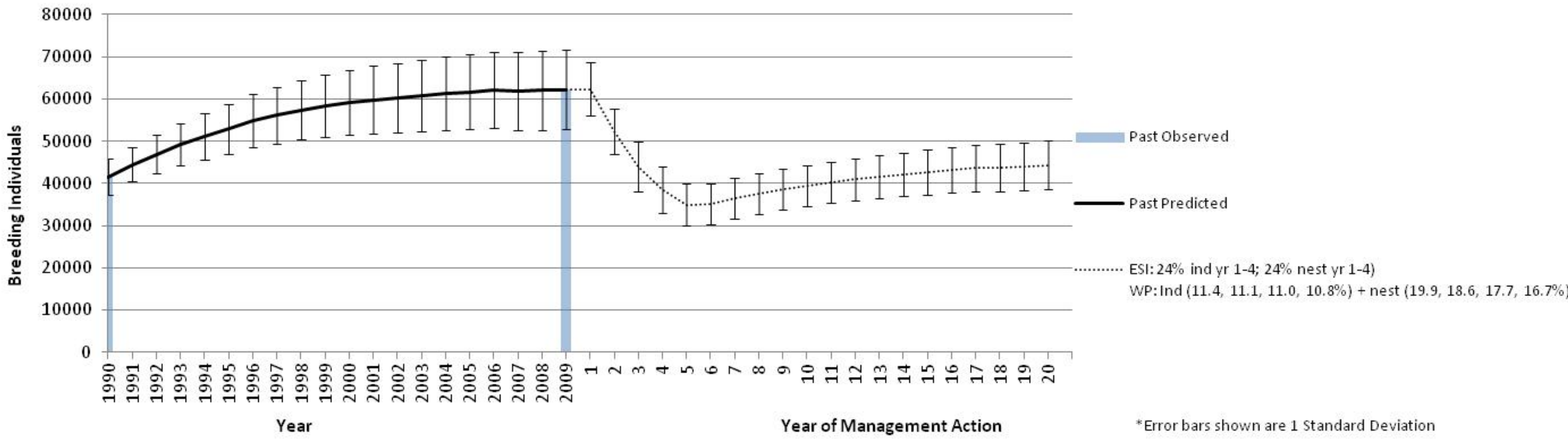


Figure E-2 2. Trajectories of the western population (WP) of DCCOs under the lethal strategies on East Sand Island (ESI) proposed in Phase I of Alternatives C and C-1. Percentages in parentheses show the estimated annual individual and nest take on East Sand Island and the western population used in the simulations. Western Population take levels include East Sand Island take plus 936 additional individuals taken per year in other areas of the western population, which were not included in modeled parameters. See Methods for description of how take levels and percentages were derived. The density dependence value modeled for future population trajectories was an 18% reduction (in 20 years) from current estimated abundance (see Table E-2 2).

Alternative C



Alternative C-1

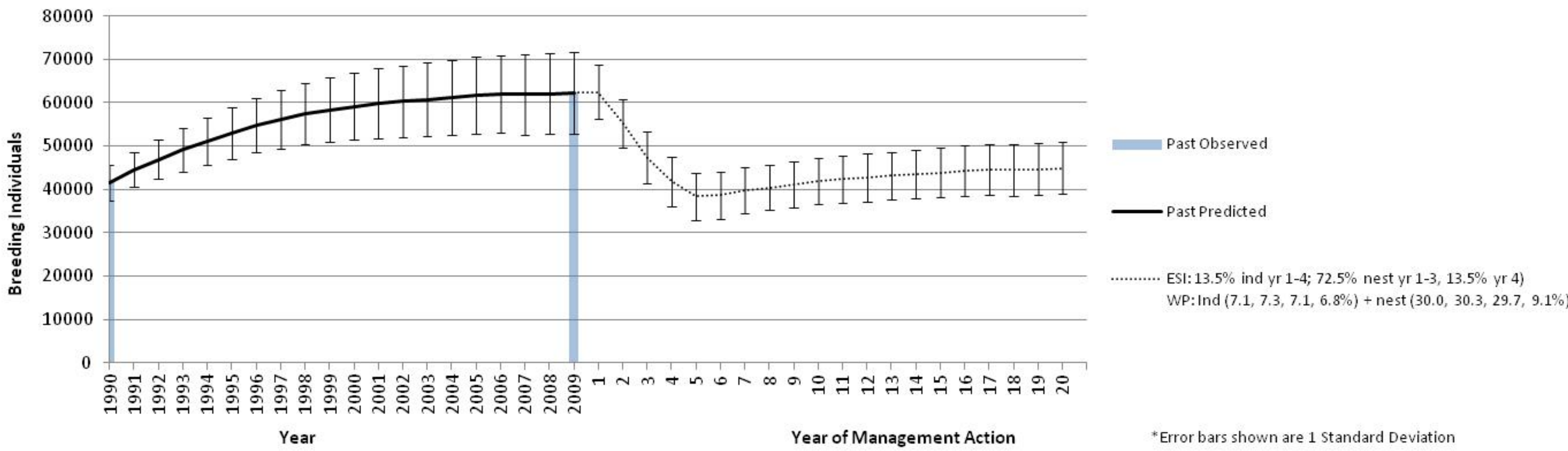


Figure E-2 3. Adaptive Management Timeline, Year, Data Delivery/Analysis, and Decision Timing.

2014
Year 0

- Year 0 PFC Western Population monitoring depicted continued colony loss at Salton Sea
- 2014 East Sand Island and western population observed abundance estimates used to assess initial pre-breeding predictions. Consider model adjustments if huge disparity.

2015
Year 1

- FEIS, ROD, Depredation Permit Application, Spring
- Year 1 implementation, Spring
- Year 1 Colony and population abundance data collected, Summer
- Process abundance data, Fall/Winter; compare observed abundance to Year 1 predicted post culling abundance
- Adaptive Management Team Convene, Fall/Winter;
- Assess whether to modify take levels; prepare and submit depredation permit application, winter/spring (2016)

2016
Year 2

- Year 2 Implementation, Spring
- Year 2 Colony and population abundance data collected, Summer
- Process abundance data, Fall/Winter; compare observed abundance to Year 2 predicted post culling abundance
- Adaptive Management Team Convene, Fall/Winter;
- Assess whether to modify take levels; prepare and submit depredation permit application, winter/spring (2017)

2017
Year 3

- Year 3 Implementation, Spring
- Year 3 Colony and population abundance data collected, Summer
- Process abundance data, Fall/Winter; compare observed abundance to Year 3 predicted post culling abundance
- Adaptive Management Team Convene, Fall/Winter;
- Assess whether to modify take levels; prepare and submit depredation permit application, winter/spring (2018)

2018
Year 4

- Year 4 Implementation, Spring
- Year 4 Colony and population abundance data collected, Summer
- Process abundance data, Fall/Winter; compare observed abundance to Year 4 predicted post culling abundance
- Adaptive Management Team Convene, Fall/Winter;
- Assess whether to implement Phase II, winter/spring (2016)
- End of year BiOp timeline, Dec., between breeding seasons

2019
Year 5

- Year 5 Implementation (Potential for Phase II), Spring
- Year 5 Colony and population abundance data collected, Summer, i.e. full evaluation of management response through Year 4

Literature Cited

Adkins, J. Y., D. D. Roby, D. E. Lyons, K. N. Courtot, K. Collis, H. R. Carter, W. D Shuford, and P. J. Capitolo. 2014. Estimated population size, trends, and limiting factors for the Double-crested Cormorant in western North America. Journal of Wildlife Management 78: 1131–1142.

Hatch, J. J, and D. V. Weseloh. 1999. Double-crested cormorant (*Phalacrocorax auritus*), the birds of North America online (A. Poole, Ed.). Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/441/articles/introduction

Pacific Flyway Council (PFC). 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55 pp.

Pacific Flyway Council (PFC). 2013. A Monitoring Strategy for the Western Population of Double-crested Cormorants within the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 37pg.

NOAA (NOAA Fisheries). 2014. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program. National Marine Fisheries Service, Northwest Region 246 pages.

Roby, D. D., K. Collis and 27 co-authors. 2014. Research, monitoring and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2013 Annual Report to the Bonneville Power Administration and the U.S. Army Corp of Engineers. 102 pp plus figures and tables.

Tyson, L. A., J. L. Belant, F. J. Cuthbert, and D. V. Weseloh. 1997. Nesting populations of double-crested cormorants in the United States and Canada. Pages 17-25 In Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest. USDA-APHIS Tech. Bull. No. 1879.

USFWS (U. S. Fish and Wildlife Service). 2009. Final Environmental Assessment: Extended Management of Double-crested Cormorants under 50 CFR 21.47 and 21.48. U.S. Dept.

of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203.

USFWS (U. S. Fish and Wildlife Service). 2014. Draft Environmental Assessment: Management of Double-crested Cormorants under 50 CFR 21.47 and 21.48. U.S. Dept. of the Interior, USFWS, Div. of Migratory Bird Management, 4401 N. Fairfax Drive MBSP-4017, Arlington, VA 22203; in cooperation with U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services.

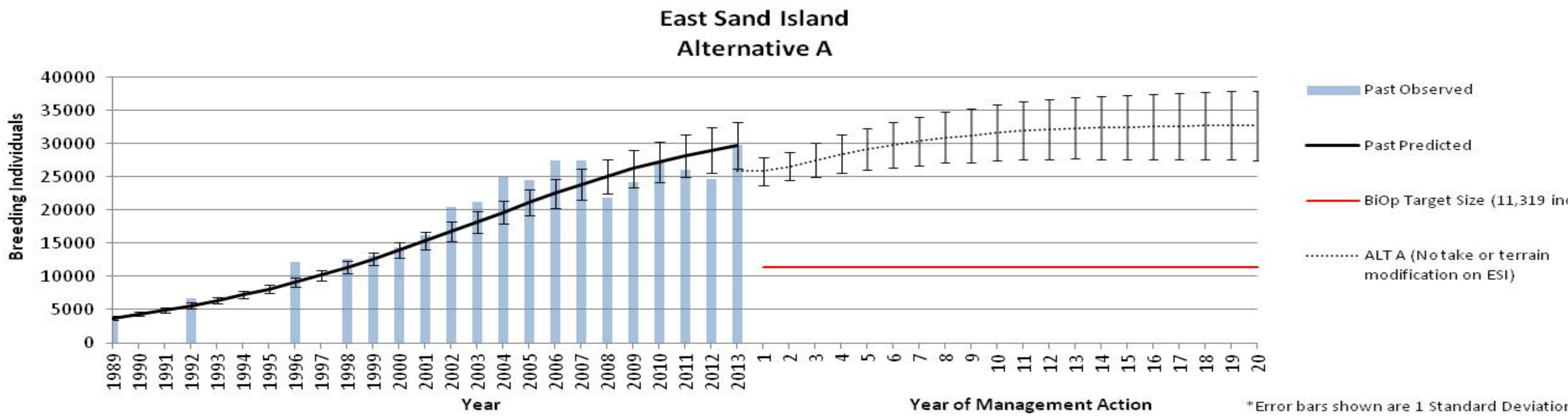
Van Der Veen, H. E. 1973. Some aspects of the breeding biology and demography of the Double-crested Cormorants (Phalacrocorax auritus) of Mandarte Island. Ph.D. thesis. Zoologisch Laboratorium der Rijksuniversiteit te Groningen, Groningen.

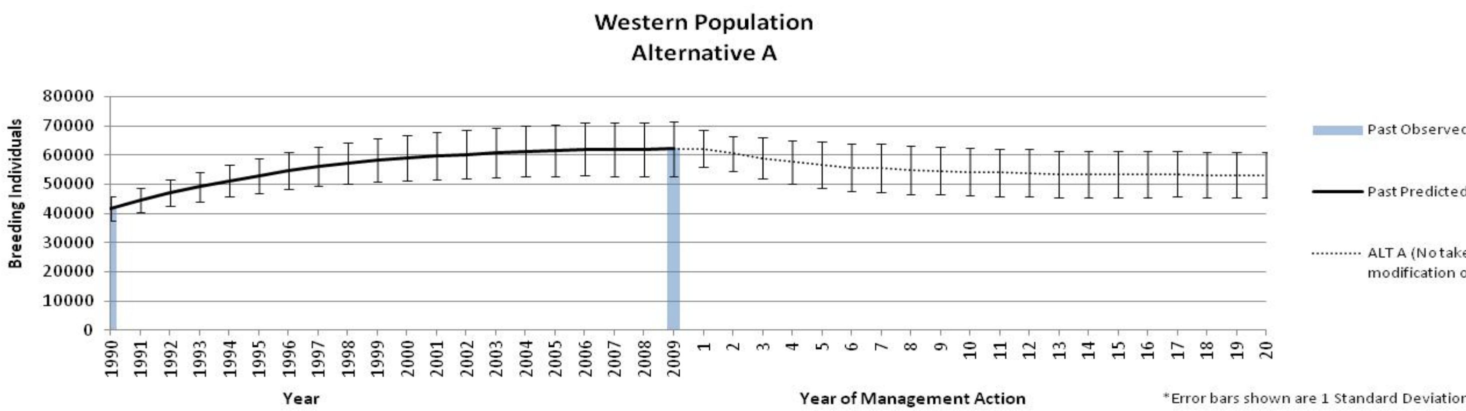
Appendix E-3: Abundance Trajectories of the Double-crested Cormorant East Sand Island Colony and the Western Population of DCCOs under EIS Alternatives

Appendix E-3 provides a graphical representation of the abundance trajectories of the DCCO East Sand Island colony and the western population of DCCOs. A brief description is included for each alternative that describes effects during each phase of implementation (Phase I and Phase II), notation when effects (thus trajectories) are similar among alternatives and modeling or other assumptions that are implicitly included or that apply to the trajectories or alternative. Details of the modeling approach for Alternatives C and C-1 are provided in Appendix E-2. The graphical representations for the other alternative are based upon the modeling approach and assumptions used for Alternative C and C-1, when applicable. Otherwise, a visual depiction is provided that approximates the ultimate effect of the alternative, as described in the FEIS.

Alternative A

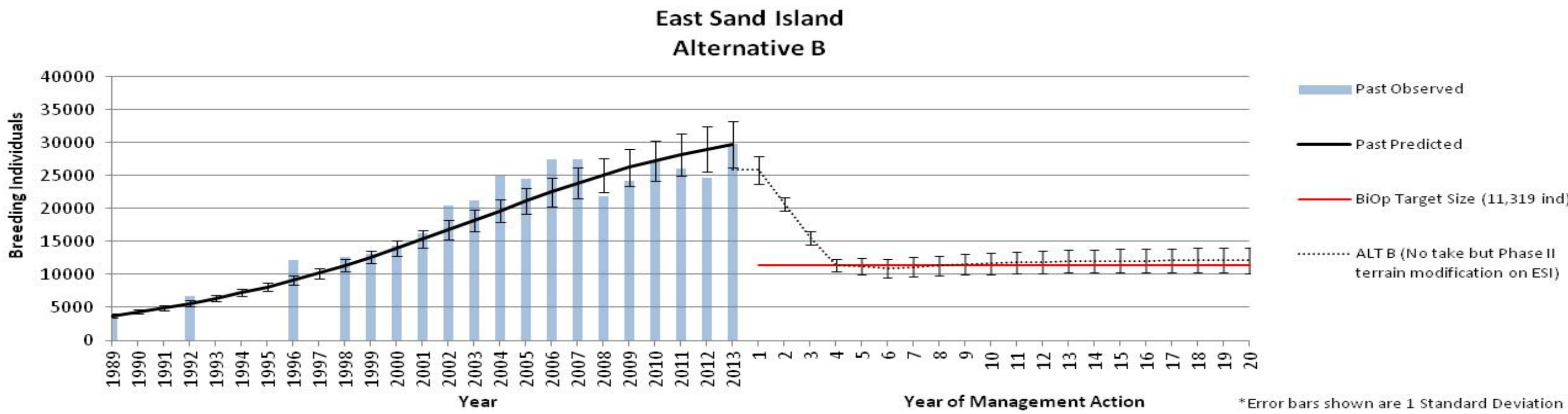
No DCCO take or terrain modification would occur on East Sand Island during Phase I or Phase II; thus, DCCO abundance would presumably remain similar to approximately 13,000 breeding pairs in the near term, but may increase slightly in the future. Western population abundance trajectories include no take on East Sand Island but the additional 936 DCCOs taken per year and a reduced carrying capacity of 7% compared to current estimated abundance (58,216 breeding individuals; b = -0.0000046579), which includes approximately half loss of the DCCO numbers associated with the Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals) but not East Sand Island habitat (62,400 – 4,184 = 58,216).

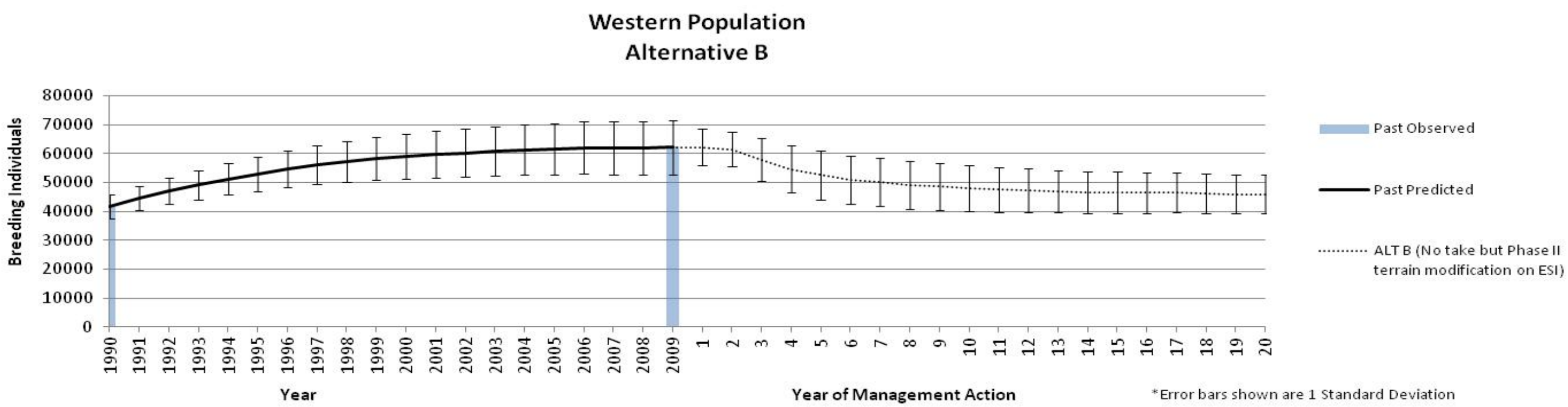




Alternative B

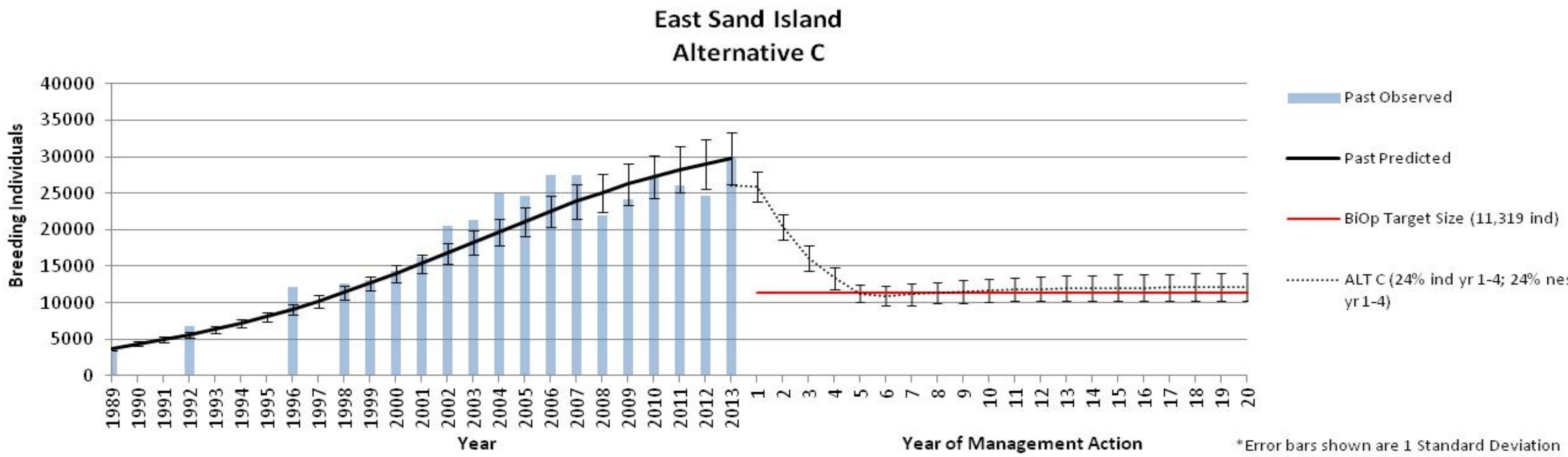
The DCCO East Sand Island colony would be reduced incrementally by approximately 4,000–6,000 breeding individuals per year using primarily non-lethal methods during Phase I to achieve the target colony size. Terrain modification would occur on East Sand Island in Phase II. Western population abundance trajectories include no take on East Sand Island but the additional 936 DCCOs taken per year and a reduced carrying capacity of 18% (same as Alternative C and C-1; half loss of the DCCO numbers associated with the Mullet Island, Salton Sea colony in 2010 [4,184 breeding individuals] and approximately half of the colony size reduction proposed on East Sand Island [7,258 breeding individuals] due to habitat loss from Phase II terrain modification; 62,400 – 4,184 – 7,258 = 50,958).

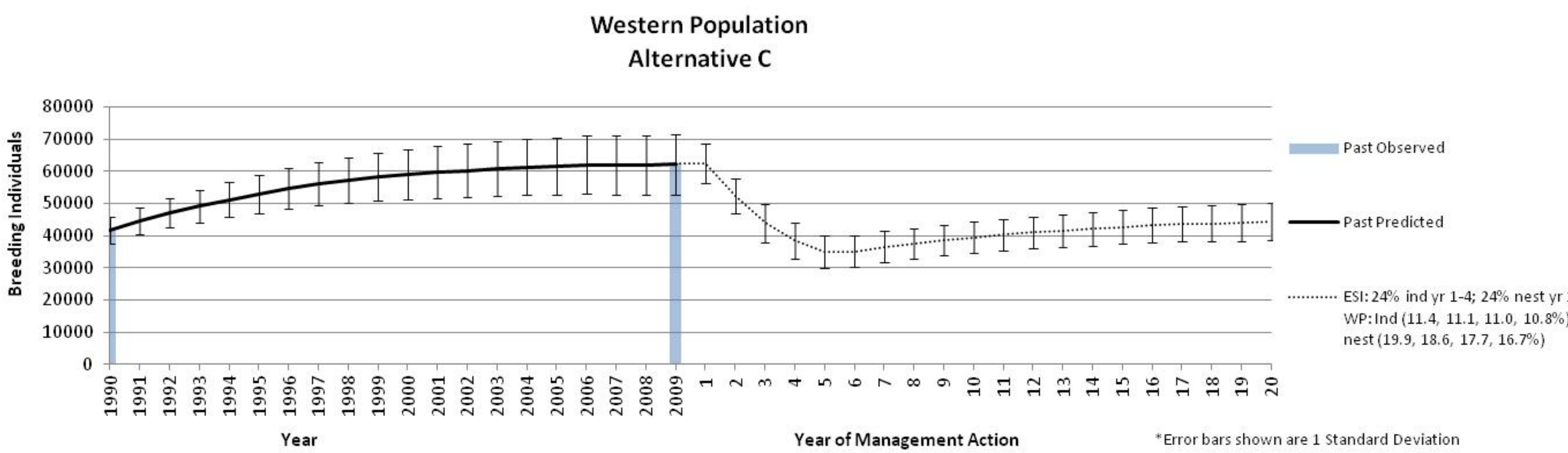




Alternative C

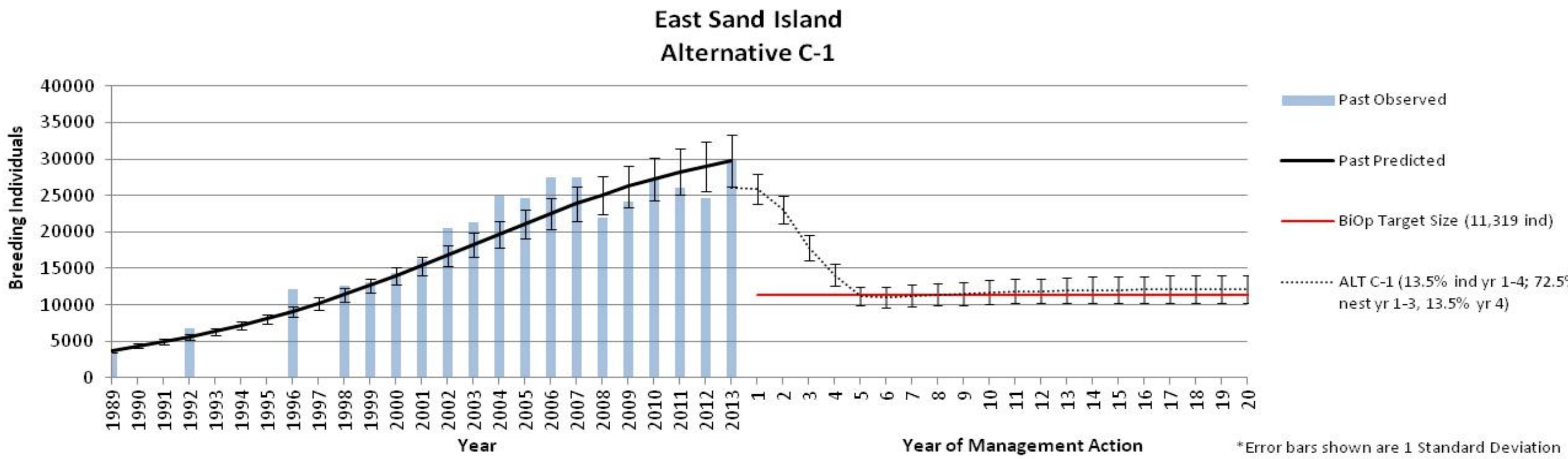
Described in Appendix E-2. The DCCO East Sand Island colony would be reduced by culling individuals during Phase I to achieve the target colony size. Terrain modification would occur on East Sand Island in Phase II. Western population abundance trajectories include take on East Sand Island plus additional 936 DCCOs taken per year and a reduced carrying capacity of 18% (same as Alternative B and C-1).

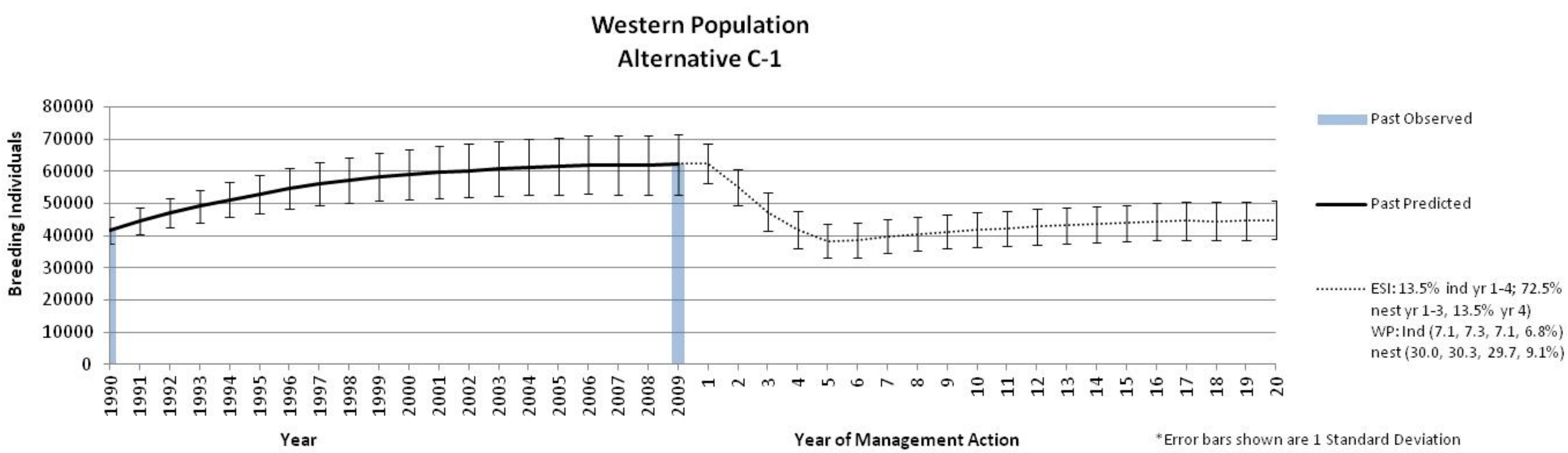




Alternative C-1

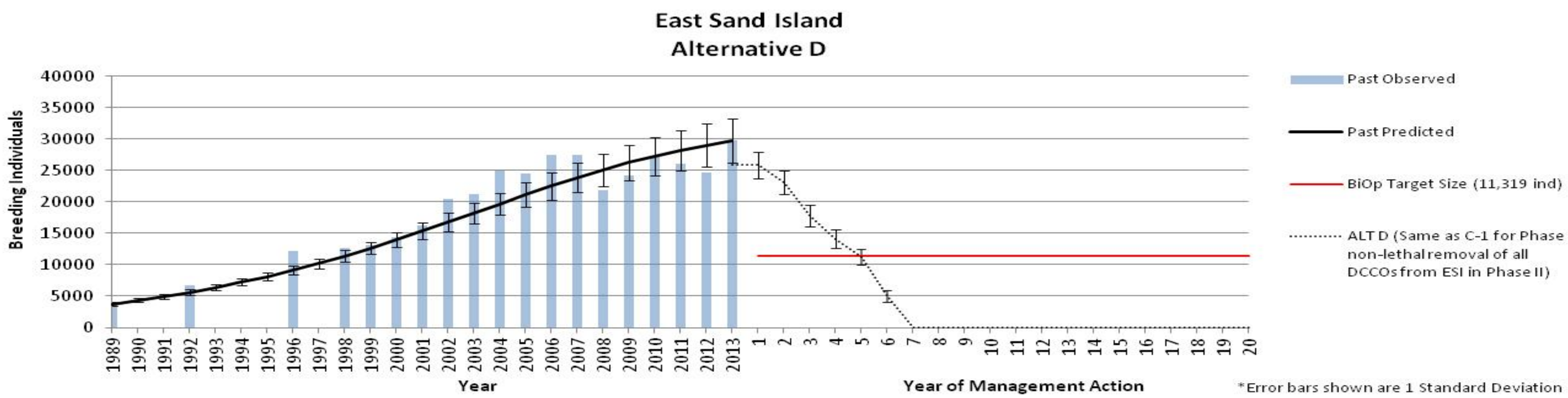
Described in Appendix E-2. The DCCO East Sand Island colony would be reduced by culling individuals and nest oiling during Phase I to achieve the target colony size. Terrain modification would occur on East Sand Island in Phase II. Western population abundance trajectories include take on East Sand Island plus additional 936 DCCOs taken per year and a reduced carrying capacity of 18% (same as Alternative B and C).

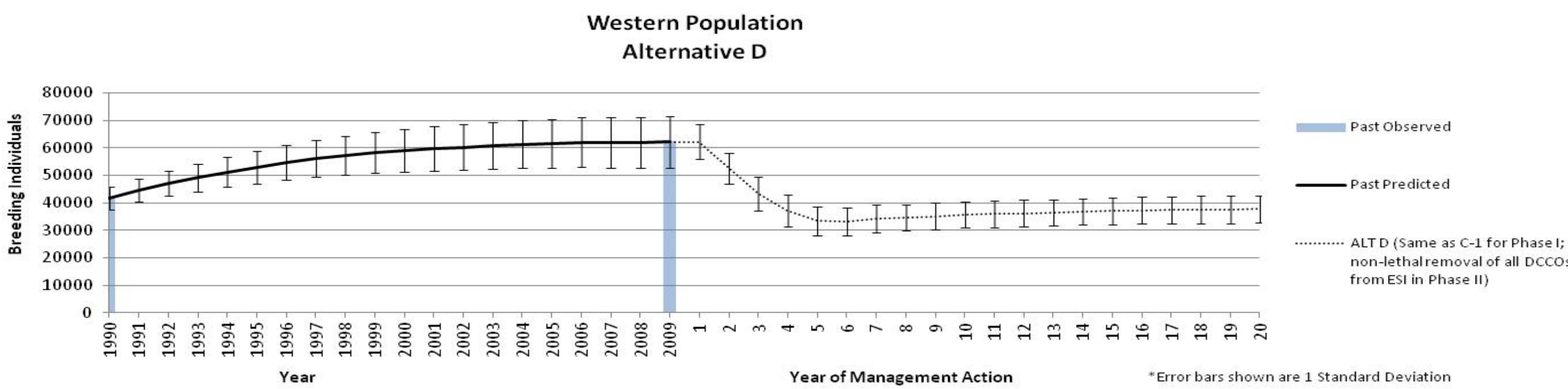




Alternative D

Same as Alternative C-1 in Phase I (i.e., culling individuals and nest oiling to achieve the target colony size). In Phase II, the remaining DCCOs would be dispersed from East Sand Island and all DCCOs would be kept from nesting there indefinitely. Western population abundance trajectories include C-1 take on East Sand Island during Phase I plus additional 936 DCCOs taken per year and a reduced carrying capacity of 30% compared to current estimated abundance (43,700 breeding individuals; *b* = -0.0000062133), which includes half loss of the DCCO numbers associated with the Mullet Island, Salton Sea colony in 2010 (4,184 breeding individuals) and all of the colony size reduction proposed on East Sand Island (14,516 breeding individuals) due to habitat loss from Phase II terrain modification and additional habitat loss from precluding all nesting (62,400 – 4,184 – 14,516 = 43,700).





Appendix F-1: Location and Size of Double-crested Cormorant Breeding Colonies in the Affected Environment

DCCO breeding colonies within the affected environment are shown in Figure F-1.1 and listed in Table F-1.1. Data came from two sources: 1) the Pacific Flyway Council (PFC) Monitoring Strategy for the western population of DCCOs (Pacific Flyway Council 2013) and 2) the status assessment of the western population of DCCOs (Adkins and Roby 2010). Active colonies were defined differently and surveys efforts and areas were not comparable between the two data sources; thus, both are provided. Pacific Flyway Council (2013) defined “active” as a breeding colony that contained ≥5 breeding pairs (BP) at least 1 time during 2008–2012. Adkins and Roby (2010) defined “active” as a breeding colony that contained ≥1 breeding pair at least 1 time during 1998–2009.

In Figure F-1.1, colonies identified as active from both data sources are shown as Pacific Flyway Council (2013) colonies. In Table F-1.1, for Pacific Flyway Council (2013) active colonies, the number of breeding pairs from the most recent survey during 2008–2012 is provided; for Adkins and Roby (2010), the maximum number of breeding pairs documented for a given year during 1998–2009 is provided. In total, 94 colonies were identified as active in both Pacific Flyway Council (2013) and Adkins and Roby (2010); in addition, there were 30 active colonies exclusive to Pacific Flyway Council (2013) and 67 active colonies exclusive to Adkins and Roby (2010). Thus, Pacific Flyway Council (2013) and Adkins and Roby (2010) identified 124 and 161 active colonies, respectively, and there were 191 active colonies in total from both sources combined.

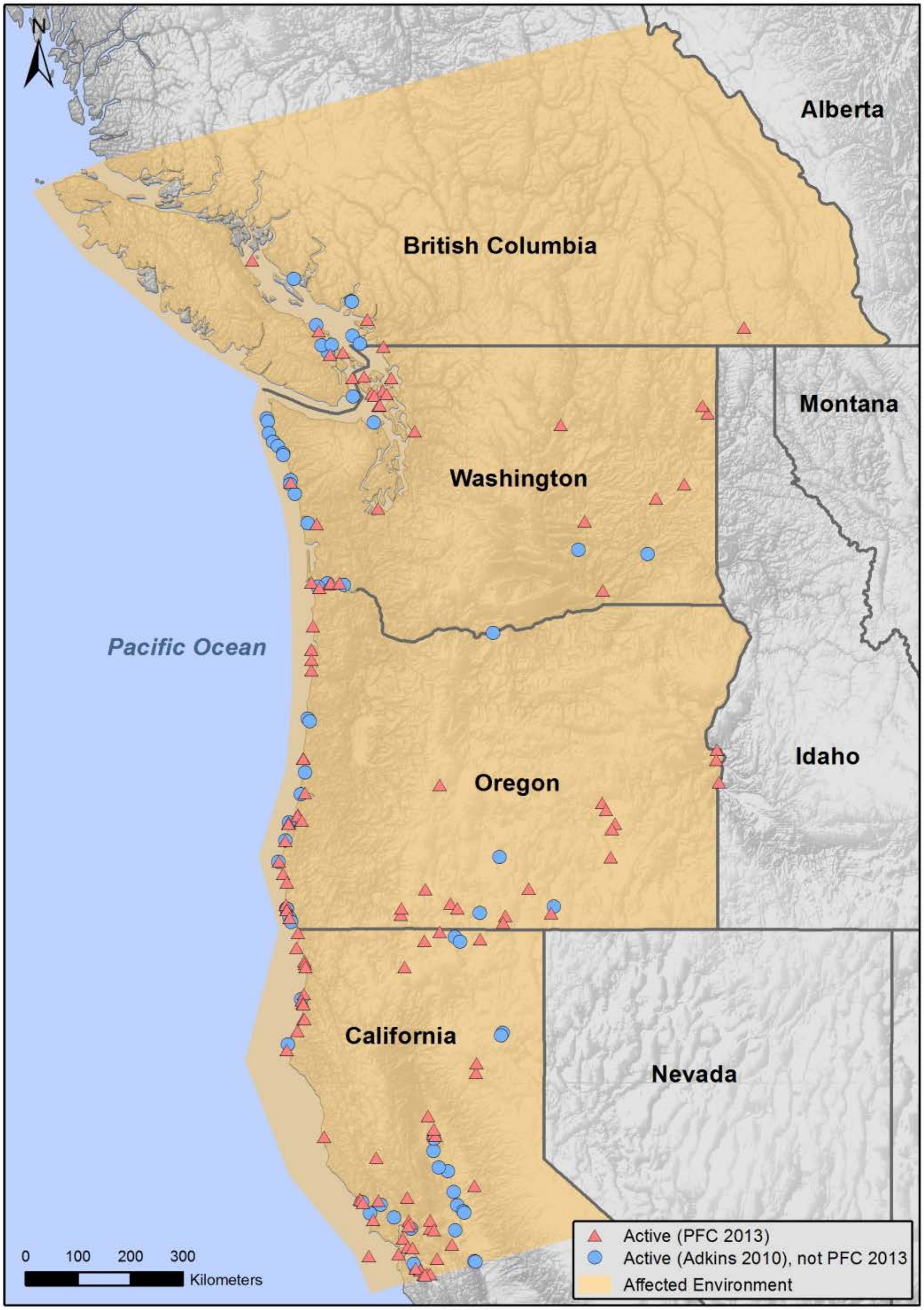


Figure F-1.1. DCCO Colonies in Affected Environment.

Table F-1.1. List of DCCO colonies in the Affected Environment.

	PFC 2013				Adkins and Roby 2010	
Colony	Active	MRS Year 2008-2012	Most Recent Survey # Breeding Pairs 2008-2012		Active	Max # Breeding Pairs 1998-2009
BRITISH COLUMBIA						
Gulf Islands						
Bare Point					X	19
Five Finger Island					X	43
Gabriola Cliffs	X	2009	43		X	95
Galiano Island cliffs	X	2009	47		X	90
Great Chain Island					X	300
Ladysmith Harbor					X	7
Mandarte Island	X	2009	143		X	225
Rose Islets					X	15
Shoal Island	X	2009	83		X	104
Interior						
Creston Valley WMA	X	2008	98		X	98
Northern Strait of Georgia						
Christie Islet					X	42
McRae Islets					X	1
Mitlenatch Island	X	2009	20		X	70
Pam Rock					X	4
Vancouver Area						
Sand Heads					X	35
Second Narrows Bridge Power Tower	X	2009	63		X	63
Westshore Terminal					X	11
CALIFORNIA						
Central Coast - Outer Coast North						
South Farallon Islands	X	2008	334		X	439
Central Coast - San Francisco Bay						
Alviso A18	X	2011	22			
Alviso Plant, Ponds A9 & A10	X	2011	130		X	75
Bair Island/Steinberger Slough Power Towers	X	2011	136		X	325
Cut off Slough (Bohannon)	X	2011	158			
Dumbarton Bridge Power Towers	X	2011	51		X	160
Greco Island Power Towers					X	62
Knight Island	X	2008	37		X	200
Lake Merced	X	2011	129		X	319
Lake Merritt	X	2011	87		X	158

	PFC 2013				Adkins and Roby 2010	
Colony	**Active**	**MRS Year 2008-2012**	**Most Recent Survey # Breeding Pairs 2008-2012**		**Active**	**Max # Breeding Pairs 1998-2009**
Moffett B2	X	2011	12			
Moffett Power Towers	X	2011	15		X	65
N. San Pablo Bay Radar Target	X	2008	15		X	15
N.E. San Pablo Bay Beacon					X	4
Richmond-San Rafael Bridge	X	2009	169		X	669
Russ Island	X	2011	33		X	38
San Francisco-Oakland Bay Bridge	X	2009	83		X	814
San Mateo Bridge & PG&E Towers					X	105
Spoonbill (Chipps Island)	X	2011	25			
Wheeler Island	X	2011	80		X	126
Interior						
American River, Mississippi Bar	X	2011	37			
Arroyo del Valle, Shadow Cliffs Park	X	2011	23		X	23
Beaver Lake					X	16
Butte Creek, Howard Slough	X	2011	5			
Butte Sink, confluence Butte Creek and Angel Slough	X	2011	100			
Butte Sink, North Butte Country Club					X	109
Butte Valley Reservoir	X	2009	11		X	24
Butte Valley WA, Meiss Lake	X	2011	35		X	84
Chiles Creek	X	2011	10			
Clear Lake	X	2011	53		X	57
Clear Lake NWR	X	2011	95		X	126
Delta Pond	X	2011	27			
Eagle Lake, island between Buck Pt. and Little Troxel Pt.					X	2
Eagle Lake, Pelican Point					X	118
Eucalyptus Island	X	2011	27			
Gray Lodge 1	X	2011	19			
Laguna de Santa Rosa					X	59
Lake Almanor, Almanor Peninsula	X	2011	15			
Lake Shastina	X	2009	41		X	41
Llanco Seco Rancho (Sac. River E)	X	2011	33		X	61
NNE Grimes (Sac. River W)					X	1
North Stone Lake, Stone Lakes NWR					X	180
Pellandini Ranch					X	38
Petaluma Waste Water Treatment Plant					X	6
Port of Sacramento					X	5
San Joaquin River NWR, Christman Island					X	34

	PFC 2013				Adkins and Roby 2010	
Colony	**Active**	**MRS Year 2008-2012**	**Most Recent Survey # Breeding Pairs 2008-2012**		**Active**	**Max # Breeding Pairs 1998-2009**
San Joaquin River NWR, Gardner's Cove					X	6
Sheepy Lake, Lower Klamath NWR	X	2011	55		X	458
Sutter Bypass West					X	12
Tule Lake NWR, Lower Sump					X	172
Tule Lake NWR, Upper Sump					X	56
Valensin Ranch, Cosumnes R. Reservoir					X	3
Venice Tip					X	9
Northern Coast - North Section						
Arcata Bay Sand Islands	X	2008	103		X	809
Big Lagoon	X	2008	42		X	42
Castle Rock	X	2008	35		X	84
False Cape Rocks					X	52
False Klamath Rock	X	2008	48		X	68
Little River Rock	X	2008	100		X	141
Old Arcata Wharf	X	2008	51		X	70
Prince Island	X	2008	220		X	323
Radar Station Rocks	X	2008	57		X	72
Sea Gull Rock	X	2008	13		X	21
Sea Lion Rock					X	20
Sugarloaf Island	X	2008	69		X	69
Teal Island	X	2008	485		X	485
Trinidad Bay Rocks	X	2008	5		X	5
White Rock	X	2008	6		X	33
Northern Coast - South Section						
Dillon Beach Rocks					X	16
Gull Rock					X	34
Hog Island	X	2011	548		X	285
Mendocino, Big River	X	2011	12			
Russian Gulch	X	2008	50		X	50
Russian River Rocks	X	2008	25		X	108
Shell-Wright Beach Rocks	X	2008	30		X	30
OREGON						
Central Coast						
Blast Rock	X	2009	12		X	50
Heceta Head	X	2012	12			
Parrot Rock	X	2009	19		X	19

Colony	PFC 2013				Adkins and Roby 2010	
	Active	MRS Year 2008-2012	Most Recent Survey # Breeding Pairs 2008-2012		Active	Max # Breeding Pairs 1998-2009
Unnamed Colony					X	4
Yaquina Bay Bridge					X	2
Columbia River Estuary						
Astoria-Megler Bridge	X	2011	60		X	24
Desdemona Sands Pilings					X	120
East Sand Island	X	2011	13045		X	13771
Miller Sands Navigational Aids	X	2009	162		X	208
Miller Sands Spit	X	2011	248		X	129
Other upper estuary Navigational Aids	X	2009	73		X	73
Rice Island					X	795
Interior						
Burns Gravel Ponds	X	2011	5			
Carlon Ranch	X	2011	7			
Crane Prairie Reservoir	X	2011	39		X	61
Crump Lake, Tern Island					X	10
Dog Lake	X	2011	15			
Drews Reservoir	X	2011	15			
Gerber Reservoir					X	6
Gosling Island, Snake River Sector, Deer Flat NWR	X	2009	25		X	25
Howard Prairie Lake	X	2011	8			
Hyatt Lake	X	2011	26			
Malheur Lake	X	2011	140		X	259
Malheur NWR, Frenchglen Area, Baca Lake	X	2011	10			
Malheur NWR, Sodhouse Ranch	X	2011	140		X	29
Pelican Lake, Pelican Island	X	2011	38		X	36
Rivers End (Lake Abert)	X	2011	11		X	16
Snake River Unnamed Island (1)	X	2009	27		X	27
Snake River Unnamed Island (2)	X	2009	63		X	63
Summer Lake, Unnamed Island					X	36
Swan Lake	X	2011	8		X	60
Upper Klamath Lake	X	2011	250		X	1270
Yonna Valley, Alkali Lake	X	2011	5			
Northern Coast						
Haystack Rock	X	2009	75		X	107
Three Arch Rocks, Finley Rock (East)	X	2009	417		X	417
Three Arch Rocks, Middle Rock (Middle)	X	2009	22		X	22
Unnamed Colony (Cape Lookout)	X	2009	128		X	132

	PFC 2013				Adkins and Roby 2010	
Colony	**Active**	**MRS Year 2008-2012**	**Most Recent Survey # Breeding Pairs 2008-2012**		**Active**	**Max # Breeding Pairs 1998-2009**
Unnamed Colony (Oswald West)	X	2009	95		X	219
Southern Coast						
Bolon Island	X	2009	763		X	763
Castle Rock	X	2009	15		X	141
Chiefs Island (Gregory Point)	X	2009	88		X	8
Coos Bay, Coos River (Chandler Bridge)	X	2011	40			
Elephant Rock					X	1
Gull Rock					X	27
Hunters Island	X	2009	222		X	297
North Crook Point Rock					X	8
Qochyax (Squaw) Island	X	2009	26		X	107
Rainbow Island					X	1
Redfish Rocks	X	2009	6		X	6
Sisters Rocks Island	X	2009	49		X	49
Siuslaw River Trees					X	144
Sunset Bay	X	2011	28			
Table Rock	X	2009	125		X	125
Unnamed Colony (Mack Reef 1)	X	2009	24		X	24
Unnamed Colony (Mack Reef 2)	X	2009	14		X	14
Unnamed Colony (OR South Unnamed Rock)					X	1
Unnamed Colony (OR Southern Coast 1)					X	163
Unnamed Colony (OR Southern Coast 2)	X	2009	56		X	145
Unnamed Colony (OR Southern Coast 3)	X	2011	183		X	183
Unnamed Colony (OR Southern Coast 4)					X	88
Whaleshead Cove (East Rock)	X	2009	17		X	17
Whaleshead Cove (West Rock)					X	17
WASHINGTON						
Columbia River Estuary						
Navigational Markers					X	70
Eastern Strait of Juan de Fuca						
Minor Island	X	2012	25			
Protection Island					X	86
Smith Island	X	2009	28		X	95
Grays Harbor						
Grays Harbor Channel Markers	X	2011	137		X	185

Colony	PFC 2013				Adkins and Roby 2010	
	Active	MRS Year 2008-2012	Most Recent Survey # Breeding Pairs 2008-2012		Active	Max # Breeding Pairs 1998-2009
Unnamed Sand Island					X	5
Interior						
Foundation Island	X	2011	318		X	359
Hanford Reach					X	8
Lions Ferry Railroad Trestle					X	2
Lower Turnbull Slough NWR	X	2012	27			
Miller Rocks					X	5
Mouth of Okanogan River	X	2011	32		X	38
North Potholes	X	2011	900		X	1156
Pend Oreille River, Kent Creek (Greggs Addition)	X	2011	14			
Pend Oreille River, Usk Bridge	X	2011	146			
Sprague Lake, Harper Island	X	2011	107		X	42
Olympic Peninsula Outer Coast						
Bodelteh Islands					X	3
Carroll Islands					X	65
Ghost Rock					X	1
Gunsight Rock					X	4
Hoh Head Mainland					X	68
Little Hogsback Island	X	2009	71		X	71
North Rock					X	31
Petrel Island (Kohchaa)					X	11
Point Grenville Islands					X	39
Tunnel Islands					X	40
White Rock (Olympic)					X	7
Willoughby Rock					X	1
Puget Sound						
Henderson Inlet, Woodard Bay	X	2012	150			
San Juan Islands						
Bird Rocks	X	2012	155		X	148
Drayton Harbor	X	2009	142		X	142
Goose Island (Cattle Pass)	X	2009	56		X	84
Gull Rock	X	2009	27			
Hall Island	X	2011	13		X	14
Snohomish River Mouth	X	2009	249		X	529
Viti Rocks	X	2012	50		X	47
Williamson Rocks	X	2010	5		X	63

Appendix F-2: Pacific Flyway Council Monitoring Strategy Data

Table F-2.1 is a partial display of data collected and contributed by State and Federal agencies in 2014 as part of the monitoring strategy for the western population of DCCOs within the Pacific Flyway (Pacific Flyway Monitoring Strategy; Pacific Flyway Council 2013). These data are preliminary and incomplete; some data are still being summarized, e.g. some aerial photographs still need to be enumerated; some data are being withheld at the request of those who collected the data, until a formal analysis under the Pacific Flyway has been completed. The data shown are those collected by federal agency personnel.

A complete synthesis will be developed into a report by the Pacific Flyway Nongame Technical Committee and submitted to the Pacific Flyway Council later in 2015. As such, these data are not yet ready to be analyzed to estimate the western breeding population of Double-crested Cormorants. Despite this caveat, these data represent a benchmark. This effort was the first time the western population has been systematically surveyed; these data demonstrate the capability and commitment of the Pacific Flyway members to achieve long-term monitoring of Double-crested Cormorants across the west. Data were also collected at over 70 colonies that were not specifically identified for monitoring in 2014 under the Pacific Flyway plan; these additional data will be incorporated into a final population analysis by the flyway.

Table F-2.1. Preliminary 2014 DCCO colony data collected as part of the Pacific Flyway Monitoring Strategy.

Location	Frame Size (Class)	Count of Nests	Source
BC			
Interior			
Creston Valley Wildlife Management Area	List (99-5)	--	
Vancouver Area			
Second Narrows Bridge Power Tower	List (99-5)	--	
CA			
Central Coast – Outer Coast North			
South Farallon Islands	List (499-100)	323	San Francisco Bay NWR Complex, USFWS
Central Coast – Outer Coast South			
San Lorenzo River Mouth	Area	--	
Central Coast – San Francisco Bay			
Alviso Plant, Pond Nos. A9 & A10	List (499-100)	275	San Francisco Bay NWR Complex, USFWS
Bair Island Power Towers (incl. Steinberger Slough)	List (499-100)	167	San Francisco Bay NWR Complex, USFWS
Interior			
Laguna de Santa Rosa	Area	--	
Lake Almanor, Almanor Peninsula	List (99-5)	0	University of California, Santa Cruz, funded by USFWS
Mullet Island, Salton Sea (So.)	List (10,000-500)	0	Sonny Bono Salton Sea NWR, USFWS
Mystic Lake	Area	--	

North Stone Lake, Stone Lakes NWR	Area	29	Stone Lakes NWR, USFWS
Northern Coast – North Section			
Arcata Bay Sand Islands	List (499-100)	--	
Big Lagoon	List (99-5)	--	
Northern Coast – South Section			
Hog Island	List (10,000-500)	771	San Francisco Bay NWR Complex, USFWS
Southern Coast			
Anacapa Island - West	List (499-100)	--	
Prince Island	List (99-5)	--	
Santa Barbara Island	List (99-5)	--	
Seal Cove Area	List (99-5)	--	
ID			
American Falls Reservoir	List (10,000-500)	--	
Bear Lake NWR	List (99-5)	93	Idaho Department of Fish and Game
Blackfoot Reservoir	List (10,000-500)	--	
Palisades Reservoir	Area	--	
MT			
East of Cont Div			
Arod Lakes	List (99-5)	22	Benton Lake NWR, USFWS
NV			
Kirch WMA	Area	--	
S-Line Reservoir	List (99-5)	--	
OR			
Central Coast			
Parrot Rock	List (99-5)	8	Oregon Coast NWR Complex, USFWS
Columbia River			
Smith and Bybee Lakes	Area	--	
Tri-Club Island	Area	--	

Umatilla NWR	Area	0	Mid-Columbia River NWR Complex, USFWS
Columbia River Mouth			
East Sand Island	List (>10,000)	13,600 (95% CI 13,300-13,900)	Oregon State University, funded by Corps of Engineers
Miller Sands Navigational Aids	List (499-100)	--	
Rice Island	Area	--	
Interior			
Malheur NWR - Frenchglen Area - Baca Lake	List (99-5)	29	Oregon State University, funded by Corps of Engineers
Rivers End (Lake Abert)	List (99-5)	--	
Northern Coast			
Unnamed Colony (Cape Lookout)	List (499-100)	207	Oregon Coast NWR Complex, USFWS
Southern Coast			
Bolon Island	List (10,000-500)	545	Oregon Coast NWR Complex, USFWS
Hunters Island	List (499-100)	121	Oregon Coast NWR Complex, USFWS
Unnamed Colony (Mack Reef)	List (99-5)	5	Oregon Coast NWR Complex, USFWS
Unnamed Colony (N of Ferry Road Park)	List (499-100)	200	Oregon Coast NWR Complex, USFWS
UT			
Great Salt Lake	List (99-5)	--	
WA			
Interior			
North Potholes Reservoir	List (10,000-500)	--	
Pend Oreille River - Sandy Shores	Area	--	
San Juan Islands			

Bird Rocks	List (499-100)	5	Washington Maritime NWR Complex, USFWS
Drayton Harbor	List (499-100)	--	

Appendix G: Summary of Double-crested Cormorant Management Feasibility Studies and Findings

The following table (Table G-1) is a listing of management feasibility studies funded by the Corps. The objective of the social attraction studies 2004-2012 and the dissuasion research (2008-2013) was to test the feasibility of potential management techniques for reducing losses of juvenile salmonids to predation by DCCOs in the Columbia River Estuary. Social attraction studies sought to determine whether habitat enhancement and social attraction techniques can be used to induce DCCO to nest at alternative colony sites outside the Columbia River Estuary where they have not previously nested and, if so, whether these techniques can be used to redistribute some of the DCCOs nesting in the Columbia River Estuary to alternative colony sites. Dissuasion research was tested to determine the feasibility of using hazing, privacy fences and nest destruction to dissuade DCCO from using a portion of their former habitat. Dissuasion research was combined with dispersal monitoring to determine locations DCCO may prospect to if habitat is restricted on East Sand Island. Summaries of study findings and applicability to larger scale management proposed in the EIS are provided.

Table G-1. Social attraction and dissuasion research 2004-2013. Data comes from Roby et al./BRNW annual reports.

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
2004	East Sand Island; 2 experimental plots (areas not previously used)	Decoys, audio playbacks of a DCCO colony, and enhanced nesting materials	Successful nesting (20 and 23 individual nests, respectively); fledglings produced (comparable rates to non-experimental plots)
	Miller Sand Spit	Experimental driftwood plot, two speakers broadcasting audio playbacks	No attempted nesting
2005	East Sand Island (in areas adjacent to previously established nesting areas)	Two elevated nesting platforms (5 x 5 m); 12 DCCO decoys and two speakers broadcasting audio playbacks	31 and 33 breeding pairs nested on platforms 1 and 2; productivity slightly higher on the nesting platforms than elsewhere on the East Sand Island
	Miller Sand Spit	24 DCCO decoys; 25 old tires with small sticks as nesting material; two speakers broadcasting audio playbacks	21 nests were partially or completely built, and six eggs were laid in four nests; site abandoned and no fledglings produced.
	Trestle Bay	26 decoys, 24 old tires, and two speakers broadcasting audio playbacks	No attempted nesting
2006	East Sand Island, 6	Four plots of elevated wooden platforms (5 m x 5 m), and two	31 to 39 breeding pairs nested in each

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
	experimental plots	ground plots (5 m x 5 m). Three types of treatments: (1) decoys, audio playbacks, and tires on the ground; (2) decoys, audio playbacks, and tires on elevated platforms, and (3) tires only on elevated platforms. Thirty-six truck and car tires were placed in each experimental plot. Each tire was filled with either old DCCO nest material or fine woody debris.	experimental plot; productivity was similar in the experimental plots compared with elsewhere on the East Sand Island
	Miller Sands Spit	41 decoys and 36 truck and car tires; four speakers broadcasting audio playbacks	41 nesting pairs; chicks successfully fledged
	Rice Island	36 truck and car tires, 40 decoys and two audio playback systems	35 nesting pairs; chicks successfully fledged
2007[14]	East Sand Island, 6 experimental plots	Same as 2006 (above)	33 to 34 breeding pairs nested in each experimental plot; productivity was similar in the experimental plots compared with elsewhere on East Sand Island
	Miler Sands Spit	40 decoys, 36 truck and car tires filled with nesting material, and four speakers broadcasting audio recordings	90 nesting pairs; chicks successfully fledged
	Rice Island	No social attraction techniques (nesting at Rice Island prior year from social attraction)	No nesting
	Foundation Island	Elevated platform, covered with sand; 30 old tires filled with fine woody debris, decoys and two audio playback systems	No nesting
	Fern Ridge	Floating platform with 48 old tires with sticks and other fine woody debris; 40 hand-painted DCCO decoys; 2 audio playback systems, each with 2 speakers, along with the solar panels and deep cycle batteries	No nesting
2008[15]	Miler Sands Spit	40 decoys, 36 truck and car tires filled with nesting material, and four speakers broadcasting audio recordings	129 nesting pairs; plot abandoned; no fledglings produced
	Foundation Island	Elevated platform, covered with sand; 30 old tires filled with fine	No nesting

[14] Social attraction techniques first applied outside of Columbia River Estuary

[15] Beginning of dissuasion experiments on East Sand Island.

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
		woody debris, decoys and two audio playback systems	
	Fern Ridge	Floating platform with 48 old tires with sticks and other fine woody debris; 40 hand-painted DCCO decoys; 2 audio playback systems, each with 2 speakers, along with the solar panels and deep cycle batteries	No nesting
	East Sand Island	Investigated two techniques for discouraging nesting by DCCO on parts of their breeding colony at East Sand Island during the 2008 nesting season: (1) human disturbance on a discrete portion of the breeding colony, prior to the onset of egg-laying by DCCOs, and (2) hazing with a green laser on DCCOs that were roosting on beaches adjacent to the breeding colony. Prior to the initiation of breeding, a visual barrier (a fence of black plastic fabric, 1.5-m tall) was erected to isolate a small section of the DCCO breeding colony at the eastern-most end of the colony. An above-ground tunnel was built prior to the nesting season to allow researcher access to this treatment area of the colony without detection by nesting DCCOs. Seventeen tests using the green laser were completed in 2008. Researchers attempted to haze roosting DCCOs daily and to vary the time of day, weather, distance to target birds, and light conditions under which the laser was tested.	Both of the disturbance measures tested in 2008 were effective at flushing DCCOs, however, each was initiated too late in the nesting cycle to determine efficacy to deter nest initiation and egg-laying. Disturbances lasting longer than 10 minutes kept DCCOs out of the treatment area for greater than 10 minutes. Additionally, when disturbances were repeated immediately after DCCOs returned to the treatment area, the length of time the birds remained off of the treatment part of the colony increased. These results suggest that to preclude egg-laying by DCCOs during the late pre-laying stage, the magnitude of disturbance (i.e., duration and/or frequency) would need to be much higher than was employed in this pilot study; (i.e., > 15 minutes/day or > 2 events/day).
2009	Miller Sands Spit	No social attraction techniques (nesting at Miller Sands Spit prior year from social attraction)	No nesting
	Foundation Island	Elevated platform, covered with sand; 30 old tires filled with fine woody debris, decoys and two audio playback systems	No nesting
	Fern Ridge	Floating platform with 48 old tires with sticks and other fine woody debris; 38 hand-painted DCCO decoys; 2 audio playback systems, each with 2 speakers, along with the solar panels and deep cycle batteries	No nesting

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
	East Sand Island	Repeated the 2008 tests of the efficacy of two active nest dissuasion techniques, human disturbance and hazing with a green laser, and added tests of a third technique in the form of habitat modification. This prospective habitat modification technique consisted of covering a discrete area (80 m2) previously used by nesting DCCOs with pond liner. An observation blind was built at the terminus of an above-ground tunnel, allowing researchers to access the colony without disturbance to nesting DCCOs.	Both of the active disturbance techniques tested were effective at flushing DCCOs, but ultimately failed to prevent nesting in the treatment areas. Human disturbance appeared to be an effective option for deterring DCCOs from nesting on part of the colony, if frequency and intensity of disturbances could be increased. Although time and resources might limit this method as a cost-effective management strategy for selective dissuasion of nesting DCCOs, cost per unit area dissuaded would be expected to decrease as the treatment area for dissuasion is increased. No nesting by any species was observed on the pond liner.
2010	Dutchy Lake Summer Lake Wildlife Area	Floating platform about 30 feet long by 15 feet wide; 54 old tires with sticks and other fine woody debris; 31 hand-painted decoys; two audio playback systems, each with two speakers with the solar panels and deep cycle batteries; tires were painted white to simulate DCCO excrement and make the platform more attractive	No nesting
	East Sand Island	The pond liner dissuasion technique was tested again on a larger area of the DCCO colony. Using the original dissuasion area from 2009, the 2010 pond liner treatment was expanded to the west to encompass 315 square meters of the rip-rap nesting habitat. The pond liner was installed using the same methods as in 2009. Installation was completed in early April, before DCCO arrived on the island to nest.	Approximately 348 nests were excluded from the 2010 pond liner dissuasion area, compared to 80 nests in 2009. High cost, difficulty of deployment, and durability were all problems with this method. Scaling up the method, would require an estimated cost of over $27,000 per acre for pond liner material alone excluding transportation and maintenance costs. Maintenance and replacement costs were estimated to be large and would need to occur annually. The 50’ x 100’ sheets noted above weigh 1,550 lbs. each.

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
2011	Dutchy Lake in Summer Lake Wildlife Area	Floating platform about 30 feet long by 15 feet wide; 52 old tires with sticks and other fine woody debris; 20 hand-painted decoys; two audio playback systems, each with two speakers with the solar panels and deep cycle batteries; tires were painted white to simulate DCCO excrement and make the platform more attractive	No nesting
	Tule Lake Sump 1B	36 old tires, 40 hand-painted adult decoys; 34 chick decoys; two audio playback systems with two speakers and associated solar panels and batteries	No nesting
	East Sand Island [16]	**Hazing and Habitat Reduction-** Tested the feasibility of techniques to dissuade DCCO from nesting on a portion of the East Sand Island colony. By design, available habitat was not reduced or hazing increased to such a level to intentionally reduce overall colony size. A 2.4-m high by 65-m long privacy fence was erected across the DCCO colony and an attempt was made to prevent DCCOs from nesting on the east side of the fence, while minimizing the disturbance to DCCO nesting west of the visual barrier. Several techniques for dissuading DCCO from nesting on the east side of the privacy fence were investigated, including human disturbance, destruction of DCCO nest structures, and experimentation with a moving coyote (*Canis latrans*) effigy (artificial coyote on a zip-line). Reflective polyester tape was also evaluated as a method to dissuade DCCOs from nesting in or near three small trees (< 2 m height) on the East Sand Island colony. **Dispersal Monitoring-**To evaluate the effectiveness of dissuasion efforts and to determine whether hazed DCCO left East Sand Island, 91 DCCOs were captured and marked in the dissuasion treatment area during 26 - 28 April, shortly after their arrival on this part of the colony. All 91 DCCOs were banded with a federal numbered metal leg band on one leg and a field-readable plastic leg band engraved	Available DCCO nesting habitat reduced by 6%. Since 2008 several techniques have been tested to discourage nesting by DCCOs: human disturbance (2008-2009, 2011), destruction of nest structures prior to egg-laying (2011), pond liner installation (2009-2010), laser hazing (2008-2009), and reflective tape (2011). Of these techniques, only human disturbance in concert with nest destruction and a large visual barrier has been a feasible means to prevent DCCO nesting in a pre-determined treatment area of the East Sand Island DCCO colony. Detections of radio-tagged DCCOs and observations of banded DCCOs displaced from the dissuasion treatment area suggested that the vast majority of DCCOs hazed in the treatment area relocated west of the visual barrier and resumed nest initiation activities in 2011. Human disturbance was determined to be a viable

[16] Beginning of hazing and habitat reductions on East Sand Island (see Figure G-1).

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
		with a unique alphanumeric code on the other. Of the 91 banded DCCOs, 60 were also tagged with a VHF radio transmitter.	option for effectively preventing DCCO nesting on part of the colony, but requires significant infrastructure and labor-intensive hazing and monitoring on a daily basis.
2012	Tule Lake Sump 1B	30 old tires, 22 hand-painted adult decoys; 34 chick decoys; two audio playback systems with two speakers and associated solar panels and batteries	No nesting
	Malheur Lake NWR	32 old tires filled with nesting material; 40 hand-painted adult decoys; two audio playback systems with 2 outdoor speakers and a solar panel	No nesting.
	East Sand Island	**Hazing & Habitat Reduction** Repeated and expanded efforts to test the feasibility of techniques to dissuade DCCOs from nesting on a portion of their breeding colony on East Sand Island. A privacy fence (2.4 m high by 25 m long) was erected across the DCCO colony and an attempt was made to prevent DCCOs from nesting to the east of the fence, while minimizing the disturbance to DCCOs nesting to the west of the fence. Two techniques to dissuade DCCOs from nesting on the east side of the privacy fence were investigated in concert: human disturbance and destruction of existing DCCO nests (i.e., scattering of sticks used to form nests using rakes or other implements). **Dispersal Monitoring-**To evaluate where displaced DCCOs might prospect for alternative nest sites if they left the East Sand Island colony, 149 adult DCCOs were captured and marked in the treatment area during 20 -28 April, shortly after their arrival on that part of the colony. All captured DCCOs were banded with a federal numbered metal leg band on one leg and a field-readable plastic leg band engraved with a unique alphanumeric code on the other. Of the 149 banded DCCOs, 12 were fitted with satellite transmitters and 126 were fitted with VHF radio transmitters. The satellite tags were programmed to collect nighttime roost locations every other night	Available nesting habitat for DCCO was reduced by 31%. Compared to the pilot study conducted in 2011, however, DCCO dissuasion activities across a much large area in 2012 required significant additional effort. DCCOs continued to initiate nests in the treatment area for up to eight weeks following the onset of hazing, compared to less than three weeks in 2011. The only evidence of permanent emigration from East Sand Island was the persistent detection of two VHF radio-tagged DCCOs on the Astoria-Megler Bridge. The general pattern of aborted dispersal trips and subsequent high return rates to East Sand Island suggests that DCCOs may display high colony site fidelity if resource managers decide to permanently reduce available DCCO nesting habitat in the future. To induce prolonged prospecting or permanent emigration from the Columbia River estuary, it may be necessary to further restrict

Year	Location	Description of Social Attraction and Dissuasion Experiments	Outcome
		for ca. 50 days, and then once a week for the remainder of their expected battery life of 14 months.	nesting habitat on East Sand Island and prevent greater use of alternative nesting sites within the estuary (e.g., the Astoria-Megler Bridge).
2013	East Sand Island	**Hazing & Habitat Reduction** Repeated and expanded 2012 efforts to test the feasibility of techniques to dissuade DCCOs from nesting on a portion of their breeding colony on East Sand Island and marked individual DCCOs. Acreage was restricted to 4 acres. **Dispersal Monitoring-** To evaluate where displaced DCCOs might prospect for alternative nest sites if they left the East Sand Island colony, 109 adult DCCOs were captured and marked in the dissuasion area during 12 - 16 April, shortly after their arrival in that part of the colony. Of the 109 banded DCCOs 83 were fitted with satellite transmitters and 26 only received bands. The satellite tags were programmed to collect nighttime roost locations every night or every other night through July, then once a week from August through March, before switching back to the more frequent cycle in April.	Available nesting habitat reduced by 75% but did not preclude the DCCO colony from nesting in remaining acreage (4 acres). DCCO colony in 2013 (14,916 breeding pairs) was a 21% increase from 2012 colony size (12,300 breeding pairs). To induce DCCOs to permanently emigrate from the Columbia River estuary, it may be necessary to further restrict nesting habitat on East Sand Island and prevent greater use of alternative nesting sites within the estuary (e.g., the Astoria-Megler Bridge).

Summaries of Study Findings

Social Attraction (2004–2012) – Social attraction research showed success at promoting DCCOs to nest in new areas on East Sand Island. In the Columbia River Estuary, social attraction techniques were successful at promoting nesting at Miller Sands Spit and Rice Island, but not at Trestle Bay. At Miller Sands Spit successful production of fledglings occurred in 2 of 4 years DCCO nesting was attempted. Without continued implementation of social attraction techniques (i.e., annual management), continued DCCO nesting at both Miller Sands Spit and Rice Island did not persist. During 2007–2012, social attraction techniques were attempted at 5 independent sites (i.e., 11 annual trials in total) outside of the Columbia River Estuary and no DCCO nesting was recorded at any site during any year from these efforts (Table G-1).

The Corps also has experience employing large scale hazing and social attraction as a method to resolve depredation damage from the largest colony of Caspian terns also located on East Sand Island (USFWS 2005, Roby et al. 2013). Alternative Caspian tern nesting sites have shown limited or no success in maintaining viable breeding Caspian tern colonies, particularly without continued annual predator management and/or need of water control management in interior sites. Based on DCCO research results and experience implementing the Caspian tern management plan, even less success would be expected from trying these techniques on DCCOs. When social attraction was first being explored, initial research findings suggested, "While studies of the use of habitat enhancement and social attraction in the Columbia River estuary have been promising, results to date indicate that DCCOs are not as responsive to these techniques as Caspian terns" (2007 Roby et al./BRNW annual report, pg 7).

Management Feasibility Studies (Human Hazing and Habitat Modification) on East Sand Island (2007–2013) and Dispersal Monitoring (2008–2013) – In 2007, the Corps initiated studies to investigate certain non-lethal methods to dissuade DCCOs from nesting in specific locations on East Sand Island. Methods tested to date include human disturbance (2008–2009 and 2011–2013), removal of nest structures prior to egg-laying (2011–2013), pond-liner material placed over nesting substrate (2009–2010), hazing using lasers (2008–2009), erection of potential perches for bald eagles (2007), placement of low (1.2m tall) silt fencing (2007), and reflective tape placed in nesting trees (BRNW 2013a). During the 2011–2013 nesting seasons, studies were conducted to test the use of privacy fences and targeted human disturbance prior to egg-laying to reduce the amount of available nesting habitat for DCCOs on East Sand Island, which consists of approximately 16 acres on the western half of the island (Figure G-1). The use of privacy fences and human disturbance during the 2011-2013 nesting seasons was effective in deterring DCCOs from breeding within the designated nest dissuasion areas (see Figure G-2). These techniques reduced the available nesting habitat during the breeding season by approximately 6 percent in 2011, 31 percent in 2012, and 75 percent in 2013 (Table G-2; Roby et al. 2014). Between 2008-2013 at East Sand Island, a total of 1,961 DCCOs (816 adults during 2010-2013 and 1,145 chicks during 2008-2013) were marked with field-readable color bands and 147 satellite tags (16 in 2008; 36 in 2009; 12 in 2012; 83 in 2013) and 186 VHF tags (60 in 2011; 126 in 2012) were deployed.

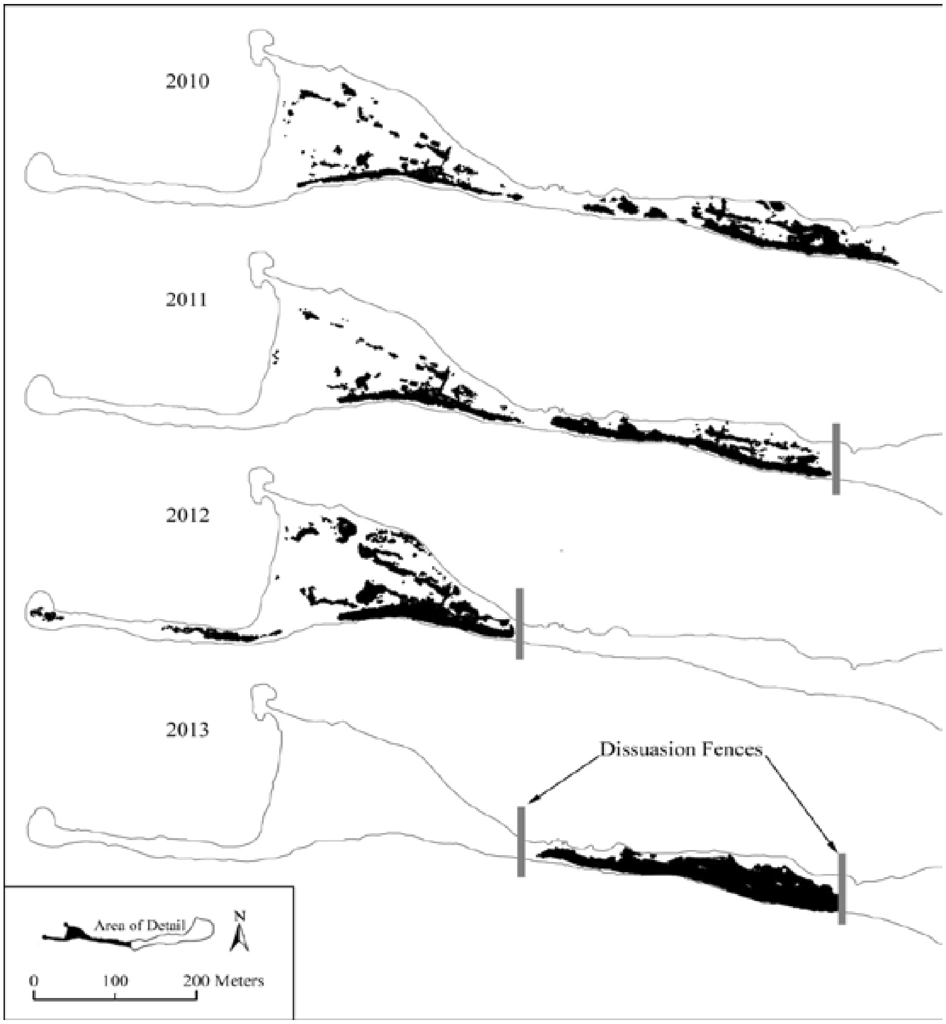


FIGURE G-1. Distribution of DCCO nests (black shading) on the western half of East Sand Island during 2010-2013 and locations of privacy (visual barrier) fences (grey bars) erected across the island during 2011-2013.

TABLE G-2. Summary of DCCO habitat restriction experiments on the west end of East Sand Island during 2011-2013. Note: "available habitat" is defined as any upland area above prevailing high tide, irrespective of substrate type, drainage, or other factors that may influence habitat suitability for DCCO nesting.

Year	Available Colony Area (acres)	Dissuaded Habitat (acres)	Actually Available Habitat (acres)	% of Potentially Available Habitat Dissuaded	Colony Area Used (acres)	Available Colony Area as % of Mean Unrestricted Area Used	Nesting DCCOs (number of breeding pairs)	Nesting DCCOs as % of Unmanaged Colony Size
Pre-dissuasion research (2004-2010)	16	0	16	0%	2.4 - 4.2 Mean=2.9	NA	10,950-13,800 Mean=12,700	NA
2011	15	1	15	6%	2.8	520% (15/2.9)	13,000	103% (13,000/12,700)
2012	11	5	11	31%	2.5	380% (11/2.9)	12,300	97% (12,300/12.700)
2013	4	12	4	75%	3.1[a]	140% (4/2.9)	14,900	117% (14,900/12.700)

[a] The 2013 estimate of DCCO nesting habitat used includes habitat used by Brandt's cormorants nesting amongst DCCOs (earlier estimates are for area used by DCCO only). Brandt's cormorants were ~8% of the total cormorant nest count at the time when nesting habitat used was estimated.

In 2011, an initial small-scale dissuasion experiment was conducted to test whether a visual barrier (i.e., privacy fence) and dissuasion could successfully restrict nesting habitat at any scale, without causing widespread nesting failure. An eight-foot tall privacy fence was constructed before the 2011 nesting season at the east end of the area used in 2010 by nesting DCCOs, cutting off approximately 1 acre of previously used habitat, in which ~15% of DCCOs had nested in 2010. Most of the area used for nesting in this acre of available habitat had been used for only 1-2 years prior to 2011. Human hazing was conducted east of the privacy fence whenever DCCOs were present in the area and displayed pre-nesting behaviors. Hazing primarily consisted of researchers emerging from portable buildings (Weatherports) and making themselves visible to DCCOs in the dissuasion area, which caused those birds to flush and leave that portion of the island. Sixty DCCO were VHF tagged. A number of potential unknowns were addressed in 2011:

- Sufficient hazing effort could be maintained by a small crew (1-3 people continuously present) to minimize DCCO presence in the dissuasion area and prevent DCCOs from nesting there. Hazing could be conducted frequently enough to avoid significant numbers of DCCO eggs from being laid in the dissuasion area, thus minimizing the need for potentially large numbers of eggs being collected to support the dissuasion effort.
- Hazing could be conducted on one side of the visual barrier (privacy fence) without disturbing nesting DCCOs immediately on the other side. Privacy fencing and hazing could experimentally restrict habitat without causing a large-scale perturbation to the entire colony or colony abandonment.
- Hazing impacted the distribution of California brown pelicans roosting on East Sand Island during the hazing period, but appeared to have no significant effect on the numbers of pelicans using the island as a whole and did not prevent California brown pelicans from using the DCCO dissuasion area once seasonal hazing activities were completed.
- Brandt's cormorants nesting on the west side of the privacy fence were not affected by hazing on the east side.
- Gulls quickly acclimated to human presence and hazing, and successfully nested in the DCCO dissuasion area.
- Sufficient numbers of DCCOs (91 individuals captured in 2011; 60 DCCOs radio-tagged) could be captured in the dissuasion area to investigate individual-level responses to dissuasion.
- Tagged individuals often departed East Sand Island soon after capture and were absent for days or weeks. Nearly all tagged DCCOs, however, eventually returned to East Sand Island and appeared to attempt to nest in areas of the DCCO colony outside of the dissuasion area (Figure G-3).
- There was not a clear relationship between the frequency of hazing events in the dissuasion area and attendance of the radio-tagged DCCOs (Figure G-3). In particular,

days with frequent hazing were not associated with lower colony attendance by the tagged DCCOs. Capture and handling before the nesting period appeared more likely than hazing to have induced departures from East Sand Island, at least for the radio-tagged individuals, when ample unoccupied DCCO nesting habitat (15 acres) was still available at East Sand Island.

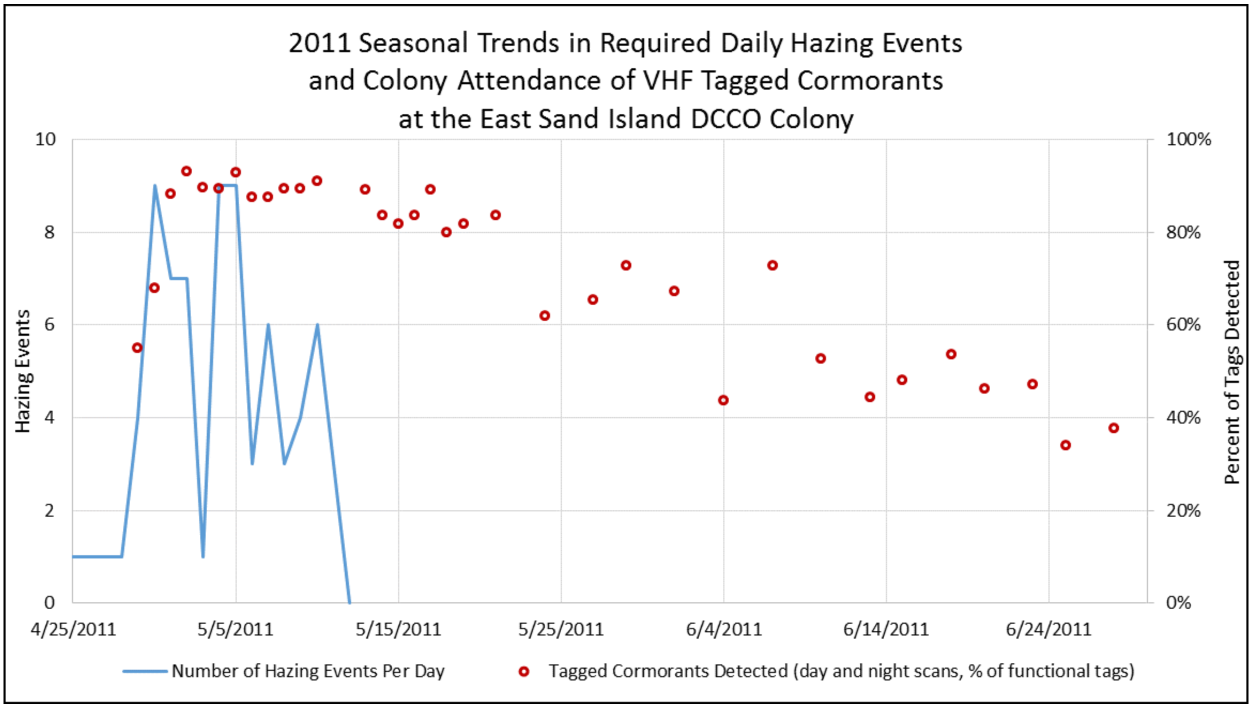


FIGURE G-2. Required daily hazing events and attendance of radio-tagged DCCOs during dissuasion experiments conducted at the East Sand Island DCCO colony during 2011. Detections of tagged DCCOs are expressed as the percentage of known active radio tags detected each day during one or more scans. Tag detections declined across the season for multiple reasons, including nest failure and subsequent dispersal, tag battery failure, and DCCOs shedding tags away from East Sand Island.

In 2012, a larger-scale dissuasion experiment than 2011 (Table G-2; Figure G-1) was conducted to further test dissuasion methods and to investigate where DCCOs might prospect for nest sites during departures from the East Sand Island colony early in the nesting season. Approximately 5 acres of previously used habitat, in which ~60% of DCCOs had nested in 2010, were restricted from use, including displacement from nest sites with a decade of consistent use and consistent occupancy early in the nesting season. DCCOs were tagged with VHF radio tags (n = 126) and satellite-tracked telemetry tags (n = 12). This tagging effort offered both the ability to track attendance of DCCOs at the East Sand Island colony, as had been done in 2011, and the identification of locations where DCCOs might prospect for alternative nesting opportunities during departures from East Sand Island. Prior to 2012, no information was available on where DCCOs from East Sand Island might prospect for nesting opportunities during the nest initiation period (April–June). The small sample of satellite telemetry tags offered data collection unhindered by tracking survey design; the larger sample of VHF radio telemetry tags offered more representative sampling of the colony as a whole, but the data that were collected was limited by the number and geographic coverage of aerial surveys conducted to relocate radio-tagged DCCOs. One to three surveys were conducted in all areas of Washington and Oregon known to have DCCO nesting or roosting. Findings of the 2012 DCCO dissuasion experiment and tracking studies were:

- Hazing could be successfully executed across a large area of the East Sand Island colony (5 acres), when greater than half of all DCCOs were displaced from their previous years' nest site and displaced from some of the apparently most preferred nesting habitat (as indicated by continuous use and consistent early occupancy). Hazing was required for a substantially longer period of the nesting season, however, compared to 2011 (Figure G-3).
- Impacts to non-target species (Brandt's cormorants, California brown pelicans, gulls) could be minimal, even with a much higher level of hazing activity.
- During early season departures from East Sand Island, tagged DCCOs were observed to utilize many sites including elsewhere in the lower Columbia River and estuary, coastal Washington (both Puget Sound and the outer coast), and coastal British Columbia (see Table G-3). No detections were confirmed east of Bonneville Dam or on the coast of Oregon south of Cannon Beach, Oregon.
- As in 2011, there was not a clear relationship between the frequency of hazing events in the dissuasion area and attendance of the tagged DCCOs (Figure G-4). In particular, days with frequent hazing were not associated with lower colony attendance by the tagged DCCOs. Capture and handling appeared more likely than hazing to induce departures from East Sand Island, at least for the tagged individuals, when ample unoccupied DCCO nesting habitat (11 acres) was still available at East Sand Island.

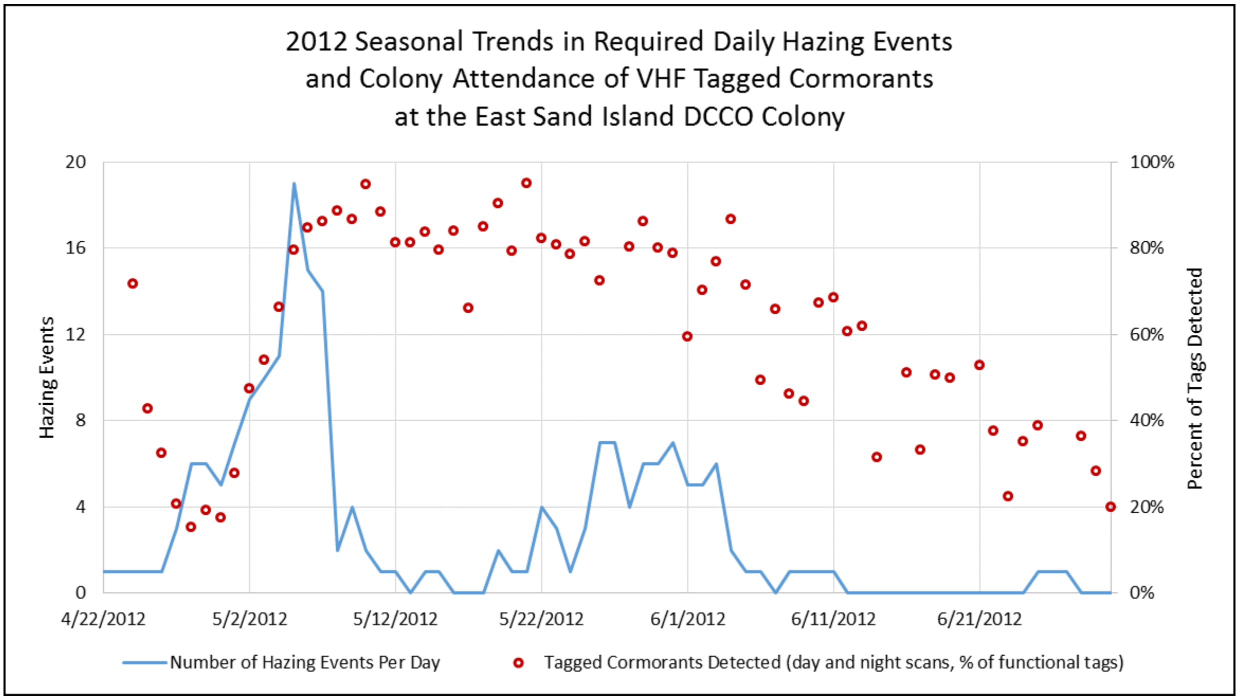


FIGURE G-3. Required daily hazing events and attendance of radio-tagged DCCOs during dissuasion experiments conducted at the East Sand Island DCCO colony during 2012. Detections of tagged DCCOs are expressed as the percentage of known active tags detected each day during one or more scans. Tag detections declined across the season for multiple reasons, including nest failure and subsequent dispersal, tag battery failure, and DCCOs shedding tags away from East Sand Island.

In 2013, a larger-scale dissuasion experiment than 2012 (Table G-2; Figure G-1) was conducted to identify the relative use of habitat away from East Sand Island by DCCOs departing the island, as well as to test dissuasion on a scale approaching what might be required to reduce the colony area to below historical levels. Approximately 12 acres of previously used habitat were restricted from use, which was 40 percent more area of nesting habitat than had historically been used in 2004–2010 but a marked decrease in available nesting habitat compared to dissuasion experiments in 2011 and 2012 when 420% and 280% more habitat was available than historically used. For the first time, dissuasion was conducted on both sides of the allowed nesting area and (2) all DCCOs were displaced from nesting sites that were used during the previous year in 2012 (see Figure G-1). Eighty-three DCCOs were marked with satellite tags. Tracking the large sample of satellite-tagged DCCOs offered the potential to evaluate relative use of sites away from East Sand Island using an apparently representative sample of DCCOs nesting at East Sand Island. Findings of the 2013 dissuasion experiment and tracking studies were:

- Hazing could be successfully executed across a management-scale area (11 acres), even when all DCCOs were displaced from their previous years' nest sites. Hazing could be conducted on both sides of a small colony area (4 acres) without impacting DCCOs nesting between the two privacy fences (dissuasion areas).

- Impacts to non-target species (Brandt's cormorants, California brown pelicans, gulls) could be minimal, even with this expanded area of hazing activity.
- During early season departures from East Sand Island, satellite-tagged DCCOs were most often tracked to sites elsewhere in the Lower Columbia River Basin and Estuary, followed by sites along the outer Washington coast and Salish Sea (see Table G-3). No birds were tracked to sites east of The Dalles Dam on the Columbia River (near The Dalles, Oregon) or along the Oregon coast.

TABLE G-3. Nighttime visits during April 1–May 30 (Years 2012 and 2013) to regions within the affected environment by DCCOs satellite-tagged on East Sand Island. Detections at East Sand Island are listed separately from other detections within the Lower Columbia River Basin region.

Region	# of Birds that Visited	% of Birds that Visited	# of Detections[1]	% of Detections
Oregon Coast	0	0.0%	0	0.0%
Lower Columbia River Basin	86	90.5%	631	22.7%
Washington Coast	22	23.2%	74	2.7%
Salish Sea	3	3.2%	18	0.6%
Vancouver Island Coast	1	1.1%	3	0.1%
East Sand Island	95	100.0%	2048	73.8%

[1]Data from tags that failed, or DCCOs that died, at any point during this period were not excluded from the summary. No attempt was made to normalize the number of detections per bird for this analysis, so detections of individual DCCOs are not necessarily evenly weighted in this aggregate summary.

Appendix H-1: Federally Listed Threatened and Endangered Species Occurring in the Affected Environment

Table H-1.1 provides a list of ESA-listed fishes (as of 1 February 2014) that are potential prey for DCCOs in the affected environment Location of origin and status (threatened {T}, endangered {E}), along with a web link to additional information, is provided for each species. Inclusion of an ESA-listed fish species was based solely on the geographic location of the species in the affected environment, with no attempt made to evaluate the likelihood of DCCO depredation. Critical habitat maps were not available for all species, and, for these species, possible occurrence was evaluated based on species distribution descriptions and other sources of information provided by the listing agency. Effects to listed species within the sub-regions of the affected environment from the proposed alternatives are addressed in Chapters 4.

Table H-1.1. ESA-Listed Fish in Affected Environment

Common Name	Scientific Name	Location (status)	Link	Critical Habitat	Critical Habitat Mapped
Bocaccio	Sebastes paucispinis	Puget Sound/Georgia Basin (E)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Borax chub	Gila boraxobius	Wherever found (E)	http://www.fws.gov/species/#endangered	Yes	Yes
Bull Trout	Salvelinus confluentus	Contiguous United States (T)	http://www.fws.gov/species/#endangered	Yes	Yes
Canary Rockfish	Sebastes pinniger	Puget Sound/Georgia Basin (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Puget Sound (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Upper Willamette River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Lower Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Upper Columbia River spring-run (E)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Snake River fall-run (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Chinook Salmon	Oncorhynchus tshawytscha	Snake River spring/summer-run (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Chinook Salmon	Oncorhynchus tshawytscha	California Coast (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Central Valley spring-run (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chinook Salmon	Oncorhynchus tshawytscha	Sacramento winter-run (E)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Chum Salmon	Oncorhynchus keta	Hood Canal (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Chum Salmon	Oncorhynchus keta	Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Coho Salmon	Oncorhynchus kisutch	Lower Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No

Common Name	Scientific Name	Location (status)	Link	Critical Habitat	Critical Habitat Mapped
Coho Salmon	Oncorhynchus kisutch	Oregon Coast (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Coho Salmon	Oncorhynchus kisutch	Southern Oregon/Northern California (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Coho Salmon	Oncorhynchus kisutch	Central California Coast (E)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Delta Smelt	Hypomesus transpacificus	Wherever found (T)	http://www.fws.gov/species/#endangered	Yes	Yes
Foskett Speckled Dace	Rhinichthys osculus ssp	Wherever found (T)	http://www.fws.gov/species/#endangered	No	No
Green Sturgeon	Acipenser medirostris	Pacific Southern (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Hutton tui chub	Gila bicolor	Wherever found (T)	http://www.fws.gov/species/#endangered	No	No
Lahontan Cutthroat Trout	Oncorhynchus clarki henshawi	Wherever found (T)	http://www.fws.gov/species/#endangered	No	No
Lost River Sucker	Deltistes luxatus	Wherever found (E)	http://www.fws.gov/species/#endangered	Yes	Yes
Modoc Sucker	Catostomus microps	Wherever found (E)	http://www.fws.gov/species/#endangered	Yes	Yes
Owens pupfish	Cyprinodon radiosus	wherever found (E)	http://www.fws.gov/species/#endangered	No	No
Oregon chub	Oregonichthys crameri	Wherever found (T)	http://www.fws.gov/species/#endangered	Yes	No
Pacific Eulachon	Thaleichthys pacificus	Southern (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Paiute cutthroat trout	Oncorhynchus clarkii seleniris	Wherever found (T)	http://www.fws.gov/species/#endangered	No	No
Shortnose Sucker	Chasmistes brevirostris	Wherever found (E)	http://www.fws.gov/species/#endangered	Yes	Yes
Sockeye Salmon	Oncorhynchus nerka	Snake River (E)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Sockeye Salmon	Oncorhynchus nerka	Ozette Lake (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Puget Sound (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	No
Steelhead	Oncorhynchus mykiss	Upper Willamette River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Lower Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Middle Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes

Common Name	Scientific Name	Location (status)	Link	Critical Habitat	Critical Habitat Mapped
Steelhead	Oncorhynchus mykiss	Upper Columbia River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Snake River (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Northern California (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	Central California Coast (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Steelhead	Oncorhynchus mykiss	California Central Valley (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes
Tidewater Goby	Eucyclogobius newberryi	Wherever found (E)	http://www.fws.gov/species/#endangered	Yes	Yes
Warner Sucker	Catostomus warnerensis	Wherever found (T)	http://www.fws.gov/species/#endangered	Yes	Yes
Yelloweye Rockfish	Sebastes ruberrimus	Puget Sound/Georgia Basin (T)	http://www.nmfs.noaa.gov/pr/species/fish/	Yes	Yes

Fish of conservation concern (as of 1 February 2014) to the U.S. Government in the affected environment are identified in Table H-1.2. The location of origin and status (species of concern {S}, ESA candidate {C}), along with a web link to additional information, is provided for each species. Inclusion of fish was based solely on the geographic location of the species in the affected environment, with no attempt made to evaluate the likelihood of DCCO predation. There is no designated critical habitat for fish of federal conservation concern (candidate species) because habitat is not officially designated until the species is ESA-listed. As such, possible occurrence was evaluated based on species distribution descriptions and other sources of information provided by the listing agency. Pelagic shark species were not included due to a lack of geographic distribution information.

Table H-1.2. Fish of Conservation Concern to Federal Government.

Common Name	Scientific Name	Location (status)	Link
Bocaccio	*Sebastes paucispinis*	Pacific-Southern (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Chinook Salmon	*Oncorhynchus tshawytscha*	Central Valley Fall and Late Fall (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Chinook Salmon	*Oncorhynchus tshawytscha*	Upper Klamath and Trinity River Basin (C)	http://www.nmfs.noaa.gov/pr/species/fish/
Coho Salmon	*Oncorhynchus kisutch*	Puget Sound/Strait of Georgia (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Cowcod	*Sebastes levis*	Central Oregon to central Baja California (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Green Sturgeon	*Acipenser medirostris*	Pacific Northern (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Pacific cod	*Gadus macrocephalus*	Salish Sea (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Pacific hake	*Merluccius productus*	Pacific - Georgia (S)	http://www.nmfs.noaa.gov/pr/species/fish/
Longfin smelt	*Spirinchus thaleichthys*	Wherever found (C)	http://ecos.fws.gov/tess_public/pub/SpeciesReport.do?listingType=C&mapstatus=1
Steelhead	*Oncorhynchus mykiss*	Oregon Coast (S)	http://www.nmfs.noaa.gov/pr/species/fish/

Other non-fish species of conservation concern (proposed [P], candidate [C], threatened [T], or endangered [E]) within the affected environment, the sub-regions of the affected environment, and the Columbia River Estuary are identified in Table H-1.3. Species lists were obtained from the USFWS's Information, Planning, and Conservation (IPaC) System and include species identified in the IPaC report that should be considered given the geographic boundary of the project. Inclusion of species was based solely on the geographic location of the species with no attempt to evaluate the likelihood of conflict from EIS actions. Species with designated critical habitat are noted and additional information for each species can be found at: http://www.fws.gov/species/#endangered.

Table H-1.3. Non-fish ESA-listed species within the Affected Environment, sub-regions and the Columbia River Estuary.

Common Name	Scientific Name	Population (if designated)	Status	Affected Environment	Sub-Regions	Columbia River Estuary	Critical Habitat	Critical Habitat Mapped
AMPHIBIANS								
California red-legged frog	*Rana draytonii*	Entire	T	X			Y	Y
Columbia Spotted frog	*Rana luteiventris*	Great Basin DPS	C	X				
Mountain Yellow-Legged frog	*Rana muscosa*	U.S.A., N of Tehachapi Mts; southern California DPS	PE; E	X			Y	Y
Oregon Spotted frog	*Rana pretiosa*		PT	X	X	X		
Yosemite toad	*Anaxyrus canorus*		PT	X				
BIRDS								
Greater sage-grouse	*Centrocercus urophasianus*	Bi-state; Columbia basin DPS; Entire	PT; C; C	X	X (CB DPS)			
Least Bell's vireo	*Vireo bellii pusillus)*	Entire	E	X			Y	Y
Marbled murrelet	*Brachyramphus marmoratus*	CA, OR, WA	T	X	X	X	Y	Y
Northern Spotted owl	*Strix occidentalis caurina*	Entire	T	X	X	X	Y	Y
Short-Tailed albatross	*Phoebastria (=diomedea) albatrus)*	Entire	E	X	X	X		
Southwestern Willow flycatcher	*Empidonax traillii extimus*	Entire	E	X			Y	Y
Streaked Horned lark	*Eremophila alpestris strigata*		T	X	X	X	Y	Y
Western snowy plover	*Charadrius nivosus ssp. Nivosus*	Pacific coastal pop.	T	X	X	X	Y	Y
Yellow-Billed Cuckoo	*Coccyzus americanus*	Western U.S. DPS	PT	X	X	X		
CRUSTACEANS								
Vernal Pool fairy shrimp	*Branchinecta lynchi*	Entire	T	X			Y	Y
PLANTS								
Whitebark pine	*Pinus albicaulis*		C	X	X	X		
Applegate's milk-vetch	*Astragalus applegatei*		E	X				
Beach layia	*Layia carnosa*		E	X				
Bradshaw’s desert-parsley	*Lomatium bradshawii*		E	X	X	X		
Burke's goldfields	*Lasthenia burkei*		E	X				
Contra Costa goldfields	*Lasthenia conjugens*		E	X			Y	Y
Cook's lomatium	*Lomatium cookii*		E	X			Y	Y

Common Name	Scientific Name	Population (if designated)	Status	Affected Environment	Sub-Regions	Columbia River Estuary	Critical Habitat	Critical Habitat Mapped
Gentner's Fritillary	*Fritillaria gentneri*		E	X				
Golden paintbrush	*Castilleja levisecta*		T	X	X	X		
Howell's spectacular thelypody	*Thelypodium howellii spectabilis*		T	X				
Howell's spineflower	*Chorizanthe howellii*		E	X				
Kincaid’s lupine	*Lupinus sulphureus ssp. kincaidii*		T	X	X	X	Y	Y
Kneeland Prairie penny-cress	*Thlaspi californicum*		E	X			Y	Y
Large-flowered woolly Meadowfoam	*Limnanthes floccosa ssp. Grandiflora*		E	X			Y	Y
Macfarlane's four-o'clock	*Mirabilis macfarlanei*		T	X				
Malheur wire-lettuce	*Stephanomeria malheurensis*		E	X			Y	Y
Marsh Sandwort	*Arenaria paludicola*		E	X	X			
McDonald's rock-cress	*Arabis macdonaldiana*		E	X				
Menzies' wallflower	*Erysimum menziesii*		E	X				
Monterey clover	*Trifolium trichocalyx*		E	X				
Nelson's checker-mallow	*Sidalcea nelsoniana*		T	X	X	X		
Northern Wormwood	*Artemisia campestris var. wormskioldii*		C	X	X			
Red Mountain buckwheat	*Eriogonum kelloggii*		C	X				
Red Mountain stonecrop	*Sedum eastwoodiae*		C	X				
Rough popcornflower	*Plagiobothrys hirtus*		E	X	X			
Showy stickseed	*Hackelia venusta*		E	X				
Siskiyou Mariposa lily	*Calochortus persistens*		C	X				
Slender Orcutt grass	*Orcuttia tenuis*		T	X			Y	Y
Spalding's Catchfly	*Silene spaldingii*		T	X				
Tahoe Yellow cress	*Rorippa subumbellata*		C	X				
Umtanum Desert buckwheat	*Eriogonum codium*		T	X				
Ute ladies'-tresses	*Spiranthes diluvialis*		T	X	X			
Water howellia	*Howellia aquatilis*		T	X	X	X		
Webber Ivesia	*Ivesia webberi*		PT	X				
Wenatchee Mountains checkermallow	*Sidalcea oregana var. calva*		E	X			Y	Y
Western lily	*Lilium occidentale*		E	X	X			

Common Name	Scientific Name	Population (if designated)	Status	Affected Environment	Sub-Regions	Columbia River Estuary	Critical Habitat	Critical Habitat Mapped
White Bluffs bladderpod	*Physaria douglasii ssp. Tuplashensis*		T	X				
Willamette daisy	*Erigeron decumbens var. decumbens*		E	X	X	X	Y	Y
INSECTS								
Behren's Silverspot butterfly	*Speyeria zerene behrensii*	Entire	E	X				
Carson wandering skipper	*Pseudocopaeodes eunus obscurus*	U.S.A. (NV, CA)	E	X				
Fender's Blue butterfly	*Icaricia icarioides fenderi*		E	X	X		Y	Y
Lotis Blue butterfly	*Lycaeides argyrognomon lotis*	Entire	E	X				
Oregon Silverspot butterfly	*Speyeria zerene hippolyta*	Entire	T	X	X	X	Y	Y
Taylor's Checkerspot	*Euphydryas editha taylori*		E	X	X		Y	Y
MAMMALS								
Canada Lynx	*Lynx canadensis*	Contiguous U.S. DPS	T	X	X	X	Y	Y
Columbian White-Tailed deer	*Odocoileus virginianus leucurus*	Columbia River DPS	E	X	X	X		
Fisher	*Martes pennanti*	West Coast DPS (OR)	C	X	X	X		
Gray wolf	*Canis lupus*	USA (WA, OR, CA)	E	X	X	X		
Grizzly bear	*Ursus arctos horribilis*	Lower 48	T	X	X			
North American wolverine	*Gulo gulo luscus*		PT	X	X	X		
Olympia pocket gopher	*Thomomys mazama pugetensis*		PT	X	X			
Point Arena mountain beaver	*Aplodontia rufa nigra*	Entire	E	X				
Pygmy Rabbit	*Brachylagus idahoensis*	Columbia Basin DPS	E	X				
Red tree vole	*Arborimus longicaudus*	North Oregon Coast DPS	C	X	X	X		
Roy Prairie pocket gopher	*Thomomys mazama glacialis*		PT	X	X			
Sierra Nevada Bighorn sheep	*Ovis canadensis sierrae*	Sierra Nevada	E	X			Y	Y
Tenino pocket gopher	*Thomomys mazama tumuli*		PT	X	X			
Washington ground squirrel	*Urocitellus washingtoni*		C	X				
Woodland caribou	*Rangifer tarandus caribou*	Selkirk Mountain population	E	X			Y	Y
Yelm pocket gopher	*Thomomys mazama yelmensis*		PT	X	X			
REPTILES								

Common Name	Scientific Name	Population (if designated)	Status	Affected Environment	Sub-Regions	Columbia River Estuary	Critical Habitat	Critical Habitat Mapped
Green sea turtle	*Chelonia mydas*	except where endangered	T	X	X	X	Y	Y
Leatherback sea turtle	*Dermochelys coriacea*	Entire	E	X	X	X	Y	Y
Loggerhead sea turtle	*Caretta caretta*	North Pacific Ocean DPS	E	X	X	X		
Olive Ridley sea turtle	*Lepidochelys olivacea*	except where endangered	T	X	X	X		

Appendix H-2: List of Bird Species Observed on East Sand Island March–June 2013

Observations of Birds on East Sand Island March–June 2013	
Common Name	***Scientific Name***
LOONS and GREBES	
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
SEABIRDS, DUCKS	
Sooty Shearwater	*Puffinus griseus*
Pigeon Guillemot	*Cepphus columba*
Common Murre	*Uria aalge*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Long-tailed Duck	*Clangula hyemalis*
OSPREY, EAGLES, FALCONS, VULTURES	
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Peregrine Falcon	*Falco peregrinus*
Turkey Vulture	*Cathartes aura*
Northern Harrier	*Circus cyaneus*
WATERFOWL	
Greater White-fronted Goose	*Anser albifrons*
Brant	*Branta bernicia*
Cackling Goose	*Branta hutchinsii*
Canada Goose	*Branta canadensis*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Harlequin Duck	*Histrionicus histrionicus*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
PELICANS AND CORMORANTS	

Observations of Birds on East Sand Island March–June 2013	
Common Name	***Scientific Name***
American White Pelican	*Pelacanus erythrorhynchos*
Brown Pelican	*Pelicanus occidentalis*
Brandt's Cormorant	*Phalacrocorax penicillatus*
Double-crested Cormorant	*Phalacrocorax auritus*
Pelagic Cormorant	*Phalacrocorax pelagicus*
GALLINACEOUS BIRDS	
Bonaparte's Gull	*Xema sabini*
Mew Gull	*Larus canus*
Ring-billed Gull	*Larus delawarensis*
Western Gull	*Larus occidentalis*
Glaucous-winged Gull	*Larus glaucescens*
Glaucous-winged x Western (hybrid)	*Larus glaucescens x occidentalis*
Caspian Tern	*Hydroprogne caspia*
HERONS	
Great Blue Heron	*Ardea herodias*
PLOVERS, SANDPIPERS, SHOREBIRDS	
Black-bellied Plover	*Pluvialis squatarola*
Semipalmated Plover	*Charadrius semipalmatus*
Spotted Sandpiper	*Actitis macularia*
Least Sandpiper	*Calidris minutilla*
Western Sandpiper	*Calidris mauri*
Greater Yellowlegs	*Tringa meanoleuca*
Willet	*Tringa semipalmata*
Whimbrel	*Numenius phaeopus*
Marbled Godwit	*Limosa fedoa*
Black Turnstone	*Aremaria melanocephala*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Red-necked Phalarope	*Phalaropus lobatus*
DOVES	
Rock Dove	*Columba livia*
Eurasian Collared-Dove	*Streptopelia decaocto*
RAVENS / CROWS	
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corvax*

Observations of Birds on East Sand Island March–June 2013	
Common Name	***Scientific Name***
SWALLOWS	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Barn Swallow	*Hirundo rustica*
TOWHEES AND SPARROWS	
Spotted Towhee	*Pipilo maculatus*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Song Sparrow	*Melospiza melodia*
Savannah Sparrow	*Passerculus sandwichensis*
BLACKBIRDS AND STARLINGS	
Brewer's Blackbird	*Euphagus cyanocephalus*
European Starling	*Sturnus vulgaris*
WRENS AND THRUSHES	
Bewick's Wren	*Thryomanes bewickii*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
American Pipit	*Anthus rubescens*
HUMMINGBIRDS, WARBLERS, FINCHES	
Yellow Warbler	*Dendroica petechia*
Rufous Hummingbird	*Selasphorus rufus*
American Goldfinch	*Caduelis tristis*

Appendix I: Economic Analysis for In-River Columbia River Fisheries

Preface

This report was prepared by The Research Group, LLC (TRG) located in Corvallis, Oregon for the U.S. Army Corps of Engineers, Portland District (Corps). The Corps is studying alternatives to reduce predation of Columbia River Basin out-migrating salmon and steelhead from a large colony of double-crested cormorants (DCCO) nesting on East Island near the mouth of the Columbia River. The preferred action will be described in a Corps developed implementation and monitoring management plan. The island was created and is nourished by dredge material disposal from nearby Corps navigation channel maintenance. The selection of a preferred alternative is being considered through procedures and requirements of the National Environmental Policy Act (NEPA). This report will be used to disclose fishery related economic and social consequences in an environmental impact statement for all of the alternatives. The reader should check that this report's version number is matched with NEPA document review stage, since report content will change as NEPA processes evolve and a final management plan is developed.

The main advisors on the report preparation were Hans D. Radtke and Christopher N. Carter. Shannon W. Davis led the technical team for TRG. These scientists have worked professionally on fishery economic analysis projects for many years. Hans D. Radtke, Ph.D. is a natural resource economist whose residence is near Yachats, Oregon. Dr. Radtke was a contract staff economist at for the Pacific Fishery Management Council (PFMC) and became a PFMC member in 2001 (chairman 2002 – 2003). Dr. Radtke is a member of many government policy level advisory committees, including the Northwest Power Conservation Council's Independent Economic Analysis Board. Christopher N. Carter, Ph.D. is a natural resource economist retired from the Oregon Department of Fish and Wildlife (ODFW). While at ODFW, Dr. Carter developed fishery management and hatchery facility benefit-cost and economic impact models. Shannon W. Davis is a principal for TRG. Mr. Davis is a system research specialist who has worked on many environmental impact statement (EIS) and other NEPA process reports related to natural resource management. Recent examples include the Puget Sound Chinook Harvest Resource Management Plan EIS, West Coast Essential Fish Habitat Plan EIS, the RegFlex Analysis for the Designation of Steelhead Critical Habitat, and the Army Corps of Engineers' FR/EIS for Lower Snake River Juvenile Salmon Migration.

The offered analysis is a very limited economic and social analysis, especially for considering what might be accomplished for tradeoffs in how predation reduction can be mitigated through other means. The authors believe the data descriptions, modeling methods, and result interpretations described in this report will assist in those investigations.

This report was reviewed in draft form to provide candid and critical comments. This feedback helped make the findings of this report as sound as possible and ensures the report meets standards for objectivity, evidence, and responsiveness to the study charges. Although reviewers provided many useful comments and suggestions, they were not asked to endorse study findings and recommendations. This independent examination task was done in accordance with accustomed procedures and review comments were carefully considered.

The authors' interpretations and conclusions should prove valuable for this study's purpose. However, no absolute assurances can be given that the described results will be realized. Government legislation and policies, market circumstances, and other situations will affect the basis of assumptions in unpredictable ways and will lead to unanticipated changes. The information should not be used for investment or operational decision making. The authors do not assume any liability for the information and shall not be responsible for any direct, indirect, special, incidental, or consequential damages in connection with the use of the information.

Authorization is granted for the study report's contents to be quoted either verbally or in written form without prior consent of the authors. Customary reference to authorship, however, is requested.

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AHA	All-H-Analyzer analytical tool. The AHA tool is a Microsoft Excel-based application to evaluate salmon and steelhead management options in the context of the four H's: habitat, hydroelectric system passage, harvest, and hatcheries.
BCA	benefit-cost analysis
BiOp	biological opinion
C&S	ceremonial and subsistence
CEA	cost-effectiveness analysis
Corps	U.S. Army Corps of Engineers, Portland District
CPUE	catch per unit effort
CRFMP	Columbia River Fish Management Plan
CRITFC	Columbia River Inter-Tribal Fish Commission
DCCO	double-crested cormorants
DFV	direct financial value
EIS	environmental impact statement
ESA	Endangered Species Act
ESU	evolutionary significant unit
FEAM	Fisheries Economic Assessment Model
HGMP	hatchery genetic management plan
HSRG	Hatchery Scientific Review Group
I/O	input/output economic model
LCR	lower Columbia River
MA	Mitchell Act
NEPA	National Environmental Policy Act
NEV	net economic value
ODFW	Oregon Department of Fish and Wildlife
OFWC	Oregon Fish and Wildlife Commission
PDO	Pacific Decadal Oscillation
PIT tag	passive integrated transponder tag
PFMC	Pacific Fishery Management Council
REI	regional economic impacts
SAS	smolt-to-adult survival rate
TRG	The Research Group, LLC
WDFW	Washington Department of Fish and Wildlife
WFWC	Washington Fish and Wildlife Commission

Executive Summary

This report provides a description of Columbia River Basin in-river fisheries related economic effects and social implications that result from reducing predation on juvenile salmon and steelhead stocks by double-crested cormorant (DCCO) colony residing on East Island located in the Columbia River estuary. A deterministic simulation economic impact model was developed for showing relative effects between adopted Alternative A conditions (status quo) and two DCCO management plan alternatives. Existing economic models were used to translate the saved out-migrating smolts survival to in-river fisheries economic impacts. The report also has brief descriptions of social implications for increasing harvest opportunities due to lowering juvenile salmonid predation. The report content poses but does not answer the question about causing other environmental burdens and benefits from carrying out the management plan alternatives. Sections of this report will be incorporated into NEPA documentation being prepared for the DCCO management plan.

Economic analysis measurements are offered for fishing industry participant (including commercial non-Indian and tribal, and recreational sectors) direct financial value (DFV), regional economic impacts (REI) from the "use" of salmon and steelhead fish resources, and the investment cost (IC) in hatchery production associated with DCCO consumption. This set of measurements is offered because they are the most understandable of economic metrics. There are other use and non-use economic metrics that could be developed. However, the measurements for such concepts as non-use existence value are abstract and less understood by non-technical audiences. It would be important to generate the additional metrics if there were to be tradeoff analysis for disparate actions, such as mitigating for DCCO unaltered predation with increased production from salmonid habitat improvements. These other metrics would provide a common unit to compare and contrast over time the impacts from the additional actions.

The economic analysis geographic scope is to assess salmon and steelhead in-river fisheries positive impacts from the predation reduction on Columbia River Basin economies. This spatially limited economic analysis excludes showing positive impacts to other out-of-basin economies where Columbia River produced adult fish show up in fisheries. The limitations also preclude inclusion of externalities such as possible negative impacts to out-of-basin regions from a non-lethal displacement alternative. Research has shown that past DCCO dissuasion and dispersal techniques on the East Island colony have caused migration to northern Washington Coast and British Columbia estuaries. Of particular concern is whether the non-lethal alternatives would cause dispersal to upriver Columbia River locations as juvenile salmonid diet share increases due to the decreasing availability of marine and non-salmonid fish. The scope limitation also excluded the economic assessment of possible positive impacts from non-salmonid in-river fisheries.

While this report contains a rich set of quantifications, also much is written about methods that are used to arrive at results. Such discussions are needed because there are many unknowns

and uncertainties in the inputs and behavior relationships built into the economic models. Definitions and focal modeling assumptions for the economic measurements are as follows.

- The participant DFV measurements are for revenue received in commercial fisheries, and expenditures made by recreational anglers that are linked with the availability of Columbia River Basin salmon and steelhead adult returns. (Commercial fishing revenue affords the expenditures for the cost of fishing.) Tribal commercial harvest revenues are included in the calculations. A value for tribal ceremonial and subsistence harvests is not included. DFV is the dollar flow that starts the economic modeling for REI. The DFV does not measure total economic impacts on an economy nor does it reflect a dollar value that can be used to compare and contrast fish resource economic benefits.

- An ***REI*** analysis is provided to show significance of economic contributions to regional economies. The regional economies are within the Columbia River Basin where in-river fisheries occur. The measurement units are in personal income. The personal income measure can be interpreted to be household net earnings and a region's average household net earnings statistic can be used to translate the measure to an equivalent job metric. The measure uses the simplifying assumption that all fishing industry spending is afforded by money originating from outside the regions and that there are no substitution activities. Some of the recreational fishery related impacts could possibly have substitutions in other recreational activities, but there would be few substitutes to commercial fisheries, especially for in-river harvesting and its processing. The REI from the proportion of hatchery returns that reach a market using per fish unit values are also provided. The accounting stance is for state level economies. The REI results are itemized for the in-river fishery's sectors. The economic contributions include the "multiplier effect."

- The ***IC*** are a financial value. The costs are hatchery operation and administration expenditures associated with the DCCO consumed out-migrating smolts. The hatchery production costs per smolt release were available from a secondary source, so the number of out-migrating smolts must be corrected for the passage mortality to know the effective smolt releases. A negative IC number associated with a smolt consumption reduction would be a positive dollar savings, i.e. the calculated negative IC would reflect the operational costs to produce and release the consumed smolts. An investment cost, or any other economic value metric, was not calculated for the estimated wild origin portion of the DCCO consumption. An investment value for wild origin fish is considerable as government agencies and private industries work on salmon and steelhead recovery.

The economic measurements are for annual short-term effects. The economic effects are for current conditions and may not be a valid measure of the long-term effects on the economy. The measures are indicators of immediate perturbations and there may be different effects in the long-term due to unforeseen adjustments to environmental conditions, government policy, and the general economic situation. All economic measurements are adjusted to be for year 2012 dollars using the GDP implicit price deflator developed by U.S. Bureau of Economic Analysis.

The economic analysis is referenced to baseline conditions (referred to as Alternative A). The baseline conditions, economic analysis modeling exogenous variables, and management plan alternatives' specifications are shown in Table ES.1. Ecosystem feedback effects such as saved juvenile salmonid compensatory predation, varying out-migrating smolts other passage mortality, and differing ocean environment mortality were not incorporated into the economic analysis. The absolute value (rather than changed value) for the economic contributions could be a conservative or liberal estimate because the out-migrating smolt biomass subject to DCCO predation is an economic analysis intermediate calculated parameter subject to many assumptions about all hydro system passage and other mortalities.

Hatchery production and release schedules are exogenous variables in the economic model. The releases are annual averages over a five year average period 2008-2012. There are two example changed conditions in hatchery production and practices that will not be reflected in economic analysis results. The first is pending staged shift in commercial non-Indian effort from lower Columbia River mainstem to off-channel fishing areas. This regulatory action is to be accompanied with increased Youngs Bay select area smolt acclimation and release numbers. The second is the expected ramp-up in the Colville Confederated Tribes' Chief Joseph Hatchery production with releases in the Okanogan River area. Changed DCCO predation on out-migrating smolts from these two examples could have important subsequent economic effects on the associated in-river fisheries.

The calculation of economic effects is dependent on the highly variable smolt-to-adult survival rate (SAS). A SAS range can be 50 percent lower and 100 percent higher than what is assumed for baseline conditions. A SAS can be different for hatchery and wild origin production. The SAS is applied linearly to out-migrating smolt biomass, so its variance over the broodstock averaging period would directly show the variance in economic effects. Single point results are shown as if the ultimate effects from DCCO depredation actions were occurring in the present economy reflected by an adopted economic input-out model.

There certainly could be a different set of baseline conditions and variances thereof applied in wider scope economic analysis, but the interest is to find changed in-river fishery related economic contributions. For example, there are other estimates of smolt DCCO consumption rather than the PIT tag recovery experiment estimated annual average. There are also bioenergetic modeling estimates for DCCO consumption. Some of the different conditions and their uncertainties would be on both sides of the alternatives' consequence equation, and in effect, cancel out the additional and different detail. The model results are useful for showing the alternatives' magnitudes and direction of effects. However, the absolute results for Alternative A and the other two alternatives are stylized representations. Other studies should be consulted and relied upon for actual economic descriptions (such as the in-river fishing industry economic contributions) and biological descriptions (such as DCCO juvenile salmonid consumption).

An important assumption in the economic analysis is holding hatchery production constant for each of the alternatives. It is often overlooked in Pacific salmon fisheries' economic analysis the importance of economic contributions that come from operating fishery enhancement and supplementation hatcheries. It could be that hatchery production can be throttled when there are returning hatchery origin adults goals to be attained, and in this case, there would be lower hatchery production costs. Hatchery facilities probably would not be used for other commercial or educational activities than for the purposes for which they were built, so the effects from hatchery operation changes would be assumed to not have a mitigating substitute. Reduced DCCO predation would increase economic contributions from fisheries, but be lessened due to the reduced hatchery operations economic effects.

Smolt production costs can range between $0.20 to $2 each depending on trapping and rearing operations and cost accounting inclusions. Production of fall Chinook subyearlings (released at 25 to 50 per pound and comprise about 50 percent of all releases) are lesser, and production of steelhead yearlings (released at eight to 12 per pound and comprise about 12 percent of all releases) are higher. If hatchery production funding is considered new money into a region, then the costs for labor, materials, administration, monitoring, and construction provide significant economic contributions particularly to rural economies where the hatcheries are located.

The procedure to determine economic effects is to first determine the presence of out-migrating smolts. This is accomplished by using average 2008-2012 annual hatchery release data expanded to account for wild production and reduced by passage mortality. The second step is to apply annual DCCO predation probabilities based on PIT tag recovery experiments for an averaging period 2008-2012 in order to determine consumption. At this step, the IC for the hatchery origin only consumed fish is calculated. The third step is to use SAS rates to generate the total adults that show up in fisheries, hatchery returns, and spawning beds. A previously developed Columbia River salmon and steelhead fisheries model is used to distribute total adult survival to in-river fisheries harvests. The last step is to use adult per-fish unit economic statistics from other studies to show the economic effects for DFV and REI foregone with the consumed out-migrating smolts.

The Alternative A conditions economic contributions from in-river fishery sectors (including commercial non-Indian and tribal, and recreational) is shown on Tables ES.2 to ES.4. The DFV for all of the in-river fisheries is $41.9 million. The REI is $49.0 million in personal income.

Figure ES.1 shows the Alternative A proportion of REI measured by personal income for the commercial and recreational fisheries. A minor amount of economic contribution (estimated to be one percent) that comes from the business use of marketable returns to hatcheries in included in the figure which brings the REI up to $49.7 million personal income.

The Alternative A commercial non-Indian REI is estimated to be 14 percent of the total economic contributions. Most of the economic contributions from this fishery occur at lower River economies. Many of the harvesters live in this location and most of the landings are delivered to processors in Astoria, Oregon.

The Alternative A commercial tribal fishery is 15 percent of in-river fisheries total economic contributions. The economic contributions from harvesting are spread throughout the upper Columbia River Basin wherever the fisheries and participants reside. Some of the landings are marketed by harvesters as direct sales to the public. Most of the landings from this fishery are purchased by processors based in northern Washington in recent years. (These processors are also active in purchasing Puget Sound commercial tribal harvests.) The added value hence economic contributions from the processor sector are less in the Columbia River Basin economies for the commercial tribal fishery than for the commercial non-Indian because the fish are exported out of the region.

The freshwater sport fishery (includes the popular fall season Buoy 10 fishery as well as all other mainstem and tributary salmon and steelhead fisheries) trip spending related economic contributions are 70 percent of in-river fisheries total economic contributions for Alternative A. Angler capital expenditures are not included in this estimate because the economic analysis is to calculate economic effects and it is assumed capital items would have been purchased with or without management plan actions.

There are essentially two basic management plan alternatives being considered, although the means to accomplish the basic alternatives generate additional alternatives' options. Alternative B-C; Phase I, Alternative D is a reduction of 56 percent of the existing colony on East Island to bring the DCCO population down to a base period level (no more than 5,380 to 5,939 nesting pairs). Phase II, Alternative D is a reduction of 100 percent of the East Island DCCO population.

The DFV and REI measurements for the alternatives by the three fishing industry sectors are shown in Table ES.2 to ES.4. The total DFV effects calculation for the participants is positive $1.4 million for Alternative B-C; Phase I, Alternative D and positive $2.6 million for Phase II, Alternative D. The DFV percentage change from in-river fisheries is about 3.4 percent greater for Alternative B-C; Phase I, Alternative D and about 6.1 percent greater for Phase II, Alternative D. The total REI effects in Columbia River Basin economies from inland fisheries are positive $1.5 million and positive $2.6 million for the two alternatives respectively. The REI percentage change from in-river fisheries is about 3.0 percent greater for Alternative B-C; Phase I, Alternative D and about 5.3 percent greater for Phase II, Alternative D.

The hatchery production IC change for the alternatives is shown in Table ES.5. The changed IC for Alternative B-C; Phase I, Alternative D is a negative $3.6 million and for Phase II, Alternative D is a negative $6.4 million.

The economic contributions from Columbia River Basin salmon and steelhead production are in economies wherever the returning hatchery and wild origin fish in-river harvesting and processing expenditures are made. The Astoria (Clatsop County, Oregon) and Ilwaco (Pacific County, Washington) area located at the Columbia River ocean entrance has the largest commercial fishing industry presence of all regional economies adjacent to the River. The fishing industry is not particularly vulnerable to in-river fisheries as the total (ocean harvest area included) commercial salmon fishery is about five percent (measured by harvest revenue) of all fisheries deliveries. The share of those deliveries from in-river commercial non-Indian and tribal fisheries is about 83 percent. While all fisheries harvesting and processing activity is important, a five percent upturn sourced to in-river fisheries due to DCCO management is not a significant increase to the area's fishing industry overall economic contributions.

A regional commercial fishing industry perspective is revealing, however dissection of vulnerability for in-river fisheries changes masks participant economic and social impacts. The Astoria area is home to many non-Indian sector permittees whose in-river fishery income is critical to their business. Many of these participants also will travel to Alaska between Columbia River fishing seasons to supplement their local harvesting incomes. An increase in catch in any of their fisheries' participation would be important to the overall viability of their business. Columbia River in-river fisheries present an even higher business risk to commercial tribal fisherman. As a group, they have less resiliency to downturns and enjoy higher proportional benefits from Columbia River harvest changes. Even small increases in harvest revenue due to DCCO management would be important to tribal fisherman household income.

Social implications qualitative discussions provide an interpretation for how changing fishery related economic effects may disproportionately affect socio-economic groups using federal environmental justice criteria. The interpretations are based on a methodological approach to answer the contentious question for fair distribution of environmental burdens and benefits. It is not an unexpected finding that American Indian ethnicity in certain Columbia River Basin geographic areas is a socio-economic group particularly vulnerable to fishery related changes. Given the group's thousands of years of life dependency on Columbia River fish resources, an analysis of fishery changes may more appropriately be analyzed from pre-hatchery system and pre-harvest regime allocation schemes rather than relative to baseline conditions. This finding is particularly apropos to the current DCCO predation reduction considerations because the DCCO consumption problem is post-European settlement. The problem is additive to the drastic alteration in wild origin salmon and steelhead populations caused by the hatchery system, river flows, salmonid habitats, etc. Relegating the social analysis to only discussions of the alternatives' economic analysis marginal changes does not show appreciation for the tribal fisheries as they historically existed.

Discerning changes in regional economic activity due to incremental changes from in-river fisheries does not address a larger policy consideration related to DCCO management. Maintaining and improving Columbia River area in-river fisheries has basis in the conservation of the wild production component. There is ominous government intervention power that follows findings that wild stocks are depleted. The federal Endangered Species Act (ESA) allows for sweeping powers to prevent further takings of listed species that can shut down fisheries. A task not undertaken in the economic analysis would be determining the magnitude of regional economic activity from in-river fisheries at risk from not having healthy wild stocks due wholly or in part from DCCO predation. Moreover, the foregone fisheries benefits would be a small component of total economic activity at risk due to effects from other curtailed land and water uses that would be imposed by the depleted fish population's recovery plans.

Table ES.1
Economic Analysis Model Baseline Conditions, Exogenous Variables, and Management Plan Alternatives' Specifications

Baseline Conditions

1) Annual average 2000's broodstock survival to analyzed fisheries
2) Recent years' ocean and river harvest exploitation rates
3) Annual average 2008-2012 hatchery production
4) Estimated wild fish production based on 2012 hatchery production ratio estimators
5) Constant DCCO predation probabilities from a 2008-2012 five year annual average based on PIT tag recovery experiments

Exogenous Variables	
Inriver Transport	50% of Snake River production
Other Mortality (post-DCCO predation)	0.0%
Compensatory predation	0.0%

Alternatives' Specifications	
Predation reduction	
Alternative A	0.0%
Alternative B-C; Phase I, Alternative D	56.0%
Phase II, Alternative D	100.0%

Table ES.2
Economic Effects From DCCO Predation Reduction to Columbia River Inriver Fisheries by Sector for Participant Direct Financial Value

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	33,941	1,284	3.8%	2,293	6.8%
Non-Indian commercial	4,152	78	1.9%	139	3.3%
Tribal commercial	3,785	79	2.1%	141	3.7%
Total	41,879	1,441	3.4%	2,574	6.1%

Notes: 1. Direct financial value (DFV) is commercial gillnet and tribal fisheries participant harvest revenue plus recreational angler trip expenditures.

2. DFV is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.

3. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table ES.3
Economic Effects From DCCO Predation Reduction to Columbia River Inriver Fisheries by Sector for Regional Economic Impacts

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	34,626	1,148	3.3%	2,049	5.9%
Non-Indian commercial	7,131	133	1.9%	238	3.3%
Tribal commercial	7,253	172	2.4%	306	4.2%
Total	49,010	1,452	3.0%	2,593	5.3%

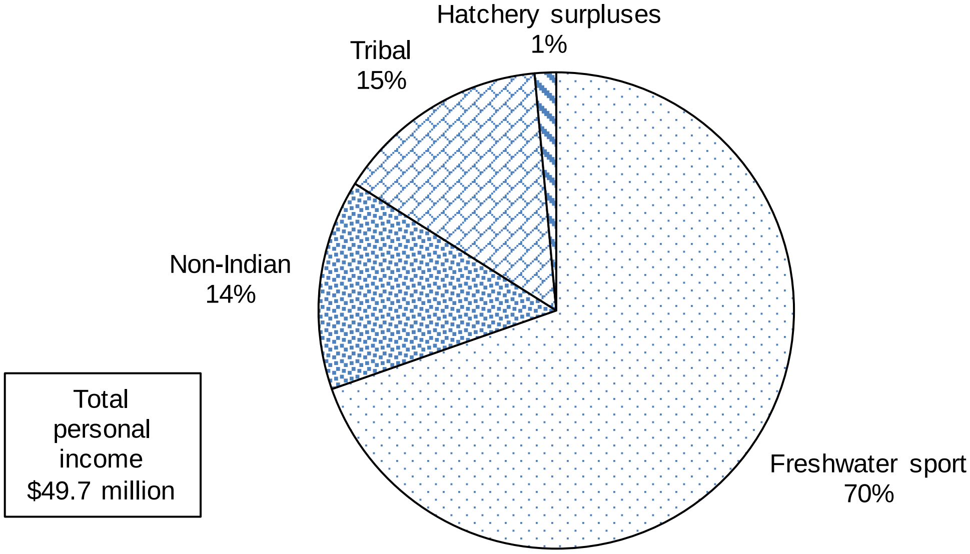
Notes: 1. Regional economic impacts (REI) are expressed as personal income. REI is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table ES.4
Economic Effects From DCCO Predation Reduction for Columbia River Hatchery Investment Costs

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Consumption	3,776.5	-2,114.8	-56.0%	-3,776.5	-100.0%
Effective hatchery releases	5,425.6	-3,038.4	-56.0%	-5,425.6	-100.0%
Investment cost	6,435.6	-3,603.9	-56.0%	-6,435.6	-100.0%

Notes: 1. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions. A negative consumption or investment cost means a savings from the Alternative A status quo conditions.

Figure ES.1
Columbia River Inriver Fisheries Regional Economic Impacts for Alternative A Conditions



Notes: 1. Regional economic impacts (REI) measurement is total personal income in millions of 2012 dollars.
2. REI includes minor economic contributions from business use of marketable hatchery returns. REI does not include economic contributions from hatchery operations.

I. Introduction

This report provides a description of Columbia River Basin in-river fisheries related economic effects and social implications that result from reducing predation on juvenile salmon and steelhead stocks by double-crested cormorant (DCCO) colony residing on East Island located in the Columbia River estuary. A deterministic simulation model was developed for showing relative effects between adopted Alternative A conditions and two DCCO management plan alternatives. Existing economic models were used to translate the saved out-migrating smolts survival to in-river fisheries economic impacts. The report also has brief descriptions of social implications for increasing harvest opportunities due to lowering juvenile salmonid predation. The report content poses but does not answer the question about causing other environmental burdens and benefits from carrying out the management plan alternatives. Sections of this report will be incorporated into NEPA documentation being prepared for the DCCO management plan.

Any changes in Columbia River Basin production will have implications to many north Pacific Ocean regional economies that depend on access to ocean salmon fisheries.[1] The economic analysis geographic scope was limited to assessing salmon and steelhead in-river fisheries positive impacts from the predation reduction on Columbia River Basin economies. The scope limitation also excluded the economic assessment of possible positive impacts from non-salmonid in-river fisheries.

The economic analysis uses measurements for participant direct financial value (DFV) from commercial and recreational fisheries, regional economic impact (REI) to households, and the investment cost (IC) in hatchery production associated with DCCO consumption. This set of measurements is offered because public interest in government actions is often directed by those who will rely on only partial measurements that support their views. The report contains descriptions for a rich set of quantified results, as well as the explanations of methods that are used to arrive at the results. The discussions and explanations are important because there are many assumptions made in developing the methods and high variances in the modeling inputs. In addition to the offered economic analysis results, there are also brief discussions about the social implications of the DCCO predation reduction.

It is important to consider the modeling caveats in the application of the economic effect measurements to public policies towards the predation reduction, especially when trying to use

1. Due to the migratory behavior of Pacific salmon and steelhead, fish originating in the Columbia River contribute to distant water fisheries. For example, a significant proportion of the Chinook catch in southeast Alaska and British Columbia salmon fisheries are from the Columbia River. The U.S.-Canada Pacific Salmon Treaty adjusts allocations between countries, depending on production origin abundances. The Pacific Fishery Management Council (PFMC) manages the U.S. allocations for West Coast ocean fisheries in anticipation of states' management of in-river fisheries and taking thresholds for populations listed under the Endangered Species Act.

the measurements to evaluate any tradeoffs for accomplishing salmon and steelhead production objectives in some other manner. The tradeoffs might include increasing wild origin production through habitat improvements or other techniques that will lower smolt mortality (such as passage improvement projects).

The content of this report first describes in-river fisheries that benefit from the Columbia River Basin salmonid production. Some detail is offered on the Columbia River fishery user groups (commercial, tribal, and recreational fishing participants) in these descriptions. Following the modeling methods and results explanations are narrative discussions of economic and social implications realized from DCCO production reduction. These discussions put into context "with" and "without" scenarios for the predation management.

II. Background

A. In-river Fisheries Economic Analysis

Columbia River Basin salmon and steelhead stocks contribute to ecosystems, economies, and cultures. The recent history of stock status illustrates the conflict between conservation, consumptive and non-consumptive use, and water and land development that impacts the stocks. The cultural and food values in tribal fisheries, commercial fisheries, recreational fisheries and competing economic developments including hydropower, transportation and water withdrawals are all telling factors in current stock conditions. Mortality from commercial and recreational fishery harvest and harvest by-catch is only one of several sources of the total mortality experienced by adult stocks. But before this mortality occurs, the downstream migrating juveniles are subject to a number of mortality sources. Included is the avian predation from colonies of double-crested cormorants (DCCO) residing in the lower Columbia River estuary. The predation reduces the numbers of fish from hatchery production that would have survived to maturity and been available for harvests. The predation on depleted wild origin fish stocks become a vital control point in their recovery. This report describes the affected Columbia River Basin's socioeconomic environment that would be changed by increased harvest opportunities if the DCCO predation was reduced.

The economic analysis geographic scope is to assess salmon and steelhead in-river fisheries positive impacts from the predation reduction on Columbia River Basin economies. This spatially limited economic analysis excludes showing positive impacts to other out-of-basin economies where Columbia River produced adult fish show up in fisheries. The limitations also preclude inclusion of externalities such as possible negative impacts to out-of-basin regions from a non-lethal displacement alternative. Research has shown that past DCCO dissuasion and dispersal techniques on the East Island colony have caused migration to northern Washington Coast and British Columbia estuaries. Of particular concern is whether the non-lethal alternatives would cause dispersal to upriver Columbia River locations as juvenile salmonid diet share increases due to the decreasing availability of marine and non-salmonid fish. The scope limitation also excluded the economic assessment of possible positive impacts from non-salmonid in-river fisheries.

Economic analysis measurements are offered for the "use" of salmon and steelhead fish resources. This set of measurements is offered because they are the most understandable of economic metrics. There are other use and non-use economic metrics that can and maybe should be developed. However, the measurements for such concepts as non-use existence value are abstract and less understood by non-technical audiences. It would be important to generate the additional metrics if there were to be tradeoff analysis for disparate actions, such as mitigating for DCCO unaltered predation with increased production from salmonid habitat improvements.[1] These other metrics would provide a common unit to compare and contrast over time the impacts from the additional actions. The other metrics could also be used in benefit-cost analysis (BCA) to show society level net economic benefits for the DCCO predation controls and judge which action might be most efficient.[2] Sometimes cost-effectiveness analysis (CEA) is a desired public policy economic analysis metric when action objectives are clearly defined (Halsing and Moore 2006, IEAB 2012). For example, it might be of interest to show if DCCO management plan costs per juvenile salmonid saved is less or more than other passage survival improvement projects. It is not unusual for the Corps of Engineers to undertake a cost effectiveness and incremental analysis (CEICA) for a management plan feasibility study (IWR June 2009). However, the DCCO management plan purpose does not lend itself to this type of analysis as the project goal is to reach acceptable DCCO population levels rather than use alternative methods or mitigation measures for the out-migrating smolt mortality. Still, showing comparative costs for other mortality reduction programs can be informative for the DCCO management plan decision making process.

The economic analysis is referenced to baseline conditions (referred to as Alternative A). Ecosystem feedback effects, such as varying other sources of passage mortality, were not incorporated into the economic analysis. The absolute value (rather than changed value) for the economic contributions could be a conservative or liberal estimate because the out-migrating smolt biomass subject to DCCO predation is an economic analysis intermediate calculated variable subject to many assumptions about system passage and other mortalities.

Hatchery production and release schedules are exogenous variables in the economic model. The releases are annual averages over a five year average period 2008-2012. There are two example changed conditions in hatchery production and practices that will not be reflected in economic analysis results. The first is pending staged shift in commercial non-Indian effort from lower Columbia River mainstem to off-channel fishing areas. This regulatory action is to

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1. This report does not discuss an assessment for redirecting DCCO management plan funds in a manner that recovers and increases wild origin smolt production levels through other means, such as habitat enhancements, fish passage improvements (flow, water temperature, withdrawal, predation reduction), and adjustments to harvest management strategies (vessel and permit forbearance, harvest avoidance, selection), etc. (Of these other items, dealing with adjustments to harvest management is a difficult and complex task because of multiple and overlapping jurisdictions, but it is a necessary inclusion at some level of detail because of the connectiveness of any fish resource change.) Such tradeoff investigations should be done when deciding on fish resource policies to show a broader perspective for decisions. This will ensure decisions are being made with visibility to cost effectiveness and economic efficiencies.
2. The BCA would rely on active and passive use net economic value (NEV) calculations. The active uses would be for such direct use activities like commercial and recreational fishing and indirect non-extractive uses like viewing birds. The passive use values are what society says they may pay for preserving wild fish runs. A cardinal dollar measure that society places on natural capital like bird populations and wild fish is subject to research conjecture, but comparative magnitudes can be revealing. The difficulty in undertaking BCA is deciding and defining what is a benefit and what is a cost. Just the explanation for trying to parameterize a BCA through such assignments can be informing to policy decision makers.

be accompanied with increased Youngs Bay select area smolt acclimation and release numbers. The second is the expected ramp-up in the Colville Confederated Tribes' Chief Joseph Hatchery production with releases in the Okanogan River area. Changed DCCO predation on out-migrating smolts from these two examples could have important subsequent economic effects on the associated in-river fisheries.

The smolt biomass includes wild origin production as well as hatchery production releases. While hatchery release numbers may be constant depending on operation budget funds, the proportion of wild origin in total smolt biomass is difficult to predict with dependencies on previous generation survival, reproductive success, and river environmental conditions during the pre-smolt life cycle rearing period.

The calculation of economic effects is dependent on the highly variable smolt-to-adult survival rate (SAS). A SAS can be different for hatchery and wild origin production.[1] The SAS is applied linearly to out-migrating smolt biomass, so its variance over the broodstock averaging period would directly show the variance in economic effects. Single point results are shown as if the ultimate effects from DCCO depredation actions were occurring in the present economy reflected by an adopted economic input-out model.

There certainly could be a different set of baseline conditions and variances thereof applied in wider scope economic analysis, but the interest is to find changed inriver fishery related economic contributions. For example, there are other estimates of smolt DCCO consumption rather than the PIT tag recovery experiment estimated annual average. There are also bioenergetic modeling estimates for DCCO consumption. Some of the different conditions and their uncertainties would be on both sides of the alternatives' consequence equation, and in effect, cancel out the additional and different detail. The model results are useful for showing the alternatives' magnitudes and direction of effects. However, the absolute results for Alternative A and the other two alternatives are stylized representations. Other studies should be consulted and relied upon for actual economic (such as the in-river fishing industry economic contributions) and biological (such as DCCO juvenile salmonid consumption) descriptions.

B. Other Economic Value Assessments

The previous section in this background chapter discussed the changed economic contribution value (sometimes called economic effect or economic impact) from increased fish harvest opportunities in commercial non-Indian and tribal fisheries, and recreational fisheries. The

1. Total smolt production by all Columbia River Basin hatcheries in the 2000's was about 140 million (CRFPC 2013), which is about half of total hatchery and wild production (IEAB 2005). Harvest contributions from all Columbia River Basin production is more than three-quarters hatchery production in recent years (IEAB 2005). This is due to fishery management attempts using fish mark selective fisheries, avoidance, and other techniques to reduce impacts on adults from wild origin.

change was in market values – revenues to the fishing industry, incomes of fishers, and the resulting income impacts of their expenditures resulting from spending these revenues. But commercial fisheries value can also entail non-market values associated with job satisfaction, stability, flexibility, food provision and minimal conflicts. Recreational fisheries have non-market values for the satisfaction of the recreational experience, subsistence and gourmet food, stability, and flexibility. Tribal C&S fisheries have cultural values. It is clear there are all kinds of values to contend with when describing benefits associated with changed fish harvest opportunities.

Using economic effects measurements for changed fish harvest opportunities will ignore other economic value measurements for all types of involved species and human perspectives about economic value. Wildlife species, including avian species, will have a "watchable wildlife" or aesthetic value. If there are no imposed DCCO population controls, there may be natural selection by other predators attracted to the colony sites such as foxes and eagles. The DCCO as well as other predators will have a watchable wildlife economic value. In Oregon in 2011, there were about twice the participants and trip spending by wildlife watchers (1.4 million participants and $1.7 billion spending) as hunters (0.2 million participants and $0.2 billion spending) and anglers (0.6 million participants and $0.6 billion spending) combined (USFWS and USCB January 2014).

In addition to economic values from active uses such as fishing and birding, there are passive use values. An example passive use value is the willingness to pay to preserve or enhance natural fish runs. Passive use values have subsets like "existence" and "option" values. Option values differ from existence values in that they are specifically associated with anticipated future uses. Whether or not existence values can be accurately measured is debatable (Diamond and Hausman 1994; Portney 1994; Conover 2002). However, existence value is conceptually an economic rationale for preservationist laws such as the ESA. DCCO may have existence values, but their prey salmon and steelhead may also have existence values.

Measuring passive use values is more complex and the results lack tangibility. This makes them difficult to understand, thus it is more problematic to incorporate them into policy making decisions (Arror 1993). The passive use values, no matter how tenuous the value calculations, are important for bringing into perspective the values from use values as compared to non-use values. Any improvements in a non-use value measurement associated with long-term policy decisions affecting salmon and steelhead stock recoveries will probably always dwarf use values. Policy discussions about continuing or just refining artificial propagation whose purpose is to support fisheries need to consider society's comparative importance on the continued existence of salmon and steelhead stocks.

Economists can discuss whether passive use values are quantifiable, and through proper data collection and analysis procedures, suggest whether predator or prey might have a higher loss through management actions. Or economists can discuss whether passive use values are unquantifiable (but still real), and suggest parallels and substitutes to characterize an action effect. Ultimately, economists are trying to provide decision making information rather than picking a best set of economic values.

Decision makers need to be wary of the economic analysis methods and measurements being offered to show an action's effects. Economic impacts from changed active use is not the same measurement as economic value from altered passive uses. Impact and value assessments measure different things and the results of one cannot be compared with another or used as respective surrogates. An economic impact study will generally refer to input-output analysis and the use of multipliers. An economic valuation study will usually refer to willingness to pay, opportunity or resource costs, net economic benefits, and/or consumer and producer surplus. Some of the basic information used in determining economic impact and economic value is the same, but the analysis is different.

III. Study Area Overview

Regions included in the economic analysis are wherever Columbia River Basin production contributes to in-river fisheries. Harvest data availability and existing regional economic models could be applied to show more widespread impacts to economies, such as southeast Alaska. However, the regions impacted by in-river fisheries will be proportionally much greater for dependence on Columbia River Basin production. This chapter provides a demographic synopsis of the study area and a current status description of in-river salmon and steelhead fisheries. This description provides a backdrop for comparing and contrasting the significance of management plan economic effects on Columbia River Basin in-river fisheries economic performance.

A. Demographics

The study area consists of the Columbia Basin ecological provinces for Columbia Estuary, Lower Columbia, Columbia Gorge, Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake.[1] Table III.1 shows how counties are assigned to the study area provinces. The assignment was necessary because demographic data is readily accessible when political boundaries are used. While impacts on other upriver areas would also likely occur because of the interrelationships between salmon populations and possible spillover effects from displaced fishing opportunities, the economic effects are likely to be substantially more focused on the defined study areas.

The study area consists of large regions that are primarily agriculture and natural resource oriented. There are several urban concentrations whose historical development was tied to river navigation. While there are local effects from Columbia River Basin production through fisheries, there will also be relative effects to state economies.

The two states (Oregon and Washington) have had similar experiences with divergent forces affecting the urban and rural economies. Each state has several urban areas along the Columbia River that have experienced significant growth in "high tech" industries while rural areas have largely continued to rely on their traditional industries. For example, an analysis of high tech employment in Oregon found several of the counties in the mid-Columbia area with no employment related to high tech. Due to the strength of the high tech sectors and the forecasts of continued growth, the impacts from changed fisheries would be hard to identify in areas where high-tech is located.

The socioeconomic data for age, gender, race, land density, poverty, income, housing, and employment by study area province is shown in Table III.2. Many of the provinces are sparsely populated. An economy's reliance on agriculture industry tends to generate higher levels of

1. Columbia River Basin ecological provinces are defined in Northwest Power Planning Council (2000).

unemployment, due to the seasonal nature and lower average earnings. Provinces with high density urban population centers, such as the Lower Columbia, grew faster in the last two decades than the mid-Columbia provinces. The unemployment rate for the provinces is considerably higher than the U.S.

Higher poverty rates are witnessed in areas with higher agriculture employment, such as in the Columbia Plateau Province (18.5 percent). Large shares of minority groups include blacks in the urban dominated population for the Lower Columbia and American Indian in the Columbia Cascade Province (4.6 percent). Hispanics make up 26.7 percent of the population in the Columbia Plateau Province and 25.2 percent in the Columbia Cascade Province where there is heavy participation by this ethnicity in farm worker occupations. The share of retirement age population (65 and older) is higher in coastal counties (Columbia Estuary Province) and mountainous counties (Blue Mountain and Mountain Snake provinces).

The social factors in Table III.2 are used to identify socio-economic groups that are particularly vulnerable to changes in fisheries. The social impacts to these groups are discussed in a later chapter. The discussions are qualitative, but methods and diachronic modeling is suggested to be used in assessments (USIC 2003).

B. Inriver Fisheries

This section of the report describes the current status of the in-river fisheries in which Columbia River Basin salmonid production contributes. The section is itemized for fishing industry commercial harvest, processing, retail market, and recreational angling segments.

1. Commercial Harvesting Segment

Columbia River Basin production contributes heavily to ocean fisheries from Oregon north to southeast Alaska, as well as Columbia River inland fisheries. This is consistent with the migration patterns of Columbia River Basin produced salmon: north turning fish (fall Chinook), south turning fish (coho), and some that tend to migrate in either direction (some populations for both Chinook and coho). Steelhead tend to scatter and migrate as far as Russian waters. Harvest amounts by geographic area depend on migration patterns and on governance intended to allocate benefits aligned with production origin.

Because salmon range over a large geographic area, production and harvest management is very complex. There are five general governance processes that give direction to production and harvest management.[1] These five are the principles in international agreements on salmon interceptions; the PST; MSA leading to the PFMC Salmon Management Plan; Columbia River ESA listed recovery stocks' harvest impact constraints; and, user group allocation

1. See Appendix A for more detailed fisheries governance descriptions.

agreements.[1,2] The ESA restricts the amount of wild salmon that may be harvested directly or indirectly once a species or sub-species has been placed on the threatened or endangered species list. Any plans or management that might affect production or harvests from Columbia River hatcheries have to address some or all of these governance requirements.

The federal government must protect tribal fishing rights guaranteed to Columbia River tribes in treaties and trust responsibilities as reaffirmed in court decisions. Harvest management has been predicated on these tribal treaty and trust responsibilities. If there are changes to Columbia River Basin salmon and steelhead production, then harvest management regimes will have to be adjusted so that the relative harvest shares are brought back into governance requirements.

The overall trend for river salmon commercial fishery landings has been downward since 1938 (Figure III.2). There was a spike in the late 1980's and a bump-up during the period 2001 to 2004. Current years have also shown increases which are encouraging that harvest levels might have bottomed to the five million pound level. While these harvest levels do provide modest inland fisheries, it is but a fraction of historical Columbia River production landed at river locations.

Inriver fisheries harvests in Year 2012 by sectors are shown in Table III.3. There was $7.3 million commercial salmon landed from the Columbia River inland catch area in 2012. Of this amount, $3.1 million was landed in lower Columbia River (LCR) non-Indian fisheries by identifiable vessels and $3.8 million in tribal fisheries. Another $0.4 million was landed by unidentifiable non-Indian vessels. Table III.4 shows deliveries for the commercial non-Indian and tribal fisheries.[3] The total number of fish tickets issued in 2012 was 10,620 with 5,253 for landings below Bonneville Dam and 5,367 above Bonneville Dam in 2012. Of all of the deliveries made on the Oregon side, there were 93 percent tickets below Bonneville Dam and seven percent tickets above Bonneville Dam. The deliveries on the Washington side were 20 percent below Bonneville Dam and 80 percent deliveries above Bonneville Dam.

The Astoria (Clatsop County, Oregon) and Ilwaco (Pacific County, Washington) area located at the Columbia River ocean entrance has the largest commercial fishing industry presence of all regional economies adjacent to the River (Table III.5). The fishing industry is not particularly vulnerable to in-river fisheries as the total (ocean harvest area included) commercial salmon

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1. User groups in this sense are commercial gillnet, commercial tribal, and recreational participants that have homogeneous interests and compete for access to salmon and steelhead in regional fisheries.
2. Columbia River Basin production is tied to the implementation of the PST by way of identified index stocks, such as the ODFW Big Creek tule fall Chinook population. This population provides an index of abundance for which regional fisheries catch sharing plans are benchmarked.
3. Fish ticket counts can be interpreted to be a count of deliveries, however in some situations more than one ticket can be issued for a delivery. Tenderers on the LCR will sometimes pick up catch from a harvester more than once per day.

fishery is about five percent (measured by harvest revenue) of all fisheries deliveries. The share of those deliveries from in-river commercial non-Indian and tribal fisheries is about 83 percent.

There were 576 gillnet fishery permits in Washington (258) and Oregon (318) in 2004 (TRG 2006). After accounting for permittee double permit holders and other factors, there are 481 vessels associated with the permits. Not all permitted vessels harvest every year in the gillnet fishery. Only 41 percent of vessels earning more than $500 in annual gillnet revenues participated every year during the last five years. (The $500 amount is an assumed threshold for active vessels participating in a directed fishery.) For WDFW and ODFW issued gillnet permits, 51 percent are registered to Clatsop and Pacific county addresses. About 98 percent are issued to addresses in Washington and Oregon. WDFW Columbia River gillnet licensees can also fish Grays Harbor or Willapa Bay locations. About 30 percent of gillnet permittees were found to have Alaska fishing permits of which 58 percent were registered to Washington, 39 percent to Oregon, and the rest to other states. Many gillnet permittees also hold other West Coast fishing permits, including Washington or Oregon Dungeness crab permits. Fishing industry operating costs are usually incurred near the fishery's access locations, but labor payments and business net income goes to permit residence locations for respending.

There were 244 vessels uniquely identified with the deliveries in the LCR in 2012 (Table III.4). Of these vessels, 224 had gillnet revenue greater than $500. The top 44 vessels by revenue harvested 50 percent of the total ex-vessel revenue in the gillnet fishery in 2012. The average active vessel gillnet revenue was $13,853 and average top 10 vessel's gillnet revenue was $50,361. The active vessels' total revenue is 77 percent from the gillnet fishery. Arrangements for issuing fish tickets in tribal fisheries does not allow for uniquely identifying vessels, so similar statistics are not available.

The tribal fishery harvests in Table III.3 do not include C&S fisheries. The average harvests in C&S fisheries over a 10 year period are shown in Table III.6. Columbia River Basin anadromous fish production also contributes to First Nation harvests in British Columbia ocean fisheries and tribal commercial and personal use fisheries in southeast Alaska, but detailed harvest numbers for these fisheries are not shown.

2. Processing and Retail Market Segments

a. Processing

There were 70 different businesses that purchased Columbia River commercial non-Indian and tribal caught salmon and steelhead in 2012. Table III.7 shows counts by purchase size categories.

There are four types of fish receiver/processors aligned with their operational characteristics are:

1. Fish receiver that buys for their own marketing purposes. These may be a retail market in Seattle or Portland, or a farmer's market in the Portland or Seattle area.

2. Buyer that purchases mainly for their own value added purposes. Product forms may include smoking and/or canning.

3. Tender and buyer that purchases mostly for resale to other larger processors.

4. Medium and large processor. Receives fish and sells them to distributors or hauls them to Seattle for further processing and marketing. Much of the lower Columbia River gillnet harvests involve tendering. The seasons are very short and the harvesters do not want to leave their fishing grounds to make deliveries. The tender/receiver weighs them, ices the fish, and grades them out. The tender also makes out the fish tickets. The fish tickets are made out in the fish processor name or in their name. The fish processor supplies ice, the transportation, and pays the harvester. They receive from $0.15 to $0.25 per pound, depending on the species. Tribal set net fisheries can be left to soak, but must be tended at least once per day. Tribal harvesters will make individual arrangement for selling to a processor.

There are five larger processors in the Astoria area that receive, process, and market fish harvested from the lower Columbia River gillnet fishery. The larger processors will have total sales over $5 million. Their operation generally receives the fish from a tender. The processor guts the fish, and in some cases removes the head, re-ices, and sells the fish to a distributor or sends the fish to be put into cold storage. Very little is processed into fillets etc. in the Astoria area. Purchases are hauled to cold storage and processing facilities in the Seattle/Bellingham area. There are seven large processors with similar sales and manufacturing characteristics that purchase commercial tribal fisheries. In addition, the Columbia River Inter-Tribal Fish Commission (CRITFC) developed a tribal owned and operated processing center at East White Salmon, Washington on an in-lieu fishing access site.

Hatchery escapements that are surplus fish (over and above needed for propagation) may be sold to processors or rendering businesses on a bid basis. For those that are food fish quality, there will be no difference in manufacturing product forms between ocean and river capture, and hatchery surplus salmon. Other surplus fish are donated to low-income food banks or used for biological stream revitalization (ODFW 2013).

Table III.8 shows typical seafood product forms and distribution for river capture salmon. Much of the salmon harvested and processed to a product for freezing (graded, headed/gutted, boxed) is sent to the Seattle/Bellingham area. This is an area that handles fish from Alaska, as well as from the Pacific Northwest. The area is also a central place from which to market fish throughout the world. Fish may be cut fresh there or put into cold storage. Fish are stored in the name of the Astoria area processor until they are sold, either in their frozen whole form or further processed for sale to the buyer's specifications. The processing in the Seattle/Bellingham area of Columbia River fish is part of a larger base. Labor is experienced, and the storage and marketing infrastructure is adequate. These plants also process farmed fish. There is not enough volume on the Columbia River to compete with the Bellingham area processing.

Local processors utilizing Columbia River Basin salmon harvests supply seafood salmon products to a growing market demand for wild caught fish. A carcass byproduct from the processing also serves as an additional added-value manufacturing input. An Astoria business uses the carcasses for the manufacture of fish meal and oil. This analog salmon product has been used at Columbia River hatcheries to rear a new generation of salmon smolts. There is also a worldwide poultry and cattle livestock market for this protein form.

In addition to buyer and processor businesses/handling harvest distribution to consumers, there are a number of harvesters that make direct sales to the public. There is a greater proportion of tribal commercial catch handled with this type of distribution than in the lower Columbia River non-Indian fishery.

Purchase price offered to harvesters by processors is usually negotiated preseason with understandings that adjustments can occur when triggered by management constraints in troll or river fisheries, and/or actual seafood retail price changes. Salmon prices vary for fish size, species, and condition. Lower river caught fish typically fetch higher prices than catch in upriver tribal fisheries (Table III.3). CRITFC sponsors programs in tribal marketing and education programs about the care and custody of fish to improve quality of deliveries or what is sold through direct sales to the public. The new marketing and product quality strategies are to increase the price balance between lower and upriver harvest locations.

Commercial salmon largely enter a global market with many substitutes. This includes readily available products from farmed salmon production and other wild capture sources. The trend is for increasing shares of farmed salmon production to provide for domestic and world salmon demand. Farmed salmon production costs have allowed significantly lower prices to be passed on to consumers. However, consumers' familiarity with the differences between farmed salmon and wild capture quality is also growing, so opportunities exist to divert gillnet fishery harvests to higher value market channels. The following section explores salmon market trends and the growth of higher value niche markets.

b. Retail Markets

Since the early 1980's, improved captive salmon propagation procedures and transportation systems have allowed salmon aquaculture to supply the needs of the world market with a consistent supply of salmon. Salmon aquaculture is setting standards that have to be addressed by any other producers of salmon. U.S. market consumption for seafood is up, but supplies from imports are more than filling increases in demand. Most of the supply increase is from foreign farmed salmon origin, which can be produced year around, in consumer desired size, with volumes needed by large retail and food service companies, and at a lower cost.

The "squeeze" between Alaska's production of canned and frozen salmon and aquaculture's production of fresh salmon puts Pacific Northwest salmon production into a price and market niche position. To realize improved prices, it is necessary to distinguish unique qualities of the production so customers will seek out and pay for its advantages.

The world supply of salmon has gone through dramatic changes. Salmon supplies that were traditionally dependent on captured harvests have changed toward farmed salmon production. Today's global salmon markets are characterized by strong competition and rapidly growing supplies of an aquaculture product. Farmed salmon production is expected to continue to be the dominant force in product and price determination.

Farmed salmon has significant competitive advantages over wild salmon with respect to production factors (Knapp 2005):

Production Factors	Wild Salmon	Farmed Salmon
Volume	Production volume is inconsistent from year to year and difficult to predict.	Farmers can accurately forecast production and guarantee supply commitments.
Timing	Wild harvests must occur during a short summer run.	Farmed production can occur over many months or year-round
Consistency	There is wide variation in the size and quality of individual wild fish.	Farmed fish can be produced of consistent sizes and quality.

Other factors affecting the marketing of captured salmon:

- Increasing consolidation of retail trade by large multinational companies (Wal-Mart, Costco, etc.) competing on price and efficiencies of scale and seeking suppliers who can offer consistent supply of high volumes at low cost.
- Changing consumer demand as incomes rise, lifestyles change, demographics change, and the range of products available to consumers change.
- Seafood reprocessing migrating to low-cost countries, such as Chinese canning of Bumblebee Russian pink salmon, and Chicken of the Sea shift of boneless/skinless salmon canning operations from U.S. to Thailand.

Salmon farming or aquaculture has been part of western civilization for some time. German biologists began hatching salmon eggs as far back as 1763. Chilean biologists began experiments with establishing non-native salmonid species in 1905. Efforts to raise salmonids as food fish began in earnest during the mid 1950's when Norwegian biologists began experimenting with Atlantic salmon smolts (Folsom et al. 1992). Production of salmon grown in net pens began in earnest in the 1980's. In 1980, pen raised salmon accounted for one percent of the world's total salmon production; in 1991 this increased to 27 percent; the estimated current percentage of farmed salmon is 65 percent.

Historically Norway has been the largest salmon farming production. But in recent years, the Norway-EU salmon agreement has slowed Norwegian growth, while Chilean production has grown very rapidly. One of the main reasons for Chilean farmed salmon producer competitiveness is low labor costs. An abundant supply of cheap fish meal, for use in farmed salmon feed, has also helped the Chilean producers' competitive edge. In Chile, about 1.5 to 1.8 kg of food is needed to produce one kg of mature farmed salmon. This is the equivalent of a cost of $0.68 to $0.82 per produced pound.

The farmed salmon industry is consolidating into large, vertically integrated multinational companies with operations in many countries. This results in:

- Increasing market power;
- Increasing economies of scale in production, processing, distribution, and marketing;
- Diversified production opportunities into other species, not just salmon.

In recent years, consolidation has decreased overhead costs as well as transportation costs to the level where fillets are delivered to the West Coast at between $2.05 and $2.50 per pound. Salmon farmers are expanding production into new markets, including frozen salmon, canned salmon, and roe.

The result of the increase in world salmon supply is to decrease total revenue received by harvesters, even though total landed fish has increased, due to price pressure from aquaculture Alaska for example has increased total harvests to about 800 million pounds, from less than 400 million pounds in the 1970's. Despite increasing harvests to record levels, total revenue from salmon fishing (adjusted for inflation) steadily decreased in the 1990's from about $500 million in the early 1990's to about $200 million in the early 2000's (Knapp 2005). In Alaska an increasing amount of salmon is being marketed as fresh. Specialty stores and restaurants represent a growing market for consumers whose needs are not met by the large chains. This is a relatively small share of the total market.

The 1990's U.S. domestic salmon market was composed of 68 percent food service consumption and 32 percent retail consumption, but the retail market segment is increasing. Two-thirds of the retail segment is purchased through supermarkets (62 percent), followed by fish markets (23 percent) and specialty outlets (15 percent). The trend in both food service and retail sectors is toward a preference for fresh salmon over frozen salmon and a declining market share for canned salmon (Knapp et al. 2007). Fresh salmon comprised 65 percent of food service sales and comprised 35 percent of retail sales. Four out of five salmon consumers use fresh salmon. This preference was reflected by the fact that 84 percent of fresh/frozen seafood sales of salmon was in fresh form and only 16 percent frozen.

The Pacific Northwest salmon fisheries are competing in the same markets as Alaska, the major producer of wild salmon in the world. Many in the industry agree that to compete on a global market, the Pacific Northwest and Alaska salmon will have to move outside the traditional forms of frozen and canned in order to receive higher revenues for their fisheries. Much food consumption has moved to eating away from home or to cooking quick, ready to eat food. This results in greater preparation at the processing sector. This involves more labor and capital input into processing.

3. Recreational Angling Segment

Columbia River Basin salmon and steelhead production provides for a very large recreational in-river fishery. Inriver fishery governance allocates fish by species and catch areas for anglers retention and takes into consideration non-retention mortalities. Very detailed regulations are issued annually for time and area closures, bag limits, gear restrictions, and other techniques to keep total mortalities within the allocation and ESA listed population impact schemes. Hatchery production levels and practices (including off-site acclimation release sites) are designed to promote both commercial and recreational harvesting.

There is no single data source that tracks total Columbia River Basin in-river angling activity. There are annual pressure counts for fall fisheries in the lower River area (Watts 2013), but upriver and tributary angling activity is generally a modeled estimate using special creel survey catch per unit effort (CPUE) estimates. The PFMC (2013) annually estimates economic contributions for the popular fall Buoy 10 fishery and there are other special studies completed for other confined mainstem and tributary fisheries (for example see Reading (2005)). Because there is no comprehensive angling activity reporting available for estimating what marginal increases in adult returns from saved DCCO juvenile salmon predation might mean, it was necessary to include a recreational angling element in the economic analysis model developed for this study.

There are many assumptions used to develop angler trips, spending patterns, and economic contributions for this study. The authors express caution in using the Alternative A absolute estimates to represent total activity for other descriptive and planning purposes. The estimates from this study are only intended to show estimated effects from change in predation levels and absolute angling activity variance from actual will be on both sides of an impact equation. With these caveats in mind, the share of total economic contribution from in-river fisheries is shown in Figure IV.1. The salmon and steelhead fishery trip spending accounts for 70 percent of all calculated in-river fisheries $49.7 million total personal income. Angler capital expenditures are not included in this estimate because the economic analysis is to calculate economic effects and it is assumed capital items would have been purchased with or without management plan actions. This means the economic contributions do not include effects from capital purchase items like boats. There are other studies that do include fishing capital costs which might be of interest to readers of this report.[1]

Table III.1
Assigned Counties Within Study Area Provinces

Study Area

Province	Major Counties
Columbia Estuary	Pacific, WA
	Wahkiakum, WA
	Clatsop, OR
Lower Columbia	Clark, WA
	Cowlitz, WA
	Lewis, WA
	Columbia, OR
	Linn, OR
	Marion, OR
	Lane, OR
	Benton, OR
	Polk, OR
	Yamhill, OR
	Washington, OR
	Clackamas, OR
	Multnomah, OR
Columbia Gorge	Klickitat, WA
	Skamania, WA
	Hood River, OR
	Wasco, OR

Province	Major Counties
Columbia Plateau	Yakima, WA
	Kittitas, WA
	Benton, WA
	Grant, WA
	Lincoln, WA
	Adams, WA
	Whitman, WA
	Garfield, WA
	Walla Walla, WA
	Columbia, WA
	Franklin, WA
	Latah, ID
	Deschutes, OR
	Crook, OR
	Jefferson, OR
	Sherman, OR
	Gilliam, OR
	Morrow, OR
	Umatilla, OR
	Wheeler, OR
	Grant, OR

Province	Major Counties
Columbia Cascade	Douglas, WA
	Okanogan, WA
	Chelan, WA
Blue Mountain	Asotin, WA
	Union, OR
	Wallowa, OR
Mountain Snake	Idaho, ID
	Clearwater, ID
	Nez Perce, ID
	Lewis, ID
	Custer, ID
	Lemhi, ID
	Valley, ID

Note: Considerations for assigning counties to provinces included relationship of land area, centers of population, and major watersheds to province boundaries. There are small exclusions of land area and, to a lesser extent, population from the assigning.

1. Estimates of the economic effects from equipment and other capital items vary widely in studies. For example, Gentner and Steinback (2008) found 63.6 percent in survey year 2006 of total economic contributions were from durable goods used for saltwater fishing in Oregon. The U.S. Fish and Wildlife Service (USFWS 2012) National Surveys found total spending for saltwater fishing nationwide was 40.4 percent in data year 2006 and 29.1 percent in data year 2011 for non-trip related items.

Table III.2
Study Area Demographic Profile by Provinces

	Study Area Provinces							
Indicator	Columbia Estuary	Lower Columbia	Columbia Gorge	Columbia Plateau	Columbia Cascade	Blue Mountain	Mountain Snake	Study Area Total
Resident population, 2012	61,927	3,412,273	79,883	1,131,469	154,169	54,533	90,010	4,984,264
Population share by age								
Under 18 years	19.2%	22.8%	22.9%	26.1%	24.9%	21.2%	20.1%	23.5%
18 to 64	59.4%	63.9%	60.2%	60.7%	58.6%	59.2%	59.2%	62.7%
65 and over	21.3%	13.3%	16.9%	13.2%	16.6%	19.5%	20.6%	13.7%
Population share by gender								
Male	49.7%	49.4%	50.1%	50.5%	50.2%	48.8%	50.9%	49.7%
Female	50.3%	50.6%	49.9%	49.5%	49.8%	51.2%	49.1%	50.3%
Population share by race								
White	92.7%	87.1%	92.7%	91.2%	91.3%	94.6%	93.1%	88.5%
Am. Indian/AK native	1.8%	1.5%	2.7%	2.8%	4.6%	1.3%	3.7%	1.9%
Other	5.5%	11.4%	4.5%	6.0%	4.1%	4.1%	3.2%	9.6%
Population share by Hispanic origin								
Hispanic or Latino origin	7.8%	11.9%	17.4%	26.7%	25.2%	3.7%	3.3%	15.4%
Other	92.2%	88.1%	82.6%	73.3%	74.8%	96.3%	96.7%	84.6%
Population per square mile, 2010	30.6	185.3	12.3	25.2	15.2	9.3	3.5	43.7
Population in poverty, 2008-2012	16.6%	14.8%	15.7%	18.5%	15.8%	15.5%	14.2%	15.7%
Median household income, 2008-2012	43,187	53,955	47,714	48,150	48,329	41,784	42,848	51,923
Per capita income, 2012	36,435	40,411	38,567	35,669	37,229	35,614	35,596	39,016
Number of housing units, 2012	39,432	1,396,911	36,304	456,455	74,108	25,422	52,110	2,080,742
Homeownership rate, 2008-2012	67.9%	62.1%	68.7%	64.0%	67.9%	67.1%	74.5%	63.3%
Number of firms, 2007	6,119	290,308	6,912	80,782	12,850	4,628	9,576	411,175
Am. Indian/AK native-owned firms	0.0%	0.6%	0.0%	1.0%	0.0%	0.0%	0.4%	0.6%
Employment, 2012	27,619	1,565,983	40,358	500,128	76,021	23,425	38,223	2,271,757
Unemployment rate	9.1%	8.6%	8.5%	9.3%	8.1%	9.3%	8.3%	8.7%

Sources: U.S. Census Bureau, U.S. Bureau of Economic Analysis, and U.S. Bureau of Labor Statistics.

Table III.3
Columbia River Inriver Fisheries Commercial Harvest Ex-Vessel Price, Value, and Pounds in 2008 to 2012

		Price					Ex-vessel Value (thousands)					Pounds (thousands)				
Fishery	Species	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
OREGON																
Non-treaty	Chinook															
Gillnet	Spring	6.57	4.75	5.13	5.17	5.82	759	460	1,962	1,189	1,056	116	97	382	230	181
	Fall	2.66	2.17	2.20	2.32	2.21	1,097	947	937	1,473	900	413	436	426	635	407
	Tules	0.61	0.57	0.62	0.59	0.54	68	95	160	138	110	112	168	257	234	204
	Coho	1.39	1.28	1.45	1.68	1.61	712	1,079	810	737	149	512	846	560	439	92
	Chum	0.69	0.55	0.70	0.78	0.49			1					1		
	TOTAL						2,636	2,582	3,870	3,537	2,215	1,152	1,547	1,626	1,537	885
Treaty	Chinook															
All gears	Spring	4.93	3.60	4.38	3.64	5.52	343	150	614	186	74	70	42	140	51	13
	Fall	2.72	1.47	2.10	2.40	2.56	997	594	476	608	350	366	403	226	253	137
	Tules	0.48	0.38	0.66	0.72	0.74	62	38	92	31	5	129	100	140	43	7
	Coho	1.23	0.97	1.97	1.56	1.85	54	25	34	31	11	44	26	17	20	6
	TOTAL						1,455	807	1,215	857	440	609	571	524	367	163
WASHINGTON																
Non-treaty	Chinook															
Gillnet	Spring	7.13	5.57	5.20	4.57	6.27	334	331	564	359	330	47	59	108	78	53
	Fall	2.71	1.88	2.03	1.94	2.04	540	566	532	760	727	199	302	262	391	355
	Coho	1.34	1.19	1.36	1.54	1.63	294	312	337	243	62	219	262	247	158	38
	Chum	1.03	0.62	0.62	0.59	0.43			2	1			1	2	1	
	TOTAL						1,169	1,210	1,434	1,362	1,119	466	624	620	628	446
Treaty	Chinook															
All gears	Spring	4.73	3.17	3.92	3.57	4.75	1,031	650	2,061	1,697	922	218	205	526	475	194
	Fall	1.45	0.98	1.19	1.85	1.73	1,695	862	1,804	2,958	1,704	1,172	880	1,521	1,596	980
	Coho	0.85	0.60	0.92	1.46	1.26	156	26	23	237	36	184	44	25	163	28
	TOTAL						2,882	1,539	3,888	4,892	2,662	1,574	1,129	2,072	2,234	1,202
TOTAL COLUMBIA RIVER (OREGON AND WASHINGTON)																
Non-treaty	Chinook															
Gillnet	Spring	6.71	5.07	5.16	5.03	5.92	1,093	791	2,526	1,548	1,386	163	156	490	308	234
	Fall	2.67	2.05	2.14	2.18	2.14	1,637	1,513	1,469	2,233	1,627	612	738	688	1,026	762
	Tules	0.61	0.57	0.62	0.59	0.54	68	95	160	138	110	112	168	257	234	204
	Coho	1.38	1.26	1.42	1.64	1.62	1,006	1,391	1,147	980	211	731	1,108	807	597	130
	Chum		0.00	1.00	1.00				3	1			1	3	1	
	TOTAL						3,804	3,790	5,305	4,900	3,334	1,618	2,171	2,245	2,166	1,330
Treaty	Chinook															
All gears	Spring	4.77	3.24	4.02	3.58	4.81	1,374	800	2,675	1,883	996	288	247	666	526	207
	Fall	1.75	1.13	1.31	1.93	1.84	2,692	1,456	2,280	3,566	2,054	1,538	1,283	1,747	1,849	1,117
	Tules	0.48	0.38	0.66	0.72	0.71	62	38	92	31	5	129	100	140	43	7
	Coho	0.92	0.73	1.36	1.46	1.38	210	51	57	268	47	228	70	42	183	34
	TOTAL						4,338	2,345	5,104	5,748	3,102	2,183	1,700	2,595	2,601	1,365
Columbia River Total							8,142	6,138	10,407	10,648	6,436	3,801	3,871	4,842	4,766	2,696

Notes: Dollars are adjusted to 2012 using the GDP implicit price deflator.
Source: PFMC, Review of Ocean Salmon Fisheries, annual in February.

Table III.4
Columbia River Inriver Fisheries Deliveries, Vessel Counts, and Revenues in 2012

Deliveries

		Count	Share
Oregon	Above Bonneville	304	7%
	Below Bonneville	3,987	93%
	Subtotal	4,291	100%
Washington	Above Bonneville	5,063	80%
	Below Bonneville	1,266	20%
	Subtotal	6,329	100%
Total	Above Bonneville	5,367	51%
	Below Bonneville	5,253	49%
	Total	10,620	100%

Lower Columbia River Commercial Fishery

	Count	Share
All vessels	244	100%
Vessels >$500	224	92%
Average LCR salmon revenue	$13,853	
LCR salmon share		77%
Vessels 50% value	44	
Vessels 90% value	132	
Top 10 vessels	10	
Average LCR salmon revenue	$50,361	
LCR salmon share		93%

Columbia River Commercial Fishery Revenue ($000's)

Lower Columbia River identified vessels	$3,107
Columbia River unidentified vessels	$4,175
Non-Indian	$396
Tribal	$3,780
Total Columbia River	$7,282

Notes: 1. Vessel counts are for lower Columbia River fishery only.
2. Total revenue is from only West Coast fisheries associated with the vessel. Some lower Columbia River fishery permittees also participate in Alaska and other distant water fisheries as well as other West Coast fisheries using a different vessel.
3. Deliveries are approximated using fish ticket counts.

Source: TRG (2013).

Table III.5
Pacific Ocean and Columbia River Inriver Fisheries Harvest Revenue Delivered to Lower Columbia River and Other Ports Itemized for Area-of-Catch in 2012

	Area-of-Catch ($000)				
Landing Location		Columbia River		Other Harvest	
Gear and Species	Ocean	Lower	Upper	Locations	Total
Salmon Net					
Astoria	0	2,221	0	0	2,221
Ilwaco	0	937	0	854	1,791
Other ports		171	3,795		3,967
Salmon Troll					
Astoria	502	0	0	0	502
Ilwaco	152	0	0	0	152
Groundfish					
Astoria	9,969	0	0	0	9,969
Ilwaco	3,257	0	0	0	3,257
Pacific Whiting					
Astoria	7,558	0	0	0	7,558
Ilwaco	512	0	0	0	512
Dungeness Crab					
Astoria	4,010	0	0	0	4,010
Ilwaco	6,614	0	0	0	6,614
Pacific Sardine					
Astoria	8,974	0	0	0	8,974
Ilwaco	1,480	0	0	0	1,480
Pink Shrimp					
Astoria	4,347	0	0	0	4,347
Ilwaco	560	0	0	0	560
Albacore Tuna					
Astoria	3,187	0	0	0	3,187
Ilwaco	10,254	0	0	0	10,254
White Sturgeon					
Astoria	0	117	0	0	117
Ilwaco	0	57	0	12	70
Other ports		3	208		211
Pacific Halibut					
Astoria	167	0	0	0	167
Ilwaco	168	0	0	0	168
Shellfish					
Astoria	51	0	0	0	51
Ilwaco	13,941	0	0	69	14,010
Other Species River					
Astoria		1	0	0	1
Ilwaco		16	31	0	47
Other ports		0	2		2
Other Species Ocean					
Astoria	245				245
Ilwaco	469				469
Total					
Astoria	39,010	2,339	0	0	41,349
Ilwaco	37,406	1,010	31	935	39,383
Total Astoria/Ilwaco	76,416	3,350	31	935	80,732
Total other ports		175	4,005		4,180

Table III.5 (cont.)

Notes: 1. Fish ticket information for Columbia River salmon area-of-catch is assigned to two general river landing codes. One code is for Washington side landings and one code is for Oregon side landings. It is assumed the lower Columbia River area-of-catch landings on the Washington side are delivered to Ilwaco purchasers and landings on the Oregon side are delivered to Astoria. Fish ticket information for area-of-catch when not made at a river location (i.e. deliveries to a Seattle area purchaser) does not have this limitation and is assigned to "other ports." The same assumption for upper river treaty harvests is not valid. About a quarter of the upper river harvests are purchased by the same processors and buying stations that purchase from lower river harvests. This means there will be a slight undercounting of business activity for Astoria and Ilwaco processing businesses.

2. For ocean area-of-catch, Astoria includes Cannon Beach and Seaside landing locations. Ilwaco includes Willapa Bay and Chinook locations. Other ports include other Columbia River points of landing as well as out-of-region locations such as the Seattle area. Other areas-of-catch include Willapa Bay, Grays Harbor, and Puget Sound.

3. Salmon net gear includes gillnet, in some years a very minor amount of set net in the lower Columbia River, and set net, dip net, and other net in the upper Columbia River.

4. Salmon troll includes a very minor amount harvested in the ocean with other non-net and net type gear.

5. There is a minor amount of groundfish showing on fish tickets for being caught in the upper Columbia River and landed at Oregon side Columbia River ports. No attempt was made to resolve inconsistencies in fish ticket information.

6. Shellfish includes Washington aquaculture shellfish.

7. "Other species river" includes anchovy ($31 thousand) and shad ($18 thousand). "Other species ocean" includes hagfish ($445 thousand), chub and unspecified mackerel ($224 thousand), and anchovy ($24 thousand).

Source: TRG (2013).

Table III.6
Columbia River Tribal Ceremonial and Subsistence Harvests

	High		Low			
	Amount	Year	Amount	Year	Mean	Median
Last 10 Years						
Coho	1,277	2003	22	2006	510	370
Spring/Summer Chinook	15,482	2012	6,435	2007	10,485	9,652
Fall Chinook	832	2012	15	2009	379	404
Steelhead	3,759	2005	1,596	2006	2,971	3,265

Notes:
1. The 10 year period is 2003 to 2012. Coho and steelhead central tendency analysis only inclusive of years 2003 to 2006. Year 2012 is preliminary.
2. Willamette River surplus hatchery fish have been used in some years to augment C&S harvests.
3. Chinook C&S are primarily mainstem fisheries between Bonneville and McNary dams. Significant subsistence fisheries also occur in tributaries throughout the Columbia and Snake River basin, especially for spring Chinook, which are not included in these estimates.
4. The Colville Confederated Tribes' C&S harvests are not included in these estimates. The Tribes harvest in two locations. The Tribes use selective harvesting gear at the mouth of the Okanogan to take advantage of a temporary thermal barrier that keeps salmon in the Columbia before they enter the Okanogan on their migration into Canada. Retained species include both hatchery-origin summer/fall Chinook and wild sockeye (both unlisted salmonid ESU's in the upper Columbia). Wild summer/fall Chinook and steelhead are released. The harvests on the mainstem Columbia River in 2013 were: 4,276 sockeye, 3,142 summer/fall Chinook, and 127 steelhead. The Tribes also harvest spring Chinook in Icicle Creek near Leavenworth, Washington. The harvests were from 2010 through 2012: 2010 – 310 adults, 13 jacks; 2011 – 248 adults, 117 jacks; 2012 – 123 adults, 8 jacks. The harvested fish from the two locations are used for C&S as well as exchanged with other tribes.

Sources: Chinook from PFMC (2013), coho and steelhead from ODFW and WDFW (July 2007), and Colville Confederated Tribes harvest from personal communication (2014).

Table III.7
Columbia River Commercial and Tribal Salmon and Steelhead Processor Characteristics in 2012

	Counts			
Category	<$10,000	<$100,000	$100,000+	Total
Tribal purchases	12	12	10	34
Non-Indian purchases	19	17	8	44
Total	26	27	17	70

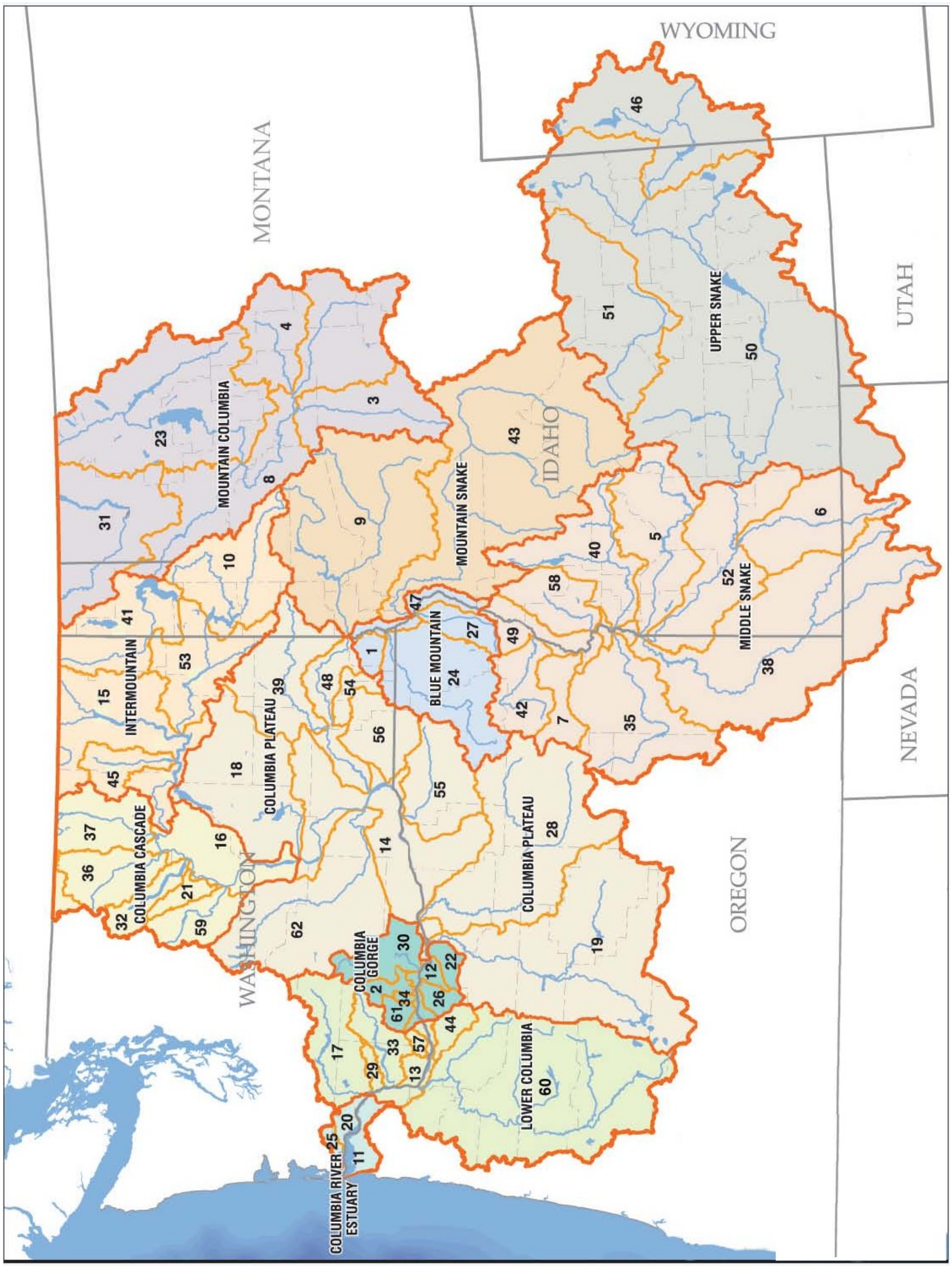
Notes:
1. Itemized counts will not sum to totals, because processors may purchase from both non-Indian and tribal harvesters.
2. The counts may be an over estimate of actual processing businesses, because one business can hold more than one license under which fish tickets are issued.
3. Harvesters that have direct sales to the public are included in the counts.
4. Purchase categories are only salmon and steelhead with area-of-catch from Columbia River locations.

Source: TRG (2013).

Table III.8
Columbia River Inriver Fisheries Typical Seafood Product Forms

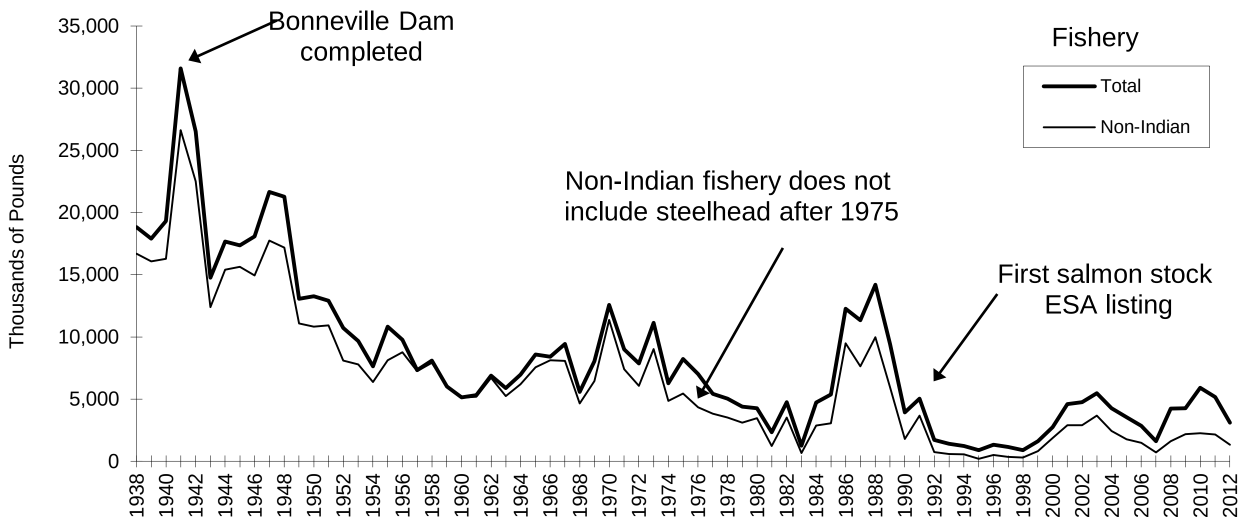
	Spring Chinook	Coho	Fall Chinook Tule	Bright
Destination market				
U.S.	Fresh	Fresh	West Coast	Fresh, Frozen
Europe		Frozen		
Product Form				
Head-on fresh	100%			
Head-off fresh		45%		75%
Head-off frozen		45%		25%
Fillets fresh		5%		
Fillets frozen		5%		
Canned				
Smoked				
Jerky			100%	
Eggs				

Figure III.1
Boundaries for Columbia River Basin Provinces and Sub-basins Superimposed on Counties



Source: Northwest Power Planning Council (2000). Map by Northwest Habitat Institute, Corvallis, Oregon.

Figure III.2
Columbia River Inriver Fisheries Commercial Landings by Non-Indian and Tribal Fisheries in 1938 to 2012



Notes: 1. Weight is round pound equivalents.
Source: Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) (August 2004), Table 14 and Table 19; Pacific Fishery Management Council (PFMC) (February 2008), Table IV-9; and TRG (2013).

IV. Economic Analysis Results

A. Baseline Conditions

Economic effects from reduced predation on Columbia River Basin salmon and steelhead production need to be addressed in several dimensions.

- Direct effects are caused by the action. Reducing smolt mortality caused by DCCO predation should increase adult returns to fisheries. If there is more opportunity to fish, then economic contributions from executing the fisheries should increase. These direct effects are dealt with extensively in this chapter. Other direct effects are acknowledged, but are not quantitatively described. For example, wildlife viewing trip changes due to DCCO management alternatives were not assessed.
- Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. An example is effects to other wildlife from shoreline and water pollution caused by fishing activity. Public health might be affected for groups that depend on production for subsistence and substitutes for changes are not available. The indirect effects are discussed in the social implications chapter of this report.
- Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. An example would be any expected changes to ESA listed species recovery plans that would cause fishery governance to compound harvest restrictions brought about by changes to Columbia River Basin production. Cumulative impacts are not assessed in this report.
- Irreversible and irretrievable impacts can occur if there is no reasonable and practicable alternative that would avoid, mitigate, and eliminate the impacts. There may not be options to adjust other production nor fisheries management to compensate for the effects to particular user groups. The irreversible and irretrievable impacts are not dealt with in this report.

In order to explain the consequences of changing hatchery and wild fish survival, there needs to be a point of reference. NEPA interpretations generally suggest using current environmental conditions. The baseline conditions used in this report were developed to closely approximate current conditions. Baseline conditions are usually not a snapshot of a certain time, but a representation of recent conditions. That does not preclude some comparative descriptions being made to historic affected conditions. This would especially be of interest to tribes who will relate current conditions to conditions in times of pre-European settlement in order to gain a point of reference for evaluating baseline condition effects. A rich impact description would both use a baseline and historic conditions for a point of reference, but research, investigation, and interpretation budget resources have limited these descriptions.

B. Methods

The procedure to determine economic effects is to:

(1) Determine the presence of out-migrating smolts. This is accomplished by using average 2008-2012 annual hatchery release data expanded to account for wild production and reduced by passage mortality. Hatchery releases are from CRFPC (August 2013 and 2014), and estimated wild smolt production is based on Zabel (2013). Passage mortality is based on Zabel (2014), Welch et al. (2008), Rechisky et al. (2013), and Carter et al. (2009). Tables in Appendix B show the successive interim results for calculating adult survival and smolt consumption changes due to DCCO management plan actions.

(2) Apply DCCO predation probability rates to get consumption. The consumption is from probability rates based on PIT tag recovery experiments for an annual average 2008-2012 period and the calculated smolt presence at the East Island colony location. The source for the probability rates is Lyons et al. (2014). At this step, the investment cost (IC) for the hatchery origin only consumed fish is calculated. TRG (2009) provides average hatchery production operation and administrative expenditure tabulations species specific per-released fish.

(3) Use fishery specific SAS to generate the adults that would have contributed to in-river fisheries. The SAS are provided in a previous Columbia River Basin hatchery study HSRG (2009).[1]

(4) Use adult per-fish unit economic statistics from other studies to show the economic effects foregone with the consumed out-migrating smolts. The unit statistics are from TRG (2009).[2]

The procedures flow is graphically depicted on Figure IV.2. The baseline conditions, economic analysis exogenous variables, and management plan alternatives' specifications are shown on Table IV.1. Appendix B has detailed tables showing total adult survival and smolt consumption changes due to DCCO management plan actions. Table IV.2 shows the assumed passage mortality rates, predation probability rates, and the smolt wild origin proportions.

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1. Fisheries effort and catch information for hatchery and wild origin production was garnered from an existing fisheries model. The model is titled the All-H-Analyzer (AHA) Model by its authors (Mobrand/Jones & Stokes). The model provides estimates for all Columbia River Basin salmon and steelhead populations' production and survival fate. The survival to fisheries is itemized for marine and in-river fisheries. The AHA Model was used by the Hatchery Scientific Review Group (HSRG) to show consequences from carrying out recommendations for changed Columbia River Basin hatchery production and practices (HSRG 2009).
2. Another approach to illustrate DCCO salmonid predation investment cost is provided by Adrean (2014). The analysis used a case example of Tillamook Bay DCCO predation rates, out-migrating smolt assumptions, state statute (ORS 496.705) defined value of $250 per salmonid adult, and state administrative rules (OAR 635-410-0030) specifications for smolt-to-adult survival factors. The analysis found losses were between $140 thousand and $752 thousand in 2012. The replacement values and smolt survival factors are used for damage assessment purposes when mortality caused actions or events are attributable to individuals or businesses.

Economic effects measurements are offered for fishing industry participant (including commercial non-Indian and tribal, and recreational sectors) direct financial value (DFV), regional economic impacts (REI), and investment costs (IC) of the DCCO consumption of hatchery origin fish. The economic measurements are for annual short-term effects. The measurements are for current conditions and may not be a valid measure of the long-term effects on the economy. The measures are indicators of immediate perturbations and there may be different effects in the long-term due to unforeseen adjustments to environmental conditions, government policy, and the general economic situation. All economic measurements are adjusted to be for year 2012 dollars using the GDP implicit price deflator developed by U.S. Bureau of Economic Analysis.

Definitions and focal modeling assumptions for the economic measurements are as follows.

(a) The DFV is for revenue received by commercial fishing participants and expenditures made by anglers that are linked with the availability of Columbia River Basin production returning adults. Tribal commercial harvest revenues are included in the calculations. A value for tribal ceremonial and subsistence harvests are not included. The calculations for revenue and first round spending measurements may give some information about revenue flows, but do not reflect total impacts on an economy nor do they reflect a dollar value that can be used to compare and contrast fish resource benefits. Those types of values are better reflected in REI measurements.

(b) The public and decision makers sometimes just want to know what level of economic activity is being stirred-up within a specified geographic region stemming from changes being made to expenditures within that region. It is a way to show how the direct change in expenditures is multiplied throughout the regional economy. This type of analysis does not include consideration of whether the expenditures are afforded by "new" money. For example, the disposable income used by Columbia Basin residents for recreation could be spent for a fishing activity or for another form of recreation. Substitution effects are not included in the REI calculation.

The measurement unit for REI with most bearing is personal income and jobs. The REI is offered despite its limitation for only having meaning in the immediate sense. It is realized that any changes made in an economy are going to have offsetting adjustments that may be unpredictable in the long-term. The measures for income changes and jobs have some comparative usefulness for showing distributional effects across economies.

Key assumptions used in the REI analysis are:

- The period of analysis is indeterminate, with quantitative changes in resource costs and benefits and regional economic activity being near-term. For benefits from actions to conserve depressed species, long-term effects from the recovery species should be made.

- The accounting stance (i.e. geographic region of study) is at the state level. The state level measurements are summed to totals which may under or over estimate impacts at the regional level because of interactions between state level economies.
- Economic effects that are quantified are presented as annual impacts as if the effects were immediate and occurred in the present economic conditions.

The relationship between DFV and REI can be confusing. There might be clarity from knowing that DFV is the beginning measure for calculating REI. The revenue received by commercial fishers affords them to spend money for hiring crew and at local supply and services businesses for the cost of fishing. Similarly the recreational anglers spend money at local businesses. This commercial and recreational fishing spending starts the dollar flows that are tracked by the I/O modeling in order to determine total economic contribution. The economic modeling translates the direct spending into a personal income measurement.

(c) The ***IC*** are a financial value. The costs are hatchery operation and administration expenditures associated with the DCCO consumed out-migrating smolts. The hatchery production costs per smolt release were available from a secondary source, so the number of out-migrating smolts must be corrected for the passage mortality to know the effective releases. The investment cost is a useful calculation in that it is comparable to other methods to protect mortality of out-migrating smolts such as passage improvements. An investment cost, or any other economic value metric, was not calculated for the estimated wild origin portion of the DCCO consumption. An investment value for wild origin fish is considerable as government agencies and private industries work on salmon and steelhead recovery (GAO 2002, William D. Ruckelshaus Center 2013).

The economic effects from changed fishing opportunities due to reduced predation are from in-river fisheries. Benefits from commercial and recreational fishing and the proportion of hatchery escapements that reach a market are based on per fish unit values using these harvests. Fishery management for the baseline period used in the harvest model was developed around understandings and stock abundances that existed at that time. It is assumed that new management regimes, such as changed user group allocations and more extensive use of mark selective fisheries, do not need to be adjusted. This is a major modeling assumption that needs careful assessment when considering the validity of the economic analysis results.

It is acknowledged there could be other benefits and costs brought into the equation. Hatchery production is to replace lost habitat due to hydropower development, so hydropower benefits and dam construction costs could be included. Dams have multiple benefits like transportation, but they also have multiple and cumulative costs. Benefits promote industrial and urban development which in-turn can have adverse consequences. Opportunity costs for land and water could be brought into the equation. There might be costs to preserve or improve that habitat to that level. However, the preserved habitat has benefits too. There are also non-market benefits that could be considered for associated habitat preservation, wild origin population recovery, and changes to other wildlife resources. Despite the simplifying assumptions for only using harvest derived values and production cost elements, results should be revealing for showing the incremental effect of policy alternatives.

Fisheries generate personal income in regional economies by their products being exports to outside economies. That is, commercial landings in a regional economy are sold directly or after processing to individuals or businesses located outside the regional economy. That transfer of money makes its way as payments to labor and those payments are re-spent regionally (multiplier effect). Similarly, recreational anglers from outside the economy will spend money on guide services, lodging, etc. that will also wind up as household income. From a regional economies perspective, the money for this type of spending comes from outside. Because angler residency information was not known for all fisheries participation, and the accounting stance was for large regional economies, economic local substitution effects for resident anglers were not considered. Similarly, the estimates do not include effects from substitution commercial fisheries that may offset contributions from the in-river fisheries. Actual economic contribution would be less because some of the funds arise within the region and there are substituting activities that should be considered.

The REI per unit values were obtained via application of an input/output (I/O) model. On the commercial fisheries side, representative budgets from the fish harvesting sector and the fish processing sector, as well as a price and cost structure for processing, are used to estimate expenditures. On the recreational side, a guide service operator budget and recreational fishermen destination expenditures provide the basic spending data. The sales of marketable hatchery returns generate expenditures from the handling of the fish at hatcheries. I/O model response coefficients are applied to the expenditures to realize the total direct, indirect, and induced economic impacts to an area's economy. The measurement selected for showing the impacts was income. Even other economic activity measurements can be made. Gross business output and gross value added (gross output less intermediate goods used up in production) is an often used measure. The per unit values were previously developed by the TRG (2009) and it was only necessary to adjust the per unit values for current dollars.

TRG (2009) study report contains detailed explanations of the I/O modeling methods. The basic premise of the I/O framework is that each industry sells its output to other industries and final consumers and in turn purchases goods and services from other industries and primary factors of production. Therefore, the economic performance of each industry can be determined by changes in both final demand and the specific inter-industry relationships. The I/O model selected in TRG (2009) study was one of the best known secondary I/O models available. The IMpact Analysis for PLANning (IMPLAN) system was originally designed by the U.S. Forest Service in the early 1980's in response to the mandates of the National Forest Management Act and the National Environmental Policy Act. These two acts required the Forest Service to consider economic efficiency and economic effects in the formulation, evaluation and selection of land management planning alternatives. The IMPLAN software can be used to construct county or multi-county I/O models for any region in the U.S.[1] The regional I/O models are derived from technical coefficients of a national I/O model and localized estimates of total gross outputs by sectors.[2] IMPLAN adjusts the national level data to fit the economic composition and estimated trade balance of a chosen region. A derivative model called the Fisheries Economic Assessment Model (FEAM) uses the IMPLAN response coefficients to generate the fisheries specific per unit REI's for the various fisheries.[3,4]

The REI, measured by total personal income generation, is economic contribution under current conditions and is not a valid measure of the long-term effects on the economy of changes in fish abundance or policy. It provides a measure of the short-term dislocations and adjustments that might be caused by collapse of a fishery. The REI is not a measure of economic value. Economic value might be additive of consumer surpluses of recreational fishermen, certain non-use values such as tribal subsistence harvests, certain industry profits or cost savings, and a variety of other economic considerations. Economic value is a more appropriate measure to show the long-term effects from changes in the fishery.

In addition to the economic benefits from non-Indian commercial and recreational fisheries, tribal fisheries also generate income in regions. Present treaty fisheries consist primarily of set gillnets, but other gear type fishing still occurs on the Columbia River and tributary locations.[5] Tribal fisheries generally take place above Bonneville Dam, but other locations are sometimes used to fulfill treaty and trust responsibilities. Catch is accounted first to ceremonial, next to

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1. Operation of the IMPLAN model and database was subsequently transferred to the University of Minnesota, where it was administered by the Minnesota IMPLAN Group, Inc. (Alward et al. 1989). The system is now owned and administered by IMPLAN Group LLC located in Huntersville, N.C.
2. The available IMPLAN models are generally two to three years behind calendar years. This is due to data availability and the time it takes to prepare the models. Unless very dramatic changes take place in a regional economy, the sector coefficients will not change dramatically from year to year.
3. The FEAM was originally developed for the West Coast Fisheries Development Foundation by Hans Radtke and William Jensen in 1986. There was a separate Alaska FEAM developed about the same period. Both the West Coast and Alaska FEAM's have been updated many times to make them current with new fleet dynamics and IMPLAN response coefficients. The FEAM is more fully described in William Jensen Consulting (1996), and more recently by Seung and Waters (2006).
4. The derivative model is necessary because certain industries are not well represented by IMPLAN sectors. The commercial fishing industry is a good example of not having representation. The derivative process includes disaggregating as well as aggregating IMPLAN sectors. The analyst must be careful to marginalize transportation services and wholesale and retail trade so as not to duplicate total business sales when undertaking the derivative model building. The process allows for the targeted industries to be further specified into supporting sectors. These supporting sectors reflect the economic activities such as housing, utilities, transportation, etc. The most important reason for using this derivation approach is that it provides the user with a detailed analysis of specific industry operations, and a thorough evaluation of resulting economic impacts on the affected region.
5. In addition to gillnet gear, tribal fisheries have been prosecuted with purse seine, hook and line (selective and non-selective), tangle-nets (a selective "struggle gear"), beach seines, hoop and dip nets, and weirs.

subsistence (both are sometimes referred to as C&S), and last to commercial purposes. No fish of any stock are sold for commercial purposes until C&S needs are met. As recently as 1995, spring Chinook were only available for ceremonial purposes. Fall Chinook are routinely harvested for commercial sale. Fish are taken from the mainstem Columbia and a number of tributaries.

Only the commercial component is given value for the calculation of REI in tribal fisheries. In some cases, exploitation rates had to be used to forecast harvests which would include commercial and C&S. Also, it is not always possible to differentiate ceremonial from subsistence landings because they are not tracked in traditional data programs.

Historically, natural resources have been the mainstay of the economies of the Native Americans in the Columbia Basin. Salmon, steelhead, and other anadromous fish were an important aspect of the cultural life and subsistence of the Indian tribes that occupied the Columbia Basin. It is difficult or impossible to monetize these purposes to tribal people. Fish is used as a primary food source for which there may not be a substitute. The availability of local fish reduces tribal reliance on other consumer goods, or travel costs to participate in other fisheries. Tribal members will exchange fish with other fish and goods from other tribes. The harvests provide a local, traditional food source as well as supporting local craftsmen who make traditional fishing gear for harvest. While it can be argued that subsistence harvests may be a substitute for a foodstuff and be equivalent to a market price for the fish, their actual economic effects are purely speculative. Ceremonial harvests should not be valued because that would be tantamount to determining a value for tribal spiritual beliefs.

C. Results

The Alternative A conditions economic contributions from in-river fishery sectors (including commercial non-Indian and tribal, and recreational) are shown on Tables IV.3 and IV.4.[1] The DFV for all of the in-river fisheries is $41.9 million. The REI is $49.0 million in personal income. Figure IV.1 shows the Alternative A proportion of REI measured by personal income for the commercial and recreational fisheries. A minor amount of economic contribution (estimated to be one percent) that comes from the business use of marketable returns to hatcheries in included in the figure which brings the REI up to $49.7 million personal income.[2]

The Alternative A commercial non-Indian REI is estimated to be 14 percent of the total economic contributions. Most of the economic contributions from this fishery occur at lower

1. The Bonneville Dam separates the commercial non-Indian fishery and commercial tribal fishery harvest areas. Tribal fisheries are allowed to fish below Bonneville Dam and in the Willamette River if necessary to attain seasonal fish allocations.
2. The disposition of the returns can make their way into actual or offsetting financial transactions, including providing reimbursements for hatchery system operation costs. Some disposition of quality fish are donations to local food banks.

River economies. Many of the harvesters live in this location and most of the landings are delivered to processors in Astoria, Oregon.

The Alternative A commercial tribal fishery is 15 percent of in-river fisheries total economic contributions. The economic contributions from harvesting is spread throughout the upper Columbia River Basin wherever the fisheries and participants reside. Some of the landings are marketed by harvesters as direct sales to the public. Most of the landings from this fishery are purchased by processors based in northern Washington in recent years. (These processors are also active in purchasing Puget Sound commercial tribal harvests.) The added value hence economic contributions from the processor sector is less in the Columbia River Basin economies for the commercial tribal fishery than for the commercial non-Indian because the fish are exported out of the region.

The freshwater sport fishery (includes the popular fall season Buoy 10 fishery as well as all other mainstem and tributary salmon and steelhead fisheries) trip spending related economic contributions account for 70 percent of in-river fisheries total economic contributions. (Angler capital expenditures are not included in this estimate because the economic analysis is to calculate economic effects and it is assumed capital items would have been purchased with or without management plan actions.)

There are essentially two basic management plan alternatives being considered, although the means to accomplish the basic alternatives generate additional alternatives' options. Alternative B-C; Phase I, Alternative D is a reduction of 56 percent of the existing colony on East Island to bring the DCCO population down to a base period level (no more than 5,380 to 5,939 nesting pairs). Phase II, Alternative D is a reduction of 100 percent of the East Island DCCO population.

The DFV and REI measurements for the alternatives by species and by the three fishing industry sectors are shown in Tables IV.3 and IV.4. The total DFV effects calculation for the participants is positive $1.4 million for Alternative B-C; Phase I, Alternative D and positive $2.6 million for Phase II, Alternative D. The DFV percentage change from in-river fisheries is about 3.4 percent greater for Alternative B-C; Phase I, Alternative D and about 6.1 percent greater for Phase II, Alternative D. The total REI effects in Columbia River Basin economies from inland fisheries are positive $1.5 million and positive $2.6 million for the two alternatives respectively. The REI percentage change from in-river fisheries is about 3.0 percent greater for Alternative B-C; Phase I, Alternative D and about 5.3 percent greater for Phase II, Alternative D.

The hatchery production IC change for the alternatives is shown in Table IV.5. The changed IC for Alternative B-C; Phase I, Alternative D is a negative $3.6 million and for Phase II, Alternative D is a negative $6.4 million. (Negative means the savings in hatchery production costs due to alternative's implementation.)

Discerning changes in regional economic activity due to incremental changes from in-river fisheries does not address a larger policy consideration related to DCCO management.

Maintaining and improving Columbia River area in-river fisheries has basis in the conservation of the wild production component. There is ominous government intervention power that follows findings that wild stocks are depleted. The federal Endangered Species Act (ESA) allows for sweeping powers to prevent further takings of listed species that can shut down fisheries. A task not undertaken in the economic analysis would be determining the magnitude of regional economic activity from in-river fisheries at risk from not having healthy wild stocks due wholly or in part from DCCO predation. Moreover, the foregone fisheries benefits would be a small component of total economic activity at risk due to effects from other curtailed land and water uses that would be imposed by the depleted fish population's recovery plans.

D. Discussion

1. Predation Reduction Replacement

An important assumption in the economic analysis is holding hatchery production constant for each of the alternatives. It is often overlooked in Pacific salmon fisheries' economic analysis the importance of economic contributions that come from operating fishery enhancement and supplementation hatcheries. It could be that hatchery production can be throttled when there are returning hatchery origin adults goals to be attained, and in this case, there would be lower hatchery production costs. Hatchery facilities probably would not be used for other commercial or educational activities than for the purposes for which they were built, so the effects from hatchery operation changes would be assumed to not have a mitigating substitute. Reduced DCCO predation would increase economic contributions from fisheries, but be lessened due to the reduced hatchery operations economic effects.

Smolt production costs at release can range between \$0.20 to \$2 each depending on trapping and rearing operations and cost accounting inclusions (TRG 2009). Production of fall Chinook subyearlings (released at 25 to 50 per pound and comprise about 50 percent of all releases) are lesser, and production of steelhead yearlings (released at eight to 12 per pound and comprise about 12 percent of all releases) are higher. If hatchery production funding is considered new money into a region, then the costs for labor, materials, administration, monitoring, and construction provide significant economic contributions particularly to rural economies where the hatcheries are located.

2. Economic Analysis Model Parameter Sensitivity

Making public policy decisions about changing situations (such as DCCO predation) that enhance smolt survival is sobering because it pertains to the use of public funds, involves many existing fishing user groups, and has long-term impacts to the environment. The economic modeling relies on inputs and has internal empirical relationships using parameters that have various levels of observed data accuracy and formalistic understandings. The modeling results are offered as point estimates without bounds for what might occur if data and prediction relationships were accompanied by uncertainties. Data descriptions and modeling assumptions were stated, but the complex interactions among the natural environment, social and economic, and political systems cannot be perfectly studied. As such, policy and management decisions must be made on incomplete information and become informed judgments.

Uncertainty and risk analysis is its own discipline and much more research could be undertaken. The National Research Council in 1983 (NRC 1983) and again in 1996 (NRC 1996) describes procedures for how risk assessment and management can have relevance to policy decisions. There is no shortage of academic reports or agency guidelines that may be relied upon to investigate uncertainties. NOAA Fisheries has its own guidelines for data quality (NOAA Fisheries 2006). The problem becomes weighing the cost to generate the information against whether there may be significant adverse impacts and inadequate information. If certain information is essential and the cost to get it is not excessive, the agency should obtain it. If the information is essential, but cost to get it is excessive or the means to get it are unknown (i.e., beyond the state-of-the art), the agency must weigh the need for the action against the risk of possible adverse effect, if the action continues with this uncertainty.

An example of how results are sensitive to different assumptions about changed conditions is to use DCCO predation rates based on bioenergetic modeling estimates for smolt consumption. Lyons (2010) and BRNW (2014) provide bioenergetic modeling estimates for a 2008-2012 average. Appendix C shows the changed economic impacts for the alternative consumption estimates. The REI for the Phase II, Alternative D is $4.5 million personal income as compared to the PIT tag recovery based economic contributions of $2.6 million. The IC for the Phase II, Alternative D is negative $10.9 million as compared to the PIT tag recovery based IC of negative $6.4 million.

Another example for how results would be different is from making different assumptions about the additive components for SAS. An influencing factor for SAS ocean mortalities is ocean conditions. While not yet fully understood on an ecosystem basis, ocean conditions appear to strongly influence smolt survival. Correlations with numbers of adult salmon returning to spawning streams and hatchery release sites have received considerable study (Mantua et al. 1997). Important changes in Northeast Pacific marine ecosystems have been correlated with the Pacific Decadal Oscillation (PDO) index (Anderson 1997 and Francis et al. 1998). Warm PDO phases have favored high salmon production in Alaska and low salmon production off the west coast of California, Oregon, and Washington states. Conversely, cool PDO eras have favored low salmon production in Alaska and relatively high salmon production for California, Oregon, and Washington (Hare 1996 and Hare et al. 1999). More recently, Peterson et al. (2013) has looked at other indicators to predict ocean salmon survival. These include measures of upwelling, water temperature and salinity, plankton composition, and presence of forage fish and predators among other elements.

The links between any of the components for smolt mortality and adult return strengths for overlaying environmental conditions is not completely understood, and there is no guarantee that past observed correlations will continue in the future. Therefore the calculated adult returns that contribute to Columbia River inland fisheries will have uncertainty. Moreover, fishery participant behavior towards upwards and downwards opportunities to fish is not accurately predictable. Different data sets, modeling assumptions, and any other relationship influences could create significant bias in the calculated economic contributions.

Table IV.1
Economic Analysis Model Baseline Conditions, Exogenous Variables, and Management Plan Alternatives' Specifications

Baseline Conditions

1) Annual average 2000's broodstock survival to analyzed fisheries
2) Recent years' ocean and river harvest exploitation rates
3) Annual average 2008-2012 hatchery production
4) Estimated wild fish production based on 2012 hatchery production ratio estimators
5) Constant DCCO predation probabilities from a 2008-2012 five year annual average based on PIT tag recovery experiments

Exogenous Variables	
Inriver Transport	50% of Snake River production
Other Mortality (post-DCCO predation)	0.0%
Compensatory predation	0.0%

Alternatives' Specifications	
Predation reduction	
Alternative A	0.0%
Alternative B-C; Phase I, Alternative D	56.0%
Phase II, Alternative D	100.0%

Table IV.2
Summary of Assumptions for Passage Mortality, Predation Rates, and Smolt Wild Origin Production Proportions

Passage Mortality Rates Between Basin Production Through Bonneville Dam

ESU Production	Snake River (not transported)	Upper Columbia	Middle Columbia	Lower Columbia	Willamette
Fall Chinook	50%	50%	20%	0%	
Spring/summer Chinook	50%	50%	20%	0%	30%
Steelhead	50%	50%	20%	0%	30%
Sockeye	50%	50%			
Coho	50%	50%	20%	0%	30%

Notes: 1. Mortality between Bonneville Dam and estuary is an assumed additional 10 percent.
2. Snake River transportation is 50 percent of Snake River production which has 10 percent mortality.
3. Assumed no differential between wild and hatchery mortality.

Source: Zabel (2014), Welch et al. (2008), Rechisky et al. (2013), Carter et al. (2009), and McMichael et al. (2011).

DCCO Predation Probability Rates

Species	Snake River	Upper Columbia	Middle Columbia	Lower Columbia	Willamette
Coho	3.1%	3.1%	3.1%	3.1%	3.1%
Spring/summer Chinook					
Yearling	4.7%	3.5%	3.5%	3.5%	2.0%
Subyearling	-	-	-	-	-
Fall Chinook					
Yearling	3.1%	3.1%	3.1%	3.1%	3.1%
Subyearling	3.1%	3.1%	3.1%	3.1%	3.1%
Steelhead	9.8%	7.6%	9.6%	9.6%	9.6%
Sockeye	4.2%	4.2%	4.2%	4.2%	4.2%

Notes: 1. Consumption using predation probability depends on lower estuary smolt presence. The assumptions used to develop rates for smolt species and sub-basin origin are:
a) Coho rate is assumed to be the same as fall Chinook subyearlings.
b) Spring/summer Chinook middle and lower Columbia rates are assumed the same as upper Columbia.
c) Fall Chinook other areas rates are assumed the same as Snake River.
d) Steelhead lower Columbia and Willamette rates are assumed the same as middle Columbia.
e) Sockeye other areas rates are assumed the same as Snake River.

Source: Predation probability is 2008-2012 average from Lyons et al. (2014), Appendix A2.

Economic Model Assumptions for Wild Share of Hatchery and Wild Fish Production

Stocks	Snake River	Upper Columbia	Middle Columbia	Lower Columbia	Willamette
Chinook					
Spring/summer	20%	24%	47%	43%	18%
Fall	5%	31%	31%	24%	n/a
Steelhead	25%	40%	37%	31%	57%
Sockeye	14%	95%	n/a	n/a	n/a
Coho	16%	16%	16%	7%	7%

Notes: 1. The fall Chinook and summer/winter steelhead are combined by summing their combined number of wild outmigrants and dividing by their sum of total outmigrants from the source table.
2. The shaded numbers are interpolations from: sockeye – U. Columbia R. expert judgment; coho – Table 7c at Tongue Pt. for Snake River, U. Columbia R., and M. Columbia R., Willamette repeats L. Columbia R.; spring/summer Chinook – Table 7b at Tongue Pt. for M. Columbia R.; fall Chinook – Table 7b at Tongue Pt. for U. Columbia R. and M. Columbia R.
3. "N/a" means there is no production being modeled.

Source: Zabel (2013), Table 7 and 11.

Table IV.3

Economic Effects From DCCO Predation Reduction to Columbia River Inriver Fisheries by Sector and Species for Participant Direct Financial Value

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	33,941	1,284	3.8%	2,293	6.8%
Coho	5,444	95	1.7%	169	3.1%
Chinook					
Spring/summer	4,795	97	2.0%	174	3.6%
Fall	4,723	82	1.7%	146	3.1%
Steelhead	18,904	1,008	5.3%	1,801	9.5%
Sockeye	75	2	2.4%	3	4.2%
Non-Indian commercial	4,152	78	1.9%	139	3.3%
Coho	1,132	20	1.7%	35	3.1%
Chinook					
Spring/summer	1,921	39	2.0%	70	3.6%
Fall	1,098	19	1.7%	34	3.1%
Steelhead	0	0		0	
Sockeye	1	0	2.4%	0	4.2%
Tribal commercial	3,785	79	2.1%	141	3.7%
Coho	154	3	1.7%	5	3.1%
Chinook					
Spring/summer	2,339	48	2.0%	85	3.6%
Fall	1,073	19	1.7%	33	3.1%
Steelhead	173	9	5.3%	16	9.5%
Sockeye	46	1	2.4%	2	4.2%
Total	41,879	1,441	3.4%	2,574	6.1%
Coho	6,730	117	1.7%	209	3.1%
Chinook					
Spring/summer	9,055	184	2.0%	329	3.6%
Fall	6,894	120	1.7%	214	3.1%
Steelhead	19,077	1,018	5.3%	1,817	9.5%
Sockeye	122	3	2.4%	5	4.2%

Notes: 1. Direct financial value (DFV) is commercial gillnet and tribal fisheries participant harvest revenue plus recreational angler trip expenditures.
2. DFV is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
3. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table IV.4
Economic Effects From DCCO Predation Reduction to Columbia River Inriver Fisheries by Sector and Species for Regional Economic Impacts

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	34,626	1,148	3.3%	2,049	5.9%
Coho	4,065	71	1.7%	126	3.1%
Chinook					
Spring/summer	12,867	262	2.0%	467	3.6%
Fall	3,526	61	1.7%	109	3.1%
Steelhead	14,112	753	5.3%	1,344	9.5%
Sockeye	56	1	2.4%	2	4.2%
Non-Indian commercial	7,131	133	1.9%	238	3.3%
Coho	2,015	35	1.7%	62	3.1%
Chinook					
Spring/summer	3,122	63	2.0%	113	3.6%
Fall	1,989	35	1.7%	62	3.1%
Steelhead	0	0		0	
Sockeye	4	0	2.4%	0	4.2%
Tribal commercial	7,253	172	2.4%	306	4.2%
Coho	293	5	1.7%	9	3.1%
Chinook					
Spring/summer	3,881	79	2.0%	141	3.6%
Fall	1,939	34	1.7%	60	3.1%
Steelhead	909	48	5.3%	87	9.5%
Sockeye	231	5	2.4%	10	4.2%
Total	49,010	1,452	3.0%	2,593	5.3%
Coho	6,373	111	1.7%	198	3.1%
Chinook					
Spring/summer	19,871	404	2.0%	721	3.6%
Fall	7,454	129	1.7%	231	3.1%
Steelhead	15,022	801	5.3%	1,431	9.5%
Sockeye	291	7	2.4%	12	4.2%

Notes: 1. Regional economic impacts (REI) are expressed as personal income. REI is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table IV.5
Economic Effects From DCCO Predation Reduction for Columbia River Hatchery Investment Costs

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Stocks	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Coho					
Consumption	477.0	-267.1	-56.0%	-477.0	-100.0%
Effective hatchery releases	612.2	-342.8	-56.0%	-612.2	-100.0%
Release cost per smolt	1.16				
Investment cost	712.5	-399.0	-56.0%	-712.5	-100.0%
Spring/Summer Chinook					
Consumption	816.3	-457.1	-56.0%	-816.3	-100.0%
Effective hatchery releases	1,299.1	-727.5	-56.0%	-1,299.1	-100.0%
Release cost per smolt	1.16				
Investment cost	1,501.3	-840.7	-56.0%	-1,501.3	-100.0%
Fall Chinook					
Consumption	1,539.7	-862.2	-56.0%	-1,539.7	-100.0%
Effective hatchery releases	2,100.5	-1,176.3	-56.0%	-2,100.5	-100.0%
Release cost per smolt	0.19				
Investment cost	393.8	-220.5	-56.0%	-393.8	-100.0%
Summer/Winter Steelhead					
Consumption	933.0	-522.5	-56.0%	-933.0	-100.0%
Effective hatchery releases	1,394.5	-780.9	-56.0%	-1,394.5	-100.0%
Release cost per smolt	2.73				
Investment cost	3,805.6	-2,131.2	-56.0%	-3,805.6	-100.0%
Sockeye					
Consumption	10.5	-5.9	-56.0%	-10.5	-100.0%
Effective hatchery releases	19.4	-10.8	-56.0%	-19.4	-100.0%
Release cost per smolt	1.16				
Investment cost	22.4	-12.5	-56.0%	-22.4	-100.0%
Total					
Consumption	3,776.5	-2,114.8	-56.0%	-3,776.5	-100.0%
Effective hatchery releases	5,425.6	-3,038.4	-56.0%	-5,425.6	-100.0%
Investment cost	6,435.6	-3,603.9	-56.0%	-6,435.6	-100.0%

Notes: 1. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions. A negative consumption or investment cost means a savings from the Alternative A status quo conditions.

2. Does not include compensatory or other mortality (post-DCCO predation) besides passage mortality.

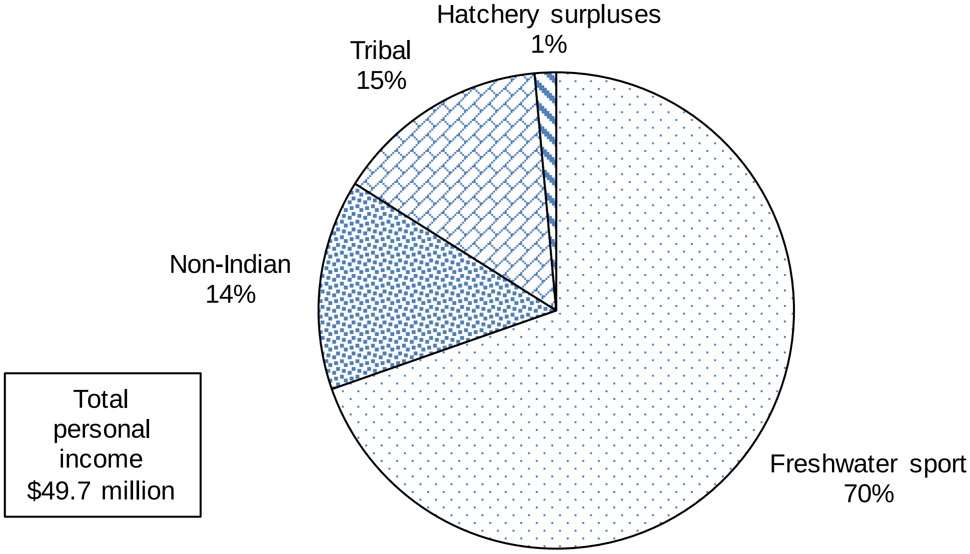
3. Passage mortality needs to be considered in the calculation of effective releases allied with smolts present in the lower Columbia River estuary where most consumption occurs.

4. Investment costs are the hatchery production operation and administration expenditures associated with the DCCO consumed out-migrating smolts.

5. Hatchery release cost per smolt is from TRG (2009). Hatchery release cost per smolt is in 2012 dollars adjusted using the GDP implicit price deflator developed by U.S. Bureau of Economic Analysis. Cost per smolt for fall Chinook is a weighted average of Chinook subyearlings and yearlings. Costs per smolt use $1.16 for coho, spring/summer Chinook, and sockeye; $0.19 for fall Chinook; and $2.73 for summer/winter steelhead.

Source: Predation rates from Lyons et al. (2014).

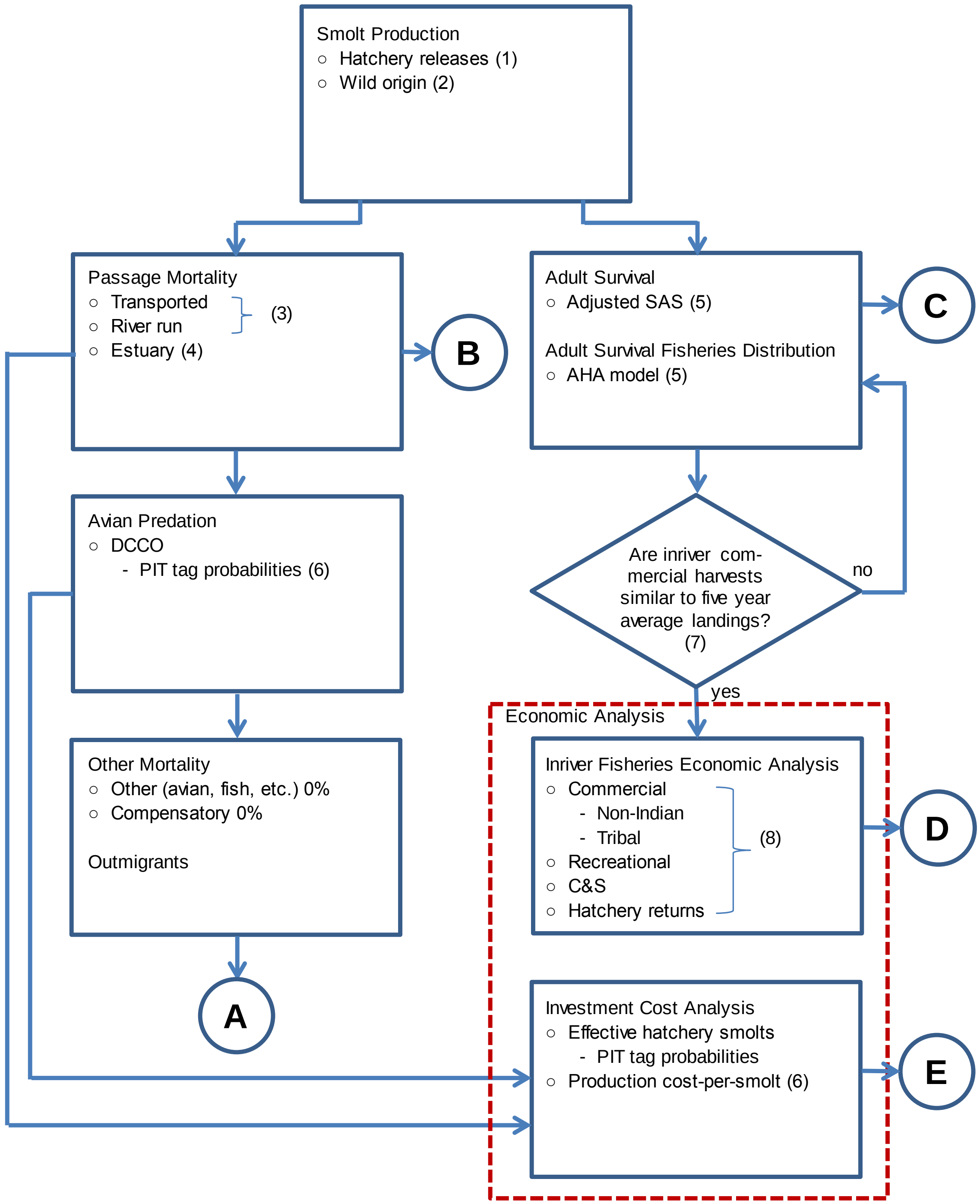
Figure IV.1
Columbia River Inriver Fisheries Regional Economic Impacts for Alternative A Conditions



Notes: 1. Regional economic impacts (REI) measurement is total personal income in millions of 2012 dollars.

2. REI includes minor economic contributions from business use of marketable hatchery returns. REI does not include economic contributions from hatchery operations.

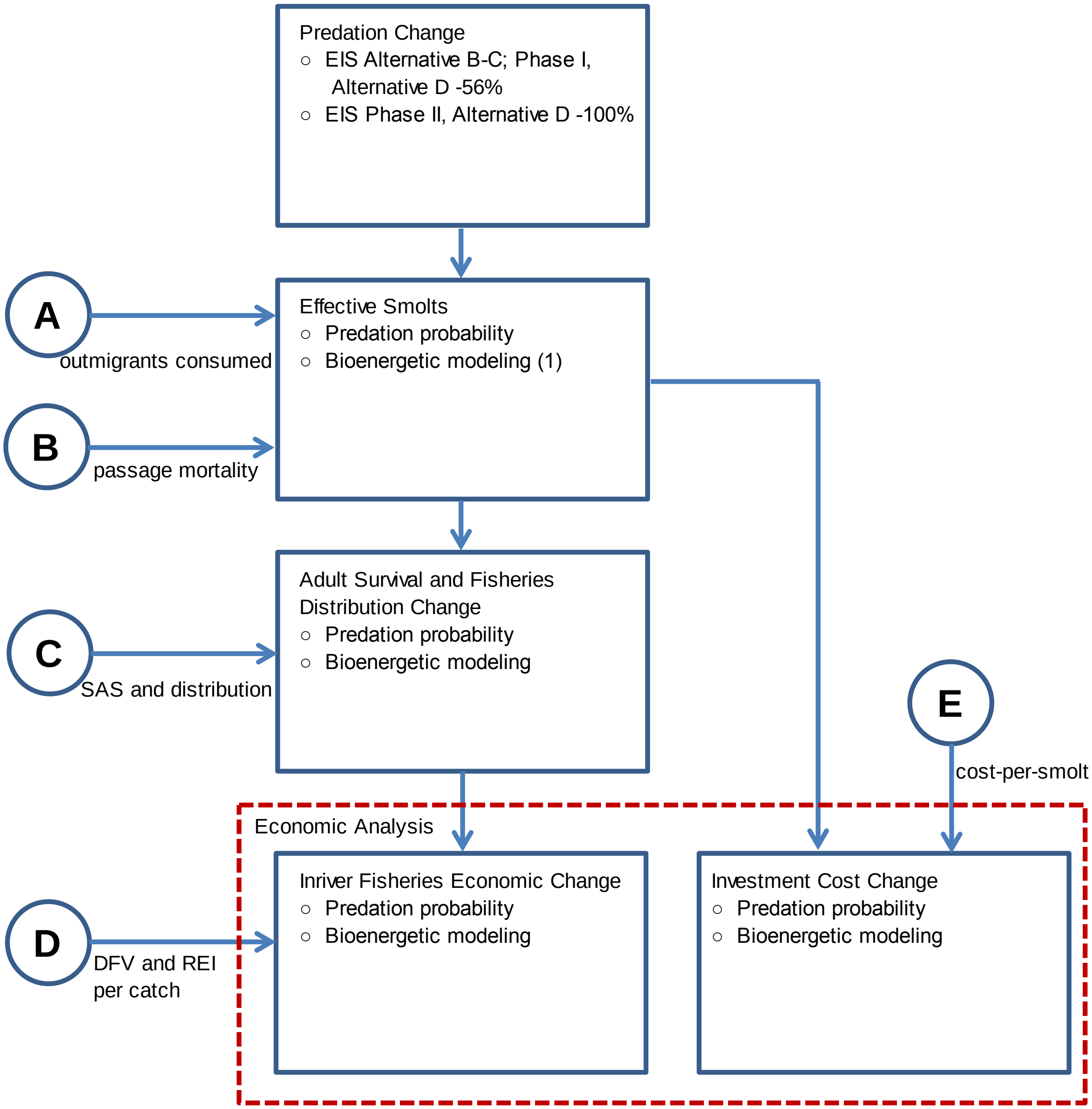
Figure IV.2
Economic and Investment Cost Analysis Methods Flow Diagram for Baseline Determination



Notes: 1. Baseline determination for status quo conditions is Alternative A.

Sources: (1) CRFPC (August 2013). (2) Zabel (2013). (3) Zabel (2014), Welch et al. (2008), Rechisky et al. (2013). (4) Carter et al. (2009) and McMichael et al. (2011). (5) HSRG (2009). (6) Lyons et al. (2014). (7) PFMC (2014). (8) TRG (2009).

Figure IV.3
Economic and Investment Cost Analysis Methods Flow Diagram for EIS Alternatives



Sources: (1) Lyons (2010) and BRNW (2014).

V. Social Implications

There can be a variety of social impacts caused because of the management plan actions. For example, any reduced predation would be expected to have attendant positive impacts to wild origin fish runs to varying extents, although the full impact might take many generations for some species. The changed hatchery and wild origin adult returns will change harvest opportunities, and therefore, change the potential to generate income and employment from commercial and recreational fishing and seafood processing in communities where inriver fisheries occur. Other chapters in this report quantify the economic effects, but sensitivity analysis discussions explain the impacts are uncertain due to unknown environmental conditions. The amount of fish available to fisheries and any adjustments to harvest management measures to compensate for the changed fish runs are unpredictable. Given the uncertainties, social impact discussions on a regional or community level can be inexact.

Social impacts are often discussed in terms of the overall indicator results, but it is important to remember that the aggregate totals conceal many important details. First, aggregate totals are often short-run effects, but there are likely to be important distinctions between the short run and the long run, and the transition periods. Second, aggregate effects often hide interpersonal or geographic differences in impact. Thus, a net increase in jobs may not mean much to someone without the appropriate skills for the jobs created, while a net decrease in jobs may mean a substantial downturn in employment opportunities for others. While it is much more difficult to determine the detail of social impacts, some discussion of likely trends may help to focus on the distribution of the impacts.

Social impact discussion categories generally of interest are regional and community impacts, quality of life, fiscal condition of local governments, and cultural effects. The categories provide for discussions about how changed salmon and steelhead adult returns may disproportionately affect socio-economic groups using federal environmental justice criteria. The discussions would be based on methodological approach to answer the contentious question for fair distribution of environmental burdens and benefits (Kruize 2007).

It is not an unexpected finding that American Indian ethnicity in certain geographic areas are a socio-economic group particularly vulnerable to inriver fisheries changes (Table III.2). Given the group's thousands of years of life dependency on Columbia River fish resources, an analysis of changes may more appropriately be analyzed from a pre-hatchery system condition rather than baseline conditions. This finding is particularly apropos to current DCCO predation reduction considerations because the DCCO consumption problem is post-European settlement. The problem is additive to the drastic alteration in wild origin salmon and steelhead populations caused by the hatchery system, river flows, salmonid habitats, etc. (The initial hatchery system development was intended and accomplished moving wild origin populations lost to upstream hydropower development to lower river hatchery production.) Relegating a social analysis to only discussions of the alternatives' economic analysis marginal changes does not show appreciation for the tribal fisheries as they historically existed.

VI. Bibliography

Adrean, Lindsay. Tillamook Bay Double-Crested Cormorant Predation Replacement Cost Analysis. Oregon Department of Fish and Wildlife. March 2014.

Alward, G., E. Siverts, D. Olsen, J. Wagner, O. Senf, and S. Lindall. Micro IMPLAN Users Manual. Department of Agricultural and Applied Economics. University of Minnesota, St. Paul, Minnesota. 1989.

Anderson, J.J. "Decadal Climate Cycles and Declining Columbia River Salmon." University of Washington. Published in Sustainable Fisheries Conference Proceedings (1998). September 26, 1997.

Arror, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner, and H. Schuman. Report of the NOAA Panel on Contingent Valuation. National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program. 1993.

Bird Research Northwest (BRNW). Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River: Draft 2013 Annual Report. Real Time Research, Bend, OR and Oregon State University, Corvallis, OR. Via Internet: www.birdresearchnw.org. 2014.

Bonneville Power Administration (BPA), U.S. Army Corps of Engineers, and Bureau of Reclamation. Federal Columbia River Power System Improvements and Operations Under the Endangered Species Act – A Progress Report. Based on analyses by BioAnalysts, Inc., Boise, Idaho and Anchor QEA, LLC, Seattle, Washington. Via Internet: http://www.salmonrecovery.gov/docs/FinalHydroSynthesisWithReview9-20-13.pdf. September 2013.

Carter, J.A., G.A. McMichael, I.D. Welch, R.A. Harnish, and B.J. Bellgraph. Seasonal Juvenile Salmonid Presence and Migratory Behavior in the Lower Columbia River. PNNL-18246, Pacific Northwest National Laboratory, Richland, Washington. Via Internet: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18246.pdf. 2009.

Columbia River Fish Passage Center (CRFPC). Personal communication. March 26, 2014.

Columbia River Fish Passage Center (CRFPC). 2012 Annual Report. Northwest Power and Conservation Council. August 29, 2013.

Columbia River Fish Passage Center (CRFPC). "Hatchery Database Queries." Via Internet: http://www.fpc.org/hatchery/Hatchery_Queries_v2.html. 2013.

Conover, M.R. Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management. Lewis Publishers, Boca Raton, Florida, USA. 2002.

Diamond, P.A., and J.A. Hausman. "Contingent Valuation: Is Some Number Better Than No Number?" *J Econ Perspect* 8(4):45-64. 1994.

Duffield, John. University of Montana and Bioeconomics, Inc. "Economic Studies of the Value of Fishery Restoration: Benefits of Passage and Reintroduction." Future of Our Salmon Technical Workshop, Spokane, WA. March 2014.

Folsom, William, et al. World Salmon Culture. Silver Spring, Maryland, The Office of International Affairs, National Marine Fisheries Service, National Oceanic and Atmospheric Administration. September 1992.

Francis, R.C., S.R. Hare, A.B. Hollowed, and W.S. Wooster. "Effects of Interdecadal Climate Variability on the Oceanic Ecosystems of the Northeast Pacific." *Fisheries Oceanography,* 7, 1-21. 1998.

General Accounting Office (GAO). Columbia River Basin Salmon and Steelhead: Federal Agencies' Recovery Responsibilities, Expenditures and Actions. GAO-02-612. July 2002.

Gentner, Brad and Scott Steinback. The Economic Contribution of Marine Angler Expenditures in the United States, 2006. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-F/SPO-94. Via Internet: http://www.st.nmfs.noaa.gov/st5/publication/ AnglerExpenditureReport/AnglerExpendituresReport_ALL.pdf. December 2008.

Halsing, David L. and Michael R. Moore. Cost-Effective Recovery Strategies for Snake River Chinook Salmon: A Biological-Economic Synthesis. June 2, 2006.

Hare, S.R, N.J. Mantua, and R.C. Francis. "Inverse Production Regimes: Alaska and West Coast Pacific Salmon." *Fisheries,* 24, 6-14. 1999.

Hare, S.R. Low Frequency Climate Variability and Salmon Production. Ph.D. dissertation, School of Fisheries, University of Washington, Seattle. 1996.

Hatchery Scientific Review Group (HSRG). Columbia River Hatchery Reform System-Wide Report. http://www.hatcheryreform.us/mfs/reports/system/welcome_show.action. February 2009.

Hatchery Scientific Review Group (HSRG). Columbia River Hatchery Reform System-Wide Report. Appendix D. http://www.hatcheryreform.us/hrp_downloads/reports/columbia_river/system-wide/4_appendix_d_user_guide.pdf. February 2009.

Independent Economic Analysis Board, Northwest Power and Conservation Council, (IEAB). Cost-Effectiveness Strategies for the Fish and Wildlife Program: Progress and Potential. Document IEAB 2012-01. February 2012.

Independent Economic Analysis Board, Northwest Power and Conservation Council (IEAB). Economic Effects from Columbia River Basin Anadromous Salmonid Fish Production. Northwest Power and Conservation Council Document IEAB 2005-1. Revised December 2005.

Institute for Water Resources, U.S. Army Corps of Engineers (IWR). Economics Primer. Prepared by Susan E. Durden and Jim Fredericks. IWR Report 09-R-3. June 2009.

Knapp, Gunnar, Cathy A. Roheim, and James L. Anderson. The Great Salmon Run: Competition Between Wild and Farmed Salmon. TRAFFIC North America, World Wildlife Fund. January 2007.

Knapp, Gunnar. "Implications of Aquaculture for Wild Fisheries: The Case of Alaska Wild Salmon." Presented for the Bevan Sustainable Fisheries Lecture Series, University of Washington, Seattle. February 10, 2005.

Kruize, Hanneke. On Environmental Equity: Exploring the Distribution of Environmental Quality Among Socio-Economic Categories in the Netherlands. Doctoral thesis Utrecht University. 2007.

Lyons, D.E., A.F. Evans, N.J. Hostetter, D.D. Roby, K. Collis, P.J. Loschl, and B. Cramer. Factors Influencing Juvenile Salmonid Predation by Double-crested Cormorants in the Columbia River Estuary. A Draft Technical Report for the Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. March 1, 2014.

Lyons, D.E. Bioenergetics-Based Predator-Prey Relationships Between Piscivorous Birds and Juvenile Salmonids in the Columbia River Estuary. Unpubl. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. Via Internet: www.birdresearchnw.org. 2010.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. "A Pacific Decadal Climate Oscillation With Impacts on Salmon." *Bulletin of the American Meteorological Society,* Vol. 78, pp 1069-1079. 1997.

McMichael, G.A., R.A. Harnish, J.R. Skalski, K.A. Deters, K.D. Ham, R.L. Townsend, P.S. Titzler, M.S. Hughes, J.A. Kim, and D.M. Trott. Migratory Behavior and Survival of Juvenile Salmonids in the Lower Columbia River, Estuary, and Plume in 2010. Via Internet: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20443.pdf. PNNL-20443, Pacific Northwest National Laboratory, Richland, WA. September 2011.

Mobrand/Jones & Stokes. All H Analyzer (AHA) User Guide. Draft. Version 3.27-Web. http://www.managingforsuccess.us/site/tools_aha/321/aha.aspx. August 17, 2005.

National Marine Fisheries Service (NOAA Fisheries). "Information Quality Guidelines." Via Internet: http://www.cio.noaa.gov/Policy_Programs/IQ_Guidelines_110606.html. Revision: November 6, 2006.

National Marine Fisheries Service (NMFS). Final Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California and in the Columbia River Basin. November 2003.

National Marine Fisheries Service (NMFS). Biological Opinion on Artificial Propagation in the Columbia River Basin. Northwest Region. March 29, 1999.

National Research Council (NRC). Sharing the Fish: Toward a National Policy on Individual Fishing Quotas. Washington, D.C., National Academy Press. 1999.

National Research Council (NRC). Understanding Risk: Informing Decisions in a Democratic Society. Washington, D.C.: National Academy Press. 1996.

National Research Council (NRC). Risk Assessment in the Federal Government: Managing the Process. Washington, D.C.: National Academy Press. 1983.

Northwest Power Planning Council. 2000 Columbia River Basin Fish and Wildlife Program. http://www.nwcouncil.org/library/2000/2000-19/ecoprovs.pdf. Council Document 2000-19. 2000.

Oregon Department of Fish and Wildlife (ODFW). Fish Propagation Annual Report for 2012. April 2013.

Pacific Fishery Management Council (PFMC). Preseason Report III Analysis of Council Adopted Management Measures for 2008 Ocean Salmon Fisheries. Published annually in April. April 2008.

Pacific Fishery Management Council (PFMC). Review of 2007 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2008.

Pacific Fishery Management Council (PFMC). Review of 2013 Ocean Salmon Fisheries. Annual in February. February 2014.

Peterson, William T., Cheryl A. Morgan, Jay O. Peterson, Jennifer L. Fisher, Brian J. Burke, and Kurt Fresh. Ocean Ecosystem Indicators of Salmon Marine Survival in the Northern California Current. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service. December 2013.

Portney, P.R. "The Contingent Valuation Debate: Why Economists Should Care." *J Econ Perspect* 8(4):3-17. 1994.

Reading, Don. The Potential Economic Impact of Restored Salmon and Steelhead Fishing in Idaho. Prepared by Ben Johnson Associates for Idaho Rivers United. February 2005.

Rechisky, Erin L., David W. Welch, Aswea D. Porter, Melinda C. Jacobs-Scott, and Paul M. Winchell. "Influence of Multiple Dam Passage on Survival of Juvenile Chinook Salmon in the Columbia River Estuary and Coastal Ocean." *PNAS* vol. 110 no. 17. Via Internet: http://www.pnas.org/content/110/17/6883.full.pdf. April 23, 2013.

The Research Group, LLC (TRG). Oregon's Commercial Fishing Industry, Year 2011 and 2012 Review. Prepared for Oregon Department of Fish and Wildlife, and Oregon Coastal Zone Management Association. September 2013.

The Research Group (TRG). Mitchell Act Hatchery EIS, Preliminary 2.1, Economic and Social Analysis Sections. Prepared for NOAA Fisheries, Northwest Regional Office Salmon Recovery Division, Portland, Oregon. January 2009.

The Research Group (TRG). Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report. Prepared for Bonneville Power Administration, Washington Department of Fish and Wildlife, and Oregon Department of Fish and Wildlife. November 2006.

Seger, Jim. Personal communication. May 2008.

Seung, Chang K. and Edward C. Waters. "A Review of Regional Economic Models for Fisheries Management in the U.S." *Marine Resource Economics,* Volume 21, pp. 101- 124 0738-1360/00. 2006.

U.S. Fish and Wildlife Service (USFWS). 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: State Overview. Via Internet: http://digitalmedia.fws.gov/cdm/ref/collection/document/id/858. September 2012.

U.S. Fish and Wildlife Service (USFWS) and U.S. Census Bureau (USCB). 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Oregon. FHW/11-OR (RV). January 2014.

U.S. Interorganizational Committee on Principals and Guidelines for Social Impact Assessment (USIC). Principals and Guidelines for Social Impact Assessment (SIA) in the USA. 2003.

Walton, Rob and Rob Jones. "An Overview of NOAA Fisheries' Upcoming Consultations on Hatcheries." NOAA Fisheries Service, Salmon Recovery Division. Presentation December 10, 2008.

Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW). Status Report-Columbia River Fish Runs and Fisheries, 1938-2002. Tables only. August 2004.

Watts, James W. Lower Columbia River and Buoy 10 Recreational Catch and Effort Estimates. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. 2013.

Welch, David W., Erin L. Rechisky, Michael C. Melnychuk, Aswea D. Porter, Carl J. Walters, Shaun Clements, Benjamin J. Clemens, R. Scott McKinley, Carl Schreck. "Survival of Migrating Salmon Smolts in Large Rivers With and Without Dams." *PLoS Biol* 6(10):e265. doi:10.1371/journal.pbio.0060265. Via Internet: http://www.plosbiology.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pbio.0060265&representation=PDF. 2008.

William D. Ruckelshaus Center. Columbia River Basin Salmon and Steelhead Long-Term Recovery Situation Assessment. 2013.

William Jensen Consulting. West Coast Fisheries Economic Assessment Model. Prepared for Pacific Fishery Management Council, Portland, Oregon. 1996.

Zabel, Richard W. "Preliminary survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2014." Via Internet: http://www.nwd-wc.usace.army.mil/tmt/agendas/2014/1015_2014_Preliminary_Survival_Estimates_Memo.pdf. Memorandum for Ritchie Graves, Northwest Fisheries Science Center. September 18, 2014.

Zabel, Richard W. "Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2012." Via Internet: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/2012-estimation-memo.pdf. Memorandum for James H. Lecky, Northwest Fisheries Science Center. January 23, 2013.

Appendix A
Fishery Management Governance

For thousands of years Native Americans have fished for salmon and steelhead, as well as other species, in the tributaries and mainstem of the Columbia River for ceremonial, subsistence, and economic purposes. A wide variety of gears and methods were used, including hoop and dip nets at cascades such as Celilo and Willamette Falls; to spears, weirs, and traps (usually in smaller streams and headwater areas). Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800's. The development of non-Indian fisheries began ca. 1830, and by 1861 commercial fishing was an important economic activity. Fishing pressure, especially in the late nineteenth and early twentieth century, has long been recognized as a significant factor in the decline of Columbia River salmon runs. Hydropower development, hatchery practices, and habitat degradation are other categories of factors contributing to the decline (NRC 1999).

The Mitchell Act (MA) was to mitigate for impacts from water diversions, dams on the mainstem of the Columbia River, and other effects in order to conserve fish resources. The hatchery activities funded by the MA represent an important share of overall Columbia River Basin hatchery salmon and steelhead production. The production contributes to not only the Columbia River commercial, tribal, and recreational fisheries, but also because of the migratory nature of anadromous fish, to distant ocean fisheries occurring off Oregon's coast and north to Alaska. The legal framework under which fisheries in which MA production contributes is managed in a complex quilt of states and provinces, tribes, federal, and international governance.

Among the treaties, laws, agreements, plans, and understandings between these jurisdictions are the court interpretations about how they apply. A partial list of agencies and organizations that are involved in management while fish are in the ocean or river and subject to harvest mortalities are (NMFS 2003):

- The United States Departments of State, Interior, and Commerce;
- The States of California, Oregon, Washington, Idaho, and Alaska;
- More than 30 tribal jurisdictions;
- The Pacific Fishery Management Council (PFMC);
- The North Pacific Fishery Management Council (NPFMC);
- North Pacific Anadromous Fish Commission (NPAFC);
- The Pacific Salmon Commission (PSC); and
- Fisheries and Oceans Canada (DFO).

The legal framework can be categorized as *international understandings*, such as the 1992 International North Pacific Fisheries Commission Convention, the 1982 United Nations Convention on the Law of the Sea (LOSC) which entered into force in November 1994, the 1985 Pacific Salmon Treaty (PST) between the United States and Canada; *harvest management agreement processes* such as the 1976 Magnuson-Stevens Fisheries Conservation and Management Act (MSA); *agreements to rebuild the stocks* such as such as through subbasin planning under the 1980 Northwest Power Planning Act; *court decisions* that have defined the obligations to Indian Tribes such as the 1969 judgment from *United States v. Oregon* that became the forum for allocating the harvest of fish that enter the Columbia River system; other *federal actions to protect salmon* stocks such as the 1915 Columbia River Compact and the 1973 ESA; congressionally mandated compensation programs (such as the Snake River Compensation Plan); ESA recovery plan dependencies; and court orders.

The understandings and agreements might have originally been driven for managing fisheries in which production from MA funded and other hatcheries contribute stocks. However, there are now mandated guidance directories in the agreements and understandings that are used to determine hatcheries' operation strategies.

A. International Understandings

The 1973-1982 LOSC prevented high seas fishing for salmon and other anadromous fish and enabling exclusive jurisdiction within a 200 nautical mile Exclusive Economic Zone (EEZ). This set the stage for resolving the contentious relationship between Canada and the U.S. for the equitable division salmon harvest because other players were removed. The complication of Russian, Japanese, and other nations' fishing fleets' interceptions was resolved, which allowed Canada and the U.S. to focus on cooperative management. The PST was first signed in 1985, updated in 1999, and updated again in 2008. (The 2008 updates have yet to be authorized by the U.S. and Canadian governments as of the publication date of this report.) The treaty is a bilateral agreement under which the U.S. and Canada cooperate on management, research and enhancement of Pacific salmon that swim through the waters of both countries. The treaty and its annexes stipulate management goals and measures for important Chinook and coho stocks that are taken in Southeast Alaska, Canada, and off the U.S. West Coast. Included among these stocks are several Columbia River listed evolutionary significant units (ESU's). The 1999 agreement establishes an abundance-based Chinook management regime for the stocks and fisheries. The 2008 agreement adds stocks to the management regime and reduces the allowable Chinook catch levels for fisheries off the west coast of Vancouver Island in B.C. by 30 percent, and in southeast Alaska by 15 percent. The most recent agreement will increase funding for accounting and monitoring.

B. Harvest Management Directed Through Federal Mandates and Court Decisions

The MSA (enacted in 1976, amended in 1996, and amended again to be called the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006) provides parameters and guidance for federal fisheries management, requiring the PFMC and NPFMC to adhere to a broad array of policymaking and national standards in crafting fisheries management regimes. The regimes must address the purposes of the international agreements, and more importantly, address the purposes of the ESA. The ESA provides a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved to provide a program for the conservation of such species, and to take steps as may appropriate to achieve the purposes of various international treaties and conventions.

The ESA is a process for listing, protection and recovery of certain species, subspecies, and distinct populations (PFMC April 2008). Starting in 1992, several evolutionarily significant units of salmon and steelhead in the Columbia River Basin were listed as threatened or endangered under the ESA. The listings further complicated fishery management since the ESA prohibits "take" of listed species. The NMFS became a key decision maker in harvest management because of the ESA consultation process and resulting biological opinions (BiOp's) which authorize "incidental take."[1] Without the BiOp's, all commercial and recreational fishers would

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1. A "Section 7 consultation" occurs when a set of standards found in an applicable BiOp applies to the subject activity and mandates those actions that must be taken in order to avoid jeopardy to the recovery of ESA listed species. NOAA Fisheries has initiated formal Section 7 consultations and issued BiOp's that consider the impacts to listed salmonid species resulting from proposed implementation of the fishery management plans, or in some cases, from proposed implementation of the annual fishery seasons management measures. The consultation standards, which are quantitative targets that must be met to avoid jeopardy, are also incorporated into the management plans and play an important part in developing annual fishery seasons management measures. A Section 7 consultation may be reinitiated periodically as environmental conditions change, and new measures may be required to avoid jeopardy.

   In addition to the Section 7 consultation, actions that fall under the jurisdiction of the ESA may also be permitted through ESA Section 10 and ESA Section 4(d). Section 10 generally covers scientific, research, and propagation activities that may affect ESA listed species. Section 4(d) covers the activities of state and local governments and private citizens. Section 4(d) of the ESA requires NMFS and the USFWS to promulgate "protective regulations" for threatened species (Section 4(d) is not applicable to species listed as endangered) whenever it is deemed "necessary and advisable to provide for the conservation of such species."

have to obtain incidental take permits. The BiOp's for ESA listed stocks require fisheries management practices to meet objectives to avoid jeopardizing the recovery of the listed stocks.

The PFMC and the NPFMC develop management plans to achieve the stock recovery plans. The PFMC and NPFMC also set ocean management regimes to meet PST defined harvest shared catch levels, while allowing sufficient Columbia River escapements contained in stock recovery plans. An EIS process is completed for each successive year's management specification.[1]

The Columbia River fisheries are managed under a continuing jurisdiction of the U.S. District Court for the District of Oregon in the Case of *United States v. Oregon* (Belloni Decision). The court affirmed that the treaties reserved to the tribes 50 percent of the harvestable surplus of fish destined to pass through their usual and accustomed fishing areas. A parallel case is *U.S. v. Washington* or Boldt Decision (interpreting the same treaty language for tribes in the Puget Sound area), where the courts have established a large body of case law setting forth the fundamental principles of treaty rights and the permissible limits of conservation regulation of treaty fisheries. The treaty rights for the Shoshone-Bannock Tribes are protected by the Fort Bridges Treaty as interpreted in *State of Idaho v. Tinno*. The parties to *U.S. v. Oregon* are the United States acting through the Department of the Interior (USFWS and Bureau of Indian Affairs) and the Department of Commerce (NOAA Fisheries), the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, the Confederated Tribes and Bands of the Yakama Nation, and the Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho. The interests of the Colville Tribal Nation rely upon the WDFW and federal government's participation in the *U.S. v Oregon* proceedings. Specifications for Colville Tribal Nation fisheries are spelled out in a joint management agreement with the WDFW.

The parties developed a Columbia River Fish Management Plan (CRFMP), which after expiring had been extended in a series of interim agreements. The last CRFMP expired in 1998 and the

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In proposing and finalizing a 4(d) rule, NMFS may establish exemptions to the take prohibition for specified categories of activities that NMFS finds contribute to conserving listed salmonids. Other exemptions cover habitat-degrading activities, hatchery operations, etc. that NMFS believes are governed by a program that adequately limits impacts on listed salmonids. The NMFS uses hatchery genetic management plans (HGMP's) to assess whether exemptions can be issued for propagation activities that may lead to harvests of ESA listed stocks.

1. NOAA Fisheries excused the PFMC from the formal EIS process in a consultation agreement in 2008 (Jim Seger personal communication May 2008).

most recent 10 year (through 2017) agreement was decided by the parties and affirmed by the court in August 2008. The agreements are devised to be consistent with stock recovery plans and address the non-Indian and treaty allocations.

With the treaty allocation as a given, the Washington Fish and Wildlife Commission (WFWC) and Oregon Fish and Wildlife Commission (OFWC) have broad discretion to decide further allocation between recreational and commercial fisheries in representing the public interest. Commissions consider economic factors along with social, recreational, aesthetic and resource management factors. Since Washington and Oregon must act jointly to determine the allocations, the commissions provide guidance to staff in how the staff should carry out negotiations for the actual season regulations. The negotiations use the process stipulated in the Columbia River Compact. The Compact does not have rule making authority, and instead decisions are exercised through the states' respective agency directors as administrative rules.

C. Cross-Cutting Federal Legislation and Executive Orders

Fisheries management governance is also subject to legislation and executive orders applicable to all federal planning and management initiatives. The more important cross-cutting federal legislation and executive orders include:

Statutes

Coastal Zone Management Act.

Marine Mammal Protection Act.

Migratory Bird Treaty Act.

Paperwork Reduction Act.

Regulatory Flexibility Act.

Other laws sometimes necessary to address in fisheries management include:

- Administrative Procedures Act
- Data Quality Act
- The Fishermen's Protective Act (Pelly Amendment)
- Marine Protection, Research and Sanctuaries Act

Executive Orders

Executive Order 12866 (Regulatory Planning and Review). The EO covers a variety of regulatory policy considerations and establishes procedural requirements for analysis of the benefits and costs of regulatory actions. Based on this analysis, NOAA Fisheries should choose those approaches that maximize net benefits to society, unless a statute requires another regulatory approach.

Executive Order 12898 (Environmental Justice). EO 12898 obligates federal agencies to identify and address "disproportionately high adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations in the United States" as part of any overall environmental impact analysis associated with an action.

Executive Order 12962 (Recreational Fishing). In order to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide, it is ordered that federal agencies shall, to the extent permitted by law and where practicable, and in cooperation with States and Tribes, improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities.

Executive Order 13132 (Federalism). EO 13132 enumerates eight fundamental federalism principles. The first of these principles states "Federalism is rooted in the belief that issues that are not national in scope or significance are most appropriately addressed by the level of government closest to the people." In this spirit, the EO directs agencies to consider the implications of policies that may limit the scope of or preempt states' legal authority.

Executive Order 13175 (Consultation and Coordination with Indian Tribal Government). EO 13175 is intended to ensure regular and meaningful consultation and collaboration with tribal officials.

Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). EO 13186 supplements the MBTA (above) by requiring federal agencies to work with the U.S. Fish and Wildlife Service to develop memoranda of agreement to conserve migratory birds.

Appendix B
Columbia River Hatchery and Wild Origin Production Adult Survival Change Due to DCCO Management Plan Actions

Filter: Alternative A

Hatchery Releases	Five year average using CRFPC estimate
SAS's	2000's brood year
Contribution to Fisheries	AHA Model
Snake River Inriver Transport	50.0%
Compensatory Mortality	0.0%
Other Mortality (post-DCCO predation)	0.0%

Notes:

1. The smolt-to-adult survival rate (SAS) is an index that accounts for all downriver passage (including avian predation) and ocean mortalities. When applied to smolt production, the result is the surviving adults that show up in all ocean and inriver fisheries, hatchery returns, or strays to natural habitat.
2. Inriver transport survival factor accounts for the saved juveniles not experiencing hydrosystem passage mortality causes. The transported portion of smolts only applies to Snake River basin production.
3. Compensatory predation mortality is the share of fish consumed by other predators that would have died from other factors subsequent to the cormorant predation event.
4. Other mortality accounts for non-compensatory related effects on outmigrants.
5. Adjusted outmigrants include effects from other and compensatory mortality.

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Coho						
Smolts	1,026,605	2,807,906	5,731,761	12,174,010	468,985	22,209,268
Hatchery Releases	862,348	2,358,641	4,814,680	11,277,112	436,156	19,748,938
Wild Origin	164,257	449,265	917,082	896,898	32,829	2,460,331
River Passage Mortality Rate (pre-predation)						
Snake River Transported	10.0%					
Not Transported	50.0%	50.0%	20.0%	0.0%	30.0%	
Estuary Passage	10.0%	10.0%	10.0%	10.0%	10.0%	
Smolts Less Passage Mortality	646,761	1,263,558	4,012,233	10,956,609	281,391	17,160,552
SAS's	1.57%	1.57%	1.57%	1.57%	1.57%	
Population Predation Rate	3.1%	3.1%	3.1%	3.1%	3.1%	
Predation	20,050	39,170	124,379	339,655	8,723	531,977
Inriver Survival	626,712	1,224,387	3,887,854	10,616,954	272,668	16,628,575
Compensatory and Other Mortality	-	-	-	-	-	-
Adjusted Outmigrants	626,712	1,224,387	3,887,854	10,616,954	272,668	16,628,575
Adult Returns (total)	16,099	44,032	89,882	190,905	7,354	348,271
Spring/Summer Chinook						
Smolts	15,838,014	10,321,632	8,538,796	7,406,328	7,738,823	49,843,593
Hatchery Releases	12,712,314	7,823,360	4,525,562	4,214,536	6,363,149	35,638,920
Wild Origin	3,125,700	2,498,273	4,013,234	3,191,792	1,375,674	14,204,673
River Passage Mortality (pre-predation)						
Snake River Transported	10.0%					
Not Transported	50.0%	50.0%	20.0%	0.0%	30.0%	
Estuary Passage	10.0%	10.0%	10.0%	10.0%	10.0%	
Smolts Less Passage Mortality	9,977,949	4,644,735	5,977,157	6,665,695	4,643,294	31,908,829
SAS's	0.21%	0.21%	0.21%	0.21%	0.21%	
Population Predation Rate	4.7%	3.5%	3.5%	3.5%	2.0%	
Predation	470,959	160,708	206,810	230,633	91,937	1,161,047
Inriver Survival	9,506,990	4,484,027	5,770,348	6,435,062	4,551,356	30,747,782
Compensatory and Other Mortality	-	-	-	-	-	-
Adjusted Outmigrants	9,506,990	4,484,027	5,770,348	6,435,062	4,551,356	30,747,782
Adult Returns (total)	33,091	21,566	17,841	15,475	16,169	104,142

Filter: Alternative A (cont.)

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Fall Chinook						
Smolts	6,160,951	17,051,560	32,138,757	36,848,591	-	92,199,858
Hatchery Releases	5,867,441	11,765,576	22,175,742	27,948,144	-	67,756,904
Wild Origin	293,509	5,285,984	9,963,015	8,900,447	-	24,442,955
River Passage Mortality (pre-predation)						
Snake River Transported	10.0%					
Not Transported	50.0%	50.0%	20.0%	0.0%		
Estuary Passage	10.0%	10.0%	10.0%	10.0%	10.0%	
Smolts Less Passage Mortality	3,881,399	7,673,202	22,497,130	33,163,732	-	67,215,462
SAS's	0.28%	0.28%	0.28%	0.28%	0.28%	
Share subyearlings	75.0%	75.0%	75.0%	75.0%	75.0%	
Population Predation Rate	3.1%	3.1%	3.1%	3.1%	3.1%	
Predation	120,323	237,869	697,411	1,028,076	-	2,083,679
Inriver Survival	3,761,076	7,435,333	21,799,719	32,135,656	-	65,131,783
Compensatory and Other Mortality	-	-	-	-	-	-
Adjusted Outmigrants	3,761,076	7,435,333	21,799,719	32,135,656	-	65,131,783
Adult Returns (total)	16,957	46,933	88,459	101,422	-	253,770
Summer/Winter Steelhead						
Smolts	11,831,970	2,136,223	872,003	4,010,294	2,460,600	21,311,091
Hatchery Releases	8,924,210	1,291,347	553,491	2,749,141	1,069,876	14,588,065
Wild Origin	2,907,760	844,876	318,512	1,261,154	1,390,723	6,723,026
River Passage Mortality (pre-predation)						
Snake River Transported	10.0%					
Not Transported	50.0%	50.0%	20.0%	0.0%	30.0%	
Estuary Passage	10.0%	10.0%	10.0%	10.0%	10.0%	
Smolts Less Passage Mortality	7,454,141	961,300	610,402	3,609,265	1,476,360	14,111,469
SAS's	0.48%	0.48%	0.48%	0.48%	0.48%	
Population Predation Rate	9.8%	7.6%	9.6%	9.6%	9.6%	
Predation	730,506	73,251	58,843	347,933	142,321	1,352,854
Inriver Survival	6,723,635	888,049	551,559	3,261,332	1,334,039	12,758,615
Compensatory and Other Mortality	-	-	-	-	-	-
Adjusted Outmigrants	6,723,635	888,049	551,559	3,261,332	1,334,039	12,758,615
Adult Returns (total)	56,972	10,286	4,199	19,310	11,848	102,615
Sockeye						
Smolts	280,762	4,408,944	-	-	-	4,689,706
Hatchery Releases	240,397	220,447	-	-	-	460,845
Wild Origin	40,364	4,188,497	-	-	-	4,228,861
River Passage Mortality (pre-predation)						
Snake River Transported	10.0%					
Not Transported	50.0%	50.0%				
Estuary Passage	10.0%	10.0%	10.0%	10.0%	10.0%	
Smolts Less Passage Mortality	176,880	1,984,025	-	-	-	2,160,905
SAS's	0.21%	0.21%	0.21%	0.21%	0.21%	
Population Predation Rate	4.2%	4.2%	4.2%	4.2%	4.2%	
Predation	7,429	83,329	-	-	-	90,758
Inriver Survival	169,451	1,900,696	-	-	-	2,070,147
Compensatory and Other Mortality	-	-	-	-	-	-
Adjusted Outmigrants	169,451	1,900,696	-	-	-	2,070,147
Adult Returns (total)	587	9,212	-	-	-	9,799
Total						
Smolts	35,138,302	36,726,266	47,281,318	60,439,223	10,668,408	190,253,516
Predation	1,349,267	594,328	1,087,443	1,946,297	242,981	5,220,315
Adjusted Outmigrants	20,787,863	15,932,492	32,009,480	52,449,004	6,158,063	127,336,902
Adult Returns (total)	123,706	132,028	200,380	327,111	35,372	818,597

Filter1: Alternative B-C; Phase I, Alternative D; Predation Reduction **56.0%**
Filter2: Consumption from Predation Probability

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Coho						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	11,228	21,935	69,652	190,207	4,885	297,907
Effective Smolts	17,822	48,745	99,503	211,341	8,142	385,553
Adult Returns (total change)	279	764	1,560	3,314	128	6,046
Spring/Summer Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	263,737	89,996	115,813	129,155	51,485	650,186
Effective Smolts	418,630	199,992	165,448	143,505	85,808	1,013,383
Adult Returns (total change)	875	418	346	300	179	2,117
Fall Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	67,381	133,207	390,550	575,722	-	1,166,860
Effective Smolts	106,954	296,015	557,929	639,692	-	1,600,590
Adult Returns (total change)	294	815	1,536	1,761	-	4,405
Summer/Winter Steelhead						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	409,083	41,021	32,952	194,843	79,700	757,598
Effective Smolts	649,339	91,157	47,074	216,492	132,833	1,136,894
Adult Returns (total change)	3,127	439	227	1,042	640	5,474
Sockeye						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	4,160	46,664	-	-	-	50,824
Effective Smolts	6,604	103,698	-	-	-	110,302
Adult Returns (total change)	14	217	-	-	-	230
Total						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	755,589	332,823	608,968	1,089,926	136,070	2,923,377
Effective Smolts	1,199,348	739,608	869,954	1,211,029	226,783	4,246,722
Adult Survival Due to Change	4,589	2,653	3,668	6,417	947	18,274

Filter1: Phase II, Alternative D; Predation Reduction 100.0%
Filter2: Consumption from Predation Probability

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Coho						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	20,050	39,170	124,379	339,655	8,723	531,977
Effective Smolts	31,825	87,045	177,685	377,394	14,539	688,487
Adult Returns (total change)	499	1,365	2,786	5,918	228	10,796
Spring/Summer Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	470,959	160,708	206,810	230,633	91,937	1,161,047
Effective Smolts	747,554	357,128	295,442	256,259	153,229	1,809,613
Adult Returns (total change)	1,562	746	617	535	320	3,781
Fall Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	120,323	237,869	697,411	1,028,076	-	2,083,679
Effective Smolts	190,989	528,598	996,301	1,142,306	-	2,858,196
Adult Returns (total change)	526	1,455	2,742	3,144	-	7,867
Summer/Winter Steelhead						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	730,506	73,251	58,843	347,933	142,321	1,352,854
Effective Smolts	1,159,533	162,780	84,061	386,592	237,202	2,030,169
Adult Returns (total change)	5,583	784	405	1,861	1,142	9,775
Sockeye						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	7,429	83,329	-	-	-	90,758
Effective Smolts	11,792	185,176	-	-	-	196,968
Adult Returns (total change)	25	387	-	-	-	412
Total						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	1,349,267	594,328	1,087,443	1,946,297	242,981	5,220,315
Effective Smolts	2,141,694	1,320,728	1,553,490	2,162,552	404,969	7,583,432
Adult Survival Due to Change	8,195	4,737	6,551	11,459	1,690	32,631

Appendix C
Bioenergetic Modeling Consumption Estimates and Economic Effects

Table C.1
Summary of Assumptions From Bioenergetic Modeling Consumption

	Bioenergetic Modeling
Coho	2,777,379
Chinook	
Yearling	1,032,811
Subyearlin	11,036,547
Steelhead	1,248,058
Sockeye	85,396

Notes: 1. Bioenergetic modeling estimates are DCCO diet based and are not associated with a sub-basin origin.

Source: Bioenergetic modeling is 2008-2012 average from Lyons (2010) and BRNW (2014).

Table C.2
Summary of Economic Effects From Bioenergetic Modeling Estimated Consumption

Economic Effects From DCCO Predation Reduction to Columbia River
Inriver Fisheries by Sector for Participant Direct Financial Value

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	33,941	2,045	6.0%	3,653	10.8%
Non-Indian commercial	4,152	252	6.1%	450	10.8%
Tribal commercial	3,785	174	4.6%	311	8.2%
Total	41,879	2,472	5.9%	4,413	10.5%

Notes:
1. Direct financial value (DFV) is commercial gillnet and tribal fisheries participant harvest revenue plus recreational angler trip expenditures.
2. DFV is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
3. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Economic Effects From DCCO Predation Reduction to Columbia River
Inriver Fisheries by Sector for Regional Economic Impacts

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	34,626	1,703	4.9%	3,041	8.8%
Non-Indian commercial	7,131	447	6.3%	798	11.2%
Tribal commercial	7,253	343	4.7%	613	8.4%
Total	49,010	2,493	5.1%	4,451	9.1%

Notes:
1. Regional economic impacts (REI) are expressed as personal income. REI is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Economic Effects From DCCO Predation Reduction for Columbia River Hatchery Investment Costs

	Alternative A	Effect (Change From Alternative A)			
		Alt B-C; Phase I, Alt D		Phase II, Alt D	
	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Consumption	12,181.6	-6,821.7	-56.0%	-12,181.6	-100.0%
Effective hatchery releases	17,005.7	-9,523.2	-56.0%	-17,005.7	-100.0%
Investment cost	10,890.7	-6,098.8	-56.0%	-10,890.7	-100.0%

Notes: 1. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions. A negative consumption or investment cost means a savings from the Alternative A status quo conditions.

Table C.3
Economic Effects From DCCO Predation Reduction to Columbia River
Inriver Fisheries by Sector and Species for Participant Direct Financial Value

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	33,941	2,045	6.0%	3,653	10.8%
Coho	5,444	521	9.6%	931	17.1%
Chinook					
Spring/summer	4,795	91	1.9%	162	3.4%
Fall	4,723	462	9.8%	825	17.5%
Steelhead	18,904	970	5.1%	1,731	9.2%
Sockeye	75	2	2.2%	3	4.0%
Non-Indian commercial	4,152	252	6.1%	450	10.8%
Coho	1,132	108	9.6%	194	17.1%
Chinook					
Spring/summer	1,921	36	1.9%	65	3.4%
Fall	1,098	107	9.8%	192	17.5%
Steelhead	0	0		0	
Sockeye	1	0	2.2%	0	4.0%
Tribal commercial	3,785	174	4.6%	311	8.2%
Coho	154	15	9.6%	26	17.1%
Chinook					
Spring/summer	2,339	44	1.9%	79	3.4%
Fall	1,073	105	9.8%	187	17.5%
Steelhead	173	9	5.1%	16	9.2%
Sockeye	46	1	2.2%	2	4.0%
Total	41,879	2,472	5.9%	4,413	10.5%
Coho	6,730	644	9.6%	1,151	17.1%
Chinook					
Spring/summer	9,055	172	1.9%	306	3.4%
Fall	6,894	674	9.8%	1,204	17.5%
Steelhead	19,077	978	5.1%	1,747	9.2%
Sockeye	122	3	2.2%	5	4.0%

Notes:
1. Direct financial value (DFV) is commercial gillnet and tribal fisheries participant harvest revenue plus recreational angler trip expenditures.
2. DFV is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
3. DCCO consumption based on bioenergetic modeling estimates.
4. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table C.4
Economic Effects From DCCO Predation Reduction to Columbia River
Inriver Fisheries by Sector and Species for Regional Economic Impacts

	Alternative A	Effect (Change From Alternative A)			
		Alt B-C; Phase I, Alt D		Phase II, Alt D	
Fisheries	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Freshwater sport	34,626	1,703	4.9%	3,041	8.8%
Coho	4,065	389	9.6%	695	17.1%
Chinook					
Spring/summer	12,867	244	1.9%	435	3.4%
Fall	3,526	345	9.8%	616	17.5%
Steelhead	14,112	724	5.1%	1,293	9.2%
Sockeye	56	1	2.2%	2	4.0%
Non-Indian commercial	7,131	447	6.3%	798	11.2%
Coho	2,015	193	9.6%	345	17.1%
Chinook					
Spring/summer	3,122	59	1.9%	106	3.4%
Fall	1,989	195	9.8%	347	17.5%
Steelhead	0	0		0	
Sockeye	4	0	2.2%	0	4.0%
Tribal commercial	7,253	343	4.7%	613	8.4%
Coho	293	28	9.6%	50	17.1%
Chinook					
Spring/summer	3,881	74	1.9%	131	3.4%
Fall	1,939	190	9.8%	339	17.5%
Steelhead	909	47	5.1%	83	9.2%
Sockeye	231	5	2.2%	9	4.0%
Total	49,010	2,493	5.1%	4,451	9.1%
Coho	6,373	610	9.6%	1,090	17.1%
Chinook					
Spring/summer	19,871	377	1.9%	672	3.4%
Fall	7,454	729	9.8%	1,302	17.5%
Steelhead	15,022	770	5.1%	1,376	9.2%
Sockeye	291	6	2.2%	12	4.0%

Notes:
1. Regional economic impacts (REI) are expressed as personal income. REI is in thousands of Year 2012 dollars adjusted using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. DCCO consumption based on bioenergetic modeling estimates.
3. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions.

Table C.5
Economic Effects From DCCO Predation Reduction for Columbia River Hatchery Investment Costs

		Effect (Change From Alternative A)			
	Alternative A	Alt B-C; Phase I, Alt D		Phase II, Alt D	
Stocks	Amount (000's)	Change (000's)	% Differ.	Change (000's)	% Differ.
Coho					
Consumption	2,469.7	-1,383.0	-56.0%	-2,469.7	-100.0%
Effective hatchery releases	3,199.9	-1,792.0	-56.0%	-3,199.9	-100.0%
Release cost per smolt	1.16				
Investment cost	3,724.3	-2,085.6	-56.0%	-3,724.3	-100.0%
Spring/Summer Chinook					
Consumption	738.5	-413.5	-56.0%	-738.5	-100.0%
Effective hatchery releases	1,222.1	-684.4	-56.0%	-1,222.1	-100.0%
Release cost per smolt	1.16				
Investment cost	1,412.3	-790.9	-56.0%	-1,412.3	-100.0%
Fall Chinook					
Consumption	8,110.7	-4,542.0	-56.0%	-8,110.7	-100.0%
Effective hatchery releases	11,237.6	-6,293.1	-56.0%	-11,237.6	-100.0%
Release cost per smolt	0.19				
Investment cost	2,106.8	-1,179.8	-56.0%	-2,106.8	-100.0%
Summer/Winter Steelhead					
Consumption	854.3	-478.4	-56.0%	-854.3	-100.0%
Effective hatchery releases	1,329.4	-744.5	-56.0%	-1,329.4	-100.0%
Release cost per smolt	2.73				
Investment cost	3,628.1	-2,031.8	-56.0%	-3,628.1	-100.0%
Sockeye					
Consumption	8.4	-4.7	-56.0%	-8.4	-100.0%
Effective hatchery releases	16.6	-9.3	-56.0%	-16.6	-100.0%
Release cost per smolt	1.16				
Investment cost	19.2	-10.8	-56.0%	-19.2	-100.0%
Total					
Consumption	12,181.6	-6,821.7	-56.0%	-12,181.6	-100.0%
Effective hatchery releases	17,005.7	-9,523.2	-56.0%	-17,005.7	-100.0%
Investment cost	10,890.7	-6,098.8	-56.0%	-10,890.7	-100.0%

Notes:
1. Effects are model outcomes for alternatives' changed conditions minus Alternative A conditions. A negative consumption or investment cost means a savings from the Alternative A status quo conditions.
2. DCCO consumption based on bioenergetic modeling estimates. Bioenergetic consumption estimates for Chinook yearlings were assumed to be spring Chinook, and Chinook subyearlings were assumed to be fall Chinook.

3. Does not include compensatory or other mortality (post-DCCO predation) other than passage mortality.
4. Passage mortality needs to be considered in the calculation of effective releases allied with smolts present in the lower Columbia River estuary where most consumption occurs. The effective hatchery releases for bioenergetic consumption estimates use a weighted average of river passage mortality rates across basins.
5. Investment costs are the hatchery production operation and administration expenditures associated with the DCCO consumed outmigrating smolts.
6. Hatchery release cost per smolt is from TRG (2009). Hatchery release cost per smolt is in 2012 dollars adjusted using the GDP implicit price deflator developed by U.S. Bureau of Economic Analysis. Cost per smolt for fall Chinook is a weighted average of Chinook subyearlings and yearlings. Costs per smolt use $1.16 for coho, spring/summer Chinook, and sockeye; $0.19 for fall Chinook; and $2.73 for summer/winter steelhead.

Source: Bioenergetic consumption estimates from Lyons (2010) and BRNW (2014).

Table C.6
Columbia River Hatchery and Wild Origin Production Adult
Survival Change Due to DCCO Management Plan Actions

Filter1: Alternative B-C; Phase I, Alternative D; Predation Reduction 56.0%
Filter2: Consumption from Bioenergetic Modeling

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Coho						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	71,894	196,640	401,400	852,555	32,843	1,555,332
Effective Smolts	114,117	436,977	573,428	947,284	54,739	2,126,546
Adult Returns (total change)	1,790	6,852	8,992	14,855	858	33,347
Spring/Summer Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	183,781	119,770	99,082	85,941	89,800	578,374
Effective Smolts	291,716	266,155	141,546	95,490	149,666	944,573
Adult Returns (total change)	610	556	296	200	313	1,974
Fall Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	412,989	1,143,023	2,154,369	2,470,085	-	6,180,466
Effective Smolts	655,538	2,540,052	3,077,670	2,744,539	-	9,017,799
Adult Returns (total change)	1,804	6,991	8,471	7,554	-	24,821
Summer/Winter Steelhead						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	388,038	70,059	28,598	131,520	80,697	698,912
Effective Smolts	615,933	155,687	40,854	146,134	134,495	1,093,103
Adult Returns (total change)	2,966	750	197	704	648	5,263
Sockeye						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	2,863	44,959	-	-	-	47,822
Effective Smolts	4,544	99,909	-	-	-	104,453
Adult Returns (total change)	9	209	-	-	-	218
Total						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	1,059,565	1,574,451	2,683,449	3,540,102	203,340	9,060,906
Effective Smolts	1,681,849	3,498,780	3,833,498	3,933,447	338,900	13,286,474
Adult Survival Due to Change	7,179	15,358	17,956	23,312	1,819	65,623

Table C.6 (cont.)

Filter1: Phase II, Alternative D; Predation Reduction 100.0%
Filter2: Consumption from Bioenergetic Modeling

Stocks	Snake R.	U. Columbia	M. Columbia	L. Columbia	Willamette	Total
Coho						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	128,382	351,143	716,785	1,522,420	58,649	2,777,379
Effective Smolts	203,781	780,317	1,023,979	1,691,578	97,748	3,797,403
Adult Returns (total change)	3,196	12,236	16,057	26,526	1,533	59,548
Spring/Summer Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	328,180	213,875	176,933	153,467	160,356	1,032,811
Effective Smolts	520,921	475,277	252,761	170,519	267,261	1,686,738
Adult Returns (total change)	1,088	993	528	356	558	3,524
Fall Chinook						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	737,481	2,041,113	3,847,087	4,410,866	-	11,036,547
Effective Smolts	1,170,604	4,535,807	5,495,839	4,900,962	-	16,103,212
Adult Returns (total change)	3,222	12,484	15,127	13,489	-	44,322
Summer/Winter Steelhead						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	692,925	125,105	51,068	234,858	144,102	1,248,058
Effective Smolts	1,099,880	278,012	72,954	260,953	240,170	1,951,969
Adult Returns (total change)	5,296	1,339	351	1,257	1,156	9,399
Sockeye						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	5,112	80,284	-	-	-	85,396
Effective Smolts	8,115	178,408	-	-	-	186,523
Adult Returns (total change)	17	373	-	-	-	390
Total						
Adjusted Reduction (predation reduction incl. compensatory mortality less other mortality)	1,892,080	2,811,519	4,791,873	6,321,611	363,107	16,180,190
Effective Smolts	3,003,301	6,247,821	6,845,533	7,024,012	605,179	23,725,846
Adult Survival Due to Change	12,819	27,425	32,063	41,628	3,248	117,184

Appendix J: Public Comment and Response

Organization of Public Comments

All comments received on the DEIS were assessed and considered, both individually and collectively, for revisions to the EIS. Comments were organized into two general categories: 1) general, opinion based comments and 2) substantive comments, meaning comments that challenged the methodologies, alternatives, and assumptions of effects made in the DEIS which the Corps has responded to by clarifying information, supplementing analysis, or modifying the alternatives in the FEIS. All comments were addressed either in revising the FEIS, or responding with explanations why changes were or were not made. Several themes emerged from the general comments and those are presented in Table J-1 with responses. More specific, substantive comments are presented in Table J-2. In responding to specific comments, Table J-1 or prior comments were referenced to reduce redundancy.

Due to the exceptionally voluminous amount of comments received (i.e., over 159,000) and because the points of consideration brought forth in the general, opinion-based comments were within the range of those assessed and considered by the substantive comments, only comment letters from entities representative of major themes or substantive issues with the DEIS were included at the end of this Appendix. Table J-1 provides a summary of the general comments received by email, online petition, handwritten letter, and otherwise. Table J-1 thus avoids lengthy or repetitive verbatim reporting of comments per Corps regulations implementing NEPA, 33 C.F.R. § 230.19(c).

Table J-3 includes detailed responses to comment letters received by ODFW and WDFW (state cooperating agencies in preparing the EIS) and the U.S. Environmental Protection Agency (EPA) comment letter submitted in accordance with its responsibilities under NEPA and Section 309 of the Clean Air Act. As cooperating agency status and pending actions, USFWS and USDA-Wildlife Services have been more actively involved in developing, reviewing, and revising the EIS alternatives and evaluating environmental consequences (see Chapter 1, Section 1.3). Thus, comment letters received by USFWS and USDA-Wildlife Services' (federal cooperating agencies) have been addressed largely through collaboration in finalizing the FEIS and only the substantive comments not represented in other received comments are included in Table J-3. The full comment letters from USFWS and USDA-Wildlife Services are included in their entirety at the end of Appendix J.

Table J-1. General comments and responses.

ID	Comment	Response	Change in Document
Geographic Scope			
G-1	Geographic scope and DCCO management area (Columbia River Estuary) is too narrow. The Corps should manage DCCO beyond the Columbia River Estuary and commit funds to the states.	Managing DCCOs outside of the Columbia River Estuary is outside the geographic region specified in Reasonable and Prudent Alternative (RPA) action 46 of the 2014 Federal Columbia River Power System Supplemental Biological Opinion; thus, it would not support the stated purpose and need stated in the FEIS. Although the Corps is not proposing to manage DCCOs outside of the Columbia River Estuary related to this action, the Corps has a responsibility to minimize potential impacts in meeting the purpose and need of the FEIS. This contributed to the Corps' selection of lethal methods as a primary strategy in Phase I, adoption of adaptive management thresholds to limit dispersal, and commitment of funding to monitor areas outside of the Columbia River Estuary to assess potential dispersal resulting from the management action.	No
Purpose and Need for DCCO Management			
G-2	Call for action is unwarranted because other factors caused or are contributing to salmonid declines, not DCCOs. DCCOs and salmonids have existed together for millions of years and the true cause of salmonid declines is man-made, resulting from dams, habitat loss and alteration, harvest, hatcheries, and non-native species. Thus, these actions should be the focus of management, not DCCOs, especially considering that man-made causes have a far greater cumulative impact to salmonids than DCCOs.	The Corps believes that management actions are warranted. In May 2008, NOAA Fisheries issued a 10-year Biological Opinion, which considered how a number of factors, in addition to the operation of the Federal Columbia River Power System, are affecting the productivity (e.g., recruits per spawner) and risk of extinction of dozens of ESA-listed salmon and steelhead populations throughout the Columbia River Basin over the past 20 or more years, for which population-specific productivity estimates are available (NOAA 2008). This analysis specifically considered how variations in ocean conditions, seasonal runoff and water withdrawals, harvest actions, habitat modification, predators, and structural and operational hydropower modifications have affected ESA-listed salmon and steelhead populations in the past and how implementation of RPA actions, would likely affect them through the period of the Biological Opinion and beyond. The 2008 Biological Opinion contains 73 RPA actions and research and monitoring efforts to be implemented by the	No

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		Action Agencies. These include improving fish passage at dams, managing river flow, improving tributary and estuary habitat, reforming hatchery practices, and controlling predators that prey on juvenile salmonids. The call for DCCO management results from the NOAA Fisheries issued Biological Opinion and supplemental Opinions (NOAA 2010, NOAA 2014), including RPA action 46, which is specific to DCCO management and includes a prescriptive target level to be achieved and timeline to follow to reduce DCCO predation to "base levels" within the context of the Federal Columbia River Power System Biological Opinion's jeopardy opinion. Thus, alternative courses of action would not achieve the specific objective of RPA action 46 (reducing DCCO predation), and these other courses of actions are more relevantly addressed in other RPA actions, such as those specific to dam operations, habitat, harvest, and hatcheries. Several comments suggested the level of DCCO caused mortality to juvenile salmonids is relatively small (3-4%) when compared to cumulative impacts at the dams, or what is harvested by recreational or commercial fishing groups. While NOAA Fisheries' "survival gap" analysis (DEIS, FEIS Section 1.2) presented the relative average increase of DCCO predation on steelhead and Chinook from the base period to the current period for ESA consultation purposes, the impacts of DCCO predation on specific ESU/DPS (DEIS Section 3.2.6, Appendix C) can be substantially higher within a given year. Predation rate data from steelhead DPSs (those originating entirely upstream of Bonneville Dam) indicate that juvenile steelhead are most susceptible to DCCO predation in the Columbia River Estuary, with average annual predation rates ranging from 2 to 17 percent (depending on the DPS and year; see Appendix C). During 2007–2010, Lyons et al. (2014) documented an average annual predation rate of 26 percent by DCCOs nesting on East Sand Island for PIT-tagged lower Columbia River hatchery Chinook salmon. Zamon et al. (2013) documented an annual predation rate of 19 percent on an	

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		experimental tagged group of Lower Columbia River ESU subyearling fall Chinook salmon released below Bonneville dam.	
G-3	DCCO predation is highly variable and colony size is a poor indicator of predation impacts. DCCO predation impacts on salmonids are highly variable and are affected to a large degree by environmental conditions and biotic and abiotic factors that influence DCCO foraging. And depending upon environmental conditions, a DCCO colony size much larger than target size specified in RPA action 46 may have similar or less predation impacts on salmonids.	The DEIS discussed that DCCO predation impacts are highly variable and influenced by environmental and biotic and abiotic factors. This was qualitatively described in the DEIS. In the FEIS, a Corps' funded retrospective analysis was included in Appendix C. This analysis provides a thorough investigation into the relationship among annual measures of DCCO predation, colony size, and environmental factors and provides a more rigorous, quantitative approach for assessing DCCO predation impacts in the future. Although environmental conditions greatly influence DCCO predation in a given year, no evidence to date suggests that per capita DCCO predation of salmonids is different at different colony sizes when controlling or accounting for environmental conditions; thus, NOAA Fisheries interprets that colony size, when considered across average environmental conditions, provides a relative index of potential or expected DCCO predation impacts. NOAA Fisheries' "survival gap" analysis for determining reduced predation levels for RPA action 46 considers average predation impacts over long time periods (i.e., base, current, and projected), and the long time durations considered likely adequately captured average environmental conditions for assessing relative predation impacts between periods.	Appendix C expanded to include a retrospective analysis. Clarifying text regarding variation in annual DCCO predation added to Section 1.1.6.
G-4	Compensatory mortality and adult returns of salmon and steelhead were not properly taken into account in setting management objectives or effects analysis. Benefits to salmonids or fisheries from reduced DCCO predation will be less than proposed, or even negligible, when accounting for other compensating mortality factors. Thus,	The DEIS discussed that benefits described in the fish and economic effects analysis were estimates and likely represent maximum benefits. The degree to which avian predation of juvenile salmonids in the Columbia River Basin is compensatory versus additive is currently unknown, and the Corps adopts NOAA Fisheries' "survival gap" analysis and its interpretation of compensatory mortality in setting the management objective (see Appendix D). Compensatory mortality was discussed in Chapter 4.6.5 in the DEIS, and additional information has been added in the FEIS. Benefits were presented	Section 4.2.5 expanded to include clarifying text describing that potential benefits are likely maximum values.

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	reducing one point-source of mortality in an ecosystem will not have a tangible effect and thus the action should be abandoned or modified.	as potential maximum values assuming no compensation; it was then qualitatively described that actual benefits could be less depending upon the degree of compensation actually observed. Other factors, such as actual levels of DCCO dispersal and the feasibility at precluding DCCOs from the Columbia River Estuary could further decrease potential benefits. Furthermore, the FEIS includes findings from a Corps' funded study evaluating predation impacts in the context of an age-structured, salmonid population growth model (lambda; Lyons et al. 2014 Benefits Analysis). The analysis represents scenarios of colony size reduction and compensatory mortality; and resulting salmonid average annual population growth rate. The analysis was intentionally structured and organized to represent a range of scenario-based conditions and respective minimum and maximum benefits to salmon. While this supplementary benefits analysis provides additional context for understanding the potential benefits of management actions, specifically by representing benefits in adult equivalents and overall population growth; specific management objectives for different salmonid life stages are established in the 2008 and supplemental Federal Columbia River Power System Biological Opinions. The salmonid life stage most relevant to a particular RPA action is the life stage most directly affected by the action causing the effect. For example, adult returns are not the metric for evaluating dam passage survival of juveniles, specific hatchery production targets, or improvements to habitat conditions. For this reason, survival improvements / benefits from reduction in DCCO predation are meaningfully considered at the juvenile life stage. Comprehensively, the Federal Columbia River Power System Biological Opinions address mortality factors at all salmonid life stages through the multiple RPA actions. No one RPA action singly results in salmonid recovery or works independently or in isolation from other RPA actions, but, collectively, all RPA actions work together to improve salmonid populations.	Section 4.6.5 expanded discussion on compensatory mortality, relevant research, and relevant results from Lyons et al. 2014, describing benefits to adult salmonid populations from reductions in DCCO predation and for various levels of compensation

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NOAA Fisheries' "Survival Gap" Analysis, Management Objectives and Bioenergetics Model			
G-5	NOAA Fisheries' "survival gap" analysis was not peer reviewed and does not pass the scientific integrity test. It did not properly account for measures of uncertainty (or compensatory mortality), resulting in a survival gap and DCCO management objectives that are too narrowly defined. Mean per capita bioenergetics based consumption estimates and smolt abundance predictions were used as input variables, which did not incorporate proper variance measures. With a more sophisticated analysis, the estimated survival gap may be significantly different (e.g., lower) than calculated in the DEIS, changing the management objective and magnitude of lethal control potentially required.	NOAA Fisheries' "survival gap" analysis for establishing RPA action 46 was included in the 2014 Federal Columbia River Power System Supplemental Biological Opinion and was available for public review in December 2013. The "survival gap" analysis was also reviewed by researchers who had developed and applied the DCCO bioenergetics model. Development and application of bioenergetics-based calculations to estimate smolt consumption has undergone peer-review and dissemination in scientific journal publications (as applied to Caspian terns), graduate student theses and dissertations, and reports to management agencies (Roby et al. 2003, Antolos et al. 2005, Lyons 2010, Lyons et al. 2011, Adrean et al. 2012, Roby et al. 1999–2014). Analytical methods for computing bioenergetics based estimates of smolt consumption are provided in Lyons (2010). Annual estimates of colony size and smolt consumption are reported in annual reports to management and funding agencies (Roby et al. 1999–2014), and available on the Bird Research Northwest website (birdresearchnw.org). NOAA Fisheries' "survival gap" analysis was developed as a management focused analysis which used the best available approach and data at the time of analysis for comparing base to current conditions. The issue of compensatory mortality and how it was handled in this analysis is described in the DEIS Appendix D: "The ultimate difference between these two periods is the difference in the effect the increase in the DCCO population has had on the populations of listed salmonids. As an example for steelhead, if we assume that compensation is 50 percent and this was applied to the analysis equally during both periods, the resulting difference would be half of the calculated 3.6 percent, or 1.8 percent. However, the number of cormorants that would need to be reduced to get back to the base period consumption rate would still be between 5,380 and 5,939 pairs."	Appendix D expanded to include Tech Memo from NOAA Fisheries on "survival gap" analysis. Bioenergetic estimates and measures of variance updated and revised in Chapter 1, Section 1.1, Appendix C, and Figures 1-3 and 1-7.

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		Uncertainty in modeling approaches was acknowledged throughout the DEIS and specifically in Chapter 4.6.5. The smolt abundance predictions used in the "survival gap" analysis are the best available data for that metric, and although commenters critiqued that metric, commenters did not provide an alternative metric that could be used similarly in the analysis. Per capita bioenergetics estimates and variance measures were updated based upon comments received on the DEIS, and these are presented in revised Figure 1-3 and Appendix C. NOAA Fisheries' "survival gap" analysis was updated with these new estimates, including presentation of estimated measures of variance in Figure 1-7. The PIT tag data presented in the DEIS and FEIS (Section 4.2.5, App. C) corroborate the findings presented in NOAA Fisheries' "survival gap" analysis regarding impacts of DCCO predation (see response in G-2).	
G-6	Target colony size does not go far enough in restoring DCCO populations to levels in existence prior to the stabilization of East Sand Island. The Corps and NOAA Fisheries should look at a smaller colony size for management objectives.	The proposed reduction in DCCO predation applies to the "base" and "current" periods for RPA action 46 of the Federal Columbia River Power System Biological Opinion. These time periods were determined by NOAA Fisheries Science Center. The Corps adopted RPA action 46 and the level of proposed reduction in DCCO predation as a condition of the 2014 Federal Columbia River Power System Supplemental Biological Opinion (per Section 7 ESA consultation).	No
G-7	PIT tag data, not bioenergetics approaches, should have been used by NOAA Fisheries for setting management objectives, as PIT tag data are more reliable and more specific to ESU or DPS.	The Corps accepted NOAA Fisheries methods and analysis for estimating DCCO predation impacts to determine juvenile survival improvement objectives for ESA-listed salmonids and adopted the analysis in the purpose and need statement. The Corps corroborated these results with a second, independent line of analysis: PIT tag recovery. With regards to methodologies, both methods were used and discussed in the DEIS and both have pros and cons and limitations. In the DEIS and FEIS, PIT tag data was used as the data source for the Chapter 4 fish effects analysis. In the FEIS,	Appendix D expanded to include Technical Memo from NOAA Fisheries explaining use of bioenergetics. Appendix C and

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		Appendix C was expanded to include a Retrospective Analysis using PIT data. NOAA Fisheries' "survival gap" analysis approach (i.e., use of bioenergetics based per capita consumption estimates and species-level targets, not ESU/DPS) was undertaken because it provided advantages regarding data history, representativeness, simplicity/availability, and associated error for estimating consumption rates most representative of the base period (further explained in Appendix D). Collectively, the DEIS and FEIS discuss predation impacts and provide a robust analysis of potential benefits to juvenile salmonids from the proposed action, as two independent data sources were used to corroborate effects. To ensure that these two lines of analysis are well understood in the context of the FEIS, additional information is provided that describes the strengths, limitations, and assumptions of each respective model.	Section1.1.6 expanded to include methodologies, assumptions and limitations of each approach
Alternatives			
G-8	Dispersal is an important factor in developing alternatives. However, the DEIS misrepresented the movement data from dissuasion research and incorrectly concludes that DCCO will remain committed to the Columbia River Estuary, when movement data suggests that DCCOs will prospect to historic and current colony locations and that these locations will be in areas of reduced fisheries conflicts (i.e., Puget Sound, Salish Sea).	DCCO dispersal was a significant concern identified during scoping and development of the DEIS and the potential for DCCO to disperse or abandon East Sand Island was evaluated throughout the DEIS. Results from dispersal monitoring (movement data) of radio tagged, banded and satellite tagged birds were summarized in the DEIS (ES-6-7, Sections 1.1.6 and 3.1, Table 3-1). Additional movement data is included in the FEIS, which summarizes movement data during just the early portion of the breeding season (i.e., April and May), when the majority of management actions would take place. All detections of satellite tagged birds summarized in Table 3-1 and added Table 3-2 occurred at night roosting locations, which better indicate secure roosting habitat and more commitment to a given location than daytime locations, which may just be foraging or short-term prospecting areas. DCCO usage of areas during the early nesting season when habitat reduction and hazing was conducted confirms that the Lower Columbia River Basin is the area most used by DCCOs during hazing events on East Sand Island. This, and	Section 3.1 expanded discussion of satellite tagged information from dissuasion research during the early breeding season. Table 3-2 added to FEIS and Appendix G added, which includes all radio- and satellite-tagged DCCO results to date.

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		continued DCCO nesting on East Sand Island throughout the management feasibility studies even when coupled with extensive natural disturbance events (i.e., eagle predation), provides evidence that DCCOs are highly committed to East Sand Island and the Columbia River Estuary; thus, supporting conclusions that their high level of commitment to the area coupled with the inability to effectively preclude and limit DCCO nesting, roosting, and foraging throughout the entire Columbia River Estuary would likely result in no significant reduction in DCCO predation rates of juvenile salmonids in the Columbia River Estuary, especially given the timeframe of the Federal Columbia River Power System 2014 Supplemental Biological Opinion. Additionally, as displayed in Figure 3-14, the state maps depicting areas of management concern were generated by ODFW and WDFW and do not included input from all stakeholders in various areas; thus, there is not complete certainty that DCCO dispersal to any given area would result in no or lessened fisheries conflicts when accounting for all stakeholders. However, the DEIS at Chapter 2, page14, discussed that "Mere presence of DCCO may not indicate a problem that needs to be addressed "and throughout the DEIS, effects resulting from DCCO dispersal outside of the Columbia River Estuary were described as being "commensurate with dispersal levels to new areas and subsequent site-specific interactions."	
G-9	The scope, scale, and results of Corps' funded non-lethal research conducted and the scientific literature on DCCOs was intentionally misrepresented and predetermined selection of an alternative relying on lethal management based on that misrepresentation.	The Corps' disagrees with this assessment, and, to clarify this point, in the FEIS- additional information was provided to more fully describe non-lethal research conducted to date. This includes reproduction of verbatim management objectives of Corps' funded research from contractual agreements with research entities, dollar values spent to date on non-lethal research methods, a full table of dates, locations, and results of prior social attraction and non-lethal research (Appendix G, Table G-1 added to FEIS), and additional information about DCCO dispersal and research findings during the	Appendix G added to include DCCO research and results to date; Table G-1 added to FEIS; Section 1.1.6 and 2.3 expanded to clarify results of

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		management feasibility studies in 2011-2013, when available habitat acreage was reduced on East Sand Island (Table 3-2 in FEIS). The DEIS stated that non-lethal methods, in particular human hazing and use of visual deterrents, were determined to be effective methods at reducing available nesting habitat on East Sand Island. Additionally, the DEIS stated that non-lethal methods would likely be effective at precluding other large DCCO breeding colonies from forming in the Columbia River Estuary (given accessibility) and have measurable success at reducing nesting, roosting, or foraging at specific areas of the Columbia River Estuary. However, based on research to date, effectively precluding DCCO usage throughout the entire Columbia River Estuary was determined not to be feasible using primarily non-lethal methods, particularly within the timeframe of the Federal Columbia River Power System 2014 Supplemental Biological Opinion (see DEIS, Chapter 1.1.6, Chapter 2, pg 7 and 8).	research and applicability to management at a larger scale.
G-10	Non-lethal management is a viable option and should be the Corps' proposed action instead of culling. Denmark and New York state at Lake Oneida have effective large scale non-lethal programs and ODFW successfully hazes DCCOs from coastal estuaries. These programs all suggest that non-lethal methods are effective in managing DCCO depredation.	Additional information has been added in the FEIS to more fully explain the rational of how the Corps came to select lethal methods as the preferred alternative. Results of Corps' funded non-lethal research are only one component of many factors that were considered. Other factors include results from other DCCO management research, particularly at a similar geographic scale, Corps' funded Caspian tern research including results and costs to date and comparative feasibility of managing DCCOs versus Caspian terns, achievement of the purpose and need of the EIS within the specified timelines, minimization of impacts to other resources both locally and regionally, specifically ESA listed species, concern of potential impacts to fish by dispersed DCCOs, and the costs of implementation. While non-lethal methods (hazing and temporary habitat modification on East Sand Island) would likely be effective at reducing the DCCO colony size on East Sand Island or in specific areas of the Columbia River Estuary, based on research conducted to date that considered non-lethal DCCO management at	Executive Summary includes additional rationale behind preferred alternative. Chapter 4, Section 4.7 provides additional narrative comparing feasibility and environmental consequences of alternatives. Appendix G changed in FEIS to include more technical

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		large geographic scale, it is not expected that similar methods would be effective at keeping DCCO out of the 172 river miles of the Columbia River Estuary, especially given access constraints and concerns of other ESA species in the Columbia River Estuary (see G-22). Past research has demonstrated that DCCOs prefer (i.e., repeatedly return to) certain locations, and express high nest site fidelity to breeding areas. Given the substantial growth and size of the East Sand Island colony compared to other areas, the Columbia River Estuary is likely one of the most productive foraging and breeding areas within the western population of DCCOs' range and thus. DCCOs would likely not abandon this area easily based upon results of other DCCO management and research that show high continued DCCO usage in productive foraging and breeding areas, DCCO commitment to East Sand Island given the scope and scale of management feasibility studies to date, and findings of very high levels of commitment of Caspian terns to East Sand Island given extensive habitat reduction and management and consecutive years of failed breeding. Additionally, the citations and research provided in comments suggesting the effectiveness of non-lethal methods were largely errant, mischaracterized, or in-line with conclusions made in the DEIS about effectiveness of methods at various spatial scales. Included is additional, relevant information from the research cited as effective non-lethal management: <u>Lake Oneida-</u> The references provided for successful non-lethal DCCO management in New York State at Lake Oneida (DeBruyne, et al., 2013) describes extensive lethal management, "From 1991 to 1997, management largely focused on restricting nesting locations to specific island locations on the lake. Control actions were increased from 1998 to 2003 when the colony was limited to 100 active nests through nest destruction and egg oiling, coupled with nonlethal harassment program designed to move all cormorants off of the lake starting around 1 September. Beginning in 2004, cormorant management consisted of nonlethal harassment through the entire breeding	information on DCCO dissuasion research.

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		and migration seasons (April through September–October), along with nest destruction and egg oiling of all nests on the lake (DeVault et al. 2012)". Denmark- Currently, up to 1/3 of all colonies and 1/5 of all nests in Denmark have been exposed to one or more forms of management, particularly egg oiling. Additionally, under national laws and regulations, individuals are allowed to shoot great cormorants within 1 km of pound nets and within estuary during smolt migrations; an estimated 6,000 cormorants are shot every year in Denmark (Niels Jepsen, DTU-Aqua, personal communication 2014.). ODFW- ODFW's non-lethal hazing program was cited as an effective program to resolve DCCO predation issues in Oregon coastal estuaries. However, this program has not resolved the DCCO predation issue satisfactorily, so much so that ODFW has applied several times for depredation permits to intensify their management efforts in those areas, as well as set DCCO population targets that are not to be exceeded (as described in the DEIS). Comments from ODFW to the Corps on the DEIS requested that the Corps expand locations listed on their depredation permit application to allow for lethal removal of DCCOs in all counties along the Oregon Coast (ODFW 2014, pg 4) As the purpose and need is to reduce predation impacts throughout the Columbia River Estuary, and doing so with minimization of adverse effects to other resources, both locally and regionally, the Corps, in its analysis, determined that a primarily non-lethal approach would not be effective in achieving predation reduction targets in the Columbia River Estuary. No comments were received that challenged the results from studies attempting non-lethal management on similar geographic scales, nor was compelling evidence provided or cited to suggest that non-lethal management could be effectively implemented to reduce DCCO predation on a geographic area as large as the Columbia River Estuary, especially given the timeframe of the	

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		Federal Columbia River Power System 2014 Supplemental Biological Opinion.	
G-11	Social attraction should not have been eliminated from detailed study as an alternative. The research on this was not characterized correctly and this method is viable.	The Corps disagrees with this assessment. The FEIS includes additional information about social attraction research and results to date and a more thorough discussion of the feasibility of identifying viable, socially accepted locations in the western U.S. that would support upwards of 14,500 DCCOs, given current perceptions of DCCOs. Furthermore, results from DCCO social attraction experimental research (and applied social attraction management for Caspian terns) do not provide a strong foundational base to support expansion of a large-scale management program in this direction, as this technique would likely have limited feasibility in achieving the purpose and need of the EIS (reducing DCCO predation through the Columbia River Estuary). When social attraction techniques were first being explored, initial research findings suggested, “While studies of the use of habitat enhancement and social attraction in the Columbia River estuary have been promising, results to date indicate that double-crested cormorants are not as responsive to these techniques as Caspian terns” (2007 Roby et al./BRNW annual report, pg 7.). There is little compelling evidence from subsequent DCCO and Caspian tern social attraction research (and management for Caspian Terns) to suggest contrary findings to this statement. Locations where DCCO social attraction techniques have had some success (East Sand Island, Miller Sands Spit, and Rice Island) would not reduce DCCO predation in the context of the EIS purpose and need. Additionally, for social attraction techniques to achieve some level of success, results suggest continued, annual funding and management would be required. During 2007–2012, social attraction techniques were attempted at 5 independent sites (i.e., 11 annual trials in total) outside of the Columbia River Estuary and no DCCO nesting was recorded at any site during any year from these efforts. Other literature cited in the DEIS, where DCCO social attraction has been attempted, is consistent with these finding and results, and no compelling evidence or cited literature was brought forth during the public comment period that	Section 1.1.6 and 2.3 includes additional information on social attraction research. Added new Appendix G, Table G-1 in FEIS, which describes Corps’ funded social attraction research and results to date.

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		would suggest DCCO social attraction would be a feasible alternative to achieve the purpose and need in the EIS.	
Adaptive Management and Monitoring			
G-12	Evaluating success of management should not be based on the number of birds specified in the RPA action 46, but rather on the need to close the survival gap for listed steelhead (and other listed salmonids).	See G-3 about colony size as a relative index of potential or expected DCCO predation impacts averaged across environmental conditions. As stated in the DEIS and all alternatives, PIT tag data will be collected and used to assess DCCO predation impacts in future. Information in the retrospective analysis (Appendix C in FEIS) will also be used to more properly assess results of monitoring in the context of environmental conditions.	No
G-13	The Corps should add to the Management Plan an explicit adaptive management option in which it would take additional management action in the near term if predation rates are not reduced commensurate with population reductions.	See G-1 (geographic scope) and G-6 (target colony size). Several consecutive years of PIT tag predation rate data will be needed to evaluate the efficacy of management actions. The number of years will depend on how quickly DCCO numbers can be reduced in the estuary and how consistent environmental conditions are during that time period. Management would occur through an adaptive process stated in the FEIS, which includes a framework to achieve the East Sand Island target colony size while ensuring the conservation of the western population of DCCOs.	No
G-14	There are too many other factors (e.g., compensatory mortality, environmental conditions, etc.) affecting salmonid survival for management actions to be evaluated.	As stated in the DEIS (Section 4.2.5) all of the action alternatives assume a reduced colony size of approximately 5,600 pairs at the end of Phase I and that this colony size would result in average annual juvenile salmonid survival increases of 1 to 4 percent depending on ESU or DPS. However these were considered maximum benefits that would vary annually depending upon other factors such as environmental conditions, and dispersal of DCCOs. Evaluation of the management action will be on the DCCO colony size on East Sand Island and abundance of DCCOs in the estuary and predation impacts to juvenile salmonids. Extensive data has been collected and rigorous monitoring and analytical techniques have been developed during the past 15 years to document and evaluate DCCO colony demographics and dynamics	No

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		and predation impacts on East Sand Island and within the Columbia River Estuary. This information, and continued lines of collected data using similar techniques and protocols, will allow for adequate evaluation of management actions.	
Ethical Concerns			
G-15	EIS fails to provide a legitimate discussion of ethics and the rights of wildlife.	The Corps has considered the role of ethics and value systems in human-wildlife conflicts (see DEIS and FEIS Chapter 4, Section 4.6.6 Human Dimensions). This section discussed relevant DCCO social acceptability research and identifies the topic of ethics as an issue raised during public scoping. This section discussed the role of an individual's value system in shaping their perceptions about wildlife management. Further, in making a decision, the Corps' record of decision will be based on the administrative record. This includes all the information before the agency prior to decision. The overwhelming majority of comments were opposed to the project on ethical grounds. These comments will be considered along with the environmental analysis in making a final decision.	No
G-16	DCCOs were vilified in the EIS. Lethal management will encourage the public to illegally kill DCCOs or encourage other agencies to take similar approaches in management and it sets bad precedent. Being made scapegoats for salmonid declines, the adverse impacts of DCCOs were overemphasized, whereas beneficial effects of DCCO were underemphasized or not mentioned at all. DCCOs provide ecological benefit to salmonids and other native fish by consuming predators of	There is no evidence that management will increase illegal take. To the contrary, in past illegal take events, frustration over lack of management from fisheries groups was often cited as the reason leading to illegal take events. For example, in the summer of 1998, frustrated fishermen who believed DCCOs were responsible for game fish declines in the eastern basin of Lake Ontario illegally shot an estimated 1500–2000 DCCOs on Little Galloo Island, Lake Ontario (Wires et al. 2001). The DEIS stated this at 4-58. Lethal management is currently undertaken to mitigate damage from wildlife conflicts for multiple species, both aquatic and terrestrial, nationwide. Lethal take of DCCOs falls under the jurisdiction of the USFWS, and the USFWS determines whether or not a depredation permit will be issued based upon issuance criteria specified under regulations promulgated under the MBTA	Section 3.3.5 and 4.3.5 added to FEIS to address existence and aesthetic values

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	juvenile salmonids (e.g., pike minnow, American shad, etc.) and contribute to healthy ecosystems.	and agency permitting policies. With regard to precedent, the DEIS cited the USFWS national DCCO management plan (USFWS 2005, USFWS 2014). Lethal take of DCCOs through depredation permits has occurred in the past and currently occurs within the Pacific Flyway by state and federal resource agencies and private aquaculturists. These levels of DCCO take are summarized in the Pacific Flyway DCCO Management Framework (Pacific Flyway Council 2012), cited in the DEIS. The beneficial effects of DCCOs, such as the contribution of DCCO guano to the ecosystem and nutrient loading, was described in the DEIS (Chapter 4.2.1 and 4.4.1). On East Sand Island, northern anchovy is the most prevalent DCCO prey type, followed by various marine and freshwater fishes, including clupeids, sculpins, and surf perch (DEIS 3-13). Given diet information presented in DEIS (Fig 3-7), DCCO on East Sand Island do not consume significant amounts of non-native predators of juvenile salmonids as the comments suggested. Predation impacts of DCCOs were not selectively included, but the EIS focuses more heavily on this particular research, since DCCO predation impacts to juvenile salmonids was the motivation for the management action.	
G-17	Suffering of DCCOs adults and chicks from crippling, injuries, and abandonment are not addressed. There was no explanation for how activities would actually occur, i.e. if shooting takes place at night from blinds and tunnels, how will injured birds be handled? Given the magnitude of the proposed cull how can this be achieved in a humane way?	In the DEIS, field methods were described in Chapter 2 and injuries to birds from shooting and loss of nests, eggs, chicks, and fledglings from loss of adults was analyzed in Chapter 4.2.2. In the FEIS, additional information has been added to Chapter 2, Section 2.1.2 to clarify that any lethal method implemented under an FEIS action alternative must be a humane euthanasia technique. Shooting, egg oiling or destruction, nest destruction, cervical dislocation, and CO2 asphyxiation are all classified as humane euthanasia techniques for birds by the American Veterinary Medical Association. Additional text was added to the description of alternatives in Chapter 2 to address the issues mentioned. The emotional suffering of DCCOs or other species from management actions is difficult to quantify, as individual's values	Additional text added in Chapter 2, to better describe humane methods and actions to minimize suffering. Section 3.3.5 and 4.3.5 added to FEIS-existence and aesthetic values.

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		and perceptions likely contribute to such an evaluation. Sections 3.3.5 and 4.3.5 were added to the FEIS to describe effects to individual's existence and aesthetic values under each alternative.	
Effects to DCCOs			
G-18	More lethal take than what is stated in the EIS will likely be needed to achieve the target size. This is due to inadequate consideration of immigration, that the DCCO population is likely not at carrying capacity (given known historic population levels and increases at East Sand Island), experience from other management efforts and that the 2013 colony size is about 4,000 individuals greater than the starting point used in the population model to predict number of adult DCCOs that would need to be culled in order to reach the target colony size. Thus, the DEIS understates the number of DCCOs that would need to be culled (approximately 16,000 individuals) to reach the management objective (approximately 5,600 breeding pairs). The EIS fails to adequately consider this; thus, effects to DCCOs are not fully represented in the EIS.	The Corps disagrees with this assessment. As described in Chapter 3, pg 15 of the DEIS, from 1987-2009, DCCO abundance increased by approximately 72 percent (i.e., 3 percent per year), or 12,000 breeding pairs, along the Pacific coastal states, which accounts for approximately 90 percent of the western population. The choice of using a lower than current abundance as the carrying capacity rather anticipating a 3 percent annual growth rate, explicitly accounts for depressed future growth of the western population that could result from the factors mentioned, i.e., loss of, and dispersal of birds from, the Salton Sea colony and, and reduction in numbers of birds nesting within the Columbia River system as a result of this proposed action. The size of the East Sand Island colony fluctuates naturally year to year. For example, during 2004 to 2013, the average percentage change in colony size between consecutive years was 11 percent; the greatest percent change was 21 percent between 2012 and 2013 (see Figure 1-2 of FEIS). Using the 10-year average was believed to be more representative of the central tendency of the colony size rather than using a particular year estimate (see S-25 for additional information about colony size). In determining proposed take levels, the DCCO population model and analyses in Appendix E-2 did explicitly account for density-dependent growth (including both growth at and immigration to East Sand Island) based on prior colony growth rates and scenarios for the ability of concurrent and long-term non-lethal methods to reduce carrying capacity. The choice of carrying	No

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		capacity and initial colony size in the modeling approach and implications for results were determined by the USFWS and are discussed in Appendix E-1 and E-2 and Chapter 4.2.2. The adaptive management approach, developed in cooperation with USFWS, describes responses to potential immigration or dispersal.	
G-19	The EIS does not properly and fully consider colony declines in areas outside of East Sand Island, (e.g., Salton Sea, Klamath Basin), current and future threats to the species (e.g., predation pressures from increases in bald eagle populations), realized and potential future habitat loss in geographic areas, and levels of persecution throughout their range. Studies show that DCCO breeding populations are declining in all locations on the West Coast besides the breeding colony on East Sand Island... "The number of coastal colonies to the north of East Sand Island has declined by approximately 50% since the early 1990s, and numbers nesting at the remaining northern coastal sites have also declined, resulting in a 66% decline in number of breeding pairs within this subpopulation...Because of the unique characteristics of the DCCO colony at East Sand Island and the tenuous status of the colonies elsewhere, the future of this colony will likely influence the entire western population" (Adkins et al. *Double-Crested*	The DEIS DCCO population model (Appendix E-1 and E-2) assumed the western population was at a carrying capacity (see G-18) and would remain constant into the future. However, in response to comments regarding colony failures in the Salton Sea and Klamath Basin, the DCCO population model was revised to assume the western population's carrying capacity has been reduced by 18% due to drought and loss of suitable habitat. This western population carrying capacity reduction was estimated by assuming a 20-year constant carrying capacity throughout the western population except for a permanent loss of 50% of the 2010 Salton Sea breeding population and a permanent 50% loss of the East Sand Island breeding colony (from the 2004-2013 average to the target colony size) that would no longer be allowed to breed at East Sand Island because of the implementation of Phase II of this proposed action (i.e., hazing and habitat management that will preclude the target colony size at East Sand Island from increasing). The FEIS includes modeled scenarios that account for colony declines at Salton Sea and projected for East Sand Island, realized and potential future habitat loss at Salton Sea and East Sand Island, and known current and future threats that will likely limit future growth due to bald eagle predation/disturbance, human disturbance and climate change. Different proposed take levels (FEIS, Section 2.2) are depicted for the various alternatives using the revised DCCO population model. In determining proposed take levels, the DCCO population model and analyses in Appendix E-2 of the DEIS did explicitly account for many of the cited threats. Current and future threats and habitat loss are represented in	Executive Summary, Section 3.2.2, 4.2.2 & 4.4. Additional information included to better qualitatively describe effects to the western population of DCCOs from habitat loss, predation from bald eagles, and illegal and legal “take”.

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	Cormorant Population Trends. The Journal of Wildlife Management. June 2014). Therefore the full impact to the western population of DCCO is not fully addressed.	the carrying capacity value chosen, which has been adjusted in the FEIS as described above. Furthermore, future lethal take of DCCOs within the western population outside of East Sand Island was explicitly accounted for in the western population analysis. Approximately 2,300 DCCOs per year are currently authorized to be lethally taken under depredation permits, scientific collecting permits, and special purpose permits within the western population, but only 1,364 per year were taken on average from 1998-2008 (USFWS, unpublished data). This level of take (1,364 DCCOs) was accounted for in model parameters; the potential additional take of 936 DCCOs (2,300 – 1,364) was included for future population trajectories; thus take of approximately 2,300 DCCOs within the western population was either included implicitly (i.e., in model parameters) or explicitly. In addition, the preferred alternative (Alternative C-1) in the FEIS reduces take levels for individual DCCOs, leaving more breeding individuals in the population as compared to Alternative C. Furthermore, implementation is planned under an adaptive management approach that takes into account the response of the western population during implementation (See Chapter 2 and Appendix E-2 Page 7).	
G-20	The conclusion that the ca. 1990 estimate used throughout this DEIS (41,660 individuals) is a sustainable population size at which to manage the western population of DCCO is arbitrary, and was arrived at without examining (1) the current status and trends for DCCO colonies in western North America, (2) how current status and trends of DCCO colonies in western North America compare with status and trends in 1990, or (3) whether the western population is	The effects analysis used the DCCO Western Population Model (Appendix E-2) to predict the potential long-term effects of the proposed action on the western population of DCCO. This model estimates the future population trajectory; it does not establish a baseline size. For the FEIS, a sustainable population was defined as a population that is able to maintain a long-term trend with numbers above a level that would not result in a major decline or cause a species to be threatened or endangered. This means that the population is capable of stable or increasing numbers of breeding birds through time (i.e., stable or increasing 20 year population trajectory), and above population levels that might lead to concerns about	Appendix E and Chapter 4, Section 4.2.2 includes additional modeled scenarios.

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	sustainable at this level with a colony of only about 5,600 breeding pairs left on East Sand Island. This analysis does not account for the fact that this species was in the 1990s and likely still is recovering from impacts of DDT and more than a century of persecution. The EIS needs to account for the difference between historical populations of DCCOs which were an order of magnitude greater than current populations in assessing effects and setting objectives.	listing the population as threatened under ESA (DEIS, ES-18). Setting aside the predictions of the population model, the history of western DCCO population growth since 1990 suggests strongly that it is sustainable at that level. Current status and trends were assessed and compared to ca. 1990 (DEIS Section 4.2.2). Based on Adkins et al. 2010, without the recent increases in population at East Sand Island, the current western population would still be ca. 1990 numbers. In other words, the sum of the breeding colony counts of the western population (excluding East Sand Island) ca. 2009 is similar to that observed in ca. 1990. See discussion of changes in the DCCO western population prior to 1990 in the Population Status and Trend section (DEIS Chapter 3 pages 15-25). Included in the sustainability evaluation were trajectories for the western population in Figure E-2.2, which include the scenario of resulting take levels if the East Sand Island DCCO colony was reduced to, and remained at, approximately 5,600 breeding pairs. In other words, the effects of the proposed level of take identified in Alternative C-1 and expected level throughout the remainder of the region, was modeled in Appendix E.2 and the predicted long-term (20 year) population trajectory shows that the western population drops to a low of approximately 38,500 breeding individuals in 2019 but rebounds to approximately 42,000 by 2024, stabilizing at approximately 44,500 through 2034. As stated in the DEIS, current population levels of DCCO in the west are substantially smaller than historical populations (likely 10 times smaller; see DEIS pg. 3-15) and the environmental conditions that supported those higher populations have been significantly altered, largely through human population growth and development along rivers and coastlines. The DEIS evaluated the cumulative effects of continued population growth on the affected environmental resources (DEIS, Section 4.4). Setting DCCO, or any other species, population objectives based on historical environmental	

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		conditions that no longer exist is outside of the Corps' authority and beyond the scope of the EIS.	
Effects to Other Birds			
G-21	Impacts to other bird species from proposed actions are not fully addressed. Given that shooting is proposed over water where it may prove difficult to retrieve carcasses. How the Corps and USFWS accurately account for the non-target take of these species? Additionally, management actions are likely to cause significant and substantial disruption to East Sand Island colony and other waterbirds on the island (pelicans, gulls, terns, other cormorants), even if actions are done at night. Additionally, effects to ESA listed streaked horned larks are not fully addressed. Actions could result in "take", which would be illegal without an incidental take statement.	The Corps disagrees with this assessment. Effects to other birds was evaluated in the DEIS (Section 4.2.3, 4.2.4). Adverse effects are expected to the DCCO population and other birds nesting near the DCCO colony on East Sand Island. Additional direct and indirect effects (see G-24) are expected to Brandt's and pelagic cormorants from the proposed cull. Human presence on the colony during nesting could result in nest destruction, abandonment, or failure, and increased susceptibility of eggs and chicks to predation for all species adjacent to where the disturbance is occurring. These actions could result in loss of nests, eggs, or chicks of other nesting species on East Sand Island. The DEIS stated that take of Brandt's and pelagic cormorants could occur due to misidentification and would be minimized to the extent possible by the best management practices and adaptive management strategies identified in the FEIS. Reports were referenced from past diet studies where DCCO were shot over water as a basis for determining the probability of this take. Efforts will be made to retrieve all culled birds over water and numbers of take of any kind will be reported to the USFWS. The DEIS stated that streaked horned larks do not nest on East Sand Island but have been observed on the Caspian tern colony outside of the breeding season by research personnel. Streaked horned larks do nest on nearby islands in the Columbia River Estuary many of which are used by the Corps to deposit dredged material excavated from annual maintenance of the Columbia River Federal Navigation Channel. The Corps shapes the dredged material to facilitate vegetation growth on these islands and after approximately 4 years (USFWS 2014c) of placing material these areas become suitable for streaked horned larks to nest. Specific measures to minimize disturbance to streaked horned larks on dredged material sites were added to	Chapter 4 Section 4.4 expanded discussion to describe relation of this EIS action to avian predation management on Corps' dredge material islands through the Corps' Channels and Harbors Program.

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		the FEIS. These measures would rely on human hazing as the primary measures on estuary islands when hazing DCCO. The Corp's Channels and Harbors program recently completed ESA Section 7 consultation with USFWS for streaked horned larks, and the resultant 2014 Biological Opinion described adverse effects to streaked horned larks from hazing avian predators, "Implementation of these activities to dissuade piscivorous birds may result in incidental adverse effects to streaked horned larks, depending on the timing, location and intensity of hazing and dissuasion. The effects to larks may include flushing adults or young, increased exposure of eggs and juveniles to weather and predation, nest abandonment or destruction, and possible mortality of eggs or young. Depending on the proximity, frequency and duration of these activities, dissuasion of avian predators could result in reduced survival of affected larks. Dissuasion measures could preclude the use of suitable nesting habitat, which would indirectly affect individual larks…" (USFWS 2014c). The Corps has an incidental take statement to support the current dissuasion activities on Rice, Miller and Pillar Islands.	
G-22	Potential effects to streaked horned larks are overstated. DCCOs and streaked horned larks habitat use does not overlap and the Corps' concerns over impacting larks from non-lethal management is overstated and unfounded.	The Corps disagrees with this assessment, see G-21. The concern over effects to streaked horned larks from DCCO dispersal are not solely about habitat preference and potential overlap but is based on adverse effects to individual birds from hazing on islands near to East Sand Island in the Columbia River Estuary designated critical habitat for streaked horned larks. Human disturbance and monitoring these islands to detect Caspian terns and subsequent hazing and placement of dissuasion materials can have direct and indirect adverse effects to streaked horned larks (USFWS 2014c). Approximately 50% of the local Columbia River breeding population of streaked horned larks resides on Rice, Miller Sands Spit and Pillar Rock Islands. Rice Island and Miller Sands Spit are former DCCO colony sites and the island's habitat types can change from the placement of dredged	Section 4.2.4, 4.4.2 added language clarifying effects to streaked horned larks and reasoning why effects are a management concern

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		material. Under Alternative B, potential dispersal of thousands of DCCOs to these islands could occur, and this would be a serious concern, given the sensitive status of streaked horned larks in the estuary. While a single hazing event on these islands may not affect the population of streaked horned larks, cumulative effects from repeated human disturbances during the nesting season year after year could adversely affect the Columbia River population, which is estimated to only be approximately 45 to 50 breeding pairs (USFWS 2014c). The Columbia River is important to the conservation of the species, given that the entire population estimate is only 1,170-1,610 individuals (Altman 2011), and this area is important for maintaining genetic connectivity between the Willamette Valley and the Puget Sound and Washington Coast regions.	
Compliance with Migratory Bird Treaty Act and Depredation Permit			
G-23	Proposed lethal management is in violation of Migratory Bird Treaty Act because non-lethal management and/or methods are required before depredation permits can be authorized.	As indicated on the USFWS's depredation permit application and fact sheet, the USFWS typically requires implementation of practicable nonlethal measures prior to and in conjunction with any authorized lethal take. But, the Corps may demonstrate that certain nonlethal measures are not practicable, for example as being ineffective, infeasible, contrary to the proposed action, or prohibited by regulation. The MBTA and depredation permit regulations do not specifically preclude issuing a permit authorizing lethal take if no non-lethal measures have been implemented. As addressed in above comments G-9, G-10, and G-11, the Corps has conducted experimental management feasibility studies and research to inform future DCCO management strategies and test efficacy of non-lethal methods. This has been an extensive undertaking by the Corps, with greater than 6 million dollars expended on these studies and research between 2008 and 2013 alone. Additionally, the DEIS identified concurrent non-lethal management techniques that would be implemented in Phase I of	Per G-9, G-10, G -11, see FEIS, Section 1.1.6, Appendix G, Table G-1

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		alternatives considering lethal methods, and primarily non-lethal methods would be used in Phase II for long-term management of the DCCO colony on East Sand Island.	
G-24	The EIS proposes killing Brandt's and Pelagic cormorants. This is incidental take of federally protected species, and no mention is made in the DEIS of obtaining a special purpose permit under the MBTA to authorize this incidental take.	A depredation permit is required before a person may take migratory birds for "depredation control purposes." 50 C.F.R. § 21.41. While DCCOs are the focus of the proposed depredation take activities, based on prior research activities, take of pelagic and Brandt's cormorants is anticipated as part of the proposed depredation program on account of the risk of mistakenly identifying a pelagic or Brandt's cormorant as a DCCO. The DEIS and FEIS estimates anticipated take of pelagic and Brandt's cormorants as part of implementing the proposed control program. The Corps would include this take in their depredation permit application for the proposed take of DCCOs, and the USFWS may consider the take of non-target species associated with the proposed depredation program when evaluating a depredation permit application. In addition to the estimated take of pelagic and Brandt's cormorants described above, the DEIS evaluated disturbance associated with management activities, such as accessing areas, hazing, or from implementation of lethal methods, in areas where other species of birds are attending nests. This could result in nest destruction, abandonment, or failure, and increased susceptibility of eggs and chicks to predation. These actions could result in loss of non-target species' nests, eggs, or chicks. Quantifying this level of take is not possible. Take would be avoided and minimized to the extent possible by the best management practices and adaptive management strategies identified in the FEIS but levels and effects could be comparable to, or higher than, those that occurred during past dissuasion research.	No
G-25	The proposed lethal management is in	The purpose and need for the proposed action is not to reduce the regional	No

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	violation of the MBTA because it results in too much take and is being used for, or will result, in population reduction of the species. Population reduction of migratory birds is the province of depredation orders, which are federal regulations promulgated for individual species (see 50 C.F.R. 21.42).	population of DCCOs but instead to address DCCO predation of salmonid smolts in the Columbia River Estuary. Depredation permits may be used to alleviate bird damage at specific locations. As described in 50 C.F.R. § 21.41(b), the permit applicant must include a description of the area where depredations are occurring and the nature of the interests being injured. Depredation permits are not typically used for regional population control; they are used for local conflicts. But the effects of the authorized lethal take may be assessed at the regional scale (such as at the state-scale or flyway-scale). The environmental analysis for this proposed action is estimating potential effects to the regional DCCO population, not targeting for regional population reduction. 50 C.F.R. § 21.42 concerns depredation orders for migratory game birds. DCCOs are not migratory game birds (see 50 C.F.R. § 20.11(a)). Regardless, the USFWS establishes depredation orders to facilitate effective species management for individual species or groups of species affecting specific resources. When the number of annual requests for depredation permits for specific bird-resource conflicts becomes excessive, the USFWS considers establishing a depredation order. Currently, unlike in the mid-western and eastern states (see 50 C.F.R. § 21.48), there is no depredation order for DCCO control over public resources in western states (USFWS 2014).	
G-26	DCCO should be removed from the Migratory Bird Treaty Act or should be considered a "game bird" in areas which require damage control.	As discussed in Chapter 2, page 32, consideration of DCCOs as "game birds" is inconsistent with the terms of conventions between the United States and foreign countries for the protection of migratory birds, as codified in the MBTA. Amending the MBTA to consider DCCOs as "game birds" is outside the scope of the EIS.	No
Compliance with National Environmental Policy Act			
G-27	While the DEIS does offer four alternatives, including an alternative of "no action," no	Pursuant to CEQ regulations and 33 C.F.R. Part 230, the Corps' regulations implementing NEPA, the DEIS defined the purpose and need for the proposed	No

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	alternative is considered in which actions to improve juvenile salmonid survival are not solely focused on the reduction of DCCOs. Thus, the DEIS does not satisfy NEPA's requirements to consider a "reasonable range" of alternatives.	action and developed a range of alternative to meet that purpose and need. The purpose and need was specific to implementing RPA action 46 in the Federal Columbia River Power System Biological Opinion. That RPA, action 46, concerns reducing DCCO predation of ESA-listed juvenile salmonid in the Columbia River Estuary. Accordingly, the range of reasonable alternatives includes those alternatives that might meet RPA action 46. While, there are a number of other factors affecting survival of ESA-listed juvenile salmonids (G-2), the Corps' purpose and need is specific to implementing an RPA action that is intended to avoid jeopardizing the continued existence of these listed species.	
G-28	NEPA has twin purposes of improving decision-making in environmental policy and facilitating broad public participation in environmental decisions. Failure to fully evaluate ethics renders the EIS inadequate as it fails to disclose the social implications required for informed decision-making.	The Corps has considered the role of ethics and value systems in human-wildlife conflicts. The DEIS provided a discussion on the human dimension of wildlife management, acknowledging that wildlife conflicts are conflicts that are ultimately based on human interests. The DEIS and FEIS discloses the variation in value systems, by including discussion of Section 1.4.1- Comments from Scoping, Section 4.6.6- Human Dimensions, and Appendix J- Public Comments and Response. The Corps' analysis under NEPA focused on how the particular action affects the quality of the "human environment." 42 U.S.C. § 4332(2)(C). CEQ has clarified that "human environment" should be "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." 40 C.F.R. § 1508.14. CEQ also clarified that the "effects" of the action include ecological, aesthetic, historic, cultural, economic, social, or health effects, 40 C.F.R. § 1508.8, and the DEIS addressed impacts to these resources. Discussion of existence and aesthetic values added to FEIS.	Section 3.3.5 and 4.3.5 added to FEIS-Existence and Aesthetic Values.
G-29	The removal of large amounts of the DCCOs on East Sand Island could have adverse effects on the local ecosystem, which are	The DEIS did consider ecosystem related effects in terms of cumulative effects to environmental resources (DEIS, Section 4.4). See G-16 response for information on non-indigenous species in the DCCO diet.	No

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	not discussed in the EIS as possible environmental consequences. This is required per NEPA.		
G-30	There are other, more humane methods that should have been considered rather than shooting individuals, such as egg oiling, and NEPA requires their evaluation because this would be mitigation for crippling and injury associated with shooting adult birds.	Based on, and in response to, substantive comments received during the public review period and input from cooperating agencies to the EIS, the FEIS includes an additional alternative, Alternative C-1, Culling and Egg Oiling with Integrated Nonlethal Methods. This is the Corps' preferred alternative for the FEIS. This alternative is a modification of Alternative C and proposes both culling and egg oiling to achieve the RPA 46 target colony size. Compared to Alternative C, the primary benefit of Alternative C-1 is that it lessens the potential effects to the short- and long-term population trend of the western population of DCCOs by decreasing the number of adults lethally removed annually by approximately 40% compared to Alternative C. Additionally, the factors mentioned (i.e., humaneness of methods, use of egg oiling to mitigate for crippling and injury associated with shooting adult birds), which were received in many public comments, were also considered in the selection of Alternative C-1 as the preferred alternative. In the FEIS, the humaneness of methods were discussed in Chapter 2 and new sections 3.3.5 and 4.3.5 (Existence and Aesthetic Values) were added, which further discusses impacts of alternative on these values.	Chapter 2- Alternative C-1 evaluated in FEIS.

Table J-2. Substantive comments and responses.

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Geographic Scope			
S-1	The economic impact of DCCO predation to the fisheries goes beyond the Columbia River- (from southern Oregon to Alaska and affected coastal communities). The Columbia River salmon stocks and their health are of direct and significant financial value to ocean fisheries from California to Alaska.	The economic analysis (Appendix I) was included in the DEIS and revised for the FEIS. Explanation of impacts to areas outside of Columbia River fisheries are acknowledged qualitatively, including a more thorough discussion of world-wide salmon fisheries markets (information is summarized in Chapter 4). The regions included in the geographic scope for economic impacts were wherever Columbia River Basin hatchery production contributes to the Columbia River and tributaries (referred in the DEIS and FEIS as "in-river") fisheries. The quantitative analysis was limited to in-river fisheries because the proposed actions are expected to have a proportionally greater impact on areas that are dependent upon Columbia River Basin hatchery production.	Appendix I includes additional qualitative information on other regional fisheries. No change to geographic scope.
Bioenergetics Model and DCCO Salmonid Consumption Estimates			
S-2	Errors were found in how variance estimates were calculated using the bioenergetics model and approach. These variance estimates were used in NOAA Fisheries' "survival gap" analysis. Use of these estimates greatly increases uncertainty surrounding DCCO consumption estimates and would drastically change the RPA action 46 target colony size identified as the management objective.	Variance measures for bioenergetics based consumption estimates have been updated in the FEIS (see S-3). NOAA Fisheries' "survival gap" analysis used the best (here, median) per capita consumption estimates. When the error was corrected and the model rerun, the point estimates did not change substantially (resulting in a 3.54% gap in steelhead survival as presented in the FEIS Section 1.2, compared to the 3.65% as presented in the DEIS). The slight change in the gap estimate was largely due to the model simulation process.	Bioenergetic consumption estimates updated with revised variance calculations in Chapter 1 and Appendix C. FEIS Figures 1-3 and 1-7 revised and include updated confidence intervals.
S-3	The diet proportion standard deviation formula used in the bioenergetics model for Tillamook Bay analysis was incorrect. This error appears to be inherent to the model and was likely applied to East Sand Island DCCO consumption data, resulting in underestimation of the variation and resulting	See S-2. This error was also present in the calculations performed for the DEIS. The formula has been corrected and revised consumption estimates and 95% confidence intervals calculated using the corrected uncertainty estimates and are presented in the FEIS (Appendix C). This error does not have a direct effect on the best estimates of smolt consumption, but the revised confidence intervals in the FEIS are wider than those previously reported in the DEIS.	Per S-2

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	confidence intervals.		
S-4	The Monte Carlo simulation used in the bioenergetics models simply involved generating 1,000 values for each input value using means and SEs then calculating the numbers consumed 1,000 times and using 2 x Standard Deviations of the result for Confidence Intervals. Implicit was that a random numbers generator was used, in this case a random normal generator, and that the values were thus random. However, an inconsistency occurred in generation of random values for proportions for prey types. The proportions were relative values--therefore changing one value changes other values. In generating 1,000 random values for each proportion, the model forced these values to sum to one for each iteration. This violates the assumption of randomness implicit in the Monte Carlo method and constrains variability in the end result, thereby minimizing Confidence Intervals.	As described in publications of the bioenergetics technique (e.g., Roby et al. 2003, Lyons 2010), a Monte Carlo process is used to estimate smolt consumption and the uncertainty in that estimate (after Furness 1978). The calculations are performed 1000 times; in each iteration, a "random" value is drawn from the empirically measured or assumed sampling distribution of each input parameter and used collectively in the calculations. The 1000 calculated values of the response variables of interest (the estimates of smolts consumed) can then be summarized as the most likely or central value with the uncertainty in that "best estimate" described using the 95% confidence interval as described by the distribution of the 1000 responses (Roby et al. 2003, Lyons 2010). In the modeling approach, each diet proportion is generated from the sampling distribution without constraint initially, but after proportions are generated for all prey types, the values are normalized to sum to a value of 1. This approach is taken because diet proportions are not, in fact, independent. If DCCOs consume more of any given prey type, they will inevitably consume less of all other prey types combined. This biological reality is particularly important because the consumption of multiple prey types (i.e. several species of salmonids) is of interest, not just a single prey type that could be modeled to vary unconstrained conditions. It is also important that an accurate representation of the complete diet is obtained for each iterative calculation as the amount of any given prey type consumed is dependent on the average quality (energy content) of the rest of the diet.	No
S-5	Almost all the prey proportions in the model were below 0.1 due to small samples and parsing into multiple categories. Normal and truncated normal distributions were used in the simulations assuming parametric values. It	In the calculations, each diet proportion is generated from an assumed normal distribution, but, for small proportions, diet proportions are generated from a truncated normal distribution, as an approximation of a one-sided distribution. Random values were drawn from a normal distribution with a mean equal to the empirically measured value and a	No

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	is more statistically appropriate to use other distributions, transformations, or calculation of asymmetrical confidence intervals for these model inputs.	standard error determined using the proportional standard deviation and diet sample size. If the random value generated was less than zero, the diet proportion for that prey type and simulation were set to zero, thus truncating the distribution of values used. An alternative distribution assumption (modified binomial) was considered for small diet proportions, but calculations using either truncated normal or binomial distributions were qualitatively similar in comparative tests (D. Lyons, unpub. data), so the truncated normal distribution was retained for simplicity and reduced computational requirements.	
S-6	For Tillamook Bay data, the bioenergetics model calculated proportions did not match what was used to allocate total energy to prey categories….back calculated values deviate from the expected by up to 30%.	The back-calculations conducted by the reviewer(s) were problematic in how they were calculated because they were trying to compare biomass consumed results for either of two two-week periods to the average diet composition of the two periods (the combined four-week period). A more accurate comparison is to back-calculate diet composition from biomass consumed results for just a single two-week time period and compare that to the diet composition data generated and used to calculate the biomass consumed in that same time period. When this comparison is performed on the Tillamook Bay analysis, discrepancies were 0.1-0.5%, with differences appearing at the third significant digit of each quantity. This level of discrepancy is the result of most input parameters being specified to three significant digits, not an internal inconsistency or error in the calculations	No
S-7	Genetic ID of diet contents provides only Yes/No or binary data. The protocol for converting binary data to quantitative data precise to three decimals was incredulous and no methods or protocol were provided for how this was conducted.	Diet composition is determined by identifying soft tissue from the digestive tracts of collected DCCOs. To identify salmonid species, salmonid tissue samples taken from DCCO stomachs were analyzed using genetic techniques developed by NOAA Fisheries Northwest Fisheries Science Center. Because the DCCO stomach sample is the independent sampling unit for diet composition, multiple salmonid samples identified from the same stomach are not independent samples of salmonid composition. The breakdown of each stomach sample containing salmonids identified to species is compiled by frequency	Appendix C expanded to include Additional clarifying text provided in FEIS to explain conversion of genetic ID of diet contents to proportion of diet.

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		(e.g., 100 percent coho salmon, 50 percent yearling Chinook salmon and 50 percent steelhead, etc.), averaged across the available samples, then translated into proportional biomass using the average masses of each salmonid species/type. Because of limited clean tissue samples in any given year, samples are pooled across years.	
S-8	In the Tillamook Bay data, an error was made by using weights for 45 gm and 5 gm for cutthroat and chum respectively, rather than 40 gm and .6 gm. Using the correct values dropped the total take by 40% from ~51,000 to ~29,000.	Distinct data preparation files are kept between the DEIS analyses and those for ODFW's Tillamook Bay study; the error in the preliminary Tillamook Bay analysis was included in the DEIS via the cited consumption estimate for Tillamook Bay. ODFW is partway through a 3 year study to assess the impacts of DCCO on salmonid populations along the Oregon coast. Preliminary results cited in the DEIS are being updated using improved methodologies (based in part on public comments received on preliminary analyses) and incorporate newly available data. Results to date continue to indicate that juvenile salmonids in coastal estuaries are susceptible to DCCO predation based on revised analyses. The FEIS has been updated to reflect the most recent information on consumption data from the Tillamook Bay study.	Section 3.2.7 and 4.2.6. revised to cite multi-year studies underway.
S-9	Very large extrapolations are made from the small number of fish in diet samples to overall DCCO annual consumption estimates. Reverse extrapolation from available data sources suggest that each fish in diet samples was extrapolated to represent 10,000 to 350,000 fish consumed. Sample sizes should be provided so that modeled estimates can be interpreted in proper context of the original sample data.	Appendix C now includes additional information about sample sizes from diet sampling. DCCO diet composition sample sizes are relatively small and do result in large extrapolations and substantial uncertainty in the estimates of smolts consumed. This is discussed throughout the FEIS. Diet sampling of DCCOs is constrained by the practical and ethical considerations of collecting animals for scientific purposes. Appropriate sample sizes are determined through Animal Care and Use Committees and when applying for Scientific Collection permits from the USFWS. Non-lethal sampling (e.g., collection of regurgitated stomach samples from adults and/or chicks) is not feasible on a larger scale without inducing significant disturbance to a large portion of the breeding colony, which might have significant impacts to reproductive success or fidelity to the breeding site. Larger scale lethal sampling (greater collection of adult DCCOs) could cause a reduction in the East Sand	Appendix C in FEIS has additional information regarding sample size from which diet composition was derived.

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		Island adult breeding population.	
S-10	The DEIS fails to provide the “individual” (not pooled) stomach contents data of species-specific salmonids obtained from cormorants lethally collected from 1998 through 2013. This raw data provides the basis for bioenergetics modeling of annual DCCO salmonid consumption within the Columbia River estuary which in turn directs the course of management decisions. At the 2012 Corps scoping meeting, WCNC raised concerns over the accuracy of the computer code created for bioenergetics modeling. On December 3, 2012, WCNC submitted a FOIA request to the Portland District for DCCO raw stomach data and computer coding. After searching, the District was unable to locate records responsive to the WCNC request and accordingly provided WCNC with a “no records” response. Notwithstanding that the DCCO raw stomach data may not be required under Corps contracts; the data is used to direct the government’s salmon recovery/avian management actions. This scientific data should be considered public domain and made available through the FOIA process. WCNC also requested DCCO raw stomach data at each of the 2014 Portland and Astoria open house sessions. At the 2014 Astoria open house, Corps personnel indicated that they “were working on” obtaining the baseline information. In a recent meeting with	See G-7. Greater documentation of the bioenergetics model including limits, assumptions, and methods is presented in Appendix C of the FEIS. PIT tag data recovered on the DCCO colony was used in the DEIS and FEIS to evaluate the potential benefits of DCCO management. Use of the PIT tag data to evaluate DCCO predation impacts on juvenile salmonids corroborates findings from NOAA Fisheries’ “survival gap” analysis in setting management objectives. Regarding WCNC's December 3, 2012 FOIA request, the Corps was not in control of records responsive to the request.	Appendix C in FEIS expanded to include methods, limits, and assumptions of the bioenergetic model parameters.

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	the Corps, et. al., the Audubon Society of Portland also requested the raw stomach data. Our expectation was that the raw data would be made available to interested parties within the public comment period which has not been the case. The premise behind management of indigenous avian piscivores is their purported impact on juvenile salmonids. If the science and methodology behind the highly publicized cormorant predation calculations are flawed, then the Corps and cooperating agencies have validated the argument that the birds are merely scapegoats to deflect attention from human caused impacts. Suppressing underlying information in an effort to prohibit public scrutiny creates an atmosphere of public distrust and hints of conspiracy. The impact of the preferred Alternative "C" will have significant consequences for the local and western region DCCO population. It is presumptuous to assume that certain segments of the public will blindly accept statistics contained in the DEIS when the ability to independently review and analyze salmonid predation data is not provided.		
Purpose and Need			
S-11	The record numbers of salmon returning to the Columbia River in the past two years calls into question the need for the management	Long-term averages and overall salmonid population trajectories (i.e., increasing or decreasing populations) are more appropriate measures for assessing the need for management actions, rather than data from	Executive Summary includes language explaining recent

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	plan.	only two years. Fall Chinook and coho salmon did return in record numbers in recent years. However, steelhead, which is the management focus of NOAA Fisheries' "survival gap" analysis, did not return in record numbers, show relatively static growth trajectories, and are still a concern for fisheries resource managers. Additionally, the high salmonids returns cited have occurred concurrent with increased DCCO abundance and predation impacts in the Columbia River Estuary, not independent or in absence of that mortality factor; thus, higher returns would be expected if DCCO predation had been reduced or absent.	returns versus long-term trends
Alternatives			
S-12	The DEIS Appendix "D" memorandum of Gary Fredrick, NOAA Fisheries dated December 9, 2013 calculates the 3.6% gap and includes the following language: ***"While this shortfall (or gap) can be addressed with any action that improve productivity,*** *it is logical that cormorant management objectives assist in this goal."* This admission and statement from NOAA Fisheries allows the Corps to consider other methods to improve juvenile survival other than DCCO management. Other methods suggested are increased spill (http://www.fpc.org/documents/FPC_memos.html; http://www.fpc.org/documents/FPC_Annual_Reports.html), supported from annual reports presenting findings from the Comparative Survival Study Oversight Committee and Fish Passage Center.	The purpose and need for the proposed action is based on implementing a particular RPA, action 46, in the 2014 Supplemental Opinion. As noted in the response to G-2, RPA action 46 is but one of many RPA actions designed to comprehensively benefit survival of juvenile and adult salmon and steelhead in the Columbia River either through direct actions (e.g., habitat restoration or flow management) or development of research and monitoring to inform future actions. The need for management action to limit DCCO predation on ESA-listed salmonids is supported by peer-reviewed scientific data. The statement in the Federal Columbia River Power System Biological Opinion, that "it is logical that cormorant management objectives assist in this goal [of addressing the survival gap]," supports the DCCO management action. The DEIS evaluated a range of alternatives developed to meet the purpose and need (G-27). The suites of actions in other RPA actions address other specific management needs. Collectively all the RPA actions function to improve salmonid survival throughout the Columbia River. But, evaluating proposed actions based on implementing other RPA actions is outside the scope of this EIS.	
S-13	In Chapter 2, Page 9, the DEIS describes the "placement of flags, rope, and stakes in a grid	Comment and results of prior Corps funded research were noted but the Corps was unable to find direct support or findings for this assertion.	Removed use of flags, ropes and stakes from

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	pattern" as a means to reduce DCCO nesting habitat on East Sand Island. This method is also proposed in the DEIS for implementation at other potential colony sites within the Columbia River estuary (Chapter 2, Page 13). While similar methods have been successfully implemented to deter Caspian terns from nesting at several sites in the Columbia River basin, this method has been tested on and found to be ineffective at deterring DCCOs from nesting (Roby et al. 2007).	The level of flagging, roping, and staking is not specified in the FEIS, nor has this method been fully tested, particularly when used in accompaniment with a primary and intensive method of human hazing, for it to be definitively determined to be ineffective.	FEIS and substituted with hazing or habitat modification techniques.
S-14	In Chapter 2, Page 12, the DEIS describes hazing triggers developed by Roby et al. (2012) that the Corps intends to apply at multiple cormorant roosting and foraging sites throughout the Columbia River estuary. While these triggers were effective in preventing cormorants from nesting in a discrete location on East Sand Island, they are entirely inappropriate for hazing DCCOs that are roosting and foraging throughout the estuary. Implementing the hazing program defined in the DEIS will require a nearly constant presence of large numbers of hazers in boats throughout the estuary during daylight hours. The DEIS fails to address the time commitment and cost of this magnitude of extensive hazing. A far more practical and demonstrated successful approach is to control where DCCOs are allowed to nest in the Columbia River estuary.	The number of boats, monitoring and hazing frequency, and associated costs were included in Chapter 2 of the DEIS for Alternative B. In the FEIS, in-season boat-based hazing is described for Alternative B, but not Alternatives C, C-1, or D. As described in the DEIS, for Alternative B, hazing would be conducted concurrently with monitoring schedules and administered to DCCOs when the identified hazing thresholds are met. This does not mean that all locations in the Columbia River Estuary would have stationary manpower waiting to administer hazing as soon as the thresholds are met. Additionally, the proposed thresholds provide likely indicators of locations that will be pervasively used by DCCOS or may be current or potential future breeding areas. The proposed approach of only controlling where DCCOs are allowed to nest in the Columbia River Estuary would not meet the purpose and need of the proposed action in fulfilling RPA action 46, as scenarios could occur where overall DCCO abundance and predation impacts throughout the Columbia River Estuary remain higher than the specific target level but DCCO breeding numbers do not.	Table 2-4 of FEIS revised to describe existing survey protocols to detect and deter Caspian terns and DCCOs

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S-15	USGS data indicate that if the area of suitable cormorant nesting habitat was reduced to 2.5 acres or less, permanent emigration of some DCCOs from the East Sand Island colony to other colonies would necessarily occur. In order to achieve the target colony size of ~5,600 breeding pairs, the amount of suitable cormorant nesting habitat would need to be reduced to 1 acre or less. Alternative C, incorporating lethal culling of adult DCCOs, relies on these habitat restriction techniques to reduce the number of DCCOs coming to the East Sand Island colony and thus reduce the level of cull required. The DEIS should address the potential success of these techniques in a consistent manner throughout the entire document (e.g., for Alternatives B, C, and D).	Text has been added and clarified in Chapter 2 of the FEIS to describe habitat reduction (using human hazing, fences and other methods to preclude nesting) under all alternatives during Phase I. Habitat reduction is proposed for Alternative B (FEIS Table 2-2), as this reduction would be necessary to achieve the target size under a primary non-lethal approach. During Phase I of Alternatives, C, C-1, and D, habitat reduction is not proposed. This will make implementation of lethal methods more feasible during Phase I and reduce the potential for DCCO dispersal. A more specific map is included in the FEIS for alternatives considering lethal methods as a primary strategy in Phase I which shows how the western portion of East Sand Island would be prepared using privacy fence to delineate various areas for management.	Additional and clarifying text added to Chapter 2 about proposed habitat reduction under each alternative during Phase I. Additional Figure 2-5 detailed map of the western portion of East Sand Island included.
S-16	The DEIS proposes to reduce the East Sand Island cormorant colony to about 5,600 pairs as an all or nothing proposition, but what are the benefits for enhancing salmonid population growth over time under a range of target levels for cormorant control? What are the incremental gains and losses of reducing the cormorant colony size by different amounts, and how do these compare to, or interact with, other factors that influence smolt survival?	Different scenarios for reduced colony sizes (i.e., 25 percent, 50 percent, 75 percent, and 100 percent) and levels of compensation are outlined in Lyons et al. 2014 Benefits Analysis (see G-4) and were presented during scoping (DEIS Section 1.4, 2.1.1). These scenarios are discussed in the FEIS Section 4.6.5. However, alternatives were designed to meet the purpose and need for the proposed action in fulfilling RPA action 46, which identified a specific colony size reduction. Alternatives that would not meet the purpose and need were not considered.	No changes to alternatives. Inclusion of Lyons et al. 2014 to FEIS per G-4
Monitoring & Adaptive Management			
S-17	The Management Plan must include provisions for adaptive management flexibility based on	See G-12 and G-13. The goal of Evans et al. (2012) was to characterize predation impacts over a four-year period (2007-2010) between	Per G-12, and G-13

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	observed annual predation rates to seek additional reductions in predator numbers if necessary. In Evans et al. (2012), the authors demonstrated that the four year period from 2007-2010 was more than sufficient to calculate predation rates for double-crested cormorants.	predators and not to compare predation rates for the same predator between two different time periods (e.g., prior to and following management actions). To do the latter, more years of data would be needed because DCCO predation rates vary considerably (often significantly) by year and by salmonid ESU/DPS. Data presented in the Retrospective Analysis in Appendix C of the FEIS better explain DCCO predation impacts in the context of colony size and environmental variation, and why it would likely take several years to fully evaluate the efficacy of DCCO management actions in the Columbia River Estuary.	
Affected Environment			
S-18	Other large colonies outside the "affected environment" analyzed in the DEIS are also experiencing significant cormorant declines, most notably at Mullet Island in the Salton Sea. We question the decision to restrict the affected environment to not include the entire western population of cormorants given data demonstrating that East Sand Island may be drawing emigrants from throughout the western populations. A significant decline in cormorant populations triggered by the proposed actions at East Sand Island could have regulatory and economic implications across the entire Western United States, especially if cormorant populations require additional protections to recover populations.	The affected environment is identified in accordance with CEQ regulations. In the DEIS and FEIS, impacts within the affected environment, and specifically sub-regions of the affected environment, are described in the most detail and given the most in-depth analysis. For DCCOs, though, the analysis does extend beyond the geographic scope of the affected environment as defined in Chapter 3 to include the entire western population. Effects to the western population were discussed throughout the DEIS, including Chapter 4, Section 4.2, Chapter 4, Section 4.4, and Appendix E. The FEIS has been updated to account for potential future declines within the western population, by including a reduced carrying capacity value in Appendix E-2 for modeling future trajectories of the western population of DCCOs. The adaptive management approach (see FEIS 2.1.3 and E-2) described how take will be adjusted based on the results of monitoring the effects of the management actions on East Sand Island and the western population of DCCOs during this action. This approach will help ensure that there will not be a significant decline in cormorant populations triggered by the proposed actions at East Sand Island	No. Appendix E-2 revised for reduced carrying capacity.
Environmental Consequences			
S-19	Within the study at the following link	Additional soils testing would occur prior to Phase II terrain modification	Section 4.2.5 and

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	http://www.nwfsc.noaa.gov/assets/25/152_09262005_142538_EstuaryTM69WebFinal.pdf, it was found that juvenile salmonids apparently adjacent to both sides of East Sand Island contained polychlorinatedbyphenols (PCBs) residues 5 times to that which is considered safe. It follows that any disturbance of these sediments would further exacerbate already high levels of contaminants in this case PCB's. Of individual fish analyzed from sites within the estuary, approximately 60% had PCB body burdens at or above this threshold. Point of emphasis, is why by this action would you further expose at risk PCB levels to potentially reach the supersaturation levels and trigger increased mortality rates?	and supplemental environmental review would be conducted as necessary pending results. However, salmonids are migratory species, and the source of PCB contamination referenced in the cited study is not directly tied to sediments on East Sand Island.	Appendix B updated with text stating soils testing would be conducted prior to finalizing terrain modification design and/or implementing those actions
S- 20	It is expected that ammunition used during lethal control will retain sufficient energy to cause damage, injury, or death even after ricocheting from sand or water to approximately a mile. To use ammunition "safely" would require (at least) restriction of boat traffic in the estuary, and, possibly vehicle traffic on Highway 101, not to mention beaches near the town of Chinook.	Safety protocols and measures to minimize risk to human safety using lethal take methods were stated in Chapter 2.2.3 and Chapter 4.3.4 of the DEIS. Of the many safety precautions that would be instituted, shooting on East Sand Island from elevated positions with appropriate backstops and monitored, clear backgrounds would eliminate the scenario presented of ricocheting ammunition and need for the safety procedures described.	No
S- 21	In Appendix E-2, Page 2 the initial abundance of DCCOs nesting on or near the East Sand Island colony in 1989 was erroneously set at 3,694 individuals; this is actually the estimate of the entire DCCO breeding population	Early DCCO estimates include abundance of both Rice and East Sand Island because DCCOs nested on both East Sand Island and Rice Island before 1999; this was stated in Appendix E-2 of the DEIS. For consistency, the Appendix E-2 analysis used the same DCCO abundance estimates in the Columbia River Estuary as those provided in the NOAA	No

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	throughout the coast of Oregon in 1988 [see Carter et al. 1995]. The actual number of DCCOs nesting on East Sand Island in 1989 was less than 200 individuals [Roby et al. 2014].)	Fisheries' "survival gap" analysis (Appendix D of DEIS). The reference provided (Carter et al. 1995) only provides an overall estimate for the Columbia River Estuary for the aggregate 1990-1992 period, which was 6,728 individuals. The 1988 estimate referenced for Oregon in Carter et al. (1995) does not include abundance estimates for the Columbia River Estuary because surveys were not conducted in this area during that time and this was described explicitly in the text and table footnotes. Columbia River Estuary locations in the table referenced were marked as locations where DCCOs were present (but estimates do not exist). In the text of Carter et al. (1995) describing DCCO abundance in the lower CRE, 262 DCCOs were first observed nesting at Trestle Bay in 1980. In 1987-1988 nesting began on East Sand Island (no estimate provided) and in 1988 at Rice Island (no estimate provided). By 1990, DCCO abundance at Rice Island had increased to 1,522 breeding individuals. By 1991, DCCO abundance at East Sand Island had increased to 4,052 breeding individuals. Additionally, Adkins and Roby (2010) and Adkins et al. (2014) only include estimates for the aggregate 1987–1992 period, and DCCO abundance in the Columbia River Estuary during that time period was 6,728 breeding individuals.	
S-22	The DEIS analysis indicates that Alternative C, which is the preferred alternative, does not yield any greater benefit to salmonid DPSs or ESUs than Alternative B, dispersal (Tables 4-2 and 4-3, Chapter 4, p. 33). The only sustained benefit to listed salmonids in the Columbia River lies in Phase II of Alternatives B and C, that is, the habitat manipulation that would be key to maintaining the target colony size of 5,600 pairs by removing DCCO nesting habitat. Phase II is identical in Alternatives B and C. Therefore, the rationale for choosing	See G-10 for discussion of all the factors, not just benefits to salmonids the Corps' considered in selecting the preferred alternative. The primary difference between Alternative B (non-lethal methods) during Phase I and Alternatives C, C-1, and D (lethal methods) is that the target colony size on East Sand Island would be achieved entirely by DCCO dispersal from East Sand Island under Alternative B, which would be greater than 14,500 DCCOs. In comparison, DCCO dispersal is expected to be minimal under Phase I of alternatives proposing lethal methods as a primary strategy. In the fish and economic effects analyses, benefits from reduction in DCCO predation is based upon the end target colony size for the	Clarifying text added to FEIS in Executive Summary, Chapter 2, and Sections 4.2.5, 4.7 to describe the rationale in selecting lethal methods over non-lethal methods as management strategy.

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	Alternative C (lethal take) as the preferred alternative is not clear. No well-documented, compelling, and measurable differences between B and C (i.e., in the impacts of Phase I) are described.	alternative, which is the same for Phase I of alternative B, C, C-1, and D. However, actual benefits would ultimately depend upon the degree to which the target colony size can be achieved throughout the entire Columbia River Estuary. This is expected to be less for Alternative B compared to C, C-1, or D, and this was qualitatively described throughout the DEIS. The actual extent of this is unknown; thus, it cannot be objectively and quantitatively included in modeling and analyses. Benefits were presented as potential maximum values, then it was qualitatively described that actual benefits could be less depending upon other factors that could decrease potential benefits, such as actual levels of DCCO dispersal and the effectiveness at precluding DCCOs from the Columbia River Estuary if dispersed from East Sand Island. Furthermore, a direct reduction in abundance and growth potential from lethal take (as in Alternative C, C-1, and D) compared to Alternative B, where greater than 14,500 DCCOs with affinity for East Sand Island would be present within the western population, is expected to improve the effectiveness of the Phase II terrain modification and non-lethal methods to limit the DCCO colony size on East Sand Island in future years.	
S-23	Table 2-8 indicates that the estimated cost of implementing Alternative B would be significantly greater than that of implementing Alternative C. The rationale is that under Alternative B, significantly more resources would be required to monitor a potentially vast area for new colony formation wherever fish of conservation concern are found in Washington and Oregon (Table 2-8, Chapter 2, p. 39; Chapter 4, p. 59). This unsupported assumption inflates the risk and the total estimated cost associated with Alternative B and lends support to selection of Alternative C	Costs of monitoring and hazing in the estuary were identified in the DEIS Table 2-8 and FEIS Table 2-11. The increase in costs of Alternative B over Alternative C, C-1, and D in Phase I was due to expected additional costs for hazing effort and monitoring within Columbia River Estuary and additional monitoring outside the Columbia River Estuary due to the high levels of dispersal that would occur. In-season boat-based hazing within the Columbia River Estuary is not proposed under Phase I of Alternative C, C-1, and D; hazing would occur at Corps' dredge material sites in-season, with potential adjustment to other areas between years based upon monitoring data and accessibility.	No

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	as the preferred alternative.		
S-24	The risk is significant of all breeding DCCO abandoning East Sand Island as a result of disturbance caused by gunfire, other methods used to capture and euthanize DCCO, and carcass collection. Colony abandonment could cause far more DCCO to emigrate to other cormorant colonies.	As noted in public comments and in the DEIS, human disturbance is a common cause of DCCO colony failure. Repeated disturbance from field personnel hazing DCCOs at the scale proposed in Alternative B and disturbances associated with the culling, nest destruction and carcass removal of Alternatives C, C-1, and D is a management concern. The adaptive management strategies for alternatives C, C-1 and D identify dispersal thresholds to reduce or minimize the potential for colony abandonment.	No
S-25	The size of the East Sand Island colony assumed for the beginning of the culling program is an average colony size during 2004-2013, rather than the most recent (2013) estimate. The 2013 estimate is the largest ever recorded and suggests growth from 2004-2012 levels. A larger initial colony size will require a larger cull to reach the management objective. A more accurate estimate of the number of DCCOs that would need to be culled to reach the target colony size would be 20,000 individuals. Given this ambiguity in the appropriate starting (current) colony size for analysis, it would be appropriate to perform a sensitivity analysis to determine how dependent the number of individuals needed to be culled is on the starting colony size used. This would greatly aid the interpretation of how accurate the needed cull estimates actually are.	See G-18. As noted, the 10-year average abundance was used as the initial East Sand Island colony size, and proposed take levels are derived from this initial colony size. The 2013 abundance estimate (largest recorded) was approximately 4,000 breeding individuals greater than the 10-year average; thus, the actual East Sand Island colony size at the time of implementation of Phase I of Alternative C and C-1 may be greater than the abundance estimate used in the model. However, the size of the East Sand Island colony fluctuates naturally year to year. For example, during 2004 to 2013, the average percentage change in colony size between consecutive years was 11 percent; the greatest percent change was 21 percent between 2012 and 2013 (see Figure 1-2 of FEIS). Using the 10-year average was believed to be more representative of the central tendency of the colony size rather than using a particular year estimate. Adaptive management thresholds and strategies outlined in Chapter 4 and Appendix E-2 will be used to adjust take levels in future years, if observed abundance substantially differs from predicted values. Modeling in Appendix E-2 no longer includes the “low” carrying capacity scenario or the taking of midpoints between the two carrying capacity scenarios for determining take levels. Additionally, the density dependence value was slightly modified. These modifications resulted in	Modeling modifications in Appendix E-2

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		higher levels of proposed take in the FEIS than were presented in the DEIS (e.g., for Alternative C, take of 18,185 total individuals compared to 15,956).	
S-26	In Chapter 1, Page 14, the DEIS states that near-term dispersal of satellite-tagged DCCOs during dissuasion studies is indicative of where DCCOs could relocate upon management of the East Sand Island colony. In Chapter 4, Page 92, however, the DEIS characterizes this dataset as "incomplete," not applicable for determining precise locations of potential relocation, and "therefore not essential to making a reasoned choice among alternatives." These two statements on Pages 14 and 92 appear contradictory. The passage on Page 92 minimizes the findings from Corps-funded research that used satellite telemetry and radio telemetry to investigate dispersal of DCCOs from the colony at East Sand Island, both during the breeding season and afterwards (Courtot et al. 2012, Roby et al. 2013, Roby et al. 2014).	See G-8. The Corps disagrees with this assessment and text has been added to the sentence cited in Chapter 4, Section 4.6.4 to clarify the intention of that sentence. The sentence in the DEIS, "Any information regarding effects of DCCO dispersal that is incomplete or unavailable at this time is therefore not essential to making a reasoned choice among alternatives" was changed to, "Any information regarding effects of DCCO dispersal that is incomplete or unavailable at this time is equivalent among alternatives and therefore not essential to making a reasoned choice among alternatives". Per G-8, additional information from past research on East Sand Island has been provided throughout the FEIS to better describe DCCO dispersal patterns during the breeding season (both early and throughout) and after the breeding season. The level of information that has been obtained concerning DCCO dispersal from past research was adequate to develop the alternatives, describe the affected environment and potential effects to resources within it, and inform the future management strategy. The intention of Chapter 4, Section 4.6.4 is to describe that, even with millions of dollars spent on research to date and multiple studies conducted, there is still a certain level of "incomplete and unavailable" information concerning exact DCCO dispersal levels and locations in response to particular EIS actions. Additional research and studies would continue to narrow this information gap but would never completely eliminate it. The cited sentence (now modified) was intended to convey that this "incomplete and unavailable" information exists but is equivalent among alternatives and thus would not differentially affect the selection of a particular alternative.	Chapter 4, Section 4.6.4 wording change to clarify selection of alternative in the context of incomplete information.

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S-27	The following published works should be consulted regarding inter-colony movements of DCCOs and colony site preferences: Carter et al. (1995), Clark et al. (2006), Wires and Cuthbert (2006), Duerr et al. (2007), Wire and Cuthbert (2010), Courtot et al. (2012). The following works should be consulted regarding the typical foraging range of DCCOs within the Columbia River estuary: Anderson et al. (2004), Lyons et al. (2007).	With the exception of Wires and Cuthbert (2010), which is specific to the Great Lakes, and Lyons et al. (2007), which includes the same general conclusions concerning foraging range as Anderson et al. (2004) but is more specific for Caspian terns than DCCOs, all the published works referenced were referenced and cited in the DEIS. The Lyons et al. (2007) reference and relevant results were added to the FEIS. Additionally, many other published works than those mentioned were consulted and cited in developing the DEIS and FEIS in discussing DCCO potential dispersal areas, known areas and regions of connectivity, and foraging range (see Chapter 3.1 and Chapter 3.2.2).	Appendix B added citation for Lyons et al. (2007) reference and relevant results added in FEIS.
S-28	The DEIS makes the assumption that DCCOs that disperse from East Sand Island will primarily prospect for new colony sites in these regions, yet there is no reference to the existing or historical colonies in these regions, or the current status of these colonies.	The Corps disagrees with this assessment, as DCCO use of active and historic colony sites was described in the DEIS and Appendix F-1 includes a list of all known historical and active DCCO colonies within the affected environment based upon two data sources (Pacific Flyway Council 2012 and Adkins and Roby 2010). When describing past research and the affected environment (Chapter 3, Section 3.1, and Appendix G), the sentence "use of historical and currently active DCCO colonies was common within each of these areas" was included in the FEIS.	Text added to describe DCCO use of historical and currently active colonies.
S-29	Some of the active DCCO colonies that are most proximate to East Sand Island (i.e., Columbia Estuary channel markers, Grays Harbor channel markers) are on man-made structures (i.e., navigational aids and bridges). Consequently, these colonies are habitat-limited, and cannot grow appreciably in size. In the case of the colony closest to East Sand	See G-10 about DCCO affinity to East Sand Island and the Columbia River Estuary and low likelihood that DCCOs would easily abandon the Columbia River Estuary. While the locations listed have limited potential for substantial DCCO abundance increases, DCCOs are nesting habitat generalists (i.e., they can nest in a wide variety of man-made and natural habitats) and there is no indication that DCCO nesting habitat is limited within the 172 river miles of the Columbia River Estuary. Additionally, with an average foraging range of approximately 25 km	No.

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	Island, the Astoria-Megler Bridge, this colony is scheduled for hazing and dissuasion by the Oregon Department of Transportation, which is currently conducting periodic maintenance work on the bridge. Thus, the concern that DCCO colonies and abundance would expand within the Columbia River Estuary if DCCOs are dispersed from East Sand Island is exaggerated.	(Anderson et al. 2004) and recorded foraging ranges of less than or equal to 62 km from colonies (Hatch and Weseloh 1999), there is a substantial amount of potential off-river habitat that would be suitable for DCCO nesting and proximate enough where DCCOs could still forage in the Columbia River.	
S-30	The DEIS should also consider long-term and cost effective management solutions mentioned elsewhere in the document (e.g., netting, wire arrays, cones, etc.) to prevent or restrict DCCOs from nesting on other artificial structures in the Columbia River estuary. Netting in particular would be effective in preventing DCCOs from re-colonizing the Astoria-Megler Bridge following completion of maintenance work.	The Corps does not have authority to manage or alter structures that other entities own, such as the Astoria-Megler Bridge. Use of the non-lethal techniques mentioned could be used on Corps owned, operated, or otherwise controlled properties. The Corps has coordinated DCCO management and monitoring efforts with the Oregon Department of Transportation (ODOT), who owns the Astoria-Megler Bridge. ODOT is considering various measures for DCCO management at the bridge.	No
S-31	In Chapter 4, Page 14, the DEIS states that, "DCCOs that nest on East Sand Island typically spend half of the year away from East Sand Island; thus, the increase in abundance at the East Sand Island colony most likely cannot be solely sourced to that location alone and likely reflects beneficial environmental changes that have occurred throughout the geographic area occupied by DCCOs that nest on East Sand Island." It is not entirely evident what is being implied in this sentence, especially when no citations or references are used. If the	No change. The sentence is in reference to the fact that DCCOs within 90 percent of the geographic range of the western population have increased by 71 percent during the past two decades (i.e., 3 percent increase per year; approximately 2 percent per year for the entire western population). Although most of the documented growth of the western population has occurred at the East Sand Island colony, this growth is not happening in isolation, as DCCOs are a migratory species and use other areas extensively. Other areas contribute to the DCCO life cycle and overall population trajectories, which have unequivocally increased during the past decades and remain positive.	No.

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	statement is intended to mean that "beneficial environmental changes" have improved the over-winter survival of DCCOs that nest on East Sand Island, there is no scientific evidence to support this hypothesis.		
S-32	The suggestion in the DEIS that "beneficial environmental changes that have occurred throughout the geographic area" are responsible for the growth of the East Sand Island DCCO colony is in all likelihood erroneous. The rapid growth of the East Sand Island DCCO colony in the 1990s and early 2000s was clearly related to the concurrent failure and abandonment of DCCO colonies elsewhere, which contributed to the growth in the East Sand Island colony through immigration (Carter et al. 1995, Anderson et al. 2004). East Sand Island possesses a unique combination of characteristics that has allowed the site to support more than 75,000 breeding and roosting seabirds annually, including the largest colony of DCCOs anywhere. Reproductive success at the East Sand Island colony of DCCOs shows no signs of density-dependent limitation at the current colony size (14,900 breeding pairs; Roby et al. 2014). Arguably, no other site within the range of the western population of DCCOs has the combination of forage base and protection in numbers from Bald Eagle depredation that the large East Sand Island colony currently possesses. It is unlikely that any other site or	Wording changes were made in Chapter 4.2 of the FEIS to better reflect the intention of the sentence. Beneficial environmental changes" were not stated as being "responsible" for the growth of the East Sand Island…but were suggested that these other factors, as those discussed in Chapter 4.2.2 (and in Chapter 4.4 - Colonial Waterbird Conservation Planning) have also likely contributed to the overall status of the western population because DCCOs are a migratory bird species and spend substantial time away from East Sand Island (also see S-31). As discussed in the EIS, relevant environmental conditions and environmental policies that have relevance to DCCOs since the 1970s include: listing of DCCOs under MBTA, prohibition on use of DDT, improvements in water quality from implementation of Clean Water Act and other environmental regulations adopted since the 1970s, and increased wetland habitat conservation and colonial waterbird planning. The DEIS discussed the importance of the East Sand Island DCCO colony, the proportion of the western population of DCCOs that nest at the East Sand Island colony, and the estimated size of all other active and historic breeding colonies within the western population, as well as local, regional, and overall population trends. Given that East Sand Island is the largest DCCO colony in the world and relatively stable over the past decade, the location has unique characteristics that are not present at other areas within the geographic range of the western population, or elsewhere. However, immigration of DCCOs from other areas does necessarily imply that those areas of emigration are unsuitable for future DCCO use. As stated in the DEIS, some colonies have failed while many others have emerged across the west, displaying the adaptability	Chapter 4.2 clarified intention of "beneficial environmental changes"

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	region within the range of the western population could support such a high proportion of the breeding population as the East Sand Island colony currently supports.	and opportunism of which this species is capable (see discussion in FEIS Chapter 4, pages 19 and 20).	
S-33	The Potential Biological Removal analyses in Appendix E-2 do not sufficiently consider immigrants from other DCCO colonies to the East Sand Island colony during the 4-year Phase 1 period of the management plan. During the 25-year period since the DCCO colony on East Sand Island first appeared, there has been a history of recruitment of large numbers of adult DCCOs from other breeding colonies in western North America. The actual number of DCCOs nesting on East Sand Island in 1989 was less than 200 individuals [Roby et al. 2014].) In 2013 alone, the DCCO colony at East Sand Island increased by about 5,200 individuals (21%) compared to the previous year (Roby et al. 2014). The magnitude of this recruitment of breeding adults to the East Sand Island colony strongly suggests that significant immigration to East Sand Island from other colonies continues, at least in some years. In 2013, for example, the large DCCO colony in the Salton Sea, southern California (over 6,000 breeding pairs in 2012) was abandoned due to falling water levels (W.D. Shuford, personal communication), and at least some of those displaced adult DCCOs likely immigrated to East Sand Island.	See G-18. The Corps disagrees with this assessment. In determining proposed take levels, the DCCO population model and analyses in Appendix E-2 did explicitly account for density dependent growth based on the past East Sand Island growth rate, which included both in situ growth at, and immigration to, East Sand Island. Past observed data was used to estimate the density dependence parameter used in modeling future population trajectories. DCCO tagging data and genetic data do not specifically support the hypothesis of Salton Sea DCCOs immigrating to East Sand Island in vast numbers. Satellite tagging data showed relatively low connectivity between East Sand Island and Salton Sea (Courtot et al. 2012) and genetic data (Mercer 2008, Mercer et al. 2013) showed greatest connectivity of Southern California to Mexico. Periodic DCCO increases at the Salton Sea colony are most likely believed to be influxes of DCCOs from Mexico during favorable environmental conditions (Mercer et al. 2013). DCCO surveys in Mexico are lacking, and there is little available data to accurately estimate DCCO abundance in Mexico.	No

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S-34	The DCCO population model used in the DEIS (Appendix E-2) assumes that the colony at East Sand Island is at carrying capacity, that culling of individuals near that carrying capacity would constitute nearly 100 percent additive mortality, and the colony size would decline in direct proportion to the number of DCCOs culled. But the large increase in the size of the DCCO colony in 2013 (21 percent) does not support the assumption that the colony is at carrying capacity. Therefore, a large proportion of the mortality due to culling could be compensatory, and recruitment could partially or completely offset losses due to culling.	See S-25 about changes to the population model, which resulted in higher proposed take levels in the FEIS compared to the DEIS. For future trajectories, past observed data on East Sand Island was used to estimate the density dependence parameter and the 10-year colony size average was used as the initial abundance. This approach is the most reasonable and objective approach to quantitatively describe future growth potential of the colony, given the available data. Take levels do not constitute 100 percent additive mortality, as take levels are greater than the difference between the 10-year average colony size and the RPA action 46 target size. The difference between the 10-year average colony size on East Sand Island (25,834 breeding individuals) and the value of the target population size (11,319 breeding individuals) is 14,515 breeding individuals. In the FEIS, total proposed individual take levels on East Sand Island were 18,185 breeding individuals (and 18,185 associated nests lost) for Alternative C, and 10,912 breeding individuals and 26,096 total nests lost for Alternative C-1 (Table E-2 4). Additionally, through the adaptive management thresholds, take levels will be adjusted in future years if observed abundance substantially differs from predicted values.	Modeling modifications in Appendix E-2
S-35	Regardless of the means chosen to reduce cormorant predation in the Columbia River estuary, the DEIS should include an explicit strategy for mitigation of impacts to the western population of Double-crested Cormorants and its nesting habitats. Where can this species find suitable and safe places to nest outside the estuary? What will be done to restore degraded nesting habitat for example, in the Salton Sea that previously attracted large numbers of cormorants?	Mitigation measures to minimize or reduce impacts to migratory birds were outlined in Chapter 2- Impact Avoidance and Minimization Measures for each alternative. Including Alternative C-1 reduces take of individual DCCOs, which is a measure to reduce impacts to the western population of DCCOs. Large scale DCCO habitat construction or restoration efforts in the western population is not considered to be a reasonable or logistically feasible mitigation measure for the following reasons: social attraction to constructed habitat does not appear to be viable approach for DCCOs (G-11), any construction of habitat would need to be in areas buffered from drought and most of these areas overlap with federally or state listed fish, and there is no evidence or	No

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		studies cited to suggest habitat is a limiting factor for DCCO across the entire western U.S., particularly since they are nesting and foraging generalists.	
S-36	Newcastle Disease may have played a significant role in the collapse of the large colony at Mullet Island in the Salton Sea and has now been identified within the population at East Sand Island. The Corps should assess the potential for significant disease outbreaks to drive cormorant population levels below targets identified in the DEIS.	The probable cause of collapse at Mullet Island colony is due to drought and lack of protection from mammalian predators due to formation of a land-bridge (T. Anderson, USFWS, personal communication. 2014, 2015). The potential effect of Newcastle Disease affecting the East Sand Island colony was evaluated in the DEIS. The DEIS at Page 3-59 stated "In 1997, Newcastle disease was diagnosed in juvenile DCCOs from breeding colonies in the Columbia River Estuary and Great Salt Lake, Utah by the National Wildlife Health Center. DCCO fledglings from East Sand Island have since been diagnosed with the disease in multiple years (i.e., 2003, 2005, 2007, 2009, 2013; BRNW unpublished data; see Roby et al. annual reports). While DCCOs on East Sand Island have tested positive for Newcastle Disease, they have tested negative for the highly virulent or velogenic form of the virus ("Exotic Newcastle Disease") that can severely impact commercial poultry operations (Roby et al. 2014). Evidence suggests that Newcastle disease is not an important cause of mortality in other wild bird species that nest in close association with DCCOs (Kuiken 1999)." In evaluating effects of increased nesting densities under the alternatives, the DEIS stated "…higher nesting density and concentration could potentially increase the risk for transmission of Newcastle's disease. However, during dissuasion research, this risk factor was present and did not appear to jeopardize the viability of the colony or suggest that further restriction of the colony would do so."	No

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S-37	In their comments on prior cormorant EAs and the public scoping process for the current DEIS associated with East Sand Island, conservation groups, including Portland Audubon, have repeatedly urged the Corps and partnering state and federal agencies to develop a credible cormorant management plan that a) identifies minimum population thresholds; b) describes how those populations will be distributed; and c) establishes sites where cormorant colonies would be welcome and likely to persist over time. These steps are crucial, and would go a long way toward lending credibility to cormorant reduction efforts on East Sand Island, especially given that population increases on East Sand Island are at least partially the result of emigration of cormorants from colonies that have declined or disappeared elsewhere. The DEIS completely fails to address these concerns and instead relies on an unsupported assumption that cormorant populations outside of the Columbia Estuary will remain stable.	Substantial regional efforts have been made during the past 3 years to improve and ensure appropriate DCCO management across the western United States. These efforts include development of a DCCO Pacific Flyway management framework (Pacific Flyway Council 2012) and a DCCO Pacific Flyway monitoring strategy (Pacific Flyway Council 2013), more formalized management by state agencies, and extensive effort and coordination that went into the development of the DEIS. Relevant agencies have been involved and provided their input into the development of these approaches. The goal of the Pacific Flyway Council Management Framework is to, "maintain DCCOs as a natural part of the waterbird biodiversity of the Pacific Flyway, while minimizing substantial negative ecological, economic, and social impacts of DCCOs" (Pacific Flyway Council 2012). The USFWS also has the mandate to ensure the long-term conservation of DCCOs. The monitoring data that will be acquired through the Pacific Flyway Council Monitoring Strategy and, occurring under the FEIS, is adequate to assess the status and trend of the western population of DCCOs. The FEIS preferred management plan and adaptive management process described herein provide an approach that allows for achievement of the East Sand Island target colony size within the context of measures to ensure the conservation of the western population of DCCOs.	No
S-38	The DEIS fails to provide meaningful analysis of what percentage of cormorant take is comprised of non-listed hatchery fish. This is important because studies have shown that hatchery fish are more vulnerable to predation.	The DEIS at Section 1.1.4 discussed that many of the hatchery populations are listed under the ESA. The issue of hatchery versus wild susceptibility to DCCO predation was investigated by Collis et al. (2001) and Ryan et al. (2003 and 2008). These investigators found through PIT tag analysis that, at least for steelhead, there was no consistent indication of DCCO preference for prey based on rearing type. Additionally, the economic analysis included in the FEIS (Appendix I) provides a complete breakdown of the estimated availability of hatchery versus wild origin salmonids in the Columbia River Estuary. PIT tag data	No.

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		presented in the DEIS and FEIS provides the best indicator of DCCO predation impacts to certain ESU or DPS runs.	
S-39	The DEIS fails to meaningfully address the fact that injured or otherwise unhealthy fish are more susceptible to predation (DEIS at 4-93). A significant percentage of the listed fish being consumed at East Sand Island may have been made vulnerable to predation by their passage through dam turbines and their loss attributable as much to dam operation as to bird predation.	There is no evidence to suggest that salmonid passage through the dams, specifically at Bonneville Dam at river mile 146, would make salmonids more vulnerable to predation 120 plus river miles downstream within the typically foraging range of DCCOs near East Sand Island. Evidence to date suggests predation vulnerability of salmonid smolts passing through dams is very proximate to the dams. Alternatively, selection events occur at each dam as well as with each additional mileage navigated with the Columbia River. Smolts in poorer condition or that are less viable likely are selected for, and lost, during the process of navigating through the Federal Columbia River Power System; thus, the sample of smolts present at river mile 5 (i.e., East Sand Island) of the Columbia River about to out-migrate to the ocean likely are not representative of unhealthy or poor conditioned fish compared to all available production of given salmonid populations. Most relevant to the subject, Hostetter et al. (2012), utilizing PIT tag recoveries of Snake River steelhead on a DCCO colony upriver in the Columbia Plateau, found that fish in poor condition (i.e., diseased, injured, or otherwise compromised) were more susceptible to DCCO predation than apparently healthy smolts. However, lower, but still substantial, levels of DCCO predation were observed on smolts seemingly in excellent condition. This issue has not been formally tested at East Sand Island in the same manner, and the extent that the results from this study upriver in the Columbia Plateau apply to the DCCO colony at East Sand Island at river mile 5 is largely unknown, given the difference in navigation length and exposure to mortality events as described above.	Chapter 4, Section 4.6.5.- text and additional research results relevant to this issue included.

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S-40	If cormorants are shot away from the East Side Island colony, their breeding status will be unknown (e.g., non-breeding individuals), meaning that more cormorants may be shot than necessary to reach the Army Corps' reduction target.	Information about past and current DCCO abundance within the Columbia River Estuary was discussed in Chapter 3, Section 3.2.2 of the DEIS, but additional text has been added in the FEIS to more clearly describe that approximately 98 percent of DCCOs breeding in the Columbia River Estuary nest on East Sand Island. Additionally, all lethal take proposed would occur within the typical DCCO foraging range (25 km) from East Sand Island; thus, there is little evidence to suggest that DCCOs taken under the proposed action would not be closely associated with the East Sand Island colony. If non-breeders associated with the East Sand Island colony are taken, this would decrease future recruitment and growth at the colony in later years. The modeling approach for deriving take levels (Appendix E-2) accounts for growth potential between years and the adaptive management measures allow for take levels to be adjusted in future years if observed abundance substantially differs from predicted values.	Section 3.2.2- text added about proportion of DCCOs in CRE that are associated with the colony on East Sand Island.
Cumulative Impacts			
S-41	The DEIS assumes that "large-scale environmental, regulatory, and management changes that have occurred over the past decades could allow for carrying capacity of the western population of DCCOs in the future to be similar to or greater than current levels" (Appendix E – 2, p. 9). This assertion does not comport with the actual status of DCCO colonies throughout the range of the western population, such as the abandonment of what had been a very large DCCO colony on Mullet Island in the Salton Sea, the extended drought in much of the West, declines in colony sizes in British Columbia and	In the FEIS, additional text and analyses were provided in Chapter 4, Section 4.4.2 and 4.4.3, Cumulative Effects, to better describe DCCO and avian predation management within the Columbia River Estuary and western population. Chapter 4, Section 4.5.3, Climate Change, was expanded to include a description of overall effects to DCCOs and salmonids. In Appendix E-2, future 20-year modeled population trajectories included a reduced carrying capacity value that explicitly accounted for these potential effects from habitat loss, as well as additional take within the western population.	Chapter 4, Section 4.4.2 and 4.4.3; Chapter 4, Section 4.5.3; additional text and analyses added, specifically the carrying capacity was reduced for modeling future western population abundance trajectories

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	Washington, and the active hazing of this species on the Oregon coast. In this regard, the discussion of climate change in Chapter 4 of the DEIS focuses on salmonids and impacts on cormorants in the Columbia River estuary and does not address projections for freshwater supplies and fish in the western interior. Such information is essential for evaluating the future sustainability of DCCOs in the western North America population.		
Compliance with the National Environmental Policy Act			
S-42	The participation of USDA-Wildlife Services as a cooperating agency in the development of this DEIS may represent a conflict of interest and a violation of the Administrative Procedure Act. DEIS Chapter 1, p. 20 identifies USDA-Wildlife Services as a cooperating agency, and p. 20 states that "[…]the Corps would request technical assistance from USDA-WS to implement the preferred alternative…". USDA-WS conducts thousands of activities under contracts to federal, state, and municipal agencies, and to private parties that employ lethal methods to remove migratory birds and other wildlife. Given the estimated cost for implementation of Phase I of Alternative C ($760,000-$1,020,000 per year; Table 2-8, Chapter 2, p. 39), USDA-WS stands to acquire a lucrative, 2- to 4-year contract to implement the preferred alternative, Alternative C. In its role as a cooperating	The Corps disagrees with this comment. The DEIS discussed USDA-Wildlife Services' role as a cooperating agency and expected future role in implementing the proposed action. USDA-Wildlife Services is a cooperating agency based on its special expertise with respect to the environmental impact involved in the proposed action. Given the scale of the proposed action and USDA-Wildlife Service's unique and specialized expertise in wildlife management, the Corps plans to request their assistance in implementing both lethal and non-lethal methods identified in the proposed DCCO management plan. As a federal agency, USDA-Wildlife Services' does not profit in the commercial sense in executing their congressionally authorized role to provide technical assistance in wildlife conflicts. The cost estimates for various alternatives were developed by the Corps using actual costs from experimental dissuasion research, hazing costs in the lower Columbia River Estuary and monitoring. These estimates were rounded up to account for additional field personnel and hazing over a larger scale. Regarding the potential for USDA-Wildlife Services' to have a conflict of interest, the CEQ regulation at 40 C.F.R. § 1506.5(c) requires contractors or consulting firms who will prepare an EIS to execute a disclosure	

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	agency, USDA-WS certainly contributed technical expertise to the design and cost estimates of this alternative. The FEIS must provide full disclosure of USDA-WS's role in developing action alternatives and their associated costs, its role in selecting the preferred alternative, and its planned role in implementation of the preferred alternative."	specifying they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is explained in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 Fed. Reg. 18,026 (Mar. 23, 1981) at Question 17a and b. "Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." 46 Fed. Reg. at 18,031. All of the contractors hired by the Corps to prepare the DEIS signed such a NEPA disclosure statement stating they had no financial or other interest in the outcome of the EIS. The CEQ regulation does not require a NEPA disclosure statement for federal agencies, including USDA-Wildlife Services, since these agencies would not realize any financial or other indirect benefit from the outcome of the decision in the same sense that a private contractor or consulting firm would.	
Consistency with other Plans			
S-43	In discussing salmon and steelhead recovery plans, the DEIS asserts that "[a]vian predation is generally acknowledged as a factor affecting certain listed [evolutionary significant units/distinct population segments], though not necessarily a factor contributing to their decline or limiting their recovery." DEIS at 2-42. It goes on to explain "[d]irect mortality from avian predation ([Double-Crested Cormorant] and Caspian terns) is identified as one of the secondary factors limiting viability for all Lower Columbia River coho and late fall	The Corps' proposed action is intended to fulfill RPA action 46 in the Federal Columbia River Power System Biological Opinion which requires development of a management plan to achieve a prescribed reduction in DCCO predation in the Columbia River Estuary. The purpose and need for the proposed action is based on fulfilling RPA action 46. The DEIS discussed the relationship to relevant plans and policies and these did include recovery plans for listed salmon and steelhead. See G-2, the DEIS and FEIS note that many actions are taken collectively, within the Federal Columbia River Power System Biological Opinion and through other actions to address the other cited threats to salmon and steelhead. See Chapter 2, Section 2.3 and Chapter 4, Section 4.4 for	Section 2.3 revised text to clarify limiting factors for steelhead populations, the management focus of the EIS per the RPA.

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	and spring Chinook salmon and steelhead populations . . . .” DEIS at 2-42. These conclusions beg the question: Why is the Corps’ EIS focusing exclusively on reducing Double-Crested Cormorant (“cormorant”) predation to recover salmonid populations when cormorant predation is “not necessarily a factor contributing to the decline or limiting [salmon] recovery”? In fact, the *Estuary Module* concludes that for salmon to recover, agencies “need to implement additional management actions in the estuary not directly related to predation.” The *Estuary Module* implies that without properly functioning ecosystems, other management actions, including reducing avian predation, are unlikely to result in salmonid recovery. *Estuary Module* at ES-11. Given that flow regulation and dike and filling practices are the top threats while aggregate altered predatory relationships are a lesser threat, the Corps must consider alternatives that address these top threats rather than focusing solely on smaller threats. Accordingly, addressing flow-related activities including flow regulation and dike and filling practices will further the Corps’ goal of recovering salmonids in the Columbia River Basin. Under the National Environmental Policy Act, the Corps must consider all reasonable alternatives likely to further its purpose. 40	additional information on other actions taken to improve salmon and steelhead runs. Developing a management plan to recover listed salmon and steelhead is outside the scope of the EIS. The scope of the EIS is to develop a DCCO management plan to meet the objectives of RPA action 46 as described in the statement of purpose and need. Other RPA actions in the Federal Columbia River Power System Biological Opinion do address flow and dam related actions, and this is consistent with the Estuary Module. Inclusion of RPA actions to manage avian predators (DCCO and Caspian terns) is also consistent with the Estuary Module and recovery planning documents. As noted, avian predation is identified as a secondary limiting factor “Direct mortality from avian predation (DCCO and Caspian terns) is identified as one of the secondary factors limiting viability for all Lower Columbia River coho and late fall and spring Chinook salmon and steelhead population (see DEIS 2-42).” However, direct mortality from avian predation is a key limiting factor affecting all Middle Columbia River steelhead populations and Upper Willamette River Chinook and steelhead; and a threat to Upper Columbia River spring Chinook and steelhead populations (DEIS Chapter 2 pages 42-43). This is consistent with RPA action and NOAA Fisheries’ “survival gap” analysis, which utilizes DCCO predation data, specifically juvenile steelhead, in setting management objectives (Section 1.2). In developing alternatives, the Corps identified alternatives that would meet the purpose and need, to reduce DCCO predation impacts on juvenile salmonids in the Columbia River Estuary. Alternatives that would not meet this need, or were otherwise infeasible, were not considered for further evaluation. However, the Corps noted in the DEIS Section 4.4 that other actions are being implemented by federal and non-federal entities to improve survival of juvenile salmonids and	

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	C.F.R. § 1502.14(a). Thus, the Corps must consider flow-related activities as alternatives to killing cormorants to further the goal of recovering salmonids. Failure to analyze all reasonable alternatives would result an in a decision that is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706. Finally, to adequately assess the likely effects of each alternative, the Corps must consider studies that evaluate the impacts of cormorant predation on stocks of salmonid and steelhead species in the Columbia River Basin, including available salmonid smolt-to-adult return ("SAR") and smolt-to-adult survival rate ("SAS") studies that differentiate between listed and unlisted salmonid and steelhead species. If the SAR and SAS studies show that the preferred alternative will likely have a small or negligible impact on recovery of salmon and steelhead listed as threatened or endangered because cormorants generally target non-listed stocks when feeding, the selection of that alternative would be arbitrary and capricious under 5 U.S.C. § 706.	improve passage for adult salmonids. Per G-4, the FEIS includes findings from a Corps' funded study evaluating predation impacts in the context of an age-structured, salmonid population growth model (lambda; Lyons et al. 2014 Benefits Analysis). The analysis represents scenarios of colony size reduction and compensatory mortality; and resulting salmonid average annual population growth rate. The analysis was intentionally structured and organized to represent a range of scenario-based conditions and respective minimum and maximum benefits to salmon.	
Compliance with the Migratory Bird Treaty Act			
S-44	Migratory Bird Treaty Act regulations for Depredation Permits at 50 C.F.R. § 21.41(c)(3) prohibit use of "blinds, pits, or other means of concealment, decoys, duck calls, or other	In normal practice, blinds are used in concert with decoys. The decoys lure the game-birds in and blinds are used as concealment as an integral part of the enticement. In the proposed management plan, the purpose is minimization of impact to non-target birds, not enticement. The	

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	devices to lure or entice birds within gun range." Yet, the draft EIS (Chapter 2 – p. 22) indicates that: Culling on-island would include multiple individuals shooting from observation points (ground or elevated) and **existing structures** [emphasis added] on East Sand Island using small caliber rifles. The only existing structures within the Double-crested Cormorant colony on East Sand Island are blinds and tunnels that are intended to conceal the people conducting research in the colony. This proposed use of "existing structures" as concealment for the lethal control of cormorants does not square with the prohibition on use of blinds for activities conducted under a MBTA depredation permit.	DCCO's have chosen their breeding colony location; there is no enticement surrounding the use of concealing structures. The purpose of the concealing structures is to minimize impacts to non-target birds. Areas with concentrations of non-target birds can be visually isolated from areas with active culling, thereby limiting disturbance.	
S-45	How does the U.S. Fish and Wildlife Service intend to handle the incidental take of non−target avian species *vis a vis* the depredation permit for Double−crested Cormorants? This is an important issue for conservation of the non-target species, and the approach chosen is also important in terms of an example and precedent under the MBTA. Will Brandt's and pelagic cormorants and their nests be monitored on their respective colonies and are the Army Corps and U.S. Fish and Wildlife Service prepared to stop the culling of Double-crested Cormorants if losses of non-target species are too great? What threshold of mortality to non−target migratory birds will be	See G-24. Monitoring Brandt's cormorants and their nests on East Sand Island is a component of the alternatives and proposed management plan. Monitoring pelagic cormorants on the Astoria-Megler Bridge is currently conducted by the Oregon Department of Transportation (see DEIS and FEIS Section 4.4). The Depredation Regulation (50 C.F.R. § 21.41) states that permits may be issued for "depredation control purposes." While DCCOs are the focus of the proposed depredation take activities, based on prior research activities, take of pelagic and Brandt's cormorants is anticipated as part of the proposed depredation program. The Corps has estimated the anticipated take (Alternatives C, C-1, and D) of pelagic and Brandt's cormorants as part of implementing the proposed control program. The Corps will include this take in their depredation permit application for the proposed take of DCCOs and the USFWS may consider the take of non-target species associated with the proposed	

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	used as a trigger for cessation of culling Double-crested Cormorants in the Columbia River estuary?	depredation program. Additionally, each alternative includes actions to minimize take of non-target species and take of non-target species would be reported annually. Evaluation will be ongoing during implementation. Should take levels approach what was predicted in the FEIS, the Corps would coordinate with USFWS in determining appropriate mitigation measures, such as discontinuing or reducing the frequency of the certain activity causing those effects (e.g., boat-based shooting).	
Compliance with Executive Order 13186			
S-46	Executive Order 13186 is aimed at federal agencies "taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations." In Appendix B (p. 4), the Army Corps suggests that it is "unclear" whether the resulting Memorandum of Understanding (MOU) between the Department of Defense and the U.S. Fish and Wildlife Service applies to "Civil Works." This may or may not be the case, but a plain reading of the executive order and the MOU makes it clear that the underlying intent is to avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions. Reducing the western North America population of Double-crested Cormorants by at least 25 percent without having first fully implemented and evaluated non-lethal means of reducing cormorant predation does not fulfill this intent.	In furthering the intent of the MOU, the Corps and cooperating agencies have developed measures to minimize impacts from the proposed action to migratory birds. These measures were outlined in Chapter 2-Impact Avoidance and Minimization Measures for each alternative. In addition, the inclusion of Alternative C-1 in the FEIS, which reduces take of individual DCCOs, is a measure that will reduce impacts to the western population of DCCOs. Additionally, the adaptive management strategy was revised for alternatives considering lethal take, to adjust take levels dependent upon information received from annual western population monitoring, per the Pacific Flyway Council Monitoring Strategy. This revision further mitigates the potential for long-term adverse effects to the western population.	No

Table J-3. Agency comments and responses.

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EPA (1)	**1.** The proposed action does not adhere to the Guiding Principles established by the Pacific Flyway Council (PFC) regarding Avian Predation on Fish Resources Information in the DEIS does not support PFC guidance principles such as: • Principle 4: Responses to perceived avian predation issues are based on sound science-(c) Expectations of how management actions will reduce impacts to affected fish populations are explicitly addressed; (d) Expected outcomes of management actions on affected avian populations are clearly understood. • Principle 5: Important considerations when evaluating the need for management action in response to avian predation of fish resources- (a) Assessment of population-level impacts for both migratory birds and fish; (e) Cost-benefit analyses for proposed management strategies. • Principle 6: Methods for reducing avian predation on fish resources are always implemented within existing regulatory frameworks- (b) Non-lethal control actions that result in no direct take of nongame migratory fish-eating birds should be attempted first.	**1.** The Guiding Principles mentioned were the basis of the Pacific Flyway Council Management Framework and incorporated therein into that document. Chapter 2.5 of the DEIS described how the proposed management action is consistent, to the extent practicable, with the Pacific Flyway Council Management Framework. The Corps notes, though, that the Pacific Flyway Council Management Framework is a guidance document and does not have any legal authority, nor does it supersede or alter requirements under NEPA, the ESA, the MBTA, or any other regulations and laws with regard to scientific integrity or management/lethal take of migratory birds. Responses to specific comments are included below: • Principle 4: The scientific analyses in the EIS were included pursuant to ESA or NEPA requirements; see G-5; c) Chapter 4 explicitly and quantitatively describes reduction in predation impacts to juvenile salmonids under each alternative; d) Chapter 4 and Appendix E includes an explicit and quantitative analysis of how the preferred management alternative will affect the DCCO colony on East Sand Island and the western population of DCCOs. • Principle 5: a) see response to Principle 4; c) an extensive economic analysis describing benefits to Columbia River Basin salmonids from the proposed action was conducted and included in full in Appendix I. Chapter 2.4 includes implementation costs of each alternative. • Principle 6: see G-10, G-23.	Chapter 1, Section 1.1.6 and Appendix C -additional information about bioenergetics consumption estimates

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	2. NOAA Fisheries used the 1990s level DCCO population as a base for calculating their 2014 gap analysis, which is a point in time used to show change in potential DCCO fish consumption; it does not represent a scientific assessment of what would be considered a viable population size for DCCOs.	**2.** See comment G-2 and G-6. NOAA's analysis for the FCRPS Biological Opinion was to develop an RPA (i.e., RPA 46) to address the predation impact to juvenile salmonids from the DCCO colony on East Sand. It in no way was assessing a viable population size of DCCOs. The "base period" of NOAA Fisheries' Survival Gap Analysis was determined by NOAA Fisheries Science Center based on ESA Section 7 consultation analysis and guidance and available datasets concerning listed salmonid species. As noted, NOAA Fisheries' analysis did not consider DCCO population impacts outside of the Columbia River Estuary. Additionally, the analysis and RPA action 46 did not specify the means to achieve the reduced target colony size, which makes evaluation of the impacts of the proposed colony reduction largely unknown until the methods and means of how that reduction would occur are specified (i.e., this EIS and subsequent depredation permit application). The definition in the EIS of a sustainable DCCO population was based upon USFWS input as a cooperating agency to the EIS and was determined independent of the FCRPS Biological Opinion timeframes.	
	3. The DEIS also states that NOAA Fisheries' calculation of fish eaten by DCCOs is based upon PIT tags and a bioenergetics model. However, no information about the bioenergetics model is provided in the DEIS or its appendices.	**3**. In the FEIS, Chapter 1, Section 1.1.6 and the Appendix C Retrospective Analysis include description of how bioenergetics consumption estimates and PIT tag estimates are calculated and additional citations. See G-5, G-7.	
	4. A DCCO western population viability analysis is needed. Among other viability and mortality factors, the analysis would need to identify	**4.** See G-19 and G-20. The Appendix E DCCO population model serves the same purpose as a viability analysis and provides an explicit, quantitative description of current and future DCCO	

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	current and likely future habitat availability for DCCOs within the range of the western population that factors in current and projected future climate change conditions. DCCOs are still rebounding from severe decline resulting from impacts such as unregulated hunting, harassment, and DDT-induced reproductive failure. NOAA Fisheries' Biological Opinion for the Federal Columbia River Power System prescribes a 56% reduction in the East Sand Island DCCO colony, resulting in a reduction of25 to 26% of the western population of DCCOs, which are currently an order of magnitude lower than historical populations. DCCOs are still rebounding from severe decline resulting from impacts such as unregulated hunting, harassment, and DDT - induced reproductive failure. The DEIS acknowledges uncertainties associated with the Preferred Alternative and that the proposed action could be taken without a clear understanding of the consequences. For example, the DEIS states (Ch. 4, p. 15) that while there are examples elsewhere of DCCO and great cormorant populations increasing after lethal management, those populations are an order of magnitude larger than the western population of DCCOs, and there is more uncertainty in how the western population of DCCOs could respond to the proposed levels of culling. There have not been large-scale culling programs within the	abundance (with explicit estimates of uncertainty) given the proposed action. The factors and uncertainty mentioned are qualitatively described in the EIS, and the rationale is provided in Appendix E-2 and Chapter 4 for how these factors and uncertainty figured into the selection of the carrying capacity value in the DCCO population model and interpretation of model results (i.e., future DCCO abundance trajectories). Data is not available at this time to develop a more robust metapopulation or habitat based population model for the western population. Doing so at this time would be speculative based on available data.	

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	western population of DCCOs, the western population exhibits little to no growth except for East Sand Island. East Sand Island is not within a connected matrix of other large breeding colonies within the affected environment, and additional annual authorized take is occurring elsewhere within the western population (Ch. 4, p. 16). *Recommendation: Conduct further studies and gather scientific information that support decisions regarding DCCO predation reduction and maintenance of a viable western population of DCCOs.*		
EPA (2)	The DEIS (Ch. 4, p. 38-40) projects the maximum potential regional economic benefits that can be derived from implementing the DCCO predation reduction program would be $1.5 million, a 3.1% increase in revenue. The significance of this increase on a per capita basis when spread among the many commercial fishermen, recreational fishing-related businesses, and tribes has not been quantified and thus is not clear. In addition, this maximum possible increased revenue may be overestimated because neither compensatory mortality nor the costs of implementing the DCCO predation reduction program nor potential increased costs outside the Columbia River Estuary that may be incurred from DCCO dispersal have been factored into this estimate. Should the DCCO predation reduction efforts and related direct and indirect impacts result in ESA listings of	See G-4, G-5, G-7, S-1 and S-2. Economic estimates have been updated for the FEIS. The DEIS provided information about implementation costs of alternatives (Chapter 2.4), information about quantity and type of fisheries user group (Chapter 3.3 and Appendix I) and impacts to each fisheries user group from the proposed action (Chapter 4.3 and Appendix I), and that benefits are maximum values (Chapter 4 and Appendix I). Inclusion of a more detailed per capita cost-benefit analysis is problematic for many reasons, including: 1) an incremental change in economic value has a different effect and meaning for various user groups (e.g., recreational versus individual fishing for livelihood, no economic value is associated with tribal ceremonial and subsistence fisheries have but changes in these fisheries have significant cultural and spiritual value), 2) economic impacts from DCCO dispersal outside the Columbia River Estuary can only be qualitatively described because no data are available to quantify this effect without excessive speculation (with regard to exact levels of DCCO dispersal to specific areas and resulting	Per G-4

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	the western DCCO population and/or non-target species populations, the costs for ESA-related expenditures to local, state, federal governments, tribes, and other entities would need to be added to the costs of the proposed DCCO predation reduction program. Based on these factors and other information, the costs could potentially outweigh economic benefits of implementing the proposed program. Other unanticipated ecosystem effects may trigger additional direct and/or indirect costs, loss of ecosystem integrity and services. *Recommendation: In the Final EIS, factor the additional costs of elements such as those discussed above, including compensatory mortality, into the analysis of economic effects. Acknowledge the potential for additional costs that cannot be quantified or fully predicted due to the complexity and uncertainty of ecological effects from the proposed action. The analysis of economic benefits from reducing DCCO predation on juvenile salmonids per RPA action 46 may overstate the benefits and understate the costs. Also, the analysis does not incorporate compensatory mortality and recent science on this subject.*	impacts to fisheries), and 3) benefits from the proposed action have other associated non-economic value (e.g., improving populations of ESA listed fish, tribal ceremonial and subsistence fisheries, etc.) whereas implementation costs for the most part do not (i.e., purchase value of materials/labor), making a one-for-one cost-benefit analysis limited if restricting the analysis to economic value alone. Additionally, the EIS analysis indicates that the proposed actions will not result in ESA listing of DCCOs or other species and incorporating potential, future ESA related listing costs into the economic analysis is unwarranted.	
EPA (3)	We have concerns regarding an apparently increasing tendency to set population objectives for cormorants and other fish-eating birds, fish, and other wildlife (such as, Caspian terns, pinnipeds, and pike minnows) based	Comments noted about importance of East Sand Island to DCCOs and other bird species. See EPA (1), 4, G-2, and S-32 concerning RPA action 46 and other RPA actions of the Federal Columbia River Power System Biological Opinion. The Corps notes that the comment about ESA-listed salmonids increasing	No

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	disproportionally on fishery or other human interests. We agree with Wires and Cuthbert that population objectives should be based on species biology, regional ecology, ecosystem health and process "that recognize humans, fish and cormorants as three components of a complex system driven by many species and dynamic interactions." Birds are considered to be good indicators of the health of the ecosystem8. Based on information presented in the DEIS (Chapters 3 and **4),** the DCCO western population is either static or in decline throughout its range except for East Sand Island. Recent growth in the western DCCO population is attributed almost entirely to the East Sand Island population. The East Sand Island population is growing as a result of immigration from other locations, as well as through reproductive success. This is largely due to the stable food supply afforded by forage fish and hatchery releases of juvenile salmon below Bonneville Dam. Studies reveal that juvenile salmonids comprise an average of only 10 to 15% of the DCCO diet on East Sand Island. The majority of DCCO diet consists of forage fish. Diet tends to shift to juvenile salmonids when high river flows and hatchery fish releases occur in spring. The lower fitness of hatchery fish makes them susceptible to predation. In the Salish Sea and throughout the west, fish eating waterbirds are experiencing severe declines. East Sand Island is one of few locations where DCCOs and a wide variety of	during the past decades is not applicable for all ESA-listed salmonid ESU/DPS (e.g., steelhead DPSs). Additionally, increases in certain populations of ESA-listed salmonids occurred concurrent with a multitude of RPA actions and other actions directed toward improving salmonid populations and concurrent with increasing DCCO abundance on East Sand Island. Because all these factors are present and correlated in a singular time series, there is no way to empirically know what ESA listed salmonid population increases or changes could have been in the absence of DCCO abundance increases on East Sand Island (or absence of any one factor), aside from the analyses methods included in the EIS that estimate effects of DCCO predation.	

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	other waterbirds, shorebirds, and waterfowl are thriving, such that the Island has been designated a Globally Important Bird Area (IBA) by both the Audubon Society and the American Bird Conservancy. Because DCCOs are highly philopatric, DCCO immigration to East Sand Island may indicate that conditions for survival are likely unsuitable elsewhere. This should be factored into any DCCO management plans, as well as the fact that even with the increasing DCCO population on East Sand Island, the population of ESA-listed salmonids has been increasing. *Recommendation: Since RPA action 46 is discretional fully investigate non-lethal alternatives and the other means available to the Corps to support recovery of listed fish populations. To put this proposed action in context, the EIS should include discussion of other means available to the Corps to assist recovery of ESA-listed salmonids.*		
EPA (4)	We are concerned that the proposed action would result in the take of non-target species due to misidentification, night shooting, direct and indirect effects of disturbance, and incidental crushing of eggs, chicks, and fledglings. Eighty-four species of birds have been identified on the 60-acre East Sand Island. It supports the largest breeding population of Caspian terns and cormorants in the world, and the largest post-breeding roost site for Brown	See G-10, G-17, G-21, G-22, G-24, S-35 and S-45. The DEIS and FEIS acknowledge that East Sand Island is designated an Important Bird Area and each alternative incorporates impact avoidance measures to minimize impacts to non-target species. Additionally, the purpose and need statement stated: "In meeting this purpose (to reduce predation), impacts to species not targeted for management would be minimized to the extent possible."	Per G-10, G-21, G-22, and G-24.

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	pelicans on the West Coast. The Streaked homed lark, recently listed as threatened under the ESA, also uses the island. Both Audubon Society and the American Bird Conservancy have designated East Sand Island as a Globally Important Bird Area. Brandt's and pelagic cormorants are the non-target bird species of most concern with respect to lethal take because they are easily misidentified and Brandt's cormorants nest among DCCOs (Ch. 4, p. 48). Streaked horned larks are of most concern off East Sand Island where hazing in the Columbia River Estuary may become more intensified. *Recommendation: Because East Sand Island is identified as high value bird habitat, we recommend selection of an alternative that fully minimizes impacts to migratory and resident species.*		
ODFW (1)	*We believe that some stated effects of avian predation on salmonids are overly simplified or are otherwise not properly represented in the DEIS.* 1. The final EIS should place double-crested cormorant predation in a life-cycle survival context by discussing its effect on smolt to adult returns (SARs). 2. The EIS should commit to assessing the	 1. See G-4, S-11 and S-43 2. See S-39. Data provided Ryan et al. 2003, Sebring et al. 2009,	Per G-4. Citations added to relevant sections in FEIS.

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	degree to which Federal Columbia River Power System fish passage operations may influence predation rates and juvenile fish mortality as part of action-effectiveness monitoring and evaluation. Avian predation rates are likely higher due to juvenile fish injury and stress related to dam passage. Further, because juvenile fish transportation (including barging and trucking) quickly moves smolts to the estuary prior to full smoltification, their susceptibility to predation may be increased. Thus, predation is likely a delayed mortality mechanism associated with Federal Columbia River Power System passage. The magnitude of this effect should be assessed by examining the fish dam passage experiences (spill, turbines, bypass, and barging) learned from PIT - tags recovered in bird colonies and in bird diet studies.	and Zamon et al. (2014) indicated that differences in predation rates between transported and in-river fish vary by year, by salmonids species and by predator. Lyons et al. (2014) concludes that "because of the lack of a clear and consistent trend in PIT tag recovery rates between transported and in-river smolts, and because in-river smolts were more representative of the run as a whole (e.g., transportation only occurs during a portion of the annual outmigration), predation rate estimates are based on data from in-river migrants only". (Lyons et al. 2014, p. 15.). This same rational was applied in the DEIS. A better understanding of these trends and the mechanism responsible for them would be valuable to fisheries managers but data collected to date do not provide strong evidence of a consistent transportation or in-river bias when it comes to susceptibility to DCCO predation.	
	3. The DEIS does not assess the effects of compensatory mortality on the outcomes of avian predation management. The DEIS states that this decision is based on the assumption that compensation equally affects base, current and future analytical periods, and it is therefore unnecessary to make allowances for it. However, this assumption is flawed	3. See G-4, EPA(1) and S-43	

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	because it does not adequately consider that improvements in passage could reduce predation vulnerability or improve migrant fish condition. Assumptions about compensation should be evaluated and considered in more detail as part of action-effectiveness assessments. 4. The overall population predation rates in the DEIS are founded on NOAA Fisheries' annual estimates of smolt abundance below Bonneville Dam. This estimate is developed for ESA take permit purposes, and does not provide a measure of precision. Additionally, this population estimate is based on a set of assumptions that include spawning fish sex ratios, spawning success rates, bypass and transportation rates, in-river mortality rates, and adipose fin-clip rates. Many of these assumptions are unsubstantiated. To ensure that the EIS establishes a sound basis for assessing the effectiveness of management actions toward recovery of depressed fish populations, the EIS should discuss how the precision and assumptions in initial smolt population estimates may affect the resulting predation rate estimates. Disproportionate tagging rates and tagged fish numbers between	4. See G-7 and G-8. To clarify species-specific consumption estimates generated by NOAA Fisheries (Appendix D; Gap Analysis, Purpose and Need) and ESU-specific PIT predation rate estimates generated by Corps funded studies (Appendix C and used in Chapters 3 and 4 of the DEIS), additional text was included in Chapter 1, Section 1.16 and the Appendix C Retrospective Analyses describing these two different methods and data sources. NOAA Fisheries used smolt abundance estimates in the estuary as a measure of fish availability to generate species-specific consumption rates, while PIT tag predation rate estimates are based on a known number of PIT-tagged fish lasted detected passing Bonneville or Sullivan dams. For PIT tag predation rate estimates in the EIS, only salmonid ESUs/DPSs with > 500 PIT-tagged smolts interrogated passing a dam were evaluated in any given year to reduce potential bias from small sample size. ESU/DPS-specific predation rates presented in Appendix C of DEIS are not based on groups of PIT-tagged fish from the Lower Columbia River but rather groups that navigated the Federal Columbia River Power System (upriver ESU/DPSs). It has been documented that different predation rates may exist between upriver and estuary salmonid stocks (see Sebring et al. 2013 and Lyons et al. 2014), but data regarding how much of this difference is due to Lower Columbia	

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	populations in the Lower Columbia River and those upstream from Bonneville Dam may bias mortality rate estimates in the EIS. This may overestimate predation on upstream fish groups and underestimate predation on Lower Columbia River fish groups. The EIS should discuss how tagging rates may affect the resulting predation rate estimates.	River fish being weaker, more naïve, or otherwise more vulnerable relative to upriver stocks is currently unknown.	
	5. The EIS Executive Summary should present at-the-dam performance standards in the correct context for each fish population group, and not selectively present those that portray the least mortality at hydropower dams. The performance standards are 96% survival (4% mortality) for juvenile steelhead and yearling Chinook, and 93% survival (7% mortality) for sub-yearling Chinook (2014 supplemental Biological Opinion Section 3.3.3.2 Juvenile Dam Passage Survival, p. 358). The EIS Executive Summary should also provide a citation for the estimate of 97.5% steelhead survival (2.5% mortality). In recent presentations to Oregon's Governor's Natural Resources Office, the USACE has indicated that survivals at Bonneville Dam were: 96.5% for juvenile steelhead in 2011, 95.9% for yearling Chinook in 2011, and 95.8% for	5. The performance standards for dam survival is cited appropriately for juvenile steelhead (96%), which is the subject of the comparison for the Executive Summary and the management focus for the survival gap. The following citation has been added to FEIS- Skalski JR, RL Townsend, A Seaburg, GR Ploskey, and TJ Carlson. 2012. Compliance Monitoring of Yearling Chinook Salmon and Juvenile Steelhead Survival and Passage at Bonneville Dam, Spring 2011.PNNL-21175, Final Report, Pacific Northwest National Laboratory, Richland, Washington.	

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	sub-yearling Chinook in 2012.		
ODFW (2)	*We consider the dispersal of DCCOs from the Columbia River estuary to be a reasonably likely outcome of Alternative C. Such dispersal could be a serious threat to Oregon's fisheries and the recovery of species of conservation concern* 1. ODFW does not agree with the Corps' conclusion that disturbed DCCO will necessarily remain in the Columbia River estuary. The non-lethal dissuasion studies conducted on East Sand Island consolidated the available nesting area and caused DCCOs to increase nesting density, but did not restrict available nesting habitat or disturb DCCOs enough to lead to dispersal. A study conducted by Courtot et al (2012) used satellite tags to track only post-breeding cormorants from East Sand Island. It remains unclear how DCCOs with a drive to breed will respond to more aggressive dissuasion or lethal take methods. Hazing or culling a single colony of ground-nesting DCCOs at the annual scale proposed has never been attempted. The studies cited in the DEIS as supporting the feasibility of Alternative C involved culling at many discrete colonies, relied heavily on oiling	The Corps notes that the concerns of ODFW were made known to the Corps in the development of the DEIS (as displayed in Figure 3-14), and these concerns were a significant factor in selecting lethal methods as a preferred alternative and establishing rigorous thresholds and adaptive management processes to limit potential DCCO dispersal. The Corps acknowledges that there is little political or social acceptability in Oregon or Washington states in receiving DCCO dispersed from East Sand Island. 1. Based on available data to date, the Corps determines ODFW's assessment about potential DCCO dispersal into Oregon from the proposed action is unfounded. The DEIS discussed available information about DCCO dispersal and usage areas, indicating highest connectivity to the Columbia River Estuary and then to the Outer Washington Coast and Salish Sea region. During the management feasibility studies during 2011-2013 breeding seasons, nearly all tagged DCCOs relocated to Astoria Bridge or other nearby areas in the Columbia River Estuary. Table 3.1 provided information on usage of DCCOs satellite tagged on East Sand Island across the entire breeding season, and Table 3-2 was added to show usage during the early breeding season. No detections of DCCOs were made on the Oregon Coast. In the Courtot et al. 2012 citation provided, only 1 coastal site along the Oregon coast, Tenmile Lake in southern Oregon, was used by a single cormorant during that study (2% of detections). With regard to feasibility, the Ontario Parks (2008) citation in the DEIS describes an annual level of culling higher than what is proposed in the DEIS 4-year lethal strategy and techniques used in that study would likely be less effective than those proposed in the EIS. Bedard et al. (1997) did not employ	Additional information about ODFW DCCO management included in Chapter 4.4 - cumulative impacts.

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	the eggs of ground nests rather than culling adults, or involved much lower rates of adult take than proposed by Alternative C. One of the very papers the Corps cites as supporting the feasibility of Alternative C (Bedard et al. 1997) describes the impossibility of culling adult DCCOs from ground nests because of the wariness of adults. Thus, available data does not seem to support claims in the EIS that dispersal of DCCOs from the Columbia River estuary is unlikely. Therefore, ODFW believes there is a reasonable likelihood that the preferred alternative will displace an unknown number of DCCOs from the Columbia River estuary, possibly into Oregon.	the methods proposed in the DEIS (use of elevated shooting platforms and privacy fence/barriers, sub-sonic shot with noise suppressors/silencers, night shooting, boat-based shooting, adaptive management thresholds and processes to curtail and modify activities based on dispersal levels), so their conclusion about lethal removal of ground nesting DCCOs is not directly applicable.	
	2. The USACE should specify a minimum amount of annual take for Alternatives C and D. If that level is not met in the Columbia River Estuary (CRE) as a result of colony abandonment, and DCCOs disperse to areas that have been identified as unacceptable by cooperating agencies, then lethal take should be conducted in areas outside of CRE. The EIS should specify that the depredation permit that is needed to perform either Alternatives C or D will need to include dispersal locations outside of the Columbia River estuary,	2. See G-1, G-6, and G-13. The DEIS specified what take levels would be initially requested on a depredation permit application. Authorized take numbers are subject to a USFWS decision. The Corps (Portland District) is not proposing to manage DCCO lethally or non-lethally outside of the Columbia River Estuary.	

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	including all counties along the Oregon Coast.		
	3. The DEIS states that culling would cease only if fewer than 70% of the expected DCCO remain on East Sand Island after a culling event. In 2013, there were approximately 7,000 DCCOs on East Sand Island by the third week of April. Dispersal of 30% of that number would equal 2,100 cormorants. This is ten times the number of foraging cormorants that are counted in Tillamook Bay during April and May, and is not an acceptable amount of dispersal. Furthermore, it is unclear how accurate counts will be obtained during the early part of the breeding season when culling would commence. At this time the colony is growing rapidly and dispersal of early arriving birds could go unnoticed. ODFW requests a minimum threshold of 90% to prevent accidental dispersal of large numbers of birds.	3. The Corps considers a 70% dispersal threshold is an even balance in attempting to optimize being able to implement the alternative effectively, account for natural variation in colony size, and limit potential dispersal. The 70% threshold was based on past baseline variation in colony size and allows for management to not be overly responsive to natural variation in colony abundance. A 90% threshold would not be feasible to implement, as it would likely be overly restrictive and not account for baseline variation in colony abundance. Furthermore, the example provided of 100% of DCCO dispersed from East Sand Island going to one location on the Oregon Coast seems unfounded given available data to date. Data to date suggest 0-5%. Monitoring and Adaptive Management components were described in the DEIS, and accurate counts would be obtained from monthly (or more frequent) aerial counts, and boat- and land-based counts.	
	4. In spite of limited opportunities for band resighting, ODFW has observed five banded DCCOs near the Oregon Coast during the last three years. In 2012, a DCCO was observed at a roost site on the Tillamook River that had been banded as a chick at East Sand Island in 2011. A	4. See ODFW (2) 3, regarding movement and dispersal. Banding and resight data was discussed in Chapter 1.1.6 of the DEIS and indicated 6% of known dead recoveries and live resights occurred along the Oregon Coast. During 2008-2013, 1,961DCCOs were banded on East Sand Island, and 5 resights represents 0.25% (5/1,961) of known banded DCCOs. This is consistent with other independent lines of evidence suggesting	

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	DCCO with bands from East Sand Island was observed on Tahkenitch Lake in 2013. So far in 2014, three unique individuals have been observed in Tillamook Bay that were originally banded on East Sand Island. These sightings confirm our concerns that the Oregon Coast is a likely dispersal area for Columbia River estuary DCCOs.	very limited usage of the Oregon Coast by DCCOs marked on East Sand Island.	
	5. The EIS does not sufficiently recognize mounting evidence that DCCOs depredate ESA-listed and State Sensitive Species across the Oregon Coast. ODFW is actively studying the effects of DCCO predation at three Oregon estuaries. Unpublished data from all sampled areas (Tillamook Bay, Umpqua River estuary, Rogue River estuary) confirm DCCO predation on juvenile salmonids of conservation concern. Although this data is limited, it all suggests the same conclusion: DCCOs that disperse from the Columbia River estuary may contribute to fish conservation issues along the Oregon Coast. To further show potential impacts to Oregon salmonids, the EIS should include requirements for the USACE to conduct diet studies in Oregon's coastal areas where data gaps exist. These areas include estuaries associated with the Nehalem, Nestucca,	5. ODFW provided information to the Corps from DCCO diet studies conducted in Tillamook Bay and DCCO management efforts within Oregon coastal estuaries. This, and other information, where available, was provided in the DEIS. The implications of this limited diet information was described in DEIS Chapter 3, pg 47 and Chapter 4, pg 36 of the DEIS, "…(Adrean 2013), indicating susceptibility of juvenile salmonids to DCCO predation in an Oregon estuary environment". The information in the DEIS appears consistent with the data and conclusion provided in the submitted comment.	

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	Yaquina, Alsea, Siuslaw, and Coquille Rivers, Coos Bay, and Tenmile Lake.		
	6. State-designated sensitive species that could be impacted by DCCO dispersal to the Oregon Coast should be included in Chapter 3 of the EIS. These include chum salmon (Coastal Chum Salmon SMU/Pacific Coast ESU), Chinook salmon (Coastal Spring Chinook SMU, Rogue Spring Chinook SMU, Southern Oregon/Northern California ESU, fall run/Rogue Fall Chinook SMU), and steelhead (Oregon Coast ESU, summer run/Coastal Summer Steelhead SMU; Klamath Mountains Province ESU, Klamath Summer Steelhead SMU; Oregon Coast ESU, summer run/Coastal Summer Steelhead SMU; Oregon Coast ESU, winter run/Coastal Winter Steelhead SMU; Klamath Mountains Province ESU, summer run/Rogue Summer Steelhead SMU). These species are of conservation concern on a state level, and could be at risk from increased mortality due to predation by DCCOs.	6. Rationale for why ESA-listed fish species were chosen as the focus of analyses was described in Chapter 3.2.5 of the DEIS. Analyses of impacts for the affected environment in the EIS are consistent with 40 C.F.R. §1502.15 guidance, which states that "data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced". Little to no empirical data exists for DCCO predation of state-listed sensitive species. Additionally, the DEIS stated that distribution of ESA listed species overlaps with state-listed species and the analyses of ESA listed fish where data is known provided adequate information for other species that could be impacted.	
	7. Salmon fishing is a defining element of the Oregon experience, and the availability of salmon for harvest across the Oregon Coast has immense social	7. See ODFW(2) 5 and 6, S-1, and EPA(2). The Corps defers to ODFWs economic analysis regarding the impacts of DCCO predation and this comment was included in the FEIS (Page 3-55, and 4.3.4 Effects to Public Resources)	

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	and economic value. In spite of this, the DEIS does not mention the impacts of potential DCCO dispersal on the availability of non-listed salmonids that are important for anglers, such as wild and hatchery steelhead and Chinook salmon along the Oregon Coast. These potential negative social costs are tied to economic costs. Preliminary economic analyses conducted by ODFW indicate that if double-crested cormorant numbers in Tillamook Bay were to increase by 200 birds, economic losses could be in the minimum range of $142,000 - $568,000 per year as result of decreased angler participation. To fill data gaps relating to economic impacts to all Oregon communities, ODFW requests that the USACE include a complete economic analysis of potential impacts to Oregon's coastal areas that could become DCCO dispersal sites. 8. ODFW believes a significant number of DCCOs may disperse into Oregon as a result of Corps' actions. Thus, we feel that specific adaptive management strategies should be clearly articulated in the EIS. These strategies should be implemented if specific DCCO breeding or occurrence thresholds are met. The central element in any adaptive	 8, 9, and 10. See ODFW (2) 2, G-1, G-6, and G-13. DCCO abundance information for different areas was described in Chapter 3.2.2 of the DEIS and reference to ODFW DCCO management along coastal estuaries was described in Chapter 3, pg 49 and Chapter 4, pg 55 of the DEIS (included and expanded upon in Chapter 4, Section 4.4.2 of the FEIS). The level of information provided in comments 8-10 is beyond the scope of the EIS, as it is not part of the proposed action being undertaken by the Corps.).	

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	management plan should be USACE assistance with reducing impacts of dispersed DCCOs on juvenile salmonids. ODFW has been monitoring and non-lethally hazing cormorants to reduce mortality of juvenile salmonids since 2011, although hazing programs have been conducted in some estuaries since 1988. The ODFW hazing program does not have the resources to manage increased numbers of foraging DCCOs. Thus, USACE assistance would be required to expand hazing programs, and the USACE depredation permit may be required to perform hazing with lethal reinforcement if non-lethal hazing is ineffective. There are currently no hazing programs in interior Oregon. 9. The EIS should contain clear baseline numbers of DCCO on the Oregon Coast before management at East Sand Island takes place, similar to the "base period" the Corps uses to justify actions in the EIS. If population levels exceed baseline levels following management on the Columbia River estuary, ODFW expects the Corps to contribute programs and funding to reduce impacts to Oregon salmonids, including hazing and/or lethal take at new or expanding colony sites. Acceptable breeding pair thresholds		

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based on coastal colony data from 1979 to 2013 are given in the following table.

	1979	*1988*	*2003*	*2006*	*2009*	*2012*	*2013*	*Mean*	*SD*	*+-95% CI*	*Breeding Pair Threshold*
North Coast	356	943	788	509	737	200	449	569	263	195	**764**
Mid Coast	12	182	52	27	31	12	64	54	60	44	**98**
South Coast	490	857	1354	1205	1616	1048	1424	1142	380	282	**1424**
Total	858	1982	2194	1741	2384	1260	1937	1765	536	397	**2162**

Number of double-crested cormorant breeding pairs in Oregon, by zone. The upper boundary of the 95% confidence interval was used for the breeding pair threshold. North Coast = Bird Rocks to Haystack Rock in Pacific City; Mid Coast = Yaquina Bay Bridge to Heceta Head; South Coast = Siuslaw River to CA border. Data from Carter et al. 1995., Adkins, et al. 2010, USFWS Oregon Coast National Wildlife Refuge Seabird Colony Database, and ODFW unpublished data. Full citations available upon request.

10. DCCOs dispersing from the Columbia River may not necessarily breed on the Oregon Coast, but may utilize estuaries for foraging. Therefore, immediate USACE assistance (hazing and/or lethal removal) is needed if the number of DCCOs in Oregon estuaries or coastal lakes exceeds one standard deviation above the 2012-2014 average. Such an average will be calculated in two week blocks. For areas where only one or two years of data are available, the threshold for foraging birds should be any level exceeding 20% above the high count for existing data. ODFW expects the Corps to contribute programs and funding to manage DCCOs if populations in interior

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	Oregon exceed l 0% above historic levels. The thresholds listed above should be considered interim thresholds that are subject to change based on completion of ODFW's statewide double-crested cormorant management plan. This plan is in development and expected to be completed in 2015.		
	11. It is possible that productivity is density dependent and could increase if removal of DCCOs lessens nest site competition. Continued leg banding of adults and chicks would reveal survival and return rates at East Sand Island and reveal sources of population change.	11. In the DEIS, data on East Sand Island DCCO colony size (Figure 1-2) and productivity (Figure 3-11) from 1997-2013 were included. DCCO colony size in 1997 was approx. 5,000 breeding pairs (i.e., lower than the target size). Observed data do not support the density dependence scenario described, as productivity was below the long-term average when colony size was smaller in the late 1990s. The Corps is proposing aerial monitoring and surveys consistent with the Pacific Flyway Council efforts to track the status of the western population.	
	12. ODFW is very supportive of the Adaptive Management Team approach mentioned in the DEIS. Unfortunately, it is unclear how such a body could be considered a team if the USACE asserts complete decision-making control. We fully embrace a truly team-based approach, and therefore suggest that the DEIS be amended so that decision-making power is distributed more equitably.	12. It is against federal policy and law to allow a non-federal entity to make decisions committing federal appropriations. The Corps will be the decision maker but will be look to the Adaptive Management Team to develop management recommendations.	

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WDFW (1)	WDFW has on multiple occasions submitted our concern regarding the level of monitoring efforts and who is responsible. Monitoring in Phase 1 of the Alternatives is limited outside of the estuary (e.g., coastal WA); however, Phase 2 and post action monitoring is inadequate and we believe does not address the potential DCCO response to management actions (especially given the most likely affected environment is the Columbia River Basin, the Washington Coast, and Salish Sea). In addition, the triggers for implementing adaptive management strategies have not been fully described and the adaptive management process is vague in terms of commitment, resources, and responsibility from the Corps and the Service to adequately fund and/or implement necessary monitoring, management, and research actions to achieve objectives. We believe monitoring and effective adaptive management strategies are essential to addressing long-term sustainability of DCCO and recovery of salmon populations.	See ODFW(2). The Corps acknowledges the concerns of WDFW. These were made known to the Corps in the development of the DEIS (as displayed in Figure 3-14), and these concerns were a significant factor in selecting lethal methods as the preferred management strategy and establishing rigorous thresholds and adaptive management processes to limit potential DCCO dispersal. The Corps acknowledges there is little political or social acceptability in Oregon and Washington states in receiving DCCOs dispersed from East Sand Island. See ODFW (2)2 and 8, G-1, G-6, and G-13.	No
WDFW (2)	The DEIS should assess the probability of DCCO dispersal based on appropriate data. WDFW does not agree with the Corps' conclusion that disturbed DCCO will necessarily remain in the Columbia River estuary. The non-lethal dissuasion studies conducted on East Sand Island did not restrict available nesting habitat or disturb DCCOs enough to lead to dispersal. It remains unclear how DCCOs with a drive to breed will respond to more aggressive dissuasion or lethal take methods. Hazing or culling a single colony of	See ODFW (2) 1. The Corps evaluated potential DCCO dispersal and usage areas based on the best data and results available, which included short-term dispersal and post-breeding connectivity data from banding, radio- and satellite tagging efforts on East Sand Island to date, as well as other literature sources. Potential areas of DCCO usage (Chapter 3.1, Tables 3-1 and 3-2), relative levels of dispersal from Alternative C (Chapter 4), and uncertainty concerning exact dispersal locations (Chapter 4.6.4) were described in the DEIS. This is an adequate evaluation per NEPA requirements for describing potential effects of a proposed action, and any further evaluation cannot	No

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	ground-nesting DCCOs as proposed has never been attempted; therefore, much is unknown. Understanding this situation and how to respond will require an adaptive response that will affect both Washington and Oregon, at the minimum. Thus, available data does not seem to support claims in the DEIS that dispersal of DCCOs from the Columbia River estuary is unlikely. Therefore, WDFW believes there is a reasonable likelihood that the preferred alternative will displace an unknown number of DCCOs from the Columbia River estuary, possibly into Washington.	be made given the limitation of available data.	
WDFW (3)	The DEIS should adequately stress the potential conservation impacts of dispersing DCCOs on state-listed and other Species of Greatest Conservation Need. These species are of conservation concern on a state level, and could be at risk from increased mortality due to predation by DCCOs. In addition, the DEIS should adequately address the potential social and economic impacts of dispersing DCCOs in Washington.	See ODFW (2) #'s 6 and 7 and S-1.	No
WDFW (4)	Finally, the DEIS should reflect a cooperative, team-based effort. WDFW is very supportive of the Adaptive Management Team approach mentioned in the DEIS. However, it is unclear how this team will be effective if all team members are not able to provide input in a way that equitably distributes the decision-making response to the potential impacts from these management actions.	See ODFW (2) 12.	No

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WDFW (5)	Under the no action alternative, the document suggests that the population of DCCO will continue to grow. But it has been stable for a number of years now.	Chapter 4.2.2 of the DEIS stated, "…average abundance would presumably remain similar to approximately 13,000 breeding pairs in the near term, but may increase in the future. During 2004 to 2013, the size of the DCCO colony on East Sand Island averaged approximately 13,000 breeding pairs, but 2013 was the greatest size ever recorded (i.e., 15,000 breeding pairs, see Chapter 1, Section 1.1.1)." The Corps considers the description of the East Sand Island colony and future growth potential (and accompanying uncertainty) was accurately captured in this description based on available data. This statement acknowledged the stability of the colony size over the past decade and the fact that the last data point on record is the largest yet recorded, suggesting potential for future increase. A visual representation of future trajectories for the DCCO East Sand Island colony and the western population of DCCOS for all EIS alternatives are included in Appendix E-3 of the FEIS.	No
WDFW (6)	If the population of DCCO on East Sand is reduced by 5,380 to 5,939 pairs, what will be done to prevent the population on the estuary (as a collection of islands) from expanding in the future?	See Chapter 2 and 5 of the DEIS for a description of Alternatives regarding hazing, non-lethal management, and limited direct egg take in the Columbia River Estuary.	No
WDFW (7)	1. The analysis in the Appendix that summarizes the impacts to the western population of the DCCO is not adequately summarized or considered in the document. Because DCCO appear to be highly philopatric to nesting colonies, perhaps the Corps should assemble spatio-temporal patterns in demographic rates (assuming they are available) and build a	1. See G-19, G-20, and EPA (1) 4. 2. In the DEIS, the preferred alternative, Alternative C, did not put forth egg oiling as a primary lethal method to be used. In the FEIS, Alternative C-1, which utilizes culling and egg oiling, is identified as the preferred alternative. For determining proposed take levels, the percentage of associated nest/egg loss was modeled equal to the percentage of adult take. This would	Inclusion of Alternative C-1 as the preferred alternative, which includes culling and egg oiling.

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	deterministic metapopulation model. This would get at the potential source-sink issue. WDFW understands that the growth of the colony has been significant, what if East Sand is an important source colony for the "western population". 2. A separate question about this modeling approach: should egg oiling and adult killing be included jointly as well as separately? Currently the preferred alternative proposes these two methods be used jointly.	be nest/egg loss that could occur if one or both breeding adults were culled, and is a separate component from nesting oiling. As described in the DEIS, this modeling approach for associated nest loss was undertaken because this future value is uncertain and the chosen approach represents a maximum value that could occur. Since associated nest/egg take cannot be avoided when culling adults, modeling these two components separately would not be warranted for determining proposed take levels. However, general results of modeling these two components separately were shown in Appendix E-1 of the DEIS.	
WDFW (8)	WDFW would like to see the western population of the DCCO defined from a true population definition (scientific definition not a popular definition). Defining this population is important in understanding/determining the impact of removing DCCO on the larger population of interest.	Comment noted. The description as to what constitutes the western population of DCCOs in the EIS is consistent with USFWS national DCCO management, status assessments conducted to date, and the Pacific Flyway DCCO management framework. Additionally, references to, and results from, Mercer (2008) and Mercer et al. (2013), were provided in the DEIS and describe current genetic information concerning DCCOs, which provides information more relevant to a strictly scientific definition of DCCO sub-species and populations.	No
WDFW (9)	WDFW would like to ensure that, if the DCCO are "dissuaded" and they settle on other islands on the lower Columbia (likely scenario based on previous dispersal after dissuasion), the impacts on other species like the streaked horned lark that nest on those islands are properly examined and that a mechanism is in place to respond accordingly. We note that this document does not have the most recent information on streaked horned lark nesting islands.	See G-21 and G22.	Per G-21 and G-22.
WDFW (10)	The science underlying this document is not	Comment noted but not specific enough for a detailed response.	No

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	adequately referenced so it cannot be adequately evaluated.		
WDFW (11)	The assumption is not supported that if X number of cormorants are removed, there will be an equal response in survival by juvenile salmon. There are many reasons to suspect this won't be true. There are many direct and indirect effects in the system. WDFW recommends modeling the top-down and bottom-up influences on juvenile salmon survival (e.g., Ecopath model). Because of indirect effects, the results on juvenile salmon survival could be different than the predicted linear relationship (other predators fill the void, other bottom up mortality factors become more important with an expanded juvenile salmon population).	See G-4.	Per G-4
WDFW (12)	The DEIS should more thoroughly describe what the anticipated responses of adult salmon return rates would be if juvenile survival is increased by 3.6%? In other words, will the action result in more adult salmon? Instead, the focus is on juvenile salmon survival.	See G-4	Per G-4
WDFW (13)	WDFW is concerned about how uncertainty is portrayed (or not portrayed) in this document. Mean estimates are usually provided throughout and occasionally the uncertainty is presented. If it is presented, it is not defined and more often it is not presented. As a result, we don't understand the uncertainty and can't reach meaningful decisions. If, for example, the uncertainty is high in DCCO juvenile salmon predation rates, then our certainty in a population response by juvenile	See G-7	Per G-7

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	salmon is also highly uncertain. For example: Table 4-2 from the document summarizes the potential juvenile survival benefits to selected salmon and steelhead ESUs/DPSs. In all cases, the range of potential benefits to juvenile salmon survival under the preferred alternative C ranges from 0-2% at the low end to a high of 2-9% at the high end. The expected (annual average) benefit ranges from 1-4%, again depending upon the species and unit. The executive summary focuses on annual average but does not provide the variation around these expected annual average benefits. This is the kind of uncertainty that needs to be clear to the reader up front in the executive summary so that they can make informed decisions. To evaluate the science, the reader needs to know how these estimates were derived.		
WDFW (14)	There seems to be a bias in how the data are presented. For example, in the introduction the authors state, "11 million juvenile salmonids being consumed on average annually and potential predation rates as high as 17 percent on particular salmonid groups within a given year". In this example and throughout the DEIS, the worst case example is often presented (17%) without the lowest estimate also being included.	See G-7. The DEIS included information on variation in DCCO predation rates and uncertainty in effects.	No
WDFW (15)	There is no variance (preferably 95% Confidence intervals) provided in the estimate of cormorant caused juvenile salmon mortality (e.g., 6. 7 percent mortality).	See G-5 and G-7.	Per G-5 and G-7.
WDFW (16)	Why is dam mortality rate compared to	See ODFW (1) 5. The operation of the Federal Columbia River	No

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	cormorant mortality? It may be beneficial to include other sources of mortality.	Power System is the basis for Section 7 consultation and resulting Biological Opinion, which includes the RPA action 46. A comparison to dam mortality was provided for readers to understand the documented impacts of DCCO predation relative to another source of familiar mortality within the Federal Columbia River Power System Biological Opinion.	
WDFW (17)	The caption for ES-1 does not provide enough information to interpret.	Comment noted.	No
WDFW (18)	Table ES-3: addresses species overlap. How are they overlapping (space, time)?	For clarity, sentence changed from: "overlap with DCCOs throughout the affected environment" to "occur with DCCOs in other areas of the affected environment". Chapter 3.2.3 and Chapter 3.2.4 of the DEIS included additional information about birds species on East Sand Island and within the affected environment.	Text changed for clarity.
WDFW (19)	Inconsistent use of the specific vs. general: auklet, gulls, falcons, and eagles vs. Caspian terns, Brandt's cormorants, pigeon guillemots, etc.	Comment noted.	No
WDFW (20)	"Streaked homed larks are the species of most concern off of East Sand Island". What does this mean? It is federally threatened under the ESA and it is state threatened in Washington.	See WDFW(9), G-21 and G22.	No
WDFW (21)	If the DCCO on East Sand is the largest in the "western population", is it a source for the other populations? Do we have any population modeling data to suggest any potential cascading effects associated with changing this population from a source (if it is?) to a sink?	See WDFW (7), G-19, G-20, and EPA (1) 4.	No
WDFW (22)	Alternative B: "the western population of double-crested cormorants would likely remain similar to,	Comment noted. See G-19, G-20, and WDFW (21)	No

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	or decrease from, current estimates (approximately 31,200 breeding pairs) in the near term." This may not be true if the East Sand island colony is an important source for the rest of the west.		
WDFW (23)	Throughout the document the Corps suggests that with the no action alternative, the cormorant population will continue to grow on East Sand. However, the data in figure 1-2 suggest that the population reached an asymptote around 2004, and consequently, has been stable since 2004. Has the "trend" been adequately analyzed? Similarly, and not surprisingly, the "trend" in juvenile consumption by DCCO may have also reached a peak.	See WDFW (5). Similarly, given data presented in DEIS, particularly Figure 1-3 of the DEIS, which shows total juvenile salmonid consumption was highest within the prior 3 years of recorded data, and Appendix C annual DCCO predation rates, there is no indication that DCCO predation has definitively peaked.	No
WDFW (24)	The Corps summarizes there is a bioenergetics model that estimated that the total annual smolt consumption by the East Sand Island DCCO colony (no citation provided) varied between 2.4 and 20.5 million smolts (mean = 11.0 million; Figure 1-3). Is this the variation in the mean annual estimates? Within year variation is provided in Figure 1-3 but not within year in Figure 1-4 and we don't know what measure of variation around the point estimates is being used. Therefore, the reader can't evaluate the variation around the point estimates.	Range of consumption described was mean estimates, and the mean annual consumptions estimates were presented in Figure 1-3. Confidence intervals, and explanatory footnotes, were added to FEIS Figure 1-3, and others, where appropriate. ***Consumption and variance estimates were revised and updated based upon comments received on the DEIS.**	Confidence Intervals and explanatory footnotes included in figures where appropriate. ***Figure 1-3 revised and updated.**
WDFW (25)	Average annual predation rate estimates derived from PIT tag recoveries at the East Sand Island: The DEIS should include a table summarizing the results, the citation, and the error associated with	Statement described, as was written, that values are the range of annual mean estimates and reference to Appendix C was included in that statement, which includes a complete table of annual predation rates and variance estimates. Additional	No

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	the estimates. Finally, if all salmon species are lumped together, how do these results compare to the bioenergetics model?	clarifying text was included in Chapter 1, Section 1.1.6 and Appendix C of the FEIS, which describe these two methods and how they were used in various analyses. Additionally, the Appendix C Retrospective Analysis and Appendix I Economic Analysis show side-by-side comparisons of the two approaches.	
WDFW (26)	Figures are not adequately labeled throughout the DEIS. As a result, the science cannot be evaluated. For example, in Figure 1-3, the individual bars are not labeled nor are the error bars and it is not explained how the average was determined in this figure. For some reason, we are apparently supposed to compare 2013 to other years? Why wasn't 2013 included in the "average"? Why is there no error associated with the average? There are similar concerns about nearly all of the figures.	See WDFW (24).	Per WDFW (24)
WDFW (27)	Factors influencing predation- are these actual factors or are these possibilities? In other words, has the causal link been made quantitatively?	See Appendix C Retrospective Analysis in FEIS, which evaluates and describes the influence of environmental factors and colony size on DCCO predation.	No
WDFW (28)	If there was little connectivity to colonies east of the Cascade-Sierra Nevada Mountains or along the coasts of Oregon, southern California, or Mexico (Courtot et al. 2012)", then why is the "western population of DCCO defined as the breeding colonies "from British Columbia to California and east to the Continental Divide"? If the band recovery data are used, how would the "population" be defined? Is there any genetic data to inform this definition? This is an important consideration if we are concerned about the impact of reducing the East Sand colony to the	See WDFW (8).	No

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	larger "population" (however that is defined). If the population (as defined by genetics or banding) is a much smaller than the colonies included in the "western population", then the impact to that population by removing individuals could be even greater than portrayed in this document.		
WDFW (29)	FIGURE 1-7: The "base" and "current" periods appear arbitrary (based on the information provided). Additional explanation would be beneficial. It would be useful to look at linear or non-linear trends over time. If one is looking for a change, then there are many change detection approaches that could be applied to these data. If one were to move the "current period" two years earlier, there may be no difference (or very little) between the base and current.	See G-5, G-6, and G-7.	No
WDFW (30)	Ch 1 p.7: "Compared to the NOAA Fisheries analysis, other studies and analyses have documented much higher mortality rates from DCCO predation". Have other studies documented lower rates or does this statement reflect a complete literature review?	See WDFW (14) and G-7. See Appendix C and D for comparison of the range of PIT based predation rates and rates identified by NOAA Fisheries in the "survival gap" analysis.	No
WDFW (31)	Ch 3. P. 3: Table 3-1. This table needs more description/clarification in text.	Additional information on DCCO usage during the early season was added to this section of the FEIS.	Table 3-2 of the FEIS
WDFW (32)	Figure 3-2: If birds visit the colonies depicted in this image, then they might well settle there if dissuaded from East Sand. If this is the case, then the San Juan Islands and the Columbia River near Portland may be disproportionally affected.	Comment noted and that information was described similarly in the DEIS.	No
WDFW (33)	Ch 3. P 13: Anchovy is the primary fish consumed by DCCO on the lower Columbia River and DCCOs	See WDFW (11), G-4, and ODFW (2) 6.	No

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	appear to have fairly broad diets. Based on this, what are the direct effects on other fish populations in the lower Columbia River caused by reducing DCCO numbers and, in turn, the indirect effects of the changes in those fish populations on juvenile salmon survival. Are any of the fish consumed by DCCO also juvenile salmon predators? Again, this is where a system level model would be helpful.		
WDFW (34)	Figure 3-11: We assume that this is the average number of young fledged per year (the caption doesn't say so). What are the error bars (SE, SD, Cis)? Where do the data come from?	See WDFW (24).	Per WDFW (24)
WDFW (35)	Figure 3-12: If these are estimates as the caption indicates, they have a variance, which should be presented.	See WDFW (24).	Per WDFW (24)
WDFW (36)	Ch. 3, p.32: Table 3-3 (the numbering on this table does not follow the previous table). Where do the breeding population estimates in this table come from? The lark estimate does not fit any published estimate that we are aware of (same in the text that follows). The rhinoceros auklet text below this figure is out of date. See Pearson et al. 2013. This numbers become important below when they are used to evaluate impacts of actions to other species. For example, the estimate of Brandt's cormorants is used to evaluate the impacts of the potential take to this species. Without information on where the information comes from, we cannot evaluate.	Reference to incorrectly numbered table not found. References for estimates provided in table and text were clarified in the FEIS. . Streaked horned lark abundance estimate came from Altman 2011(also included in Federal Register listing October 3, 2013 [78 FR 61452]) and reference was included in FEIS. Pearson et al. 2013 estimates for rhinoceros auklet were included in the DEIS.	References clarified in Table 3-3 and following text. Included Altman (2011) reference for SHLA.
WDFW (37)	Ch 4, p. 6: "However, overall direct or indirect	See WDFW (6). See Chapter 2 and Chapter 5 of the DEIS, which	No

ID	Agency Comment	Response	Change in Document
	adverse effects to DCCOs within the designated nesting area from actions taken under Alternative B are expected to be negligible and similar to effects during past research efforts. Productivity within the designated nesting area would likely remain similar to the average during 1997 to 2013 (i.e., 1.83 fledglings produced per breeding pair, see Figure 3-11)." If this is the case and the western population was growing with that level of output, wouldn't we expect the DCCO population along the Columbia River to grow after the initial reduction? In 10 years, we might be back in the exact same situation unless Columbia River wide hazing is done for a very long time. If not, is the Corps prepared to do similar reductions on other islands in the future? The timing of Phase II under the different alternatives is not described. Would this continue for 10 years, 20 years, indefinitely? What is the process for evaluating the effectiveness of Phase II?	discuss Phase II management and timeframes. See Appendix E-2 and E-3 DCCO population model colony growth scenarios for East Sand Island.	
WDFW (38)	Figure 4-7: This image is illegible.	Footnote provided to explain colors in Figure 4-7, as well legend included in the figure.	Footnote provided for Figure 4-7.
WDFW (39)	Tables 4-2 and 4-3: This assumes a direct one-to-one relationship between a reduction in DCCO population and a reduction in juvenile salmon loss. This seems highly unlikely in the long-run given the complexity of the ecosystem. It is very important to understand how the information in this table was derived.	See G-4. Chapter 4.2.5 described how information in the table was derived; see Appendix C Retrospective Analysis in FEIS.	Per G-4.
WDFW (40)	Table 4-4: Uncertainty associated with this information is not presented.	See WDFW (13) and (14) and G-7. The economic analysis used a deterministic model and this was described in the DEIS.	No

ID	Agency Comment	Response	Change in Document
WDFW (41)	Appendices: Many tables are presented with estimates but it is not clear how these estimates were derived.	See WDFW (24).	Per WDFW (24)
USFWS	Reference letters (provided in full, following Table J-3) regarding comments about sustainable population language and DCCO status, threats and limiting factors affecting DCCO, carrying capacity for western population, and recommendations for modifying Alternative C in DEIS.	See revised definition for sustainable population, description of Alternative C-1, Chapter 5, Adaptive Management Framework, expanded discussion of threats and limiting factors in Chapter 4, and modeling changes in Appendix E.	Revised FEIS-Executive Summary, Chapters 2-5, Appendices E, F, J
USFWS (1)	Climate Projections Multiple references cited in the DEIS, e.g., ISAB 2007 are outdated. More recent regional climate trends and projections summaries published in the National Climate Assessment (Mote et al. 2014) are available. We recommend that the material summarizing climate trends and projections for the Region (Chapter 4, Climate Change Section, Page 65-66 etc.) be updated and reanalyzed for the FEIS. This document also summarizes Northwest region water-related changes and coastal vulnerabilities. Because there is substantial climate variation within the Northwest region (e.g., coastal areas experience less warming than interior areas) we also recommend using more specific projections by comparing two 2014-released, robust, and easily accessible statistically downscaled data sets summarized below: (1) The Multivariate Adaptive Constructed Analogs (MACA) is a statistical downscaling	The references provided (Mote et al. 2014, Multivariate Adaptive Constructed Analogs [MACA], USGS National Climate Change Viewer, and NOAA's 2014 Supplemental Biological Opinion) were reviewed for consistency with information and effects disclosed in the DEIS. Where applicable, additional references and relevant information, including comparable projection, were included in the FEIS. No modifications to the quantitative analyses and modeling approaches (AdH and ATIIM) were made to Chapter 4.5.4 of the DEIS, "Modeling Climate Change-Related Effects to East Sand Island" because: 1) East Sand Island, at RM 5 of the Columbia River Estuary, is predominantly tidally influenced, and the adaptive hydraulics modeling (AdH) and area-time inundation index model (ATIIM) are the most applicable data sources and modeling approaches to use. As stated in the DEIS, "Of the total variance in water level	Section 4.5 - Mote et al. (2014) and NOAA (2014) information and reference added to FEIS

ID	Agency Comment	Response	Change in Document
	method, which utilizes a training meteorological observation dataset to remove biases and match spatial patterns in the climate model outputs. MACA was used to downscale daily model outputs for 20 GCMs from CMIP5 for the historical period (1950-2005) and the future (2006-2100) for Representative Concentration Pathways (RCPs) 4.5 and 8.5 scenarios from the native resolution of the GCMs to 4 km and about 6 km (i.e. there are currently 2 MACA products available for CMIP5). Main Website: http://maca.northwestknowledge.net/ (2) The USGS National Climate Change Viewer allows the visualization of model output at monthly timesteps of 30 GCMs from CMIP5 for the historical period (1950-2005) and projected changes in climate from the Representative Concentration Pathways (RCPs) 4.5 and 8.5 scenarios. The dataset used for these visualizations is the NASA NEX-DCP30 dataset, which is a statistical downscaling of temperature and precipitation to an 800-meter grid that covers the continental United States using the Bias Correction Statistical Downscaling method. See the website for more information and access to the Viewer: http://www.usgs.gov/climate_landuse/clu_rd/nccv.asp.	in the lower 60 km of the Columbia River, weather contributes only 2 to 4 percent, and river flow 5 to 15 percent of the total variance in the water level regime, while tidal processes account for more than 60 percent (Jay et al. in revision).” This is even more pronounced at East Sand Island (i.e., at RM 5) compared to the entire 60 km of the Columbia River. Additionally, potential effects of sea level rise on inundation and land cover change at East Sand Island were estimated using the best available models based on data previously collected in the Columbia River Estuary (Borde et al. 2011; Coleman et al. 2014). 2) Modeling approaches conducted are consistent with USACE and CEQ policy directives concerning climate change. 3) The qualitative and quantitative analyses are sufficient for evaluating and disclosing potential climate change effects and related uncertainty. Additionally, as described in the DEIS, more specific engineering modeling would be conducted prior to actual construction of the Phase II terrain modification. Furthermore, as the Corps is the federal land manager of East Sand Island, monitoring will allow the Corps to adaptively respond and construction can occur on island to reinforce the structure at a future date, if necessary.	
USFWS (2)	Climate Change: Effects to Salmon and Other Species	The DEIS climate change section was written specifically for describing potential effects of climate change to DCCO predation	NOAA (2014) information and

ID	Agency Comment	Response	Change in Document
	NOAA produces a very thorough analysis of climate change impacts for Pacific Northwest salmonids and associated ecosystems, and we recommend that the Corps review these findings for analysis and incorporation into the FEIS. Excerpts from the main sections of the 2014 FCRPS Supplemental Biological Opinion that addresses climate and climate change and recent findings based on annual literature reviews is provided in the 2014 FCRPS Biological Opinion. These include a stronger evaluation than, and, in some cases, alternate, findings than the DEIS on such topics as the impacts of climate change on the freshwater environment (e.g., stream flow, stream temperature), ocean conditions (upwelling, ocean acidification, temperatures), marine ecosystems and fisheries, and salmonids (both freshwater and marine impacts to processes and life stages).	of juvenile salmonids in the Columbia River Estuary, not just the effects to salmon or the effects to the physical environment, which were the primary focus of the references provided. Findings provided in the DEIS were reviewed for consistency with the effects of the additional provided references, and NOAA (2014) information and citations were included where applicable. The Corps notes that the ISAB (2007) was the original scientific assessment for climate change effects adopted by NOAA in the 2008 FCRPS Biological Opinion. The Supplemental FCRPS Biological Opinion have augmented and re-evaluated information relative to this original assessment, but most all of the general climate change effects described in ISAB (2007) are still valid and consistent with the latest information pertaining to climate change. This is described throughout the 2014 Supplemental FCRPS Biological Opinion and specifically at pages 168, 169, 174, 179, 182 and 442, with general conclusions that new research and climate change predictions are consistent with ISAB (2007b) and expectations of the 2008 BiOp.	reference added to FEIS
USDA-Wildlife Services'	Reference letter (provided in full, following Table J-3) regarding comments about dispersal effects when comparing Alternative C and C-1.	See revised FEIS, specifically Chapter 2, description of alternatives, and Chapter 4, Effects.	Revised FEIS, Chapter 2 and 4.

AMERICAN BIRD CONSERVANCY

Shaping the future for birds

19 August 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Comments provided electronically to: cormorant-eis@usace.army.mil

Dear Ms. Ruckwardt,

Please find attached comments from American Bird Conservancy (ABC) to the US Army Corps of Engineers, Portland District regarding the Draft Environmental Impact Statement (hereafter DEIS) for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (CENWP-PM-E-14-08, Public Announcement Date 12 June 2014).

G-7, G-3, G-5 →

We have deep concerns about the DEIS and the preferred alternative that involves the killing of nearly 16,000 Double-crested Cormorants (DCCO) on East Sand Island (ESI). The determination that the breeding population on ESI must be reduced to approximately 5,600 breeding pairs is not based on any rigorous or peer-reviewed analysis. Salmon smolt consumption by cormorants has varied from levels that are considered acceptable by NOAA Fisheries (2 million smolts in 2005) to those considered highly unacceptable (20 million smolts in 2011), despite little change in size of the ESI DCCO colony. The lack of a direct correlation between smolt consumption and DCCO colony size means that the number of smolts saved from management to reduce colony size is difficult to predict based on colony size alone.

G-10, G-8 →

The DEIS concludes that the lethal approach (alternative C) to reducing the numbers of DCCO is the appropriate one without adequate justification and explanation of why the same result cannot be achieved through non-lethal methods (alternative B). The expected benefits to salmon hinge not in *how* cormorant numbers are controlled (through harassment or lethal control), but in the *habitat modification* that must occur to maintain the breeding DCCO population at the target of 5,600 breeding pairs.

G-25, G-10 →

Furthermore, the recommended alternative would reduce the entire western DCCO population by approximately 25%, constituting a depredation control order with not merely local ramifications, but an impact to the entire western DCCO population. It is not clear if depredation permits issued under the Migratory Bird Treaty Act (MBTA) can be legally used to reduce an entire regional population of a species protected under the MBTA. Add to this that the MBTA requires that permits for lethal control not be issued until it has been demonstrated that non-lethal methods have been demonstrated to be ineffective. Even then lethal control cannot be the sole method of control and must be used in concert with no-lethal methods. We question the legality of issuing a depredation permit that apparently violates basic operating tenants of the MBTA.

G-9 → Finally, the DEIS' use of scientific literature, both published in scientific peer-reviewed journals and in government reports is uneven and often contradictory. Some information has been used while other information has been ignored or apparently misinterpreted.

General regulatory and other concerns

1. The DEIS estimates that benefits of Alternatives B and C to Endangered Species Act (ESA)-listed salmonid Distinct Population Segments (DPSs) and Evolutionarily Significant Unit (ESUs) in the Columbia River would be the same, but does not adequately explain or justify selection of Alternative C as the preferred alternative.

   S-22 → Alternative C, lethal take to reduce the DCCO colony on ESI to 5,600 breeding pairs, is estimated to result in 25-26% reduction of the Western population of DCCOs (Chapter 4, p. 13). The DEIS analysis indicates that Alternative C, which is the preferred alternative, does not yield any greater benefit to salmonid DPSs or ESUs than Alternative B, dispersal (Tables 4-2 and 4-3, Chapter 4, p. 33). However, the DEIS analysis of predation rates, and consequent setting of targets for DCCO management and evaluation of projected benefits to individual DPSs and ESUs), is highly problematic; see point #2 below. If these problems were rectified, the values in Tables 4-2 and 4-3, and indeed the entire effects analysis and management alternatives in the EIS, might be quite different, although the responses to Alternatives B & C likely would remain the same.

   The only sustained benefit to listed salmonids in the Columbia River lies in Phase II of Alternatives B and C, that is, the habitat manipulation that would be key to maintaining the target colony size of 5,600 pairs by removing DCCO nesting habitat. Phase II is identical in Alternatives B and C. Therefore, the rationale for choosing Alternative C (lethal take) as the preferred alternative is not clear. No well-documented, compelling, and measurable differences between B and C (i.e., in the impacts of Phase I) are described.

   S-23 → Table 2-8 indicates that the estimated cost of implementing Alternative B would be significantly greater than that of implementing Alternative C. The rationale is that under Alternative B, significantly more resources would be required to monitor a potentially vast area for new colony formation wherever fish of conservation concern are found in Washington and Oregon (Table 2-8, Chapter 2, p. 39; Chapter 4, p. 59). This unsupported assumption (see point #6 below) inflates the risk and the total estimated cost associated with Alternative B and lends support to selection of Alternative C as the preferred alternative. Other potential benefits of Alternative C and risks of Alternative B are overstated or mischaracterized in the DEIS:

   - The risk of Alternative B (dispersal to reach the target colony size on ESI) resulting in birds settling on islands or human infrastructure in the upper Columbia River estuary (Chapter 4, p. 29). See point 6 below.

- The inherently higher certainty of reducing the number of DCCO nesting on ESI to the target of 5,600 pairs by lethally removing the numbers of birds described in Alternative C, rather than dispersing them, and doing so expeditiously (within two or three years, under the likely adaptive management regime) (Executive Summary, p. 21). See point #9 below.

Based on the available scientific information described in the previous section, we judge Alternative C as the far riskier option:

G-18

- To reach the target colony size of 5,600 breeding pairs of DCCO on ESI, the number of DCCOs that will have to be killed will likely exceed (by thousands of birds) the 15,955 estimated in the DEIS (see point # 9 below), necessitating additional years of resources invested in ongoing lethal take on the island and in the estuary (along with the disturbance to and incidental take of other migratory birds inherent in those activities).

G-24

- The risk is significant of killing many non-target Brandt's and Pelagic cormorants in the process of killing nearly 16,000 (or more) DCCOs (Executive Summary, p. 19; Chapter 4, pp. 27, 30-31). This is incidental take of federally protected species, and no mention is made in the DEIS of obtaining a special purpose permit under the MBTA to authorize this incidental take. Moreover, the poor justification for selecting Alternative C as the preferred alternative renders this incidental mortality of non-target migratory birds needless and wasteful.

S-24

- The risk is significant of all breeding DCCO abandoning ESI as a result of disturbance caused by gunfire, other methods used to capture and euthanize DCCO, and carcass collection. Colony abandonment could cause far more DCCO to emigrate to other cormorant colonies.

comment noted

- The public is unlikely to tolerate this magnitude of lethal take of a native migratory bird.

G-23

2. <u>Alternative C does not qualify for issuance of a depredation permit (50 CFR 21.41) under the MBTA.</u>

The depredation permit application form indicates that permits for lethal take should be sought "…*only after deterrents such as hazing and habitat modification prove unsuccessful*." Section 6 of the application itself requires documentation that non-lethal methods have not been successful:

"**6.** Nonlethal deterrents tried.

(a)Describe the hazing or harassment techniques (e.g., horns, pyrotechnics, propane cannons) you have tried to manage or eliminate the problem. How long (e.g., number of weeks, months, year(s)) and how often have you conducted these deterrents?

(b)Describe the habitat management measures (e.g., vegetative barriers, longer grass management, fencing and netting) you have taken to discourage migratory birds from using the area.

(c)Describe the cultural practices (e.g., crop selection and placement, management of pets and feeding schedules, no feeding policies) you have established to discourage migratory birds from using the area.

(d) Attach copies of any receipts, invoices, contracts, or other available records documenting the deterrent measures taken."

This documentation does not exist to support a permit application to implement Alternative C, and the DEIS does not provide an explanation or justification for circumventing this standard permit requirement.

G-9, G-10, G-11, G-23

As described below in point #4, the dissuasion feasibility studies conducted in 2010-2013 did not aim to effect a sustained reduction in the number of breeding pairs of DCCO on ESI. In fact, the stated aim of these studies was to ensure that the birds in the circumscribed colony area did not abandon ESI and attempt to nest elsewhere in those years. Therefore, these studies do not provide any results from which to conclude that dissuasion or other non-lethal methods would not be effective when implemented as a management action, at a different scale and with different goals.

Guidance provided with the USFWS depredation permit application includes the following: "*Capture or killing of birds cannot be the primary methods used to address depredation and will ONLY be authorized in conjunction with ongoing nonlethal measures*" (Form 3-200-13). How Alternative C meets this threshold is unclear; Alternative C is lethal removal to reduce the DCCO colony on ESI to 5,600 breeding pairs. The implementation of habitat modification in Phase II may not meet this threshold; if not, Alternative C contains no description of meaningful use of non-lethal methods that will be used "*in conjunction with*" killing birds to achieve the same end, as specified in the permit application guidance.

G-25

3. Alternative C constitutes population reduction and whether depredation permits can be used legally for population reduction is not clear.

The DEIS accurately describes the western population of DCCO as a distinct management population of this species (e.g., Glossary of Terms, p. xvii). This population is also geographically isolated from the rest of the species' range (Adkins and Roby 2010). The DEIS quantifies the percent reduction of the western population as 25%-26% under Alternative C, the preferred alternative (Chapter 4, p. 13). However, the DEIS does not adequately explain whether or how a depredation permit issued under the MBTA can be used for the purpose of population reduction in a migratory bird species that is otherwise federally protected. Population reduction of migratory birds is the province of depredation orders, which are federal regulations promulgated for individual species (see 50 CFR 21.42).

G-20

The "sustainable" 1990 baseline size for this population provided in the DEIS, and the judgment that reduction in the current population to a level modestly higher than that (but 25% lower than the current population) are both arbitrary determinations, as described above (see point #9 below), and do not account for the fact that this species was in the 1990s and likely still is recovering from impacts of DDT and more than a century of persecution.

S-42

4. <u>The participation of USDA-Wildlife Services as a cooperating agency in the development of this DEIS may represent a conflict of interest and a violation of the Administrative Procedure Act.</u>

   DEIS Chapter 1, p. 20 identifies USDA-Wildlife Services as a cooperating agency, and p. 20 states that "[…]the Corps would request technical assistance from USDA-WS to implement the preferred alternative…". USDA-WS conducts thousands of activities under contracts to federal, state, and municipal agencies, and to private parties that employ lethal methods to remove migratory birds and other wildlife. Given the estimated cost for implementation of Phase I of Alternative C ($760,000-$1,020,000 per year; Table 2-8, Chapter 2, p. 39), USDA-WS stands to acquire a lucrative, 2- to 4-year contract to implement the preferred alternative, Alternative C. In its role as a cooperating agency, USDA-WS certainly contributed technical expertise to the design and cost estimates of this alternative. The FEIS must provide full disclosure of USDA-WS's role in developing action alternatives and their associated costs, its role in selecting the preferred alternative, and its planned role in implementation of the preferred alternative.

<u>Summary of Scientific Comments:</u>

G-5, G-7

1. The specific management objective (~ 5,600 breeding pairs on ESI) is quantified using analyses with unknown uncertainty, large extrapolations outside the available data, and methods that apparently have never received independent peer review. These analyses do not use the best available scientific information and are substantially less rigorous than analyses identifying other salmon recovery objectives in NOAA's 2014 Supplemental Biological Opinion for the Federal Columbia River Power System.

2. The DEIS unjustifiably downplays the potential to manage cormorant dispersal from ESI under Alternative B, citing perceived high cost and logistical complexity.

G-8

   - The analysis implies that dispersal locations are unpredictable. In actuality, experiments exploring possible dispersal locations and behavioral strategies have indicated that currently active and historical colony sites are the most likely locations dispersing cormorants would attempt to nest. These sites are well known and readily monitored.

G-11

   - The potential of social attraction techniques to attract dispersing cormorants to acceptable existing or former colony sites is ignored. Experiments conducted to explore this technique were misinterpreted and the potential for successful application unjustifiably downplayed.

G-8

   - The analysis implies that sites elsewhere in the estuary and lower Columbia River would be the primary dispersal locations explored by cormorants. This conclusion ignores substantial cormorant use of sites in coastal Washington and British Columbia, areas of reduced conflict with fisheries during dispersal experiments. Additionally, active colonies elsewhere in the estuary and lower river utilize artificial structures with either limited capacity to support additional cormorant nests (e.g., navigational aids or transmission line towers) or are located in areas readily hazed (e.g., bridges).

- G-22 The analysis exaggerates the risk that dispersing cormorants might compete with ESA-listed Streaked Horned Larks for nesting habitat. There is little overlap in habitat preferences between cormorants (vertically structured habitats that facilitate stick nest construction such as trees, shrubs, rip-rap, driftwood piles) and Streaked Horned Larks (bare or sparsely vegetated flat sandy areas) in the lower Columbia River and estuary.
- G-9, G-10 The analysis ignores the susceptibility of cormorants to human or other disturbance, particularly during potential colony formation. Human or other disturbance is the most often cited cause of cormorant colony failure in the scientific literature. Experiments at ESI during 2010-2012 successfully dissuaded cormorants from nesting in designated portions of the island, despite a long history of cormorant nesting in those areas.
- G-9 The analysis fails to acknowledge that the management of cormorant nesting habitat to reduce fisheries conflicts (e.g., hazing to limit cormorant nesting in areas of fisheries concerns) has been successfully used elsewhere (e.g., Denmark), as an alternative to culling.
- G-10 The analysis fails to acknowledge that the Oregon Department of Fish and Wildlife (among others) has successfully administered a large-scale multi-estuary non-lethal cormorant hazing program on a modest budget.

3. The DEIS substantially downplays the uncertainty and risks associated with Alternative C (large-scale culling), the preferred alternative.

- G-20 Proposed annual take for the ESI cormorant colony is similar to those in cormorant culling programs east of the Continental Divide in terms of the number of individuals culled. However, the effect of the proposed take level on the cormorant population west of the Continental Divide (a distinct management unit) is substantially greater. At least 1/4th of the western population is proposed to be culled at a single site, a very different scale of action than any culling program within the eastern population.
- The DEIS proposes that an estimate of population size circa 1990 is sustainable (*sensu* the minimum viable population). Little justification for this choice is provided and the choice appears to ignore recent status and trends of major colonies in the western population. Notably, the three most significant nesting areas in the western population since the 1990 census all have uncertain, but likely negative, trajectories: ESI (the culling program outlined in the DEIS), Upper Klamath Basin (drought, water allocation issues), and the Salton Sea (reduced water allocation, drought).
- S-25 The size of the ESI colony assumed for the beginning of the culling program is an average colony size during 2004-2013, rather than the most recent (2013) estimate. The 2013 estimate is the largest ever recorded and suggests growth from 2004-2012 levels. A larger initial colony size will require a larger cull to reach the management objective.
- G-18 The potential for immigration to ESI is not adequately considered. Colony size trends over the last 15 years suggest substantial immigration has occurred, and could occur again. Any substantial immigration during the culling program would require a larger cull to reach the management objective.

G-11, App. G FEIS

- Experiences with major cormorant culling operations in the Upper Midwest indicate that the level of cormorant culling necessary to reach target population sizes can be several times greater than the difference between current cormorant population size and target population size after management.
- The DEIS and subsequent outreach efforts imply that a non-lethal management technique – habitat restriction to induce breeding dispersal away from ESI - has already been attempted and has not been successful. This misrepresents the scope of experiments conducted during 2011-2013 to test such a technique. Those experiments restricted habitat very successfully and induced temporary dispersal from ESI. However, sufficient nesting habitat was retained – by design – to allow all cormorants to continue nesting at ESI if they chose to, which they did. It is incorrect and misleading to imply that non-lethal management techniques have been attempted and have failed in advance of the lethal preferred alternative.

Specific Scientific Comments:

G-3

1. In the Executive Summary, Page 1, the DEIS states that "over the past 15 years, double-crested cormorants on East Sand Island consumed approximately 11 million juvenile salmon and steelhead per year." This statement fails to point out that the annual consumption of juvenile salmonids has varied widely from as few as 2 million juvenile salmonids to as many as 20 million (Lyons et al. 2014a). Thus, smolt consumption by cormorants has varied from levels that are considered acceptable by NOAA Fisheries (2 million smolts in 2005) to those considered highly unacceptable (20 million smolts in 2011), despite little change in size of the DCCO colony (12,287 breeding pairs in 2005 compared to 13,045 breeding pairs in 2011; Lyons et al. 2014b). Thus the lack of a direct correlation between smolt consumption and DCCO colony size means that the outcome with regard to the number of smolts saved from management to reduce colony size is difficult to predict based on colony size alone. Later in the Executive Summary (Page 4), the large inter-annual variability in cormorant predation rates on juvenile salmonids is acknowledged, but is dismissed as a factor in the evaluation of action alternatives and selection of the preferred alternative in the DEIS with the statement, "these factors will be considered when predicting and interpreting the success of management actions on East Sand Island within a given year and over the long-term."

2. In the Executive Summary, Page 3, the DEIS refers to the "survival gap analysis" performed by NOAA Fisheries. This analysis was used by NOAA in their 2014 Supplement to the Federal Columbia River Power System Biological Opinion (FCRPS BiOp) and concluded that reducing the DCCO colony on ESI to 5,380 to 5,939 breeding pairs (see Appendix D of DEIS) would result in acceptable smolt predation levels, levels that would allow salmonid recovery plans to continue unabated. NOAA Fisheries' analysis concluded that survival of juvenile steelhead was approximately 3.6 percent higher in the "base period" (1983-2002) compared to the "current period" (2003-2009), due to higher consumption of smolts by DCCOs nesting on ESI during the "current period" (see Appendix D of the DEIS). The "survival gap" was much smaller for yearling Chinook salmon (1.1 percent) and presumably sockeye salmon (a specific survival gap for sockeye was not reported but predation rates on sockeye were lower than those for

G-5 yearling Chinook and steelhead). To our knowledge, NOAA's "survival gap analysis" was not independently peer-reviewed and did not utilize the scientific information and analyses to measure the potential benefits to recovery rates of ESA-listed salmonids from the Columbia River basin due to reduction of the numbers of breeding cormorants in the estuary (referred to herein as the "benefits analysis;" Lyons et al. 2014a). NOAA's analysis relied instead on smolt abundance estimates that have limited (unknown) accuracy and precision, combined with estimates of smolt consumption based on
G-7 bioenergetics modeling (Lyons 2010). NOAA's analysis did not use: (1) NOAA Fisheries' collected data on smolt PIT tag recoveries on the DCCO colony at ESI (used to measure stock-specific predation impacts), an alternative dataset that avoids several problematic issues presented in the "survival gap analysis"; (2) NOAA Fisheries' conservation units for salmonids commonly used in its biological opinions and recovery plans (i.e., Evolutionarily Significant Unit [ESU] or Distinct Population Segment [DPS]); (3) NOAA Fisheries' age-structured deterministic matrix population modeling procedure (or other more complex life cycle models) to compare the change in λ) in salmonid
G-4 population growth rates (from different management alternatives; and (4) the "benefits analysis" (Lyons et al. 2014a), a detailed examination of the benefits to ESA-listed salmonid ESUs/DPSs from different potential management objectives for the ESI DCCO colony. The uncertain and imprecise average per capita DCCO predation rates on juvenile steelhead and yearling Chinook are then used in NOAA's "survival gap
G-5 analysis," without reference to large inter-annual variability in these rates, to identify the "survival gap" for these salmonid species between the "base period" and the "current period," two arbitrary periods that correspond to the timing of NOAA Fisheries Biological Opinions on the Federal Columbia River Power System. Consequently, NOAA's projected improvement in survival (3.6%) of juvenile steelhead (the salmonid species subjected to the highest reported predation rate) by reducing the numbers of DCCOs nesting on ESI from about 29,800 individuals to about 11,200 individuals is speculative, and not based on the available peer-reviewed science.

In the sections of the DEIS entitled "Purpose and Need" and "Appendix D," as well as the referenced NOAA 2014 Supplemental FCRPS BiOp, the determination of the salmon survival objective is described and presented. Following are specific comments on the data and methodology used in this determination, which in turn drives the management objectives for DCCOs described in the DEIS.

- Annual predation rates by DCCOs on steelhead and yearling Chinook salmon were calculated using bioenergetics-based estimates of smolts consumed (i.e., number of smolts consumed by the DCCO colony on an annual basis) and NOAA-generated estimates of the number of smolts available to DCCOs in the estuary.
    - While estimates of the (1) total number of smolts consumed and (2) stock-specific smolt predation rates both include associated estimates of uncertainty (95% confidence intervals), with general methods having undergone formal (scientific journal) peer review (Roby et al. 2003, Evans et al. 2012), NOAA's estimates of smolts available in the estuary do not have associated estimates of uncertainty, nor have they undergone any formal peer review (published in internal agency memoranda or emails, not in technical reports or scientific journal articles). Estimates

    of smolt availability are generally based on data-poor and imprecise inputs, and are not validated by any empirical measurements in the Columbia River estuary. Consequently, the derived estimates of DCCO predation rates are imprecise and have unknown estimation uncertainty.

G-7

    - The NOAA "survival gap analysis" was conducted at the species level for steelhead, sockeye salmon, and at a particular age-class (yearling) for Chinook salmon. For each species/age-class, the analysis combines or pools impacts to smolts of several different populations (ESUs/DPSs), rearing-types (hatchery or naturally-spawned), and includes both fish that are listed under the U.S. Endangered Species Act (ESA) and those that are not. Alternative measures of predation rates are available (collaboratively generated by NOAA's Northwest Fisheries Science Center and USGS) that are at the level of specific ESUs/DPSs, the conservation units listed under the ESA and nominally the motivation for considering management of DCCOs. These measures have advantages, in comparison to the predation rate estimates in the NOAA "survival gap analysis," of specificity to the conservation units of interest as well as explicit estimation of uncertainty (e.g., 95% confidence intervals), greater precision, and consideration of possible variation in predation rate due to rearing and migration history. These predation rates are provided in the DEIS for DCCO management, but were not used to quantify the objective for DCCO management. The rest of the NOAA 2014 Supplemental FCRPS BiOp (as well as previous BiOps) uses ESU/DPS-specific data for analyses and quantification of management objectives.

G-3

- Empirical data for smolt consumption by DCCOs and estimates of smolt availability were used for the period 1998-2012. However, the NOAA "survival gap analysis" relies on extrapolations of these data for the period 1980-1997, in combination with sparse estimates of DCCO colony size during that period. Given the high inter-annual variability in DCCO predation on smolts during the 1998-2012 period (related to climate variability and other factors), it is difficult, if not impossible, to rigorously assess the appropriateness of the extrapolation to the period 1980-1997. This uncertain extrapolation has a large effect on the derived difference in DCCO predation between the "base period" (1980-2002) and the "current period" (2003-2009), which defines the management objective for DCCOs.

G-5

G-2, G-3, G-4

- The increase in estimated DCCO predation from the base period (1980-2002) to the current period (2003-2009) is identified as the predation "gap," and used to define the management objective – how much DCCO predation should be reduced (i.e., return to 1980-2002 predation levels). There is no supporting analysis to interpret the biological meaning of this level of reduction in DCCO predation. It is not clear what the exact ramifications are for salmonid populations experiencing the current predation rate, and what the population benefit (e.g., difference in salmonid population growth rate) would be if the stated management objective were achieved (return to predation rate during base period). The analysis is substantially less complete than for other possible recovery actions for ESA-listed salmonids considered in the 2014 Supplemental FCRPS BiOp.

In summary, while the need for management action to limit DCCO predation on ESA-listed salmonids is supported by abundant peer-reviewed scientific data, the quantification of a management objective is based on analyses with unknown uncertainty, large extrapolations outside the available data, and methods that apparently have never received independent peer review. Furthermore, the development of a quantified management objective appears to be derived using a less rigorous process than other salmon recovery actions in the 2014 Supplemental FCRPS BiOp. Finally, the time period when DCCO consumption of Columbia Basin salmonids is deemed acceptable was defined by the policy framework of the 2014 Supplemental FCRPS BiOp, not by any attributes of the cormorant population, ESA- listed salmonid populations, or cormorant predation on ESA-listed salmonids.

G-11

3. In the Executive Summary-Page 5-6, the DEIS states that "social attraction techniques (setting up decoys and broadcasting audio playback of bird calls to encourage nesting) were tested within and outside the Columbia River Estuary for several years as a possible method to redistribute the East Sand Island double-crested cormorant colony." The DEIS then goes on to state that "during 2004–2008, social attraction was employed on Miller Sands Spit and Rice Island with some success, primarily on Miller Sands Spit." In actuality, social attraction techniques were highly successful in restoring a historical DCCO colony on Rice Island during the first year when social attraction was tried there (Suzuki 2012). Social attraction on Miller Sands Spit was successful in attracting a colony of nesting DCCOs during the third year; there had never before been a successful DCCO colony on Miller Sands Spit (Suzuki 2012).

The DEIS continued on this topic by stating "during 2007–2012, social attraction techniques were used outside of the Columbia River Estuary at four known roosting sites in Oregon, but there were no nesting attempts made by double-crested cormorants." It is true that for the sites where social attraction was tried outside the Columbia River estuary these efforts were unsuccessful in establishing new DCCO colonies. It is important to point out, however, that none of these social attraction sites had any previous history of DCCO nesting or roosting, and there was no concurrent effort to discourage nesting at nearby DCCO colonies to provide an incentive for DCCOs to shift to the site where social attraction was being tested.

In Section 1.1.6 (Page 11) the DEIS states "during 2004–2008, social attraction was also employed on Miller Sands Spit and Rice Islands with limited success as a means to easily redistribute a large portion of the East Sand Island colony. Since 2009, there have been no documented DCCO nesting attempts at Miller Sands Spit or Rice Islands." This description is misleading by implying that habitat enhancement and social attraction techniques have no potential as management techniques for redistributing DCCOs. The social attraction study on Rice Island successfully attracted DCCOs to nest in 2006, the first year that habitat enhancement and social attraction techniques were used at the site. DCCOs nesting at the restored site fledged young during the first year. The prompt restoration of the colony and good nesting success during the first year were considered highly successful. The habitat enhancement and social attraction were removed from Rice Island before the 2007 breeding season to test the cormorants' response to the site when habitat enhancement and social attraction tools were not present. DCCOs did not return to Rice Island to nest in 2007 or thereafter, which suggests that habitat enhancement and social attraction were critically important for maintaining the colony. The research objective was to test whether habitat enhancement and social attraction could restore a breeding colony of DCCOs on Rice Island only as a means to evaluate the efficacy of the technique. It was not intended to establish a long-term DCCO colony on Rice Island.

The social attraction study on Miller Sands Spit was conducted during 2004- 2007, and DCCOs successfully fledged young from this new colony in both 2006 and 2007. Because DCCOs previously had only attempted to nest there, but with no success, the two breeding seasons when DCCOs successfully fledged young at Miller Sands Spit were considered highly successful. In 2008, habitat enhancement and decoys were deployed again, but audio playback of DCCO calls was not included as part of the social attraction. The DCCO colony on Miller Sands Spit was abandoned in June 2008, possibly due to the lack of audio playback systems at the site. Habitat enhancement and social attraction techniques were not redeployed after 2008, and no subsequent nesting by DCCOs was recorded there.

In evaluating the success of habitat enhancement and social attraction as non-lethal techniques for reducing the size of the DCCO colony on ESI, it is important to keep in mind that the feasibility studies on Rice Island and Miller Sands Spit were conducted when there was a large DCCO colony less than 25 km away on ESI, where there was ample unoccupied cormorant nesting habitat. Because there was no effort to discourage DCCOs from nesting on ESI concurrent with the attempts to attract DCCOs to nest at these other islands within the Columbia River estuary, one would expect these attraction techniques to be even more effective if paired with efforts to discourage nesting at ESI. Significantly, the unsuccessful attempts to establish DCCO colonies using habitat enhancement and social attraction were all at sites where there was no history of prior nesting by DCCOs, and where no DCCO colonies in the area were being dissuaded to induce DCCOs to seek alternative colony sites.

In summary, results of research on habitat enhancement and social attraction techniques for relocating nesting DCCOs to alternative colony sites were encouraging (Suzuki 2012). However, this research did not by itself fully investigate the potential of using these techniques to relocate DCCOs currently nesting on ESI to alternative colony sites outside the basin as a way to decrease their impacts on ESA-listed salmonids from the Columbia Basin. Testing of habitat enhancement and social attraction techniques at historical (and currently suitable) nesting sites outside the basin, while simultaneously preventing all or a portion of the DCCOs from nesting at the ESI colony, is the next logical step in developing this methodology. In the absence of such feasibility studies, this management option should not be dismissed in the DEIS as unworthy of further consideration.

G-9, G-10

4. In the Executive Summary-Page 6, the DEIS states that "despite annual reductions in the amount of available nesting habitat, double-crested cormorants nested successfully on East Sand Island every year." Elsewhere in the DEIS, the Corps claims that it has tried using non-lethal management approaches, but when it reduced habitat for nesting cormorants on ESI by 70% in 2013, the colony size increased by 15%. These misleading statements are used to both support the preferred alternative (lethal control; alternative

C), and discredit the non-lethal alternative (colony size reduction; alternative B). To the contrary, the DCCO nest dissuasion feasibility studies during 2011-2013 funded by the Corps were successful in achieving the primary goal of the studies: demonstrating the efficacy of limiting the area of nesting habitat and, therefore, the size of the cormorant colony (Roby et al. 2012, 2013, 2014), using non-lethal techniques.

The dissuasion feasibility studies consisted of using privacy fences, human hazing, and nest destruction on parts of the cormorant colony during 2011-2013, and were highly successful in preventing cormorants from nesting in specific locations on ESI, locations with a long history of DCCO nesting and productivity. While these efforts were somewhat labor intensive (requiring constant monitoring during daylight hours), they were effective over a relatively short time period (< 60 days) and were accomplished by just 3-4 technicians (Roby et al. 2012, Roby et al. 2013, Roby et al. 2014). Additionally, these studies required little to no cormorant egg take over the 3-year study period; only four DCCO eggs were observed and collected in the dissuasion study area during 2012 (Roby et al. 2013).

The DEIS, however, appears to mischaracterize these nest dissuasion feasibility studies, suggesting that large-scale and permanent emigration of DCCOs from the Columbia River estuary was a primary goal. These studies were not designed to reduce available nesting habitat for DCCOs to a level that would cause large-scale emigration from ESI and reduce colony size. It was hoped that some of the DCCOs attempting to nest in areas where nesting birds were dissuaded would prospect for alternative nest sites outside the Columbia River estuary. By satellite-tagging, radio- tagging, and banding some of these dissuaded DCCOs, some alternative colony sites were identified (Roby et al. 2014). It was determined that cormorants nested on an average of less than 3 acres of habitat during 2005-2012 (x 2.7 acres). ased on the average nest density (1.28 nests m2) and the area of nesting habitat made available to nesting cormorants in 2013 (4 acres), more than 20,000 breeding pairs of cormorants could have nested on ESI. The actual colony size in 2013 was about 16,500 breeding pairs (DCCOs and randt's cormorants combined). Thus the interpretation suggested by the DEIS, that habitat reduction as a non-lethal method to reduce cormorant colony size was tried, but failed, is inaccurate.

While dissuasion feasibility studies have demonstrated that privacy fences and human hazing can be an effective method for limiting the area of nesting habitat, and therefore colony size, these techniques have never been employed in an attempt to reduce the area of DCCO nesting habitat on ESI below the amount necessary to accommodate the entire DCCO colony. USGS data indicate that if the area of suitable cormorant nesting habitat was reduced to 2.5 acres or less, permanent emigration of some DCCOs from the ESI colony to other colonies would necessarily occur. In order to achieve the target colony size of ~5,600 breeding pairs, the amount of suitable cormorant nesting habitat would need to be reduced to 1 acre or less. Alternative C, incorporating lethal culling of adult S-15 DCCOs, relies on these habitat restriction techniques to reduce the number of DCCOs coming to the ESI colony and thus reduce the level of cull required. The DEIS should address the potential success of these techniques in a consistent manner throughout the entire document (e.g., for Alternatives B, C, and D).

App. G FEIS

The Final EIS should accurately characterize the goals and results of the dissuasion feasibility studies that were conducted during 2011-2013. In addition the Final EIS should make a clear distinction between the terms "available nesting habitat," "suitable nesting habitat," and "actual nesting habitat" (habitat used by cormorants) during these studies. As used in the DEIS, these terms seem interchangeable, whereas they have very different biological interpretations.

G-8, G-10

5. In the Executive Summary-Page 7, the DEIS states that "dispersal of double-crested cormorants [from the ESI colony] has the potential to cause greater impact to juvenile salmonids if they move to upriver locations in the Columbia River Estuary where juvenile salmonids compose a higher proportion of their diet." This risk of greater impacts to the survival of juvenile salmonids is based on Roby et al. 2002, and is a primary consideration in the impact analysis of the action alternatives, including the preferred alternative. But the DEIS portrayal of risk due to dispersal fails to mention other research that demonstrates the feasibility of dissuading DCCOs from nesting at sites where they could cause unacceptable mortality to fish of conservation concern (Roby et al. 2012, 2013, 2014). Multiple studies have demonstrated that nesting DCCOs are highly sensitive to human hazing and can be easily dissuaded from nesting at sites deemed undesirable by resource managers.

G-9

As part of a long-term cormorant management study in Denmark, Bregnballe and Eskildsen (2009) have documented the efficacy of various management approaches for limiting the formation of new colonies of Great Cormorants (closely related to the DCCO). The Danish approach to managing cormorant depredations on fish stocks of conservation concern has been recognized and adopted in other European nations. Based on the Danish experience, the skepticism expressed in the DEIS over the practicality of controlling where DCCOs are allowed to nest once dispersed from ESI seems unwarranted. Hazing cormorants that are prospecting at new colony sites is an effective and efficient means for controlling where DCCOs nest and, therefore, what they eat, including salmonids of conservation concern.

S-13

In Chapter 2, Page 9, the DEIS describes the "placement of flags, rope, and stakes in a grid pattern" as a means to reduce DCCO nesting habitat on ESI. This method is also proposed in the DEIS for implementation at other potential colony sites within the Columbia River estuary (Chapter 2, Page 13). While similar methods have been successfully implemented to deter Caspian terns from nesting at several sites in the Columbia River basin, this method has been tested on and found to be ineffective at deterring DCCOs from nesting (Roby et al. 2007).

S-14

In Chapter 2, Page 12, the DEIS describes hazing triggers developed by Roby et al. (2012) that the Corps intends to apply at multiple cormorant roosting and foraging sites throughout the Columbia River estuary. While these triggers were effective in preventing cormorants from nesting in a discrete location on ESI, they are entirely inappropriate for hazing DCCOs that are roosting and foraging throughout the estuary. Implementing the hazing program defined in the DEIS will require a nearly constant presence of large numbers of hazers in boats throughout the estuary during daylight hours. The DEIS fails to address the time commitment and cost of this magnitude of extensive hazing. A far more practical and demonstrated successful approach is to control where DCCOs are allowed to nest in the Columbia River estuary.

G-8 6. The DEIS claims that where DCCOs that are prevented from nesting on ESI would settle and nest cannot be predicted, and this unpredictability presents a considerable risk that DCCOs displaced from ESI might settle at sites where they would cause even greater impacts to fish species of conservation concern than if they remained at ESI. In Chapter 1, Page 14, the DEIS states that near-term dispersal of satellite-tagged DCCOs during dissuasion studies is indicative of where DCCOs could relocate upon management of the S-26 ESI colony. In Chapter 4, Page 92, however, the DEIS characterizes this dataset is "incomplete," not applicable for determining precise locations of potential relocation, and "therefore not essential to making a reasoned choice among alternatives." These two statements on Pages 14 and 92 appear contradictory. The passage on Page 92 minimizes the findings from Corps-funded research that used satellite telemetry and radio telemetry to investigate dispersal of DCCOs from the colony at ESI, both during the breeding season and afterwards (Courtot et al. 2012, Roby et al. 2013, Roby et al. 2014).

G-8 In Chapter 1, Pages 14-15, the DEIS does not discuss findings of a study by Courtot et al. (2012) that 75% (38/51) of satellite-tagged DCCOs that left the Columbia River estuary after the breeding season visited 19 current and historical DCCO colonies, demonstrating clear knowledge of and connectivity to alternative breeding sites throughout the range of the DCCO along the West Coast. The DEIS should also consider findings that 43% of satellite-tagged DCCOs visited locations within the Puget Sound/Salish Sea region, demonstrating a high level of connectivity to a region that the Washington Department of Fish and Wildlife describes as of "moderate management concern and could tolerate some increase in DCCO numbers if closely monitored" (DEIS, Chapter 3, Page 49). Subsequent satellite telemetry studies of DCCOs tagged on East Sand Island during 2012-2013 confirmed these findings, even during short-term dispersal from ESI during the breeding season (Roby et al. 2013, Roby et al. 2014). Satellite-tagged DCCOs visited several active and historical colonies both in and outside the Columbia River estuary, before returning to ESI to nest.

While the DEIS does discuss connectivity of DCCOs from ESI to the general regions where active and historical DCCO colonies exist, it does not consider published results in the scientific literature that indicate that DCCOs are far more likely to relocate to existing colonies or re-colonize historical colonies upon experiencing colony disturbance and reproductive failure. In its rejection of non-lethal alternatives, the DEIS speculates that relocation of displaced DCCOs would be unpredictable, that new colonies could spring up unexpectedly at almost any site near water, and that few data exist that would allow prediction of likely alternative nesting sites. Overall, the DEIS minimizes or ignores findings in the published literature that clearly demonstrate the connectivity of DCCOs nesting at ESI to other specific colonies (Clark et al. 2006, Courtot et al. 2012) and how this connectivity relates to potential immigration from ESI. These published findings suggest how DCCOs emigrating from ESI would disperse across the range of the western

S-27

North America population of DCCOs, if non-lethal management alternatives were implemented. The colonies with the greatest connectivity to ESI (aside from a few nearby colonies in the Columbia River estuary) are to the north, including colonies where DCCO numbers have been declining and increases in DCCO abundance may be acceptable to the Washington Department of Fish and Wildlife. The following published works should be consulted regarding inter-colony movements of DCCOs and colony site preferences: Carter et al. (1995), Clark et al. (2006), Wires and Cuthbert (2006), Duerr et al. (2007), Wire and Cuthbert (2010), Courtot et al. (2012).

G-8

In Chapter 3, "Affected Environment," Pages 1-2, the DEIS states, "during efforts to restrict DCCO nesting on ESI during the 2011–2013 breeding seasons, nearly all satellite-tagged DCCOs relocated to the Astoria-Megler Bridge or other nearby areas to East Sand Island immediately following hazing events, and there was little evidence of permanent emigration from the Columbia River Estuary (Roby et al. 2014)." This is the only statement supporting the claim in the DEIS that DCCOs deterred from nesting on ESI "would initially prospect for alternative nesting sites nearby." The DEIS does not mention that many detections of satellite-tagged DCCOs in the estuary represent typical movements among roost sites, and are not necessarily indicative of nesting at other colonies. The DEIS would benefit from a discussion regarding the commuting, roosting, and foraging behavior within the Columbia River estuary of DCCOs nesting at ESI. The Astoria-Megler Bridge, Rice Island, Miller Sands, and other locations mentioned in the DEIS fall within the known foraging range (25 km) of ESI; dispersal to these sites is expected given their proximity to ESI, and do not necessarily indicate that these DCCOs are attempting to nest at these nearby sites.

S-27

The following works should be consulted regarding the typical foraging range of DCCOs within the Columbia River estuary: Anderson et al. (2004), Lyons et al. (2007).

Chapter 3, Pages 2-3, the DEIS correctly identifies the Lower Columbia River Basin and the Washington Coast as regions used by DCCOs satellite-tagged on ESI during 2012-2013. There is only a brief summary (Chapter 3, Page 20), however, of the active colonies identified within these two regions.

S-28

The DEIS makes the assumption that DCCOs that disperse from ESI will primarily prospect for new colony sites in these regions, yet there is no reference to the existing or historical colonies in these regions, or the current status of these colonies.

S-29

Finally, some of the active DCCO colonies that are most proximate to ESI (i.e., Columbia Estuary channel markers, Grays Harbor channel markers) are on man-made structures (i.e., navigational aids and bridges). Consequently, these colonies are habitat-limited, and cannot grow appreciably in size. In the case of the colony closest to ESI, the Astoria-Megler Bridge, this colony is scheduled for hazing and dissuasion by the Oregon Department of Transportation, which is currently conducting periodic maintenance work on the Bridge.

S-30

The DEIS should also consider long-term and cost effective management solutions mentioned elsewhere in the document (e.g., netting, wire arrays, cones, etc.) to prevent or restrict DCCOs from nesting on other artificial structures in the Columbia River estuary. Netting in particular would be effective in preventing DCCOs from re-colonizing the Astoria-Megler Bridge following completion of maintenance work.

G-22

7. Streaked Horned Larks were recently listed as a threatened species under the ESA, and this species nests on several dredged material disposal sites in the upper Columbia River estuary. The need to avoid disturbance to and take of Streaked Horned Larks during management efforts to reduce the size of the DCCO colony on ESI is mentioned repeatedly in the DEIS as a reason for preferring Alternative C (primarily lethal approach). The DEIS reasons that if DCCOs are non-lethally dissuaded from nesting on ESI, that the dispersing cormorants would start to nest on other islands in the Columbia River estuary where Streaked Horned Larks nest. Therefore, dissuading DCCOs from nesting on these dredge spoil islands would necessitate disturbance to and take of Streaked Horned Larks. But Streaked Horned Lark habitat is very different from DCCO nesting habitat. Streaked Horned Larks use sparsely vegetated habitats (recently deposited dredge spoil), whereas DCCOs select vertically structured habitats that facilitate nest construction, including trees, rocky revetment, or artificial structures. We are not aware of observations of Streaked Horned Larks in the ESI cormorant colony, even when breeding cormorants are not present, and even though cormorants have converted densely vegetated habitats (continuously covered by European beach grass) to bare sand habitat (through guano deposition). While DCCOs occasionally nest in this scarified habitat on ESI, sparsely vegetated habitat was not selected by DCCOs for nesting when other, more structured habitat was available. Consequently, there is virtually no overlap between Streaked Horned Larks and DCCOs in preferred nesting habitat, and dissuading or hazing DCCOs prospecting for nest sites on upper estuary islands would not be expected to have an effect on Streaked Horned Larks.

8. In Chapter 4, Page 12, the DEIS states that, "proposed annual take levels [of DCCOs] on East Sand Island are comparable to take levels of other culling programs in Canada and the United States that effectively reduced DCCO abundance to acceptable levels for mitigating impacts to resources in particular areas." The population of DCCOs east of the Continental Divide (to which this statement refers) is at least an order of magnitude larger than the western North America population (Hatch 1995). The eastern and western populations of DCCOs are distinct and separate management units (Adkins et al. 2014), and there is little exchange of individuals between these populations (Mercer et al. 2013). G-20 The comparisons made in this paragraph are misleading, as the ESI colony makes up a much larger proportion of the western population (more than 40%) compared to the proportion of the eastern population made up by the specific colonies referred to in Chapter 4 of the DEIS. G-18, G-19 While the annual take levels proposed for the ESI DCCO colony are similar to those in other culling programs within the range of the eastern population, the effect of the proposed take levels on the overall western population is very different.

In Chapter 4, Page 14, the DEIS states that, "it appears that the western population of DCCOs is sustainable at approximately ca. 1990 numbers. A sustainable population is defined for this analysis as a population that is able to maintain numbers above a level that would not result in a major decline or cause a species to be threatened or endangered." G-20 The conclusion that the ca. 1990 estimate used throughout this DEIS (41,660 individuals) is a sustainable population size at which to manage the western population of DCCO is arbitrary, and was arrived at without examining (1) the current status and trends for DCCO colonies in western North America, (2) how current status and trends of DCCO colonies in western North America compare with status and trends in 1990, or (3) whether the western population is sustainable at this level with a colony of only about 5,600 breeding pairs left on ESI. ESI is currently home to more than 40% of all DCCO breeding pairs in the western population. The number of coastal DCCO colonies to the north of ESI (i.e., the Salish Sea region, Strait of Juan de Fuca, and the outer coast of Washington) has declined by approximately 50% since the early 1990s, and the numbers of DCCOs nesting at the remaining northern coastal sites have also declined, resulting in a 66% decline in numbers of breeding pairs of DCCOs within this sub-population (Adkins et al. 2014). Numbers of DCCO breeding pairs at inland sites in Oregon and northern California can experience large inter-annual variability; nesting at formerly large colonies (i.e., Malheur National Wildlife Refuge, Lower Klamath National Wildlife Refuge, Clear Lake National Wildlife Refuge) has been greatly reduced or eliminated in recent years due to severe drought and associated water allocation restrictions (Adkins and Roby 2010, Adkins et al. 2014). Current water levels in the Salton Sea in southern California are receding, causing Mullet Island to land-bridge; Mullet Island was the primary DCCO nesting site in the area and home to about 6,000 breeding pairs (13% of the western population) of DCCOs during 2009-2010. Water depth adjacent to Mullet Island is no longer sufficient to prevent access by mammalian predators (Adkins et al. 2014), and no DCCOs nested at Mullet Island in 2013 or 2014 (W.D. Shuford, pers. comm.). Given these declines and the tenuous status of a number of other DCCO colonies throughout the western population, it is unclear how sustainable the western population will be after culling at least 16,000 individuals and the reduction in size of the ESI colony to about 5,600 breeding pairs. The ESI colony has been the most productive DCCO colony in the western population for over a decade.

S-31

In Chapter 4, Page 14, the DEIS states that, "DCCOs that nest on East Sand Island typically spend half of the year away from East Sand Island; thus, the increase in abundance at the East Sand Island colony most likely cannot be solely sourced to that location alone and likely reflects beneficial environmental changes that have occurred throughout the geographic area occupied by DCCOs that nest on East Sand Island." It is not entirely evident what is being implied in this sentence, especially when no citations or references are used. If the statement is intended to mean that "beneficial environmental changes" have improved the over-winter survival of DCCOs that nest on ESI, there is no scientific evidence to support this hypothesis. Unlike the eastern population of DCCOs, which is highly migratory and a large portion of which spends most of the winter in areas of the Deep South with intensive fish aquaculture (Wires and Cuthbert 2006), most DCCOs in the western population spend the winter relatively close to their nesting areas (Courtot et al. 2012), and do not forage in aquaculture ponds during the over-winter period. Additionally, other colonies in the western population, especially colonies to the north where most DCCOs from ESI spend the non-breeding period, are much smaller, are not growing, and their overall nesting success is much lower than at the ESI colony (Adkins et al. 2014). These observations call into question the premise that "beneficial environmental changes" have increased overall population carrying capacity for the western population through enhanced over-winter survival. Instead, the increase in abundance of DCCOs at the ESI colony seems to be largely attributable to the favorable

S-32

nesting conditions at that site alone. The suggestion in the DEIS that "beneficial environmental changes that have occurred throughout the geographic area" are responsible for the growth of the ESI DCCO colony is in all likelihood erroneous. The rapid growth of the ESI DCCO colony in the 1990s and early 2000s was clearly related to the concurrent failure and abandonment of DCCO colonies elsewhere, which contributed to the growth in the ESI colony through immigration (Carter et al. 1995, Anderson et al. 2004). ESI possesses a unique combination of characteristics that has allowed the site to support more than 75,000 breeding and roosting seabirds annually, including the largest colony of DCCOs anywhere. Reproductive success at the ESI colony of DCCOs shows no signs of density-dependent limitation at the current colony size (14,900 breeding pairs; Roby et al. 2014). Arguably, no other site within the range of the western population of DCCOs has the combination of forage base and protection in numbers from Bald Eagle depredation that the large ESI colony currently possesses. It is unlikely that any other site or region within the range of the western population could support such a high proportion of the breeding population as the ESI colony currently supports.

G-18

In Appendix E-2, Page 9, the DEIS states that, "for the western population of DCCOs analysis, carrying capacity was modeled as the initial abundance of the western population (62,400 breeding individuals; Adkins et al. in press), as this was determined to be the most objective value. There is uncertainty when choosing a carrying capacity value. Carrying capacity cannot be empirically known…" The estimate of 62,400 breeding individuals as the carrying capacity of the western population of DCCOs is simply the most recent estimate (ca. 2009) of the size of the western population (Adkins et al. 2014). If the generally accepted definition in population biology of "carrying capacity" is used (capacity of the environment to sustain a population's requirements for resources), it is highly unlikely that the western population of DCCOs is currently at its biological carrying capacity. The western population is recovering from over a century of overharvest, persecution, and the detrimental effects of persistent organochlorine pesticides. There is a strong likelihood that the potential carrying capacity for the western population of DCCOs is considerably higher than the current population, especially considering recent increases in the size of the ESI colony.

G-18, S-25

9. In the DEIS, the size of the DCCO colony on ESI (number of breeding pairs) is given as an average of the colony size over the 10-year period 2004-2013 (Appendix E–2, Page 2). This average colony size (25,834 breeding individuals) is used as the starting point for management to reduce the size of the DCCO colony to the target size of 10,760 to 11,878 breeding individuals (5,380 to 5,939 breeding pairs; see Appendix D of DEIS). The most recent estimate of the size of the DCCO colony on ESI is 29,800 breeding individuals (14,900 breeding pairs; 95% c.i. = 14,550 – 15,290 breeding pairs) in 2013 (Roby et al. 2014). The 2013 point estimate is 2.4 standard deviations greater than the 2004 – 2012 average, suggesting that the larger colony size seen in 2013 represents something other than natural variation around a stable population size. Given that significant difference, the 2013 colony size is a more appropriate starting point for population modeling and evaluating the magnitude of the cull necessary to reach the management objective under the preferred alternative (lethal control; Alternative C). The 2013 colony size is about 4,000 individuals greater than the starting point used in the population model to predict

number of adult DCCOs that would need to be culled in order to reach the target colony size. Thus, the DEIS understates the number of DCCOs that would need to be culled (~16,000 individuals) to reach NOAA's management objective (~5,600 breeding pairs). A more accurate estimate of the number of DCCOs that would need to be culled to reach the target colony size would be 20,000 individuals. Given this ambiguity in the [S-25] appropriate starting (current) colony size for analysis, it would be appropriate to perform a sensitivity analysis to determine how dependent the number of individuals needed to be culled is on the starting colony size used. This would greatly aid the interpretation of how accurate the needed cull estimates actually are.

[S-33] In addition, the Potential Biological Removal analyses in Appendix E-2 do not sufficiently consider immigrants from other DCCO colonies to the ESI colony during the 4-year Phase 1 period of the management plan. During the 25-year period since the DCCO colony on ESI first appeared, there has been a history of recruitment of large numbers of adult DCCOs from other breeding colonies in western North America. (Note: [S-21] In Appendix E-2, Page 2 the initial abundance of DCCOs nesting on or near the ESI colony in 1989 was erroneously set at 3,694 individuals; this is actually the estimate of the entire DCCO breeding population throughout the coast of Oregon in 1988 [see Carter et al. 1995]. The actual number of DCCOs nesting on ESI in 1989 was less than 200 [S-33] individuals [Roby et al. 2014].) In 2013 alone, the DCCO colony at ESI increased by about 5,200 individuals (21%) compared to the previous year (Roby et al. 2014). The magnitude of this recruitment of breeding adults to the ESI colony strongly suggests that significant immigration to ESI from other colonies continues, at least in some years. In 2013, for example, the large DCCO colony in the Salton Sea, southern California (over 6,000 breeding pairs in 2012) was abandoned due to falling water levels (W.D. Shuford, pers. comm.), and at least some of those displaced adult DCCOs likely immigrated to ESI.

[S-34] The DCCO population model used in the DEIS (Appendix E-2) assumes that the colony at ESI is at carrying capacity, that culling of individuals near that carrying capacity would constitute nearly 100% additive mortality, and the colony size would decline in direct proportion to the number of DCCOs culled. But the large increase in the size of the DCCO colony in 2013 (21%) does not support the assumption that the colony is at carrying capacity. Therefore, a large proportion of the mortality due to culling could be compensatory, and recruitment could partially or completely offset losses due to culling. [G-18] If as large of a natural increase in ESI colony size as occurred from 2012 to 2013 were to occur during any of the four years of Phase 1 of the preferred management plan described in the DEIS, the number of DCCOs that would need to be culled to reach NOAA's management objective would necessarily increase by the thousands, perhaps requiring the culling of 20,000 – 30,000 adult DCCOs to reach the target colony size of 5,600 breeding pairs by 2018. As above with starting colony size, given the uncertainty in carrying [S-25] capacity and density dependence, it would be appropriate to perform a sensitivity analysis to determine how dependent the number of individuals needed to be culled is on the assumed carrying capacity. This would greatly aid the interpretation of how precise the estimates of the numbers of DCCOs that would need to be culled actually are.

G-18 Experiences with major cormorant culling operations in the Upper Midwest indicate that the level of cormorant culling necessary to reach target population sizes can be several times greater than the difference between current cormorant population size and target population size after management. In Michigan, for example, a population reduction by 20,000 individuals required the lethal take of over 50,000 DCCOs over eight seasons. In Minnesota, a reduction in the size of one breeding colony by 4,000 individuals required the lethal take of over 20,000 DCCOs over eight seasons. The numbers of DCCOs that would need to be culled at ESI to reach the target colony size could far exceed the projected number of 16,000 culled individuals.

G-19 While the DEIS (Appendix E-2) does discuss the annual cull rate as a fraction of the western North American population of the species, it does not acknowledge the cumulative impact of the cull proposed over the course of the management plan. In total, the cull would include from a quarter to a half of all the breeding age DCCOs in the western North America population of the species. What is described in the DEIS as a local management plan to reduce the numbers of DCCOs nesting at the ESI colony would have major implications for the western population as a whole, and would constitute population control of DCCOs on a large and extensive scale.

Conclusions

American Bird Conservancy believes that the analysis presented in the DEIS is inadequate to proceed to a Final EIS and project implementation. We are concerned that there is weak scientific justification for establishing a target of 5,600 breeding pairs of DCCO for ESI in that the connection between DCCO numbers and endangered salmon smolt survival is tenuous. The Corps has gravitated to a lethal control method without adequate justification and without evidence than non-lethal control methods could achieve the stated project objectives, especially when one considers that the success of both lethal and non-lethal control methods hinges entirely on post-control habitat modification to limit the size of the DCCO breeding colony. Finally, we do not believe a depredation permit authorizing lethal control can legitimately be issued given MBTA regulations and guidance policies without verifying that non-lethal methods will not work and without considering the impacts of such a massive DCCO cull on the well-being of the entire western DCCO population.

Thank you for the opportunity to comment on the proposed Project. Should you have any questions concerning our comments, I encourage you to contact me or George E. Wallace, Vice President for Oceans and Islands (gwallace@abcbirds.org).

Sincerely,

George H. Fenwick
President

Literature Cited:

Adkins, J.Y. and D.D. Roby. 2010. A status assessment of the double-crested cormorant (*Phalacrocorax auritus*) in western North America: 1998-2009. Final Report to the U.S. Army Corps of Engineers, Portland, Oregon. (Available through internet: www.birdresearchnw.org)

Adkins, J.Y., D.D. Roby, D.E. Lyons, K.N. Courtot, K. Collis, H.R. Carter, W.D. Shuford, and P.J. Capitolo. 2014. Recent population size, trends, and limiting factors for the double-crested cormorant in western North America. Journal of Wildlife Management DOI: 10.1002/jwmg.737.

Anderson, C.D., D.D. Roby, and K. Collis. 2004. Foraging patterns of male and female double-crested cormorants nesting in the Columbia River estuary. Canadian Journal of Zoology 82:541-554.

Bregnballe, T., and J. Eskildsen. 2009. Forvaltende indgreb i danske skarvkolonier i Danmark 1994-2008 – Omfang og effekter af oliering af æg, bortskræmning og beskydning. Danmarks Miljøundersøgelser, Aarhus Universitet. 46 s. – Arbejdsrapport fra DMU nr. 249. 46 pp. [Management intervention in great cormorant colonies in Denmark 1994-2008 - Extent and effects of oiling eggs, scaring, and shelling. National Environmental Research Institute, Aarhus University, 46 pp. - Research Notes from NERI No. 249]. (Available through internet: www.dmu.dk/fileadmin/Attachments/AR249.pdf.)

Carter, H.R., A.L. Sowls, M.S. Rodway, U.W. Wilson, R.W. Lowe, G.J. McChesney, F. Gress, and D.W. Anderson. 1995. Population size, trends, and conservation problems of the Double-crested Cormorant on the Pacific of North America. Colonial Waterbirds 18:189–215.

Clark, A.C., T.M. Kollasch, and D.A. Williamson. 2006. Movements of double-crested cormorants fledged on the Columbia River estuary. Northwestern Naturalist 87:150-152.

Courtot, K.N., D.D. Roby, J.Y. Adkins, D.E. Lyons, D.T. King, and R.S. Larsen. 2012. Colony connectivity of Pacific Coast double-crested cormorants based on post-breeding dispersal from the region's largest colony. Journal of Wildlife Management 76:1462–1471.

Duerr, A.E., T.M. Donovan, and D.E. Capen. 2007. Management-induced reproductive failure and breeding dispersal in double-crested cormorants on Lake Champlain. Journal of Wildlife Management 71:2565-2574.

Evans, A.F., N.J. Hostetter, K. Collis, D.D. Roby, D.E. Lyons, B.P. Sandford, R.D. Ledgerwood, and S. Sebring. 2012. A system-wide evaluation of avian predation on juvenile salmonids in the Columbia River Basin based on recoveries of passive integrated transponder tags. Transactions of the American Fisheries Society 141:975-989.

Hatch, J.J. 1995. Changing populations of double-crested cormorants. Colonial Waterbirds 18:8-24.

Lyons, D.E., D.D. Roby, and K. Collis. 2007. Foraging patterns of Caspian terns and double-crested cormorants in the Columbia River estuary. Northwest Science 81:91-103. Lyons, D.E. 2010. Bioenergetics-based predator-prey relationships between piscivorous birds and juvenile salmonids in the Columbia River estuary. Ph.D. dissertation in Wildlife Science, Oregon State University, Corvallis, OR. 310 pp. (Available through internet: www.birdresearchnw.org)

Lyons, D.E., D.D. Roby, A.F. Evans, N.J. Hostetter, and K. Collis. 2014a. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double- crested cormorants nesting at the East Sand Island colony in the Columbia River estuary. Final Report to the U.S. Army Corps of Engineers – Portland District, Portland, OR. 64 pp. (Available through internet: www.birdresearchnw.org)

Lyons, D.E., A.F. Evans, N.J. Hostetter, A. Piggot, L. Weitkamp, T.P. Good, D.D. Roby, K. Collis, P.J. Loschl, and B. Cramer. 2014b. Factors influencing predation on juvenile salmonids by double-crested cormorants in the Columbia River estuary: A retrospective analysis. Report prepared for the U.S. Army Corps of Engineers – Portland District, Portland, OR. 30 pp.

Mercer, D.M., S.M. Haig, and D.D. Roby. 2013. Phylogeography and population genetic structure of double-crested cormorants (*Phalacrocorax auritus*). Conservation Genetics 14:823-836.

Roby, D.D., K. Collis, D.E. Lyons, D.P. Craig, J.Y. Adkins, A.M. Myers, and R.M. Suryan. 2002. Effects of colony relocation on diet and productivity of Caspian terns. Journal of Wildlife Management 66:662-673

Roby, D.D., D.E. Lyons, D.P. Craig, K. Collis, and G.H. Visser. 2003. Quantifying the effect of predators on endangered species using a bioenergetics approach: Caspian terns and juvenile salmonids in the Columbia River estuary. Canadian Journal of Zoology 81:250-265.

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, E. Dykstra, J. Harm, W. Mashburn, J. Tennyson, N. Ventolini, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, R.D. Ledgerwood, and S. Sebring. 2012. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2011 Annual Report to the Bonneville Power Administration and the U.S. Army Corps of Engineers, Portland, OR. 171 pp. (Available through internet: www.birdresearchnw.org)

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, A. Patterson, S. Collar, N. Banet, K. Dickson, G. Gasper, L. Kreiensieck, K. Atkins, L. Drizd, J. Tennyson, A. Mohoric, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, J. Zamon, and D. Kuligowski. 2013. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2012 Annual Report to the Bonneville Power Administration and the U.S. Army Corps of Engineers, Portland, OR. 239 pp. (Available through internet: www.birdresearchnw.org)

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, A. Patterson, S. Collar, A. Piggott, H. Davis, J. Mannas, A. Laws, J. Mulligan, K. Young, P. Kostka, N. Banet, E. Schniedermeyer, A. Wilson, A. Mohoric, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, A. Turecek, J. Zamon, and D. Kuligowski. 2014. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2013 Annual Report to the U.S. Army Corps of Engineers and the Bonneville Power Administration, Portland, OR. 237 pp. (Available through internet: www.birdresearchnw.org)

Suzuki, Y. 2012. Piscivorous colonial waterbirds in the Columbia River estuary: Demography, dietary contaminants, and management. Ph.D. dissertation in Wildlife Science, Oregon State University, Corvallis, OR. 183 pp. (Available through internet: www.birdresearchnw.org)

Tyson, L.A., J.L. Belant, F.J. Cuthbert and D.V. Weseloh. 1999. Nesting populations of double-crested cormorants in the United States and Canada. Pages 17-26 in Symposium on Double-crested Cormorants: Population status and management issues in the Mid-west (M. E. Tobin, ed.). USDA/APHIS Tech. Bull. No. 1879. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Washington, D.C.

Wires, L.R., and F.J. Cuthbert. 2006. Historic populations of the Double-crested Cormorant (*Phalacrocorax auritus*): Implications for conservation and management in the 21st century. Waterbirds 29:9-37.

Wires, L.R. and F.J. Cuthbert. 2010. Characteristics of double-crested cormorant colonies in the U.S. Great Lakes island landscape. Journal of Great Lakes Research 36:232-241.

Animal Legal Defense Fund

July 22, 2014

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Re: Draft Environmental Impact Statement on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Dear Ms. Ruckwardt:

On behalf of the Animal Legal Defense Fund (ALDF), a nonprofit organization founded in 1979 with over 100,000 members and hundreds of supporting attorneys that are dedicated to protecting the lives and advancing the interests of animals through the legal system, with an office in Portland, Oregon, I write to comment on the Draft Environmental Impact Statement for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (DCCO Draft EIS). *See* 79 Fed. Reg. 35,346 (Jun. 20, 2014).

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G-15, G-28

The DCCO Draft EIS has currently identified a massive culling of double-crested cormorants as the preferred alternative. ALDF strongly disagrees with this alternative selection. More broadly, ALDF opposes the U.S. Army Corps of Engineers (the Corps) and U.S. Fish and Wildlife Service (FWS) (collectively, the Agencies) narrowing their focus to a single cormorant colony as the significant source of salmonid population decline. As detailed in the comment below, the Agencies have thus far failed to follow their best practice of exploring the ethical considerations of killing and harming individuals of one species in the uncertain hopes of protecting individuals of another. Resulting from this omission, the DCCO Draft EIS improperly jumps immediately to "lethal control" of cormorants without rigorously exploring other available alternatives, in contravention of the National Environmental Policy Act (NEPA).

[cont'd next page]

I. The Agencies Should Form an Ethical Stakeholder Group to Assist Understanding the Ethics of Double-Crested Cormorant Management

The FWS' environmental impact analysis of the experimental removal of barred owls is an illustrative example of how an agency can incorporate an ethical framework into its decision-making process. The inclusion of an ethicist at the preliminary stages of selecting a project alternative accomplished two goals.

First, the ethics working group helped "USFWS identify and clarify the moral values and issues that are woven into this case." William Lynn, *Barred Owls in the Pacific Northwest: An Ethics Brief* 7 (Jul. 16, 2012) (attached as Exhibit A). For example, Lynn writes, "Because of their sentience and / or sapience, many non-human creatures have a moral value that deserves consideration and inclusion in a *more than human* moral community," and also discusses the owls' intrinsic values. *Id.* at 36-39. In contrast, the DCCO Draft EIS fails to bring to bear this "discursive power" of ethics.[1] The Draft EIS quickly recounts two separate ideologies within the human dimension – "use" and "non-use" values of wildlife – and dismissively explains that proposed alternatives integrate some of the stakeholder values from each ideology. *See* DEIS at 4-95.

Second, the ethics working group intended to "provide conceptual tools for ethical guidance in the development of relevant environmental policies and wildlife management practices." Lynn, *Barred Owls in the Pacific Northwest*, at 7. The working group arrived at many moral findings, including that compassion and the avoidance of suffering are crucial values when managing barred owls, and removal experiments should be limited and humane, with a defined protocol conducted by professionals. *Id.* at 19-20. These types of findings help map out the various interests that humans have in the individual members of managed wildlife, and the interests that the animals have in their own lives. *See, e.g.*, Elizabeth Anderson, *Animal Rights and the Values of Nonhuman Life*, ANIMAL RIGHTS: CURRENT DEBATES AND NEW DIRECTIONS 283 (Sunstein & Nussbaum, Eds. 2005) (human and animal rights "exist not only to protect the interests that the rights bearer has in relating to humans, but the interests humans have in decent relations to the rights bearer. They do not flow immediately from a creature's capacities, but make sense only within a complex system of social relations and meanings"); *Animal Legal Def. Fund v. Glickman*, 154 F.3d 426, 433 (D.C. Cir. 1998) (the law "specifically recognizes that people have a cognizable interest in 'viewing animals free from . . . inhumane treatment.'"). The Agencies have not sufficiently explored and considered similar ethical findings in the instant DCCO Draft EIS. The concern for humane management of cormorants does not appear to be a priority, as the term "humane" appears only once within the entire document, and solely in the consideration of introducing predators to East Sand Island. *See* DEIS at 2-32.

As a result, "[w]ith the [ethics working group]'s insights in mind, the USFWS was also able to design a better experiment that met the tests of sound ethical and

[1] *See* Lynn, *Barred Owls in the Pacific Northwest*, at 13 ("Ethics is a form of power. . . . It binds together our ideas and actions about what we ought to do (or ought not do). It provides a powerful motivational force that explains and justifies how we treat others and the earth.").

scientific reasoning." *See* William Lynn, "Ethical Process Behind Barred Owl Removal," posted Aug. 5, 2013, *available at* http://www.williamlynn.net/ethical-process-behind-barred-owl-removal/ (last visited Jul. 15, 2014).

Similarly here, the Corps and FWS should develop an ethics working group to identify the moral considerations of killing sentient, sapient individuals of one species in attempts to protect those of another. The inclusion of an ethical values perspective will refine the alternatives analysis. For example, the DCCO Draft EIS shows that a reverence for cormorant life led to more accurate knowledge of cormorant biology and a reduced concern with cormorant impacts to the fishery – and thus, reduced interest in a massive cormorant cull.[2] *See* DEIS at 4-96.

II. The Agencies Should Not Use "Lethal Control" to Remove the Cormorants from East Sand Island

As other commenting groups have observed, ALDF believes that the cormorants on East Sand Island are unfairly targeted for their interaction with the salmon population.

G-2, G-3, G-4, G-16

Human activities are responsible for the most drastic impacts on the salmon at East Sand Island, and thus should be more rigorously considered in developing salmon population management alternatives.

Other causes of salmon decline include the many dams and habitat loss along rivers in the Pacific Northwest. *See* Peter Smith, Jul. 30, 2010 Interview with Paul Greenberg, author of *Four Fish*, available at http://magazine.good.is/articles/will-all-the-wild-fish-be-gone-by-2048 (last visited Jul. 15, 2014) ("Salmon is really the one that suffers the most from environmental degradation, but fish have never been a valuable enough commodity to consider them before we do something. Just look at the oil exploration in the Gulf of Mexico. It's the biggest pelagic spawning ground for bluefin and swordfish. Instead of food security, we went for energy security—just like we threw up dams in the Northwest to harvest hydropower.").

comments noted

Moreover, the United States' "illogical arrangements" of seafood trade creates a "destruction and outsourcing of the very ecological infrastructure that underpins the health of our coasts." Paul Greenberg, Opinion, *Why Are We Importing Our Own Fish*, N.Y. Times Jun. 30, 2014 (attached as Exhibit B) (discussing the fact that a majority of United States' "nova lox" comes from selectively bred farmed salmon in Chile, which "is curious, given that salmon are not native to the Southern Hemisphere"). Greenberg continues:

> The prevalence of imported farmed salmon on our bagels is doubly curious because the United States possesses all the wild salmon it could possibly need. Fives species of Pacific salmon return to Alaskan rivers

---

[2] "Reverence for life" was discovered to be a broadly shared idea among the diverse stakeholders in the barred owl ethics working group. *See* Lynn, *Barred Owls in the Pacific Northwest*, at 21.

> every year, generating several hundred pounds of fish flesh every year. Where does it all go?
>
> Again, abroad. Increasingly to Asia. Alaska, by far our biggest fish-producing state, exports around three-quarters of its salmon.
>
> To make things triply strange, a portion of that salmon, after heading across the Pacific, returns to us: Because foreign labor is so cheap, many Alaskan salmon are caught in American waters, frozen, defrosted in Asia, filleted and boned, refrozen and sent back to us.

Id. By focusing on cormorants engaging in their natural behavior of fish eating, the DCCO Draft EIS fails to see that inefficient "trade completely severs us from our coastal ecosystems." *See id*.

G-27

The above-described alternative causes of salmon decline must be adequately considered before the agencies decide to target cormorants for removal. *See, e.g., Dubois v. U.S. Dep't of Agric.*, 102 F.3d 1273, 1286-88 (1st Cir. 1996) (holding that the Forest Service did not "rigorously explore all reasonable alternatives" in conducting its EIS); *Or. Natural Desert Ass'n v. BLM*, 625 F.3d 1092, 1122 (9th Cir. 2010) (finding the BLM inadequately declined to consider wilderness characteristics in its land use plan and quoting Ninth Circuit precedent for the rule that "[t]he existence of a viable but unexamined alternative renders an environmental impact statement inadequate").

III. Conclusion

G-28

FWS properly created an ethical working group – led by a trained ethicist – as part of the environmental analysis of the barred owl experimental removal. The working group was consistent with NEPA's twin purposes of improving decision-making in environmental policy and facilitating broad public participation in environmental decisions. *See* 42 U.S.C. §§ 4321-27. In addition, there are many other, more significant sources of salmonid decline, which NEPA requires the Agencies to rigorously consider. ALDF respectfully requests that the Agencies reconsider the current preferred alternative of pursuing a "lethal control" approach to double-crested cormorant management on East Sand Island.

Sincerely,

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ALDF Cormorant Comment

Exhibit A

not reproduced
in FEIS

Sondra Ruckwardt
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**Response to Double-crested Cormorant Management Plan to
Reduce Predation of Juvenile Salmonids in the Columbia River Estuary**

I am writing on behalf of Born Free USA in response to the "Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary", hereafter referred to as "the Plan". We oppose the "Preferred Alternative".

comments noted

As the title suggests, the Plan is designed to enhance smolt survival by killing a large number of cormorants. The Plan discusses a multiplicity of anthropogenic factors influencing smolt survival, but then has simply scapegoated cormorants – one species in a complex ecosystem. The Plan assumes that if more smolt leave the Estuary, more adults will return to spawn thereby enhancing the salmon populations. Our position is that this approach – based on the assumption that each predator removed results in an increase in the species equal to the number of individuals not consumed – reflects a long outdated approach to ecology and wildlife management in which no positive role is assigned to the predator. But in fact, in a naturally-evolved predator-prey relationship, it is the number of prey that determine the number of predators.

S-11

Recent media coverage, reporting on the current presence of cormorants and other predators, suggests that the numbers of Sockeye and Chinook Salmon taken in 2013 broke all previous records. Yet, there appears to be no empirical evidence provided in the plan that demonstrates having the largest take of two Salmonid species is related to having a large cormorant population which the Plan alleges is having a deleterious effect?

G-3 FEIS App. C

While the Plan examines the various Salmonid populations in the Columbia River, showing some populations increasing and some in decline, it fails to identify what Salmonid populations cormorants feed on and whether the consumption enhances, reduces or has no significant effect on the overall carrying capacity of the River for the different Salmonid populations.

I argue that such a simplistic approach to a complex system will have ecological consequences not considered in the Plan and with no guarantee that the Plan's assumed outcome will indeed become a reality.

G-2, G-5 FEIS Section 1.2, 4.4. App. C

There are multiple human activities that affect Salmon, including fish farming, an increase in numbers of sea lice within the oceanic environment, acidification, dams and the results of various forms of land use. The singular and accumulative effects of these impacts are not well understood. Nor is there any real consideration of the need to modify such activities to mitigate negative impacts on Salmonids and other species. Instead, simplistically, blame is attributed to the cormorants. Given the enormity of the anthropogenic changes to the river ecosystem, the simplistic notion that more salmon leaving the estuary means more salmon returning and the singular blame of one (or a few) predatory species reduces the credibility of the Plan and calls into question the management approach.

Wildlife managers tend, too often, to operate under the inherent assumption that when apex predators are reduced or removed from a region, prey species of concern will not be consumed and will survive and be part of and contribute to their respective populations. This assumption is not based on empirical evidence or peer reviewed science but is presented as a "logical assumption".

Dating back over a century, study after study has demonstrated that Double-crested Cormorants are rarely responsible for declines in fish species, exclusive of highly contrived situations, such as a diurnal hatchery release, or when the fish are confined by some construction. In most cases the species of fish that are of concern typically are "game" or "commercial" species, or "forage" fish they consume (see, for example: http://www.aou.org/committees/docs/ConservationAddn) since they are of the greatest interest to commercial fishers and anglers. Indeed, the Columbia River Estuary appears to be an example of an ecosystem that sustains a large cormorant population where at least two Salmonid species, the Sockeye and Chinook Salmon populations are currently on the increase.

G-16

Yet cormorants are, for a variety of reasons, irresistibly attractive as scapegoats, and "traditional" reasons for blaming them are often complex, as discussed by Linda Wires in her book, The Double-crested Cormorant: Plight of a Feathered Pariah (Yale University Press, 2014) and by Richard King, in his book, The Devil's Cormorant A Natural History (University of New Hampshire Press, 2013).

Wildlife managers single out the Double-crested Cormorant as the "villain" with no consideration of its role as an apex predator. No weight is given to the possibility that Cormorants can enhance or maintain fish species by removing ill or genetically compromised fish, predators and competitors, or even contribute to ecological health by transferring nutriment from aquatic to terrestrial environments as is true of "sea" birds generally. It seems likely that the species has had a role in making newly emerged islands more fertile, thus enhancing biodiversity.

comments noted

The nineteenth century lethal approach to wildlife management, however politically expedient, did not then and does not now effectively resolve the concern for the decline in some species, in this case a decline in specific Salmonid at the smolt stage. Such management approaches divert resources from efforts which, while perhaps more complex to explain, are more likely to actually work.

The decline in some Columbia River Salmonids has coincided with the decline in a variety of fish and other species of wildlife native to the region, including a variety of other seabird species. The species involved are diverse. But they do share a common food source, the herring (*Clupea*) and other small oceanic fish species such as Sand Lances (*Ammodytes*).

According to Iain McKechnie, a coastal archaeologist with the University of British Columbia, the archaeological record indicates that for the past 7,000 years herring population levels have been robust and steady, but now are in decline. Herring are consumed by seabird populations including wintering loons, Western Grebes and other species that may nest in salt or fresh water, leading to the theory that, depending on the species, their decline is at least to a variable degree the result of documented and unprecedented declines in herring populations, and those of other small fish species that occurred in the region in much greater numbers than now

But the system is far more complicated than that. For example, one of the Alcids that is increasingly rare, the Marbled Murrelet, is famous for being Old Growth forest dependent. Thus a decline in Old Growth forests is generally cited as a causative factor in the decline in Marbled Murrelet. This is not to suggest that the decline in Old Growth forest habitat is the only factor contributing to the decline in murrrelets, since it also apparently has a high dependence on viable herring stocks.

FEIS Section 4.4

What is overlooked, I fear, is the effect not only of the loss of Old Growth forest on Salmonids but also the loss of all forests in the vast, Columbia River drainage, including the Snake River. This river is 1,240 in lenth, fed by networks of other lakes, ponds, artesian wells, rivers and streams, which in turn are fed by variable amounts of precipitation and snow and glacial melt, themselves influenced by suites of other factors ranging from local to global in scope.

I mention these variables to emphasize the changing and dynamic nature of the environment and to demonstrate that no single factor can be attributed to the decline in Salmonids but that it involves s suite of interacting factors.

For example, when I visited the upper reaches of the Columbia River basin last year, I noted that the trees in the region have been influenced by heavy infestations of Mountain Pine Beetle which are considered "natural processes". Parks Canada writes, "Mountain pine beetle (*Dendroctonus ponderosae* Hopk., hereafter referred to as MPB) and fire are major natural disturbance agents for lodgepole pine ecosystems in western North America". This natural disturbance potentially impacts the ecosystems, including the Columbia River and may contribute to a suite of factors that impact the Salmonid populations.

Numerous other influences contribute to Salmonid survival during the sea-going stage, including a large variety of anthropogenic factors, many of relatively recent origin. Among these one of outstanding concern is fish farming. Areas of concern about salmon farming include the risk of escaped domestic fish interbreeding with wild Salmonids, the transference of disease associated with such contrived and intensive concentrations of fish, and the presence of artificially enhanced population sizes of sea lice (see http://www.farmedanddangerous.org/scientific-case/sea-lice-research/).

comments noted

There is a relatively new potential threats as we can see from the fates of other species. In nearby Puget Sound, north of the Columbia delta, the production of oyster larvae went from a peak of 7 billion in the 2006 – 07 season to less than a third as many by 2009, with similar catastrophic declines in shellfish up and down the coast. These coincide with indications of stunted growth in Alaskan king and tanner crabs. Evidence suggests the cause is likely increased acidification of the water. A senior scientist of the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory and the University of Washington, Richard A. Feely, has predicted that in about 36 years some fifty to 70 percent of the water will be corrosive (see http://www.pmel.noaa.gov/pubs/PDF/feel2899/feel2899.pdf).

Such acidification will destroy the ability of small marine organisms with calcium-based shells or other calcium-dependent physiological components to survive, which, in turn, can deplete the foundation of food chains that end up with Salmonids, as well as whales, seals, cormorants and other species that may or may not be scapegoated.

G-2, G-5,

The degree to which smolt survival is key to ultimate population goals is similarly unclear from the Plan. It is of particular concern as it is not only smolt survival that contributes to the fishery, but also other events in the marine environment. Positive fisheries management, which has resulted in the declines in fishery catch, seems to have led to increased populations of Salmonid populations overall.

The Plan's calculations on smolt survival in the lower Columbia lacks empirically derived estimates. The estimates in the Plan are based on unpublished, non-peer-reviewed and non-accessible data. Why would the authors of the Plan not access the arguably more reliable data set, provided by Passive Integrated Transponder tags (PIT tags)?

FEIS Section 1.2 G-2

The following questions must be asked: If the purpose of the Plan is to enhance smolt survival, which smolt species are targeted for enhancement? Where are the scientific papers that demonstrate a carrying capacity of the river and estuary that can support a greater number of smolts and adults should they return as the Plan assumes? Given that there are other Salmonid predators such as terns, sea lions etc, why focus on cormorants? Indeed, are all opportunistic piscivorous species common in the region to be targeted.

G-3, G-4 FEIS, App. C

There is a vast range in the amount of consumption of Salmonid smolts by cormorants in the Columbia River from year to year (see http://www.birdresearchnw.org/final%20esi%20dcco%20benefits%20analysis.pdf) and yet fish biomass per cormorant, times the number of cormorants, is presumably more consistent. Thus opportunistic consumption would be tied to availability. The fewer smolt consumed, the more of other fish species which may be displacing competitors or predators of smolts.

As in any opportunistic predator-prey interaction, it is important for wildlife managers to know-what species are consumed when smolt consumption is lower to make up the equivalent aquatic biomass consumed.

It appears, at the very least, to be possible that within a given population size of cormorants, consumption by the birds of predatory or competitive species within the overall Salmonid smolt habitat adjoining the Sand Island colony may be at least neutral, and possibly positive, in affecting Salmonid smolt survival. Certainly the range of species documented as being consumed by cormorants is vast, with numbers of individuals of given species determined by accessibility, thus availability.

The positive role of predators was very poorly, if at all, understood in the 19th century. We should do better in the 21st.

S-39

And yet I read that cormorant predation of smolt is comparable to the number of smolt lost to a dam. This contention totally ignores the difference between impacts of man-made devices such as dams on species verses natural ecological processes. Cormorant consumption of smolt is far more, and differently, selective, with said selectivity possibly benefiting smolt survival overall. Losses from dams are far more random than losses to predation by any species.

G-18

As well, the authors of the Plan admit that reduction of nesting cormorants may be counterbalanced by arrival of more Double-crested Cormorants, with no particularly significant decrease in the amount of consumption of whatever the cormorant is preying upon.

Cormorants prey on individual smolts, on individuals of species that would prey upon smolts, on individuals of species that would compete with smolts for resources, and on individuals of species whose presence or absence would have a neutral effect on smolt survival. That's inevitable.

G-3, G-20

I would further argue that what cormorants prey upon and in what number would also be a function of the number and availability of smolts relative to other species and that there remains an unanswered question as to what has been or is the limiting factor in cormorant numbers.–Removing cormorants from the nesting site would not reduce consumption of whatever is being consumed. If it is food availability that limits cormorant numbers, there should be some indication of it (and none is given) as demonstrated by such indicators as reduced cormorant recruitment, a decline in mean weight of adult birds, etc.

G-18, G-19, G-20

Thus reducing nest site carrying capacity, as proposed, literally by making nesting a fatal option for a percentage of the cormorant population, will not necessarily, or even likely, reduce cormorant predation of any species (smolt, smolt competitors, smolt predators, or neutral species) any time soon, or ever, given the likelihood of compensatory mortality and subsequent immigration from other locations, which will counterbalance the losses from management action.

Such a Draconian action as the massive destruction of so many individuals of a native species is completely unsupportable given that cormorants have never been demonstrated to be responsible for, nor even implicated in, the loss of a single fish species or significant population of a single fish species anywhere.

G-2

Many government regimes talk about "sustainable" consumption of renewable resources, and then proceed to do no such thing. The current take of Columbia River Salmonid species by commercial or recreational fishers cannot be called "sustainable" so long as it is deemed necessary to augment the population with the addition of hatchery-raised smolts . The "average" number of Chinook Salmon sub-yearlings released into the environment may annually be around 75,000,000 (half way between the low of 50,000,000 and the high of 100,000,000 given).

What is more to the point, though, is the admission that even though some Salmonid species numbers are on the rise, there has been a steady decline in Salmonids overall "since the late 19th century", due to various anthropogenic factors that are, as we indicate above, increasing, both in number and in kind. Thus what Salmonids are experiencing is not different, in kind, than the losses of herring and other species in the Pacific region, as indicated above. The loss of major Salmonid stocks from the Okanagan River system, for example, had nothing whatsoever to do with cormorants (or Caspian Terns, sealions or other Pinnipeds, Orcas, mergansers or other natural predators).

Historically there were some ten to sixteen million Salmonids breeding in the Columbia River system. With fewer than two million anadromous Salmonids (not all Salmonids are anadromous) returning to spawn currently, there are millions not accounted for.

When Salmonids fail to recover after the killing of thousands of cormorants what other natural predator will be targeted as a causative factor impacting the Columbia River Salmonds? We can only speculate, and the Plan does not even do that. It is not as if fish declines only occur where there are cormorants. Freshwater Atlantic Salmon, once found in Lake Ontario, were completely exterminated when cormorants were absent from the environment. There is certainly no dearth of candidate causations for Salmonid decline, and fish stock decline of species that are not eaten by cormorants are certainly widespread and widely documented.

G-8, G-10, G-11

In Toronto, near where I am based, we have the largest Double-crested Cormorant colony in eastern North America, and it is managed, but without any lethal culling. While the Plan states non-lethal procedures to reduce cormorant smolt predation have been tried and failed, the Plan does not acknowledge that the killing of cormorants in other jurisdictions has also been tried and failed. The Plan is lacking in any scientific studies showing that cormorants negatively impact the fish biomass.

Because I do not think a case for reducing cormorants has been made in the first instance, I am reluctant to advocate for dispersal procedures, since I would prefer to focus on preventing known anthropogenic detriments to fish stock declines. That said, hazing techniques to prevent establishment of nesting (or, in other terms, to lower the capacity of the environment in question to accommodate nests) does work and has the added advantage of being relatively humane and possibly of not removing non-target species (such as Brandt's Cormorants). Hazing also has the benefit of being socially more acceptable, because it is more humane, than culling. Uet there is no indication in the Plan that a well-thought out hazing regime has been adequately tried.

G-14, G-18

I have long witnessed a scenario, now at play in the Plan, whereby a wildlife management agency assures itself that simply by removing “X” number of cormorants from a breeding colony (with “X” always being a significant percentage of the number present) a reduction to “Y” will occur, with “Y” always being a number that meets whatever the objective is, usually either to protect a given fish stock or age class within a given fish stock, and/or vegetation at risk, and/or other species dependent on that vegetation within the colony. It never works because the population is fluid and other birds will simply replace those removed, making culling a permanent management strategy.

G-21, G-22

Lastly, I would like to address the Plan’s concern over the perceived threat of the Double-crested Cormorant to the local, endangered subspecies of the Horned Lark. After a life devoted professionally and otherwise to an appreciation of wild birds and dedicated to their survival, with species always valued over individual, I’m naturally concerned about the survival of an endangered local race of the Horned Lark. I believe that endangered species legislation in both our countries is correct and valid to the degree that it addresses survival at the taxon level, thus giving the subspecies consideration equal to that of the species. The last thing I would want would be to champion a common species at the expense of an endangered species or subspecies.

But I think it is disingenuous in the extreme to suggest that the activities of Double-crested Cormorants, in any way have a negative impact on the *strigata* race of the Horned Lark. There is nothing about the habitat requirements of the lark, which all literature sources I have referenced suggest are similar to the several subspecies I am familiar with, including those that nest in my home province of Ontario. In fact, I respectfully suggest that it discredits the document overall to imply that the Horned Lark is at risk from the presence of the Sand Island cormorant colony, or would be compromised by hazing and other non-lethal, non-culling procedures.

I strongly urge rejection of the “Preferred Alternative” as the case that reducing the number of cormorants on Sand Island will result in enhanced Salmonid smolt survival has not been made. Do not scapegoat the cormorants for the excesses of our own species.

Sincerely,

Barry Kent MacKay
Senior Programme Associate
Born Free USA
Canadian Office
31 Colonel Butler Drive
Markham, ON L3B 6B6.

From: [redacted]
To: Cormorant EIS
Subject: [EXTERNAL] Double Crested Comorants
Date: Tuesday, August 12, 2014 4:57:01 PM

Sondra Ruckwardt
Project Manager
Attn.: CENWP-PM-E-14-08
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208

Dear Sondra,

Please don't sanction any policies that would allow the murder of the double crested cormorants. It is a misguided notion that attempts to reduce predation on juvenile salmon and steelhead trout. This would tear apart cormorant families and leave orphaned young to starve! And many wounded birds would not be recovered, only to succumb unseen to their injuries.

Opponents to lethal methods believe the population of double-crested cormorants could spiral downward, as they have in the past. Bostrom et al. (2009) reported that in Europe, during the early 20th century, the great cormorant, Phalacrocorax carbo sinensis, was close to extinction due to culling. There are other successful programs besides culling. Non-lethal harassment programs were successfully used to reduce the loss of emigrating Atlantic salmon smolts in the Narraguagus River estuary (Hawkes et al. 2013).

G-16 → Cormorants also provide a service to salmonids. As generalist feeders, they aid in controlling piscivorous fish populations. The adult pikeminnow, Ptychocheilus oregonensis, preys on salmon smolts, but is also preyed on by the double-crested cormorant. It is believed that if the double-crested cormorant were culled then threats to the salmon population would only increase. Wiese et al. (2008) suggest allowing cormorants to stay in the system, and deter them from the river when smolts are present would save approximately 2 million smolts per year over an 11 year period. Completely eliminating the double-crested cormorant would have devastating impacts on the region, and the northern pikeminnow would be a significant threat. *

Please"reject Alternatives C and D" (which allow the massacre), and urge them to focus instead on the biggest threats to salmon—dams, human development, and the fisheries industry.

Sincerely,

[redacted]
One More Person for the Ethical Treatment of Animals

*Nichols cs1 revised white paper.docx <http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0CD0QFjAE&url=http%3A%2F%2Fpeople.oregonstate.edu%2F~lyonsd%2Ffw488%2Ftemp%2FNichols%2520cs1%2520revised%2520white%2520paper.docx&ei=TKfqU6a7CoegyQTX0YLwAg&usg=AFQjCNGu40oGfIntCisL-ubIiP32A87sXQ&sig2=Vi-scfFbhJBg3YqVxxOHbw&bvm=bv.72938740,d.aWw>

From: [redacted]
To: Cormorant EIS
Subject: [EXTERNAL] Comment Re Draft EIS
Date: Tuesday, August 19, 2014 7:52:26 PM

G-2

I am submitting this comment for consideration by the Army Corps of Engineers re the draft EIS for the plan to reduce predation of juvenile salmonids in the Columbia River estuary by double-crested cormorants and for inclusion in the administrative record for this proposed action. By way of summary, I am most concerned that the draft EIS fails to consider non-lethal actions designed to reduce predation by double-crested cormorants (and other avian predators) by reducing variations in hour-to-hour and day-to-day discharge from federally owned and operated projects sited upstream on the main stem of the Columbia River, as well as the Willamette River. These fluctuations in discharge occur as a result of operation of upstream hydroelectric projects for purpose of load following, power peaking and integration of renewable resources. River operations for these purposes, when combined with changes in tidal volumes, create hour-to-hour and day-to-day modifications in designated critical habitat for listed species of salmon and steelhead that are ideal for avian predators. Without such fluctuations, avian predation would be significantly diminished. Modification of river operations to reduce the deleterious impacts of load following, power peaking and integration of renewable resources should be included among the range of actions considered in addition to the mix of other lethal and non-lethal measures described in the draft EIS. In addition, modification of such river operations--and failure to take steps to mitigate for the adverse impacts of such operations--should be a key part of the environmental analysis of all actions considered. While operations for purposes of load following, power peaking and integration of renewable resources are carried out by the Army Corps of Engineers (and the Bureau of Reclamation), they are the result of power marketing decisions made by Bonneville Power Administration. For this reason, Bonneville Power Administration should be participating in the preparation of the EIS as a "lead" agency, along with the Army Corps. At a minimum, Bonneville should be among the list of "cooperating" agencies and entities. Thank you for your consideration of my views.

BPA declined to be a cooperating agency

CITY OF ILWACO

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info@ilwaco-wa.gov
www.ilwaco-wa.gov

August 7, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Ms. Ruchwardt,

comments noted

The City of Ilwaco has a rich history in the fishing industry. Its economy is based around the fishing seasons. The current population of the cormorants is abundant and only growing larger. These birds are detrimental to the future of the fishing industry. Therefore, I am in support of Alternative C, the most aggressive solution put forth. Without an extreme approach, there would be no end in sight. The salmon runs are sacred and the livelihood of the City and its residents rely on it.

It is estimated that the colony on the East Sand Island has consumed over 11 million juvenile salmon annually over the last 15 years. This has caused the salmon population to become threatened. Not only wild stocks, but hatchery fish as well. There have been many attempts to control the cormorant community. They have been relocated numerous times. That is why Alternative C seems to be the best solution to this problem. Everything else has been tried before at least once. The birds return to the area with higher populations directly effecting the salmon runs. Millions of dollars have been spent over the years to try and recover the salmon population, only to be ruined by the cormorants.

Please select Alternative C as the best solution. The coastal communities have suffered enough.

Sincerely,

Mike Cassinelli
Mayor
Cc: Senator Patty Murray

Coalition of Coastal Fisheries

Coastal Office: PO Box 1448, Westport, WA 98595 – 360 268 0076, Fax 360 268 0000
Administrative Office: 5132 Donnelly Dr. SE, Olympia, WA 98501 – 360 456 1334, Fax 360 923 0762

…….Serving the needs of the coastal fishing industry and coastal fishing communities………

Sondra Ruckwardt
US Army Corps of Engineer District, Portland
PO Box 2946
Portland, OR 97208-2946

CENWP-PM-E/Double-crested Cormorant draft EIS

Cormorant-eis@usace.army.mil

Re: Full support of Corps preferred Alternative C to cull the number of Cormorants

USACE:

The Coalition of Coastal Fisheries is a strong advocate for the welfare of the commercial fishing fleet and represents 1000's of fishing families. Salmon MUST be returned to the people that depend upon salmon for both livlihoods and recreation for use, not continuing to allow Cormorants and Caspian Terns to eat billions of dollars of salmon restoration dollars and the salmon smolt that have traversed the gauntlet of the upper Columbia River on their journey to the ocean and this horrendous loss of salmon to simply feed and perpetuate Cormorants cut dramatically and unnecessarily into the coastal fishing economy to the point a hundred and fifty year old commercial gillnet fisheries is being phases out of business unnecessarily as the birds eat the people's share of the Columbia River Salmon. Return salmon to the people, don't continue to let them go to the birds.

CRCFA is wholeheartedly behind the Corps preferred alternative - Alternate C.

The Corps has to take responsibility for getting things back in balance and meet ESA requirements. By controlling the population of the cormorants it will be one of the most reasonable and prudent actions that the USACE can do to recover salmon and meet ESA requirements in the Salmon BiOp that reverses trends that jeopardize ESA list salmon species. For example between the cormorants and terns these birds eat more than 25 million smolts each year, that is almost 200,000 returning adult salmon that come back to the Columbia River that are being made into expensive bird food instead of perpetuation of the species and adding surplus salmon for public harvest instead of every user group fighting over the last fish available to catch! Culling Cormorants is far superior to extremely expensive and uncertain attempts at rehabilitating critical habitat. These salmon smolt that are eaten so close to the ocean's edge represent the strongest of the strong that have made the tortuous journey down stream and survived only to be consumed unnecessarily by overly protection of birds that are overpopulating on our ex pensive hatchery endeavors.

There is nothing we could do that would recover salmon faster than controlling avian predators. We think it is very unfair to the people of the Northwest that have spent billions of dollars in salmon recovery and Coastal Communities that have sacrificed millions and millions of dollars in fishing opportunity for the sake of the salmon recovery to let this travesty go on any longer!! So please pick, Alternate C and let's really get serious about saving salmon to be returned to the people that depend on them to support their fishing communities.

CCF members have frequently visited East Sand Island for decades and in the history of the Island nesting Cormorants have been few, certainly well below the number of nesting pair numbers of 5,380 to 5,939 on East Sand Island that the Corps is proposing to use as a baseline number for maintenance. History would
G-6 → suggest a maintenance number "well" below 5000 pairs and still easily maintain Cormorant populations. The 1996 WRDA authorization to control avian predators should be used to the maximum extent possible without threatening to jeopardize the Cormorant species to protect and preserve salmonoid species of the Columbia River for use and enjoyment of present and future generations.

G-26 → DCCO's should be removed from protection by the US Migratory Bird Treaty and the USACE should pursue actions to that affect considering the recent burst of proliferation and added very expensive rehabilitation efforts to meet the 2014 and prior salmon BiOps.

Thank you for doing the RIGHT thing and greatly reducing the excessive lower Columbia River Cormorant population not only for the sake of restoring salmon but so that people can once again can use and enjoy the salmon resource.

Sincerely appreciate this effort,

Dale Beasley,

Coastal Trollers Association

Created to enhance and protect an economically viable Washington salmon troll fishery.

15 Aug 2014.
Ms Ruckwardt,

The Coastal Trollers Association represents commercial hook and line fishermen of Washington working on the west coast. The policies adopted to address predation on juvenile salmonids are of great interest and economic consequence to our members and the larger fishing community.

Please accept our belated comments.

We urge adoption of the preferred alternative, C, as discussed in the draft EIS.

S-1 Further we suggest that the 'direct financial value' (page 14) overlooks and thus seriously underestimates this quantity by only analysing the in-river fisheries.
The Columbia River salmon stocks and their health are of direct and significant financial value to ocean fisheries from California to Alaska, as noted in the several Biological Opinions and other documents.

We look forward to the Corps timely progress in addressing this issue and appreciate the opportunity to comment.

Sincerely, Jeremy Brown,
president,
Coastal Trollers Association,
PO Box 2434,
Auburn, Wa 98071.

Columbia River Crab Fisherman's Association

P.O. Box 461 Ilwaco, WA 98624 – 360-642-3942

…Serving the needs of the coastal crab fishing industry and coastal fishing communities…

CRCFA Commissioners:

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CENWP-PM-E/Double-crested Cormorant draft EIS

Cormorant-eis@usace.army.mil

Re: Full support of Corps preferred Alternative C to cull the number of Cormorants

USACE:

The Columbia River Crab Fisherman's Association is a strong advocate for the welfare of the crab fleet and the other fisheries in which CRCFA members participate. Cormorants and Caspian Terns eat billions of dollars of salmon restoration dollars of the salmon smolt that have traversed the gauntlet of the upper Columbia River on their journey to the ocean and this horrendous loss of salmon to simply feed and perpetuate Cormorants cut dramatically and unnecessarily into the coastal fishing economy to the point a hundred and fifty year old commercial gillnet fisheries is being phases out of business unnecessarily as the birds eat the people's share of the Columbia River Salmon.

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There is nothing we could do that would recover salmon faster than controlling avian predators. We think it is very unfair to the people of the Northwest that have spent billions of dollars in salmon recovery and Coastal Communities that have lost millions and millions of dollars in fishing times for the sake of the salmon to let this travesty go on any longer!! So please pick, Alternate C and let's really get serious about saving salmon.

G-6 → CRCFA members have frequently visited East Sand Island for decades and in the history of the Island nesting Cormorants have been few, certainly well below the number of nesting pair numbers of 5,380 to 5,939 on East Sand Island that the Corps is proposing to use as a baseline number for maintenance. History would suggest a maintenance number "well" below 5000 pairs. The 1996 WRDA authorization to control avian predators should be used to the maximum extent possible without threatening to jeopardize the Cormorant species to protect and preserve salmonoid species of the Columbia River for use and enjoyment of present and future generations.

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Thank you for doing the RIGHT thing and greatly reducing the excessive lower Columbia River Cormorant population not only for the sake of restoring salmon but so that people can once again can use and enjoy the salmon resource.

Sincerely appreciate this effort,

Dale Beasley, CRCFA

August 13, 2014

By email and first-class mail

Ms. Sondra Ruckwardt, Project Manager
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208
Email: Sondra.K.Ruckwardt@usace.army.mil

Re: Comments of Confederated Tribes of the Colville Reservation on Draft Environmental Impact Statement on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Dear Ms. Ruckwardt,

comments noted

The Colville Confederated Tribes (CCT) submits the following comments on the Draft Environmental Impact Statement (DEIS) prepared by the U.S. Army Corps of Engineers regarding double-crested cormorant (DCCO) management in the Columbia River estuary. The Tribes support the preferred Alternative C: Culling with Integrated Non-Lethal Methods Including Limited Egg Take. The preferred alternative provides for significant, near-term reductions in the double-crested cormorant population on East Sand Island to improve juvenile salmonid survival while maintaining a viable population of double-crested cormorants on East Sand Island.

As CCT wrote in its December 2012 scoping comments for this EIS process, we are deeply concerned about the impact that cormorants, Caspian terns, and other avian species throughout the Columbia River basin are having on salmon and steelhead populations. These fish form a core part of Colville subsistence and ceremonies, and CCT has a federally protected right to harvest them. We appreciate the Corps' description, at DEIS pp. 3-52, 3-56 and 3-57, of CCT's federally protected fishing rights in the Columbia River and the Tribes' subsistence and ceremonial fisheries.

In addition, CCT has devoted substantial resources in the basin-wide effort of tribes, states and the federal government to protect and recover ESA-listed salmonids and enhance those populations that are not at risk of extinction. CCT, along with the Corps and other federal agency partners, has completed a major new hatchery at Chief Joseph Dam and many habitat restoration projects designed to improve habitat utilized by the Okanogan River population of the Upper Columbia River steelhead distinct population segment (DPS). The Chief Joseph Hatchery was completed and dedicated in June 2013, and at full capacity will produce approximately 2 million summer/fall Chinook and 900,000 spring Chinook for release directly from the hatchery and in the Okanogan River. With the recent approval of a non-essential experimental population, hatchery operations will include rearing up to 200,000 Methow Composite spring Chinook for release in the Okanogan River and establishment of a fourth population in this endangered ESU starting in the fall of 2014. All of the fish produced at Chief Joseph Hatchery, the farthest point on the Columbia from East Sand Island accessible to anadromous fish, will have to run the gauntlet in the estuary (as well as inland avian colonies) in order to reach the ocean and, ultimately, return to the upper Columbia both to restore their wild populations and to fulfill the subsistence and ceremonial needs of the Colville people.

CCT strongly supports the DEIS' purpose of reducing cormorant populations on East Sand Island to levels "at or below" the target established by Reasonable and Prudent Alternative 46 in the 2014 Federal Columbia River Power System Supplemental Biological Opinion (Supplemental BiOp). In light of the need for an immediate and dramatic turnaround in double-crested cormorant predation on juvenile salmonids in the estuary, the Preferred Alternative provides a clear choice to achieve near-term reductions in the cormorant population without the uncertainties, expense and direct and indirect effects on other resources of dispersing approximately 15,000 birds from the 145-mile estuary after they are dissuaded from East Sand Island. Dispersal presents both opportunities and risks. If successful, it reduces the number of cormorants that must be culled to achieve benefits for fish; if the birds do not leave the estuary, or, worse, travel to inland areas in the basin where listed salmonids would make up a greater percentage of their diets, little or no gains for fish may be realized. Moreover, the Preferred Alternative clearly achieves greater benefits for listed fish than a primarily non-lethal approach, and as, CCT has emphasized throughout the development of the management plan, this objective should be the driving force behind the plan and its long-term implementation. (DEIS at 4-33, Tables 4-2 and 4-3). The Preferred Alternative is also likely to maintain double-crested cormorants as a meaningful element of the estuary and west coast ecosystems, because over 5,000 breeding pairs would remain on East Sand Island--easily making it many times larger than any other double-crested cormorant colony in the western population.

G-12

We wish to emphasize again that an appropriate fish-centered approach in the plan must evaluate its success or failure based not on the number of birds remaining but on the benefits that accrue to listed salmonids from reducing double-crested cormorant predation. In short, the plan must not be fixated on the number of birds specified in the Supplemental BiOp, but rather on the objective of closing the survival gap for listed UCR steelhead (and, as a result, for other listed salmonids). Under the Management Plan incorporated into the DEIS, "[m]anagement would be considered successful once the DCCO target colony size is achieved and maintained, and the Corps would continue to implement non-lethal methods, as necessary, to maintain the target size." (DEIS at p. 5-11). Assessment of predation rates via PIT tag recoveries after the breeding season during Phase I would ostensibly occur; however, predation rates are not factored into adaptive management because "the time period is too short to determine trends." (DEIS at p. 5-13, Table 5-4). PIT tag recovery during Phase II would likewise not factor into adaptive management "until data has been collected for [a] sufficient period of time (5-10 years) due to seasonal and annual variability in predation rates." (DEIS at p. 5-16, Table 5-6). However, it is likely that PIT tag recovery data could provide reliable information relating to cormorant

G-13, S-17

comments noted

predation on ESA-listed salmonids that would enable the Corps to assess plan implementation and the potential need for adaptive management within a shorter time frame. For example, in Evans et al. (2012), researchers were able to determine predations rates for a wide range of avian predators and salmonid species and populations, including East Sand Island double-crested cormorant predation on UCR steelhead, based on a four-year PIT tag study. Accordingly, the Corps should to add to the Management Plan an explicit adaptive management option in which it would take additional management action in the near term if predation rates are not reduced commensurate with population reductions. As CCT has noted in other comments, management of Caspian terns at East Sand Island has not followed predicted outcomes with respect to predation reduction and decreases in abundance. In the Tribes' view, a similar near-term result for double-crested cormorant management in the estuary should result in additional actions to achieve the fish survival increases expected by the Supplemental BiOp. It would be unacceptable to wait 10 or more years before an adaptive management response is triggered.

In summary, while CCT remains concerned about the high level of salmonid predation by double-crested cormorants nesting at East Sand Island and the corresponding challenges it poses to CCT's and others' salmon and steelhead recovery efforts, the Tribes firmly support the adoption of Alternative C with the addition of a near-term adaptive management response option should salmonid predation rates not decrease in parallel with double-crested cormorant abundance. We look forward to the Corps' implementation of the Management Plan and the significant benefits to the Columbia Basin's salmon and steelhead that will follow. As refinement and implementation of the management plan is an ongoing process, CCT intends to continue providing input to the Corps and other agencies through government-to-government consultation or other processes.

Sincerely yours,

Randall Friedlander
Program Director
CCT Fish & Wildlife Department

cc: Elisa Carlsen, U.S. Army Corps of Engineers (Elisa.Carlsen@usace.army.mil)

REFERENCES

Evans, A. F., N. J. Hostetter, D. D. Roby, K. Collis, D. E. Lyons, B. P. Sandford, and R. D. Ledgerwood. 2012. Systemwide evaluation of avian predation on juvenile salmonids from the Columbia River based on recoveries of Passive Integrated Transponder tags. Transactions of the American Fisheries Society 141:975-989.

From:	Meagan Flier
To:	Cormorant EIS
Cc:	Mike Wilson; Michael Karnosh
Subject:	[EXTERNAL] Double-Crested Cormorant Draft EIS comments
Date:	Friday, July 25, 2014 9:15:22 AM

To Whom It May Concern,

On behalf of the Confederated Tribes of the Grand Ronde Community of Oregon, thank you for the opportunity to provide comment. The Natural Resources Department of Grand Ronde has reviewed the draft EIS for the Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary for its potential impact to natural resources. At this time the Tribe has one comment of concern regarding the tribal fisheries section 3.3.2.

Suggested text added to FEIS Section 3.3.2

While the Tribe is appreciative that Tribal fisheries interests are included in the draft EIS, it is not only the four treaty Tribes, with adjudicated treaty fishing rights as mentioned in the draft, that have a unique connection and fisheries interests in the Columbia River Estuary. An additional sentence to clarify and address this discrepancy would be useful. Such a sentence might precede the second paragraph to look something similar to the following: "The Columbia River encompasses many different kinds of Tribal cultural and natural resource interests from at least 16 federally-recognized Tribes which collectively span the entire length of the river." In this way the EIS might address that many Tribes, not solely the four with adjudicated fishing rights, have similar fishing interests in the region.

Please feel free to contact me by email at Meagan.Flier@grandronde.org <mailto:Meagan.Flier@grandronde.org> , or by phone at 503-879-2312 should you have any questions or like to discuss the Tribe's concerns further. Once again, thank you for the opportunity to provide comment.

Sincerely,

Meagan Flier, Environmental Resources Specialist

Natural Resources Department

Confederated Tribes of the Grand Ronde

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503-879-2312

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VIA E-mail and First-Class mail

August 18, 2014

Colonel Jose L. Aguilar
District Commander
U.S. Army Corps of Engineers, Portland District
ATTN: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS/ Sondra Ruckwardt
P.O. Box 2946
Portland, OR 97208-2946

RE: Comments on the *Draft Environmental Impact Statement* for the Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Dear Colonel Aguilar:

comments noted

The Columbia River Inter-Tribal Fish Commission (CRITFC) appreciates the opportunity to provide comments on the *Draft Environmental Impact Statement* for the Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (DEIS). The restoration and conservation of Columbia River salmon and steelhead have immeasurable value to the region's tribes. Salmon and steelhead are one of the First Foods celebrated by Columbia Basin tribes, making them keystone to tribal culture and identity. Not surprisingly, CRITFC tribes are highly vested in the outcome of double-crested cormorant management in the Columbia River estuary.

Avian predation is a major source of juvenile salmonids losses throughout the Basin and is of a particular concern in the estuary. Colonies of double-crested cormorants have annually consumed millions of juvenile salmon and steelhead since the 1990's, but consumption has increased tremendously in recent years. From 2010 through 2013, double-crested cormorants at East Sand Island consumed approximately 74 million juvenile salmon and steelhead. Depending on the year, these losses represent 10-15% of the entire annual juvenile salmonids outmigration. Double-crested cormorant predation at East Sand Island on Snake River steelhead stocks averaged approximately 11% from 2008 through 2012 (Lyons et al. 2013). The 2014 Biological Opinion for the Federal Columbia River Power System only allows for a 4% loss of steelhead at each dam. Predation by the double-crested cormorants at East Sand Island alone is adding the equivalent of nearly three more dams in the system. Furthermore, they are consuming the salmonids that made it through the entire hydro-system and are about to enter the ocean. The magnitude of these losses represents a significant impact to the salmon and steelhead restoration efforts of the Columbia Basin tribes and the region as whole, particularly as these fish are highly valuable to the overall recovery process. The region spends hundreds of millions of dollars and invests countless hours annually in efforts to enhance and restore Columbia River salmon and steelhead, but a significant portion of this effort is wasted just a few miles from the Pacific Ocean.

Alternative A is a no action baseline alternative, a necessity for the process, but it will obviously not meet the purpose and need of the EIS. Alternative B will simply focus on scattering the predators away from East Sand Island, but this alternative is unrealistic. The notion that we can effectively and permanently haze (i.e. move) tens of thousands of birds away from an area they have inhabited for decades is not supported by years of research. Extensive hazing will waste millions of dollars and more than likely will drive the birds into areas where the predation rate may very well be higher than rates observed in the estuary. Alternative D is a useful alternative as it incorporates lethal removal as one aspect, but the idea that the remaining birds could be dissuaded significant distances (i.e. outside the Columbia Basin) is likely to fail.

The Commission supports Alternative C in the draft EIS Plan. This alternative expedites the purpose and need of the EIS, “to reduce double-crested cormorant predation of juvenile salmonids in the Columbia River Estuary.” Phase I, begins what the Commission considers the most important aspect of the entire plan; lethal removal of double-crested cormorants from East Sand Island, within a 2 to 4 year working period. This effort, followed by Phase II, terrain modification, reduces the amount of the available nesting habitat. This one-two approach is critical if the proposed management plan is to be successful in the short term as well as long term to increase the survival of juvenile salmon and steelhead outmigrants. Given the range of actions available in the draft EIS, Alternative C is the only realistic alternative that will result the reduction of predation rates on juvenile salmonids.

G-12, G-13, S-17

Although CRITFC supports Alternative C, there are aspects of the alternative that can be improved. The Management Plan must include provisions for adaptive management flexibility based on observed annual predation rates to seek additional reductions in predator numbers if necessary. The goal is an overall increase in salmon and steelhead survival rates. Additionally, the extended research effort in Alternative C prior to conducting any additional management actions is unnecessary and inconsistent with the Corps’ treaty trust responsibilities. The purpose and need of the draft EIS is “to reduce double-crested cormorant predation of juvenile salmonids in the Columbia River Estuary”. The current bird-centric approach puts the health and sustainability of western population of double-crested cormorants ahead of the survival and recovery of listed Columbia River basin salmon and steelhead stocks. The need for the long term study is unnecessary, particularly when published literature has demonstrated that short term studies can adequately document predation rates on juvenile salmonids. In Evans et al. (2012), the authors demonstrated that the four year period from 2007-2010 was more than sufficient to calculate predation rates for double-crest cormorants.

comments noted

The largest return of upriver fall Chinook salmon since the construction of Bonneville Dam is expected this year. The fall fishery is the backbone of the tribal fishery, and very likely, opportunities to harvest this abundant run will be severely limited due to the poor return of Group B steelhead this fall. This is the same group of steelhead that is preferentially preyed upon by double-crested cormorants and Caspian terns as juvenile outmigrants. Tribal fisheries are managed to protect weak stocks, particularly Group B steelhead.

The primary tribal harvest management strategy to protect Group B steelhead is to limit the harvest rate by restricting or closing fisheries. Fall chinook and Group B steelhead adults return to the Columbia during similar time periods and treaty fisheries impact both. In prior years, tens of thousands of prime fall chinook were not harvested by tribal fishers because of fishery closures to protect Group B steelhead. The resulting economic impacts are very significant to the tribal fishing community. Greater survival of steelhead juveniles that will result from the implementation of Alternative C is an appropriate and necessary management tool that is long overdue.

In closing, we appreciate your inclusion of our comments and concerns in the written record of the EIS on the management of the double-crested cormorants on East Sand Island. If there are any questions or comments, please contact myself or my staff. We will closely track the remainder of the EIS process and its' outcome later this year.

Sincerely,

Babtist Paul Lumley
Executive Director

Cc: Sondra Ruckwardt, Portland District, U.S. Army Corps of Engineers
Barry Thom, Deputy Regional Administrator, NOAA Fisheries

Literature Cited

Evans, A. F., N. J. Hostetter, D. D. Roby, K. Collis, D. E. Lyons, B. P. Sandford, and R. D. Ledgerwood. 2012. Systemwide evaluation of avian predation on juvenile salmonids from the Columbia River based on recoveries of Passive Integrated Transponder tags. Transactions of the American Fisheries Society 141:975-989.

Lyons, D. E., D. D. Roby, A. F. Evans, N. J. Hostetter, K. Collis. 2013. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony: A report to the U.S. Army Corps of Engineers Portland District. Bird Research Northwest. Available online at www.birdresearchnw.org.

Pacific Eco Logic

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August 19, 2014

To: Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E / Double-crested cormorant draft EIS

Dear Ms. Ruckwardt,

comments noted

The Double Crested Cormorant (DCCO) draft EIS does not offer a reasonable plan for management of natural resources at East Sand Island (ESI), therefore I strongly support Alternative A: No Action. Although there is no compelling evidence that DCCO control will contribute to salmon restoration efforts, the goal of 5-6,000 breeding DCCO pair on ESI is attainable using much more humane and cost-effective methods than those outlined in Alternatives, B, C, or D. I believe that the USACE could meet the mandated objectives for DCCO colony size on ESI long-term through 1) less costly and more thoughtful island habitat restoration, 2) modification of specific fishery practices and facilities, and 3) reducing researcher presence on the island thereby allowing native predators to more freely regulate the colony.

DEIS/FEIS Section 4.2.3

G-18, S-33

The preferred alternative, Alternative C, would have numerous negative effects on the natural and human environment of the Columbia River Estuary that have not been considered in the EIS, and would result in foreseeable escalation of economic costs not included in the equation. The plan to carry out the non-lethal measures in Alternative B along with the lethal control, may increase smolt consumption due to disturbance effects on cormorant energetics and result in unacceptable harm to non-target species such as the Brown Pelican. In addition, lethal removal of one generation of cormorants does not preclude the next generation from emigrating into the estuary from outside of it as long as food and nesting substrate are still available, so the preferred alternative is not only very costly and controversial, it is not a very long term solution.

comments noted

Currently there is no shortage of alternate nesting habitat for DCCO in the Columbia River estuary and the hatcheries apparently provide a steady reliable food source for terns and cormorants during spring, regardless of natural variability in fisheries and prior to greater availability of marine fish in summer. I agree with the assessment in the EIS, that it is not feasible to haze the cormorants out of the estuary due to the size of the area and the draw of the resources. I predicted that attempts to haze DCCO from ESI would result in greater use of the Astoria-Megler Bridge and I remain very concerned about this issue and associated negative impacts to the bridge and users of the bridge. I believe that both the bird and public response to shooting will be stronger than anticipated by the authors of the EIS. If lethal control and repeated nighttime disturbances on the colony take place, in Year 1 I expect that DCCO will attempt to move to the bridge in large numbers, and possibly the trees at Fort Columbia Sate Park. I also anticipate that negative public response and legal challenges will result in termination of shooting breeding adults by Year 2.

comments noted

I am a resident of the Columbia River Estuary and a professional biologist who has been engaged in colonial bird monitoring, management, and habitat restoration for over 30 years. I have been tracking the situation at ESI since 1999, largely due to interest in the Brown Pelican. I have been critical of the logic and methods employed by USACE and associated contractors with respect to avian predation in the past, but am now encouraged by the fact that the Corps has realized the futility of many of these costly efforts, and has come to recognize the historic significance and greater potential ecological value of the island. I would welcome the opportunity to provide detailed constructive input on an alternate progressive path forward in the future. There is an exciting opportunity for a win-win situation for fish and wildlife of the Columbia River that could result from a change in the course of natural resource management at East Sand Island and redirection of seabird research funds to improvements in management and facilities of Columbia River fish hatcheries. This shift can begin with No Action on the Draft DCCO EIS.

Thank you for considering these comments.

Deborah Jaques

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16 August 2014

Sondra Ruckwardt, Project Manager
ATTN: CENWP-PM-E-14-08
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208-2946

Dear Ms. Ruckwardt:

comments noted

I write this letter as the Principal Investigator (PI) for research, monitoring, and evaluation related to avian predation on juvenile salmonids in the Columbia River estuary. I have served as PI for this project, which has been jointly funded by the U.S. Army Corps of Engineers - Portland District (Corps) and the Bonneville Power Administration (BPA), for 18 years. I would like to address the scientific basis for the Draft Environmental Impact Statement (DEIS) to Reduce Double-crested Cormorant Predation of Juvenile Salmonids in the Columbia River Estuary in my capacity as PI on this long-term research project, as Unit Leader for the U.S. Geological Survey's Oregon Cooperative Fish and Wildlife Research Unit, and as Professor of Wildlife Ecology at Oregon State University. The professional opinions expressed in this letter are not necessarily those of my supervisors or those I supervise, nor are they necessarily those of the U.S. Geological Survey or Oregon State University.

The DEIS represents a major effort to assemble and compile the relevant information for a complex and complicated natural resource management issue, and the Corps, plus its cooperators and contractors in the preparation of the DEIS, are to be commended for their efforts. Nevertheless, there are aspects of the DEIS and the selection of the Preferred Alternative that are either unsupported by the science, or at variance with the best available science. In many cases the relevant science was produced by the research group that I lead, and I am likely more familiar with the body of scientific work cited in the DEIS than any other scientist.

G-9, G-10, G-11, FEIS App. G

The DEIS and subsequent outreach efforts by the Corps imply that a non-lethal management technique – habitat restriction to induce breeding dispersal away from East Sand Island - has already been attempted and has not been successful. This misrepresents the scope of experiments that our research team conducted during 2011-2013 to test such a technique, experiments that were funded by the Corps. Those experiments restricted habitat very successfully and induced temporary dispersal from East Sand Island; however, sufficient nesting habitat was retained – by design – to allow all cormorants to continue nesting at East Sand Island if they chose to, which they did. It is incorrect and misleading to imply that non-lethal management techniques have been attempted and have failed in advance of selecting a primarily lethal management approach as the Preferred Alternative in the DEIS.

G-10

The DEIS unjustifiably downplays the potential to manage cormorant dispersal from East Sand Island under Alternative B, citing perceived high cost, logistical complexity, and high risk of simply moving the problem to a new location or possibly even exacerbating the problem. The DEIS fails to acknowledge that the Oregon Department of Fish and Wildlife (among others) has successfully administered a large-scale multi-estuary non-lethal cormorant hazing program on a very modest budget. The DEIS also fails to acknowledge that the management of cormorant nesting habitat to reduce fisheries conflicts (e.g., hazing to limit cormorant nesting in areas of fisheries concerns) has been successfully used on a large scale elsewhere (e.g., New York State, Denmark), as an alternative to culling thousands of cormorants. The G-9 DEIS ignores the susceptibility of cormorants to human or other disturbance, particularly during the early stages of colony formation. Human or other disturbance is the most often cited cause of cormorant colony failure and abandonment in the scientific literature. Experiments at East Sand Island during 2010-2012 successfully dissuaded cormorants from nesting in designated portions of the island, despite a long history of cormorant nesting in those areas. Taken together, these scientific studies and previous management efforts provide compelling evidence for the feasibility of non-lethal methods for reducing cormorant predation on salmonid smolts in the Columbia River estuary.

G-8, G-10 The DEIS implies that locations where cormorants would disperse to from East Sand Island are unpredictable. In actuality, experiments conducted by our research team and funded by the Corps investigated possible dispersal locations and behavioral strategies, and demonstrated that currently active and historical colony sites are the most likely locations that dispersing cormorants would attempt to nest. These sites are well known and readily monitored. The DEIS indicates that sites elsewhere in the estuary and lower Columbia River would be the primary dispersal locations explored by cormorants. This conclusion fails to acknowledge substantial use by cormorants from East Sand Island of sites in coastal Washington and British Columbia, areas of reduced conflict with fisheries, during Corps-funded dispersal experiments. Additionally, active colonies elsewhere in the Columbia River estuary and lower river utilize artificial structures with either limited capacity to support additional cormorant nests (e.g., navigational aids or transmission line towers) or are located in areas readily hazed (e.g., bridges). The G-22, G-21 DEIS exaggerates the risk of cormorants dispersing from East Sand Island and competing with ESA-listed streaked horned larks for nesting habitat in the Columbia River estuary. There is little overlap in habitat preferences between cormorants (vertically structured habitats that facilitate stick nest construction, such as trees, shrubs, rip-rap, driftwood piles) and streaked horned larks (bare or sparsely vegetated flat sandy areas) in the lower Columbia River and estuary. Finally, the DEIS fails to recognize the potential of social attraction techniques to attract dispersing cormorants to acceptable existing or former colony sites. Experiments funded by the Corps and conducted by our research team to explore this technique were misinterpreted and the potential for successful application was unjustifiably downplayed.

Whereas the DEIS exaggerates the uncertainty and risks associated with non-lethal management techniques that are part of Alternative B, the DEIS substantially downplays the uncertainty and risks associated with Alternative C (large scale culling), the Preferred Alternative. The effect of the proposed G-19, G-20 cull (~ 16,000 individuals) represents about a quarter of the cormorant population west of the Continental Divide. This is because about 40% of the breeding adults in the western population nest at the East Sand Island colony, and the reduction of that colony by two-thirds using lethal take would necessarily have a major impact on total population size. Banding and satellite telemetry studies, conducted by our research team and funded by the Corps, have demonstrated the connectivity of the East Sand Island colony with other colonies from British Columbia to the Mexican border, and from the coast to the Continental Divide. Thus the local management action in the Columbia River estuary to reduce the numbers of double-crested cormorants will have a major population-wide impact throughout western North America.

The DEIS indicates that the proposed annual take for the East Sand Island cormorant colony under the Preferred Alternative is similar to those in cormorant culling programs east of the Continental Divide in terms of the number of individuals culled; however, the effect of the proposed take level on the

S-25, G-18

cormorant population west of the Continental Divide (a distinct management unit) is substantially greater. At least 1/4th of the western population is proposed to be culled at a single site, a very different scale of action than any culling program within the range of the eastern population. The size of the East Sand Island colony assumed at the onset of the culling program is an average colony size during 2004-2013 (12,917 breeding pairs), rather than a more recent (2011-2013) average (13,420 breeding pairs), or the most recent estimate of colony size (14,900 breeding pairs in 2013). A larger initial colony size will require a larger cull to reach the management objective. The potential for cormorant immigration to East Sand Island is also not adequately considered in the projections of how many cormorants would need to be killed to reach the target colony size. Colony size trends over the last 15 years, and most recently in 2013, suggest substantial immigration has occurred to the East Sand Island colony, and could occur again. Any substantial immigration during the culling program would require a larger cull to reach the management objective. Experiences with major cormorant culling operations in the Upper Midwest indicate that the level of cormorant culling necessary to reach target population sizes can be several times greater than the difference between current cormorant population size and target population size after management. Taken together, these data and observations indicate that the estimated total cull of ~ 16,000 cormorants to reach the target colony size of ~ 5,600 breeding pairs significantly downplays the level of lethal take that would be required, perhaps by a factor of two. Consequently, the numbers of cormorants taken as part of the cull may significantly exceed one quarter of the entire western population in order to reach the target colony size, and thereby place the western population at greater risk.

G-18 G-19, G-20

The DEIS proposes that an estimate of population size circa 1990 is sustainable (*sensu* the minimum viable population). Little justification for this choice is provided except that this was the size of the western population before the East Sand Island colony began to increase substantially during the 1990s. The reasoning seems to be that if the population consisted of about 20,800 breeding pairs before the advent of the East Sand Island colony, then the carrying capacity of the available nesting habitat exclusive of East Sand Island should still be at least as high as it was in 1990. This ignores the recent status and trends of major colonies in the western population. Notably, the three most significant nesting areas in the western population since the 1990 census all have uncertain but likely negative trajectories: East Sand Island (the culling program outlined in the DEIS), Upper Klamath Basin (drought, water allocation issues), and the Salton Sea (reduced water allocation, drought). Cormorant colonies in coastal British Columbia, Washington, and southern California have been in decline for two decades. In addition, much of the initial growth in the East Sand Island colony was due to immigration from other colonies in western North America, especially those in British Columbia and Washington, suggesting that many of the other colonies within the range of the western population are at or near carrying capacity. The Corps funded a detailed, extensive, and up-to-date study of the status of the western population of double-crested cormorants, a study that was recently published by our research team, but much of the results of this research are at variance with the DEIS's "minimum viable population" size for the western population.

G-5, G-7

The specific management objective for the DEIS (~ 5,600 breeding pairs on East Sand Island) is quantified using analyses with unknown uncertainty, large extrapolations outside the available data, and methods that apparently have never received independent peer review. These analyses do not use the best available scientific information and are substantially less rigorous than analyses identifying other salmon recovery objectives in NOAA's 2014 Supplemental Biological Opinion for the Federal Columbia River Power System. The Corps has funded NOAA Fisheries to collect salmonid smolt PIT tags on the cormorant colony at East Sand Island, and to conduct studies of those tag recoveries in order to obtain accurate, unbiased estimates of cormorant predation rates on listed stocks of salmonids. These results are the best available science on the impact of cormorant predation on ESA-listed salmonid populations in the Columbia River estuary, yet they were not used to assess the benefits of various management objectives for cormorant colony size on East Sand Island. Research to specifically quantify the

G-4 → prospective benefits to ESA-listed salmonids of various cormorant management scenarios has been conducted, but the results of that research were not used to assess or interpret the value of the alternatives relative to other potential levels of cormorant management or other salmon recovery objectives. Finally,

G-3, FEIS App. C → the Corps funded our research team to investigate the factors that are responsible for the large inter-annual variation in cormorant predation rates on salmonid smolts; depending on the year, cormorants have included as little as 2% salmonids in their diet or as much as 20%. The results of this Corps-funded study were ignored in setting or interpreting the specific management objective; instead one average per-cormorant smolt consumption rate was assumed for setting management objectives.

In summary, the DEIS was not consistently based on the best available science, science that in a number of cases was paid for by the Corps and is either published in the peer-reviewed scientific literature or destined for publication in the near future. Specifically, more robust scientific information is available to support the quantification of a specific management objective and the analysis of relative risk between non-lethal and lethal alternatives than was selected for use in the DEIS. Consequently, the selection of the Preferred Alternative in the DEIS is neither rigorously science-based, nor defensible from a scientific perspective, regardless of its merits as a management policy for resolving this natural resource management issue.

Sincerely,

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Comments on CENWP-PM-E / Double-crested cormorant draft EIS
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In support of Alternative A, no action, based:

Comments S-2 through S-9

- Predation estimates for Double-crested Cormorants at East Sand Island are simulated.
- I had an opportunity to review the inner working of the bioenergetics model used for simulations where is was used in a nearby Tillamook Bay, OR.
- Problems with the simulation included:
  - Mistakes in allocation of salmonid proportions resulting in 40% overestimation of consumption in Tillamook Bay.
  - A tenuous protocol for converting binary data from genetic id to quantitative data for salmonid proportions in the diet.
  - Mistakes in estimating standard deviations used to compute confidence intervals.
  - Mistakes in assumption of normality for small proportions
  - Exorbitant extrapolation from relative few fish in samples to millions.
  - Internal inconsistencies in calculations.
- Similar problems probably exist in simulated predation estimates for this DEIS, but this cannot be determined because code for generating the numbers and input data were not provided.
- Foregut sampling could be abandoned as it is a waste of time and effort without truthing the miniscule samples to the population as a whole. As is, the data simply provides input for a garbage in, garbage out modeling efforts.

Management of piscivores in the Columbia River Estuary is ultimately a numbers game revolving around predator numbers vs how much of the resource is consumed because the impacts of predation on salmon populations are unknown. Consumption estimates are based on a bioenergetics model that generates the number of items consumed. Ultimately these numbers, usually ranging between 10-20 million salmonids, provide the rationale for the management actions outlined in the DEIS. Little is known of the inner working of the model or input values used to produce the consumption numbers. I had an opportunity to view the inner workings of the model in review of consumption numbers for double-crested cormorants in Tillamook Bay, OR in 2012. The analysis revealed that the model was inapplicable for the specific example of Tillamook Bay 2012, and probably for other instances where it has been used, such as East Sand Island, which is the focus of this DEIS. Note that the model and data used to generate numbers for East Sand Island were unavailable being deemed proprietary, thus the Tillamook Bay 2012 example was used as a surrogate. After examination of the model, current and historical consumption numbers are in need of review and recalculation after repair and modification of the model. Even after such an effort this modeling approach appears to be unworkable because of statistical limitation and an alternative approach using simple frequency of occurrence and non-parametric methods are needed in order to inject some scientific validity to the consumption numbers

I've dispensed with the detailed comments on the DEIS and simply agree with bioenergetics guru, Don Lyons and the rest of Roby et al. team, that

"Despite over a decade of study by scores of biologists, scientific uncertainty remains regarding the significance of avian predation on juvenile salmonids in the Columbia River estuary. We now know that millions of smolts are consumed by… (Don Lyons et al. 2010, p. 250)

Updated to 2014, we really know that piscivores eat fish and some of these are salmonids, including some that are designated threatened/endangered. Demonstrating a significant impact on salmonid populations is difficult due to effects related to density of predators and prey, compensatory mortality, ocean conditions, condition dependent survival, differential digestibility of prey, experimental design, and psychological/political bias (Welsh et al 2008, Lyons et al 2010, Fort et al. 2011, Göktepe et al. 2012, Hilborn 2013, Rechisky et al. 2013a, Rechisky et al. 2013b, Hilborn 2013, Evans et al. 2014). Alternatively there may be no significant impact on salmonid populations as evidenced by the record runs of late despite record predation in brood years (e.g., CBB Bulletin, Aug 2014), and higher survivorship in the Columbia River than in the Fraser River, which lacks both dams and significant predator populations (Welch et al. 2008). Lacking any demonstrable impacts on salmonid populations, the DEIS and management effort focus on simulations of fish consumed using a bioenergetics model.

The model that has been used to generate the number of fish and other prey items eaten by piscivores in the Columbia River Estuary (CRE), East Sand Island (ESI) and elsewhere for about 15 years beginning with Roby et al.'s (2003) use on Caspian terns (*Hydroprogne caspia*). Ultimately estimates from the model, termed "best estimates" as usually cited, provide the rationale for management. For example in this DEIS (p 2-3), predation estimates provide the basis for the suggestion of a 3.6% gap in the former vs current steelhead survivorship, which then provides the prime driver for management (Fredricks 2013). However, data and code used to generate estimates are lacking and the model is essentially a black box except for sketchy details in what appears to be the model's original conception (Roby et al. 2003). The inner workings of the model including the code used for calculations and input values should be in this DEIS and should have been provided in yearly reports (see yearly reports from Bird Research NW, Roby et al 2009-2013). Current usage of the model, apparently retitled "Bird Research NW Bioenergetics Model" (hereafter BRNW/OSU model), usually provides some "best estimates" numbers and putative 95% confidence intervals (CIs) referencing Roby et al. (2003). The CIs are an integral part of the science underlying this protocol and they should provide statistically and thus scientifically sound estimates that "inoculate" estimates from criticism. However, based on this analysis the opposite is true.

In analyzing the BRNW/OSU model many errors or lapses are apparent; some may have been specific to the Tillamook Bay 2012 example (Appendix A). However I'll concentrate on what appear to be some the more glaring fundamental problems after an explanation of calculations and content that provide the basis for this analysis.

Methods: The input and output of the BRNW/OSU model were received from OSU through Oregon Department of Fish & Wildlife (ODFW) on 9 May 2013 as an Excel workbook "2012TillamookBayDCCOBioenergeticsModel". Within the workbook, data were in the form of worksheets or tabs including:

1. Input Data
2. Input Variable Values
3. Energy Needed
4. Output Numbers by Time Period
5. Output Biomass by Time Period
6. Output Biomass by Prey Type
7. Output Energy by Prey Type
8. Output Graph - Total Salmonids
9. % Consumed

I received second copy of the "2012TillamookBayDCCOBioenergeticsModel" on 21 June 2013 after a query to Lindsay Adrean (ODFW) and Don Lyons (OSU) regarding some aspects of the original workbook. The two copies did not differ indicating that there had been no updates or change to input or output data. Data used for input to the model were received as three additional workbooks: "TMK_DCCO_2012_StomachContents", "TillamookSurveysAprilMay2012" and "TMK_DCCO_2012_Salmonids (Genetic id's)". An additional pdf, "OriginalData", provided copies of field stomach dissection results. All workbooks and pdf's were deemed public domain by ODFW.

From the workbooks and raw data I verified input variables that appeared in Input Values and Input Variable Values tabs on the "2012TillamookBayDCCOBioenergeticsModel" workbook. The macro used to calculate the output was not provided to ODFW or me after specifically requesting it for review because it was deemed proprietary by BRNW or OSU (D. Lyons, pers. com.). However a macro to run the simulation was simple to reconstruct from the embedded formulae that were still in the workbook and from obvious calculations from inspection of input and output data. I wrote a macro (GWS macro) to run the calculations using the same values in the Input Variable Values tab and output the results for comparison. The model was also run with corrected input values for a comparison (see below). The macro is available upon request.

Major steps in the simulation include the calculation of total energy as

***Total Energy = Population Size x DEE (kJ/day)* x *Days/Assimilation Eff*,**

where Populations Size was based on an indexed number of pairs, DEE was Daily Energy Expenditure based on seven males and three females for nonstandard day lengths (see Lyons et al 2010, Table 3.1), assimilation efficiency was from literature values, and days represented days two-week periods. At some point in calculations, indexed pairs was converted to individuals. Using total energy, the

Energy for each prey type = Total Energy x Proportional representation of prey in diet.

The latter value was based on DCCO foregut sampling to quantify non-salmonids and overall salmonids, followed by genetic id and conversion of binary data to quantitative data (see below). Energy for each prey type was extrapolated to numbers as

Numbers consumed=Energy for each prey type/ Energy Density/Average "mass" of prey type

where energy density was kJ/gm of prey based on empirical data and estimation yielding biomass for each prey type that was extrapolated to numbers using average "mass", which was the average weight of prey items.

Values for the above quantities that were input to the BRNW/OSU model for Tillamook Bay 2012 appear on the Input Data tab. These were combinations of simulated, guesstimated, and empirically derived values. In some instances means and SDs were based on a single value. Using these initial values as input (or seeds) to a random numbers generator after converting SDs to standard errors (SEs), 1,000 values were produced for each mean or simulated mean that appear on the Input Variable Values tab. These were then used to calculate numbers consumed 1,000 times in a process referred to as a Monte Carlo simulation. These 1,000 values were then used to calculate SDs and +/-2 SDs were used as the CIs. Given that SDs were simulated for many variables, the SEs represent a second level of simulation and compounded error (see Peralta 2012). Although the type of distribution wasn't specified, I assumed a random normal distribution based on plots of the 1,000 input values and the apparent original basis for the model (Furness 1978).

Once numbers were computed, these were then used to estimate the % of that prey items that were consumed based on estimated populations. A more detailed analysis is available upon request and presented in summary form as Appendix A. Obvious problems included:

Non-random "randomized" simulations. The Monte Carlo simulation simply involved generating 1,000 values for each input value using means and SEs then calculating the numbers consumed 1,000 times and using 2 x SD's of the result for CIs. Implicit was that a random numbers generator was used, in this case a random normal generator, and that the values were thus random. However, an inconsistency occurred in generation of random values for proportions for prey types (Table 1). The proportions were relative values, therefore changing one changes others. In generating 1,000 random values for each proportion, the model forced these to sum to one or each iteration. This violates the assumption of randomness implicit in the Monte Carlo method and constrains variability in the end result thereby minimizing CIs. It appeared that adjustments were made by adding or subtracting small values to proportions until the total equaled one.

Incorrect calculations. The SDs and subsequent SEs used to generate 1,000 iterations for prey proportions in the diet that were used to calculate CIs were incorrectly calculated. There were insufficient raw data to compute SDs empirically, so SDs were estimated, but an incorrect formula was used, actually the variance, resulting in gross underestimation of the variation and resulting CIs (Tables 2 & 3). The results using the incorrect SEs are provided in Fig. 1. The results of a run using SEs computed correctly are shown in Fig. 2 where all confidence intervals venture in the negative numbers. This illustrates a novel ecological phenomenon of negative consumption, and is facetious, but provides a striking example of a problem that appears to be hard coded into the model. This is that variation and CIs were underestimated thereby making it seem that the CIs and midpoint "best estimates" were reasonable. In reality, the CIs reported as 95% range from 10-50% which seriously undermines the credibility of the estimates and has no scientific validity. Without 95% CIs, the best estimates have unknown reliability.

Violation of a first lesson in biostatistics. Related to the above is precaution given in Biostats books and classes (e.g., Zar 2010), or just Google it, that proportions below ~0.2 or above ~0.8 are not normally distributed and cannot be treated as such without transformation. Almost all the prey proportions in the model were below 0.1 due to small samples and parsing into too many categories, but the authors apparently proceed to generate random normal distributions using assumed parametric values. Even if samples size were adequate, the distribution would not be normal and thus could not be used in this type of modeling without transformation of the variables or calculation of asymmetrical CIs.

The model calculations failed internal consistency checks. A problem emerged in examining the input vs output values in that there appeared to be an internal inconsistency in the calculations. Specifically, the proportions on the Input Values and Input Variable Values tab did not match what was used to allocate total energy to prey categories. The calculations were deterministic therefore it should be possible to calculate backward from any intermediate step. For example, assume total energy is 10,000 kJ, and the proportional allocation to a prey category is of .3 yielding 3,000 kJ for this prey category. A back calculation of 3,000/10,000 should equal .3, but the values deviate from the expected by up to 30% (Table 4, Fig. 3). Because of the extreme extrapolations from few data and large multipliers like population size, the resulting errors in final results would be significant. I discovered this in comparing the results from single calculations and verified it in running the GWS macro using the values provided on the Input Variable Values tab, which although incorrect (see below), were used for comparative purposes. Slight differences might be due to the sequence of calculations combined with rounding errors but this difference wasn't slight. Alternatively there could have been hidden correction factors in play to adjust proportions, but more likely there was an error in calculations or summations in the coding that currently is in use. To resolve this, code and raw data are needed.

Converting quantitative data (Yes/No) to quantitative data precise to 3 decimals. Proportions of individual prey categories in the diet including total salmonids were estimated from foregut samples. Then salmonid samples were further analyzed using genetic identification (Roby et al 2009-3013, Lyons 2013). This protocol was an essential part of the model as it generates the proportions of individual salmonids in the diet that were then used to calculate the numbers consumed. However genetic id provides only Yes/No or binary data. The protocol for converting binary data to quantitative data precise to three decimals was incredulous and no methods or protocol were provided in yearly reports other than genetic id was used estimate proportions of salmonids (Roby et al. 2009-2013). Reconstruction of the protocols was done in inspection of an ancillary Excel workbook entitled “TMK_DCCO_2012_Salmonids” (Fig. 4). This hidden protocol adds unaccounted error to estimates and lacks scientific rationale or common sense. The protocol is outlined in Fig. 4, correspond to:

1. Compute salmonid vs non-salmonid proportions based on individual stomach proportions (not shown in Fig. 4)
2. Genetic Id of some of the salmonid samples, 11 of 14 in Tillamook Bay 2012
3. Populate a frequency of occurrence (FO) matrix parsed by the number categories found (e.g., if two species or categories were found, each is assigned a FO of 0.5)
4. Sum FO by category
5. FO expressed as proportions of all summed FOs
6. FO proportions were weighted by average weight of fish
7. Weighted FO were expressed as proportions of the total weighted FOs
8. Weighted FO proportions were used to apportion the overall salmonids to category
9. Use proportions from 8 to apportion Total kJ/ energy density (kJ/gm) to get biomass, then /average mass (gm) to get the number of fish in each category.

A simple mistake leads to over estimating salmonid consumption by 40% in Tillamook Bay 2012. Perhaps unique to the Tillamook Bay 2012 data, an error was made by using weights for 45 gm and 5 gm for cutthroat and chum respectively, rather than 40 gm and .6 gm used in the model. Using the correct values dropped the total take by 40% from ~51,000 to ~29,000 (Fig. 4, compare 6a-9a to 6b-9b). The initial incorrect calculation were submitted to the Oregon Legislature in support of cormorant control (Lyons 2013), used in a final report (Adrean 2013), and in summary form are in the DEIS. This might be a single mistake, but since the code used for calculations and input data were not provided for ESI, it is impossible to tell. This alone is sufficient reason to review the ESI consumption data because the personnel that produced the Tillamook Bay 2012 numbers also produced those numbers for ESI apparently using the same model and protocols.

Small sample sizes were obfuscated by the fog of modeling. A related data disability that emerged from the Tillamook Bay 2012 data were that sample sizes were incredibly small even though 2-10% of the populations were sampled. Using data from workbooks, I calculated that the entire effort was based on a minimum of 29.7 salmonids. These were extrapolated to

~51,000 salmonids using the incorrect proportions or 29,000 using the corrected proportions (Fig. 4). Similar detailed data were not available in annual draft reports for ESI (Roby et al. 2009-2014) although, some creative summaries can be done to produce similar estimates. Using data from yearly reports (Roby et al. 2009-2013), reverse extrapolation can be done to determine the approximate number of salmonids in the original sample (Table 5) and the extrapolations for each fish in the sample (Fig. 5). Results from the latter shows that each fish was extrapolated from 10,000 to 350,000 fish consumed, depending on the category (Fig. 5). Actual sample sizes and data typically are forgotten in modeling, but these data should have been presented in tabular form in yearly reports and in the DEIS to ground the “science” in reality. In conducting this analysis, it also occurred to me that there are two categories or Chinook, sub-yearling and yearling, but the protocol indicates salmonids were id’d genetically, which raises additional questions regarding methodology and incomplete protocols.

I provided a few examples of what appear to be fundamental flaws in the BRNW/OSU bioenergetics model and data that was used to generate the number of prey consumed in Tillamook Bay 2012. There were numerous problems specific to the Tillamook example summarized in Appendix A. More significantly, the Tillamook workbook provided a look at the inner workings of the model used to generate the number of prey items consumed by DCCOs at ESI. A problem with modeling is that the details often are obscured or ignored in the quest to run the model. Although the model might be reasonable, the output might simply be garbage due to sketchy input data. In model speak this phenomenon is referred to as “garbage in, garbage out” or GIGO modeling. This appears to be the case for a specific example I’ve examine where the model was used to calculate the take of salmonids in Tillamook Bay, OR in 2012. In addition, the model appears to be flawed due to statistical anomalies and mistakes. Although the model and data used in the CRE & ESI were unavailable (D. Lyons, pers. com.), the deficiencies in the model appear hard coded rendering the model as configured unusable where it has been used.

The end result of simulation, or “best estimates” produced by the model, are simply midpoints of putative 95% confidence intervals (CIs). For management and public relations, these are taken as the numbers consumed and CIs are largely ignored (e.g. Fredricks 2013, Lyons 2013, Adrean 2013, this DEIS). For example, Fredricks (2013) naively used the “best estimates” expressed to three decimal places to calculate that there was a .036 (or 3.6%) deficiency in survival for steelhead between former and present conditions. Reducing DCCOs at ESI to ~5,600 pairs as recommended in management alternative in the DEIS (p 2-3) would theoretically restore the former condition. However, given the imprecision of the estimates based on CIs and sketchy extrapolated numbers (Fig. 5), the estimates were so imprecise that a .036 difference would not be detectable. At some point in the history of using the current modeling approach, the best estimate midpoint was substituted for the interval probably to give managers, public relation officers, and the public a single number to focus on. Without including the CIs in analysis, there is no way to assess the believability of the “best estimate” midpoints and as such efforts lack statistical and scientific credibility.

References

Adrean, L. 2013. Avian Predation Program 2012 Final Report, 10 pp, (http://www.dfw.state.or.us/conservationstrategy/docs/2012AvianPredationReport.pdf).

CBB (Columbia Basin Bulletin), 8/9/2014. **EXPECTED RECORD RETURNS, 1.5 MILLION FALL CHINOOK, 638,300 COHO, LIKELY A FISHING SEASON TO REMEMBER.** (Intentionally left bold)

Evans, A. F., N. J. Hostetter, K. Collis, D. D. Roby & F. J. Loge. 2014. Relationship between Juvenile Fish Condition and Survival to Adulthood in Steelhead. Transactions of the American Fisheries Society. 143 (4): 899-909.

Fort, J., W.P. Porter and D. Grémillet. 2011. Energetic modelling: A comparison of the different approaches used in seabirds. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 158: 358‑365

Furness, R. W. 1978. Energy requirements of seabird communities: a bioenergetics model. Journal of Animal Ecology 47: 39-53

Fredricks, G. 2013. Appendix D in DEIS. Double-crested Cormorant Estuary Smolt Consumption BiOp Analysis. NMFS (National Marine Fisheries Service).

Göktepe, O, v P. Hundt, W. Porter and D. Pereira. 2012. Comparing Bioenergetics Models of Double-Crested Cormorant (*Phalacrocorax auritus*) Fish Consumption. Waterbirds 35(sp1):91-102.

Hilborn, R. 2013. Ocean and dam influences on salmon survival: The Decline of Columbia River Chinook Salmon. PNAS 110 (17): 6618–6619

Lyons, D. 2013. Summary of Preliminary Juvenile Salmonid Consumption Estimates by Double-crested Cormorants in Tillamook Bay during April and May, 2012, 2pp. Submitted to Oregon Legislature by J. Rohleder for Seafood, OR, McKenzie River Guides Assoc in support of a cormorant (species unspecified) control bill. (https://olis.leg.state.or.us/liz/2013R1/Downloads/CommitteeMeetingDocument/25650)

Peralta, M. 2012. Propagation of Errors. How to Mathematically Predict and Measure Errors of First and Second Order. San Bernadino, CA.

Ridgway, M. S. 2009. A review of estimates of daily energy expenditure and food intake in cormorants (*Phalacrocorax* spp.). J. Great Lakes Research 36:93-99.

Roby et al 2009-2013, yearly reports.
http://www.birdresearchnw.org/DRAFT_2013_Annual_Report.pdf
http://www.birdresearchnw.org/FINAL_2012_Annual_Report_v9.pdf
http://www.birdresearchnw.org/FINAL_2011_Annual_Report.pdf
http://www.birdresearchnw.org/FINAL_2010_Annual_Report.pdf
http://www.birdresearchnw.org/09Final_Columbia_Basin_Annual_Report.pdf

Roby, et al. 2003. Quantifying the effect of predators on endangered species using a bioenergetics approach: Caspian terns and juvenile salmonids in the Columbia River estuary. Can. J. Zool. 81: 250–265.

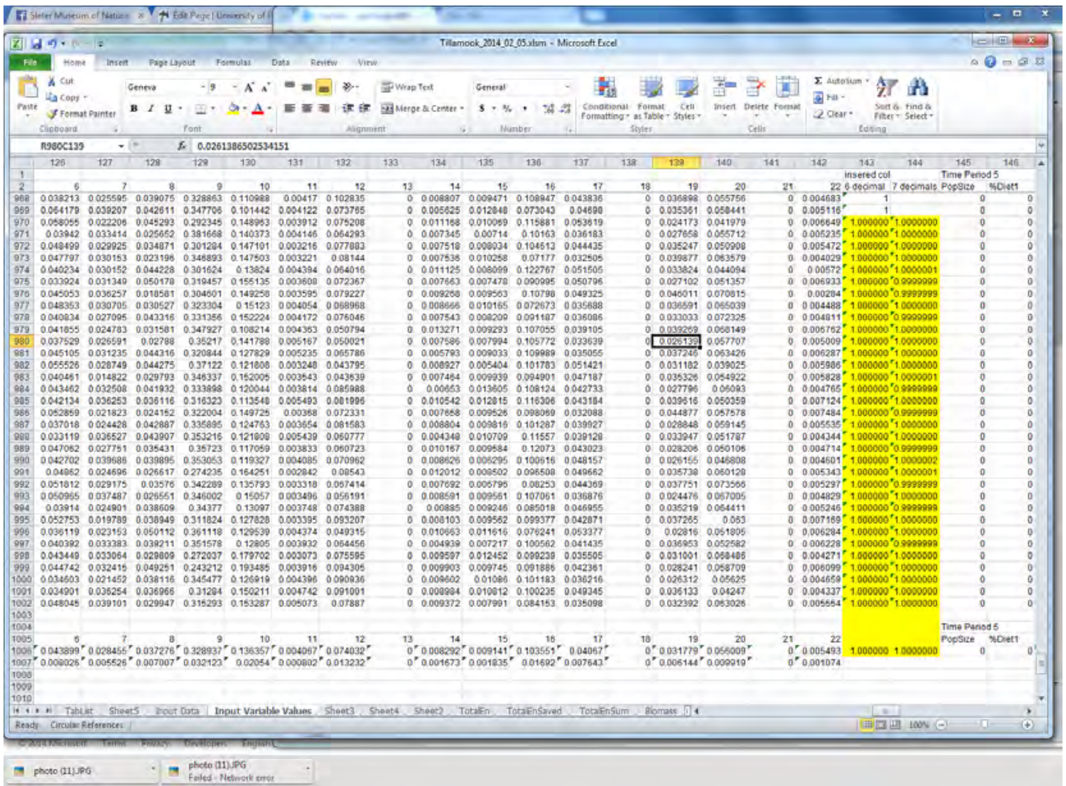
Rechisky, E. L., D. W. Welch, A. D. Porter, M. C. Jacobs-Scott, and P. M. Winchell. 2013a. Influence of multiple dam passage on survival of juvenile Chinook salmon in the Columbia River estuary and coastal ocean. PNAS (April) 110 (17):| 6883–6888.

Rechisky, E. L., D. W. Welch, A. D. Porter. 2013b. Reply to Haeseker: Value of controlled scientific experiments to resolve critical uncertainties regarding Snake River salmon survival. PNAS 110 (37):| E3465.

Trites, A. W. and R. Joy. 2005. Dietary analysis from fecal samples: How many scats are enough? J. Mammalogy 86 (4): 704-712.

Welch DW, Rechisky EL, Melnychuk MC, Porter AD, and Walters CJ. 2008. Survival of Migrating Salmon Smolts in Large Rivers With and Without Dams. PLoS Biol 6(10): e265
.
Zar, J. H. 2010. Biostatistical Analysis.

Table 1. Input Variable Values tab from "2012TillamookBayDCCOBioenergeticsModel" showing prey types 6-22 labeled in row 2 with the values from "random" generation of values in respective columns. I added columns 143 and 144 showing sums of the 22 "random" values illustrating the random values were adjusted to sum to 1 at the precision of six decimal places. Using truly random values and the sums vary from .5 to 1.5 depending on the seed values for standard error used to induce variation in the random numbers generator. The end result is that by forcing proportions to sum to 1, the simulation is not random and the variation in the final CIs are constrained.



	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
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2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	6 decimal	7 decimals	PopSize	%Diet1
968	0.038213	0.025595	0.039075	0.328863	0.110988	0.00417	0.102835	0	0.008807	0.009471	0.108947	0.043836	0	0.036898	0.055756	0	0.004683	1		0	0
969	0.064179	0.039207	0.042611	0.347706	0.101442	0.004122	0.073765	0	0.005625	0.012848	0.073043	0.04698	0	0.035361	0.058441	0	0.005116	1		0	0
970	0.058055	0.022206	0.045293	0.292345	0.148963	0.003912	0.075208	0	0.011168	0.010069	0.115881	0.053619	0	0.024173	0.041979	0	0.006649	1.000000	1.0000000	0	0
971	0.03942	0.033414	0.025652	0.381668	0.140373	0.004146	0.064293	0	0.007345	0.00714	0.10163	0.036183	0	0.027658	0.055712	0	0.005235	1.000000	1.0000000	0	0
972	0.048499	0.029925	0.034871	0.301284	0.147101	0.003216	0.077883	0	0.007518	0.008034	0.104613	0.044435	0	0.035247	0.050908	0	0.005472	1.000000	1.0000000	0	0
973	0.047797	0.030153	0.023196	0.346893	0.147503	0.003221	0.08144	0	0.007536	0.010258	0.07177	0.032505	0	0.039877	0.063579	0	0.004029	1.000000	1.0000000	0	0
974	0.040234	0.030152	0.044228	0.301624	0.13824	0.004394	0.064016	0	0.011125	0.008099	0.122767	0.051505	0	0.033824	0.044094	0	0.00572	1.000000	1.0000001	0	0
975	0.033924	0.031349	0.050178	0.319457	0.155135	0.003608	0.072367	0	0.007663	0.007478	0.090995	0.050796	0	0.027102	0.051357	0	0.006933	1.000000	0.9999999	0	0
976	0.045053	0.036257	0.018581	0.304601	0.149258	0.003595	0.079227	0	0.009268	0.009563	0.10798	0.049325	0	0.046011	0.070815	0	0.00284	1.000000	0.9999999	0	0
977	0.048353	0.030705	0.030527	0.323304	0.15123	0.004054	0.068968	0	0.008666	0.010165	0.072673	0.035688	0	0.036591	0.065039	0	0.004488	1.000000	1.0000000	0	0
978	0.040834	0.027095	0.043316	0.331356	0.152224	0.004172	0.076046	0	0.007543	0.008209	0.091187	0.036086	0	0.033033	0.072325	0	0.004811	1.000000	0.9999999	0	0
979	0.041855	0.024783	0.031581	0.347927	0.108214	0.004363	0.050794	0	0.013271	0.009293	0.107055	0.039105	0	0.039269	0.068149	0	0.006762	1.000000	1.0000000	0	0
980	0.037529	0.026591	0.02788	0.35217	0.141788	0.005167	0.050021	0	0.007586	0.007994	0.105772	0.033639	0	0.026139	0.057707	0	0.005009	1.000000	1.0000000	0	0
981	0.045105	0.031235	0.044316	0.320844	0.127829	0.005235	0.065786	0	0.005793	0.009033	0.109989	0.035055	0	0.037246	0.063426	0	0.006287	1.000000	1.0000000	0	0
982	0.055526	0.028749	0.044275	0.37122	0.121808	0.003248	0.043795	0	0.008927	0.005404	0.101783	0.051421	0	0.031182	0.039025	0	0.005986	1.000000	1.0000000	0	0
983	0.040461	0.014822	0.029793	0.346337	0.152005	0.003543	0.043639	0	0.007464	0.009939	0.094901	0.047187	0	0.035326	0.054922	0	0.005828	1.000000	1.0000001	0	0
984	0.043462	0.032508	0.041932	0.333898	0.120044	0.003814	0.085988	0	0.00653	0.013605	0.108124	0.042733	0	0.027796	0.06093	0	0.004765	1.000000	0.9999999	0	0
985	0.042134	0.036253	0.036116	0.316323	0.113548	0.005493	0.081996	0	0.010542	0.012815	0.116306	0.043184	0	0.039616	0.050359	0	0.007124	1.000000	1.0000000	0	0
986	0.052859	0.021823	0.024152	0.322004	0.149725	0.00368	0.072331	0	0.007658	0.009526	0.098069	0.032088	0	0.044877	0.057578	0	0.007484	1.000000	0.9999999	0	0
987	0.037018	0.024428	0.042887	0.335895	0.124763	0.003654	0.081583	0	0.008804	0.009816	0.101287	0.039927	0	0.028848	0.059145	0	0.005535	1.000000	1.0000000	0	0
988	0.033119	0.036527	0.043907	0.353216	0.121808	0.005439	0.060777	0	0.004348	0.010709	0.11557	0.039128	0	0.033947	0.051787	0	0.004344	1.000000	1.0000000	0	0
989	0.047062	0.027751	0.035431	0.35723	0.117059	0.003833	0.060723	0	0.010167	0.009584	0.12073	0.043023	0	0.028206	0.050106	0	0.004714	1.000000	0.9999999	0	0
990	0.042702	0.039686	0.039895	0.353053	0.119327	0.004085	0.070962	0	0.008626	0.006295	0.100616	0.048157	0	0.026155	0.046808	0	0.004601	1.000000	1.0000002	0	0
991	0.04862	0.024696	0.026617	0.274235	0.164251	0.002842	0.08543	0	0.012012	0.008502	0.096508	0.049662	0	0.035738	0.060128	0	0.005343	1.000000	1.0000001	0	0
992	0.051812	0.029175	0.03576	0.342289	0.135793	0.003318	0.067414	0	0.007692	0.005796	0.08253	0.044369	0	0.037751	0.073566	0	0.005297	1.000000	0.9999999	0	0
993	0.050965	0.037487	0.026551	0.346002	0.15057	0.003496	0.056191	0	0.008591	0.009561	0.107061	0.036876	0	0.024476	0.067005	0	0.004829	1.000000	1.0000000	0	0
994	0.03914	0.024901	0.038609	0.34377	0.13097	0.003748	0.074388	0	0.00885	0.009246	0.085018	0.046955	0	0.035219	0.064411	0	0.005246	1.000000	0.9999999	0	0
995	0.052753	0.019789	0.038949	0.311824	0.127828	0.003395	0.093207	0	0.008103	0.009562	0.099377	0.042871	0	0.037265	0.063	0	0.007169	1.000000	1.0000000	0	0
996	0.036119	0.023153	0.050112	0.361118	0.129539	0.004374	0.049315	0	0.010663	0.011616	0.076241	0.053377	0	0.02816	0.051805	0	0.006284	1.000000	1.0000000	0	0
997	0.040392	0.033383	0.038211	0.351578	0.12805	0.003932	0.064456	0	0.004939	0.007217	0.100562	0.041435	0	0.036953	0.052582	0	0.006228	1.000000	0.9999999	0	0
998	0.043449	0.033064	0.029809	0.272037	0.179702	0.003073	0.075595	0	0.009597	0.012452	0.099238	0.035505	0	0.031001	0.068486	0	0.004271	1.000000	1.0000000	0	0
999	0.044742	0.032415	0.049251	0.243212	0.193485	0.003916	0.094305	0	0.009903	0.009745	0.091886	0.042361	0	0.028241	0.058709	0	0.006099	1.000000	1.0000000	0	0
1000	0.034603	0.021452	0.038116	0.345477	0.126919	0.004396	0.090936	0	0.009602	0.01086	0.101183	0.036216	0	0.026312	0.05625	0	0.004659	1.000000	1.0000000	0	0
1001	0.034901	0.036254	0.036966	0.31284	0.150211	0.004742	0.091001	0	0.008984	0.010812	0.100235	0.049345	0	0.036133	0.04247	0	0.004337	1.000000	1.0000000	0	0
1002	0.048045	0.039101	0.029947	0.315293	0.153287	0.005073	0.07887	0	0.009372	0.007991	0.084153	0.035098	0	0.032392	0.063026	0	0.005664	1.000000	1.0000000	0	0
1003																					
1004																				Time Period 5	
1005	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22			PopSize	%Diet1
1006	0.043899	0.028455	0.037276	0.328937	0.136357	0.004067	0.074032	0	0.008292	0.009141	0.103551	0.04067	0	0.031779	0.056009	0	0.005493	1.000000	1.0000000	0	0
1007	0.008026	0.005526	0.007007	0.032123	0.02054	0.000802	0.013232	0	0.001673	0.001835	0.01692	0.007643	0	0.006144	0.009919	0	0.001074				
1008																					
1009																					
1010																					

Table 2. From BRNW Bioenergetics Model workbook "2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx" Input Values tab showing incorrect computation of SDs as the mean x the complement of the mean (Column I * (1-Column I)), which is the variance in a binomial distribution. Only Period 1 of 4 was used as an example but the error was repeated for all periods and presumably was systematic where the model has been used. The formula should have been the square root (SQRT) of the value shown in Std. Dev. From this the error is further compounded by using the incorrect formula for standard error. Note that Col I is mistakenly labeled "%"when it is actually a proportion. The mislabeling occurred numerous times in the workbook.

Column C	D	I	J
Prey species		% of diet by number fish watch	mean*(1-mean) Std. Dev.
Salmonidae	cutthroat	=I143*I144	=I154*(1-I154)
	chum	=I143*I145	=I155*(1-I155)
	Coho	=I143*I146	=I156*(1-I156)
	unid salmonid	=I143*I147	=I157*(1-I157)
	Steelhead	=I143*I148	=I158*(1-I158)
Clupiedae	Herring, Sardine, Shad	0	=I159*(1-I159)
Engraulidae	Anchovy	0	=I160*(1-I160)
Osmeridae	Smelt	0	=I161*(1-I161)
Embioticidae	Surf Perch, Shiner Perch	0	=I162*(1-I162)
Unid Nonsal	Unid Nonsal	0.0976169358827603	=I163*(1-I163)
Gasterosteidae	Stickleback	0	=I164*(1-I164)
Cottidae	Sculpin	0.110655945737682	=I165*(1-I165)
Ammodytidae	Sandlance	0	=I166*(1-I166)
Pholididae	Gunnel	0	=I167*(1-I167)
	Snake Prickleback	0	=I168*(1-I168)
	Other Prickleback	0.0824784085395439	=I169*(1-I169)
	Prickleback/Gunnel	0	=I170*(1-I170)
	Pipefish	0.00590722761596548	=I171*(1-I171)
	Rockfish	0	=I172*(1-I172)
	Greenling	0	=I173*(1-I173)
Gadidae	Cod	0	=I174*(1-I174)
Non-fish	Crustaceans, insects	0.0876003819004242	=I175*(1-I175)

Table 3. From BRNW Bioengergetics Model workbook "2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx" Input Values tab Period 1 of 4. Showing proportions (mislabeled as %), incorrectly computed SD and SE, correctly computed SD and SE, and differences. By using the incorrect SD and SE, variation is grossly underestimated, which significantly underestimates confidence intervals making it appear that the estimates of consumption were statistically and scientifically valid. Use of the incorrect SE was verified by inspection of summary values on the Input Variable Values tab.

	% of diet by fish watch	Incorrect Std. Dev.	Sample Size	Incorrect SE=SQRT(n)	Correct SE= SQRT(p (1 - p)) / n]	% difference relative to incorrect original value
cutthroat	0.139	0.120	14	0.032	0.092	77
chum	0.007	0.007	14	0.002	0.022	330
Coho	0.111	0.099	14	0.026	0.084	85
unid salmonid	0.009	0.009	14	0.002	0.025	286
Steelhead	0.350	0.228	14	0.061	0.127	56
Herring, Sardine, Shad			14			
Anchovy			14			
Smelt			14			
Surf Perch, Shiner Perch			14			
Unid Nonsal	0.098	0.088	14	0.024	0.079	90
Stickleback			14			
Sculpin	0.111	0.098	14	0.026	0.084	85
Sandlance			14			
Gunnel			14			
Snake Prickleback			14			
Other Prickleback	0.082	0.076	14	0.020	0.074	97
Prickleback/Gunnel			14			
Pipefish	0.006	0.006	14	0.002	0.020	349
Rockfish			14			
Greenling			14			
Cod			14			
Crustaceans, insects	0.088	0.080	14	0.021	0.076	95

Table 4. From BRNW/OSU Bioengergetics Model workbook “2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx”. Data suggesting there was an internal inconsistency in the BRNW/OSU model. Percent difference of prey proportions as reported on Input Tab and Input Variable Values tabs vs what was used based on back calculations from Output Biomass by Time Period tab. The numerical differences in the proportions are small but because of the extrapolations, predicted numbers can be large. See Fig 3.

	Back Calculated from Biomass		Period 1&2			Back Calculated		Period 3&4		
	Period 1	Period 2	Input Var. Values tab	numerical diff	% difference	Period 3	Period 4	Input Var. Values tab	numerical diff	% difference
cutthroat	0.1474	0.1431	0.13882	0.0064	4.6307	0.0217	0.0219	0.02059	0.0012	5.9422
chum	0.0053	0.0054	0.00661	-0.0013	-19.0140	0.0008	0.0008	0.00098	-0.0002	-19.4529
Coho	0.1292	0.1294	0.11145	0.0178	15.9937	0.0191	0.0194	0.01653	0.0027	16.5399
unid salmonid	0.0090	0.0092	0.00881	0.0003	3.3892	0.0013	0.0013	0.00131	0.0000	2.5254
Steelhead	0.3641	0.3671	0.35005	0.0155	4.4331	0.0552	0.0556	0.05192	0.0035	6.6767
Herring, Sardine, Shad	0.0000	0.0000	0.00000	0.0000		0.0492	0.0500	0.04347	0.0061	14.1185
Anchovy	0.0000	0.0000	0.00000	0.0000		0.0351	0.0352	0.02827	0.0069	24.3640
Smelt	0.0000	0.0000	0.00000	0.0000		0.0423	0.0431	0.03704	0.0057	15.3279
Surf Perch, Shiner Perc	0.0000	0.0000	0.00000	0.0000		0.3162	0.3157	0.32868	-0.0127	-3.8639
unid non salmonid	0.0967	0.0965	0.09762	-0.0010	-1.0172	0.1357	0.1350	0.13799	-0.0026	-1.9165
Stickleback	0.0000	0.0000	0.00000	0.0000		0.0034	0.0034	0.00406	-0.0006	-15.8712
Sculpin	0.0970	0.0987	0.11066	-0.0128	-11.5709	0.0652	0.0654	0.07358	-0.0083	-11.2460
Sandlance	0.0000	0.0000	0.00000	0.0000		0.0000	0.0000	0.00000	0.0000	
Gunnel	0.0000	0.0000	0.00000	0.0000		0.0084	0.0084	0.00832	0.0001	0.9971
Snake Prickleback	0.0000	0.0000	0.00000	0.0000		0.0096	0.0096	0.00911	0.0005	5.4376
Other Prickleback	0.0858	0.0849	0.08248	0.0029	3.5086	0.1100	0.1087	0.10429	0.0050	4.8182
Prickleback/Gunnel	0.0000	0.0000	0.00000	0.0000		0.0431	0.0425	0.04078	0.0020	4.9363
Pipefish	0.0054	0.0053	0.00591	-0.0005	-9.2352	0.0000	0.0000	0.00000	0.0000	
Rockfish	0.0000	0.0000	0.00000	0.0000		0.0352	0.0356	0.03173	0.0037	11.5389
Greenling	0.0000	0.0000	0.00000	0.0000		0.0446	0.0445	0.05590	-0.0113	-20.2370
Cod	0.0000	0.0000	0.00000	0.0000		0.0000	0.0000	0.00000	0.0000	
Crustaceans, insects	0.0601	0.0603	0.08760	-0.0274	-31.2379	0.0038	0.0038	0.00546	-0.0017	-30.6325
	1.0000	1.0000	1.0000			1.0000	1.0000	1.0000		

Comments on CENWP-PM-E / Double-crested cormorant draft EIS, Shugart, 14

Table 5. Data copy/pasted and parsed (gray cells) from Bird Research NW website (http://www.birdresearchnw.org/project-info/weekly-update/columbia-river-estuary) yearly breakdown of consumption.

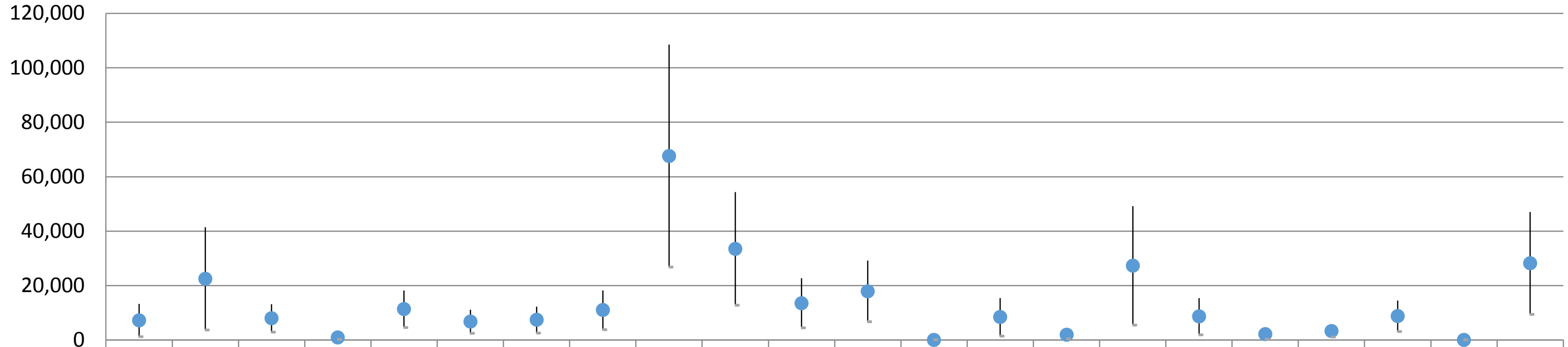
Using the total gm of fish in yearly samples, the gm of salmonids can be estimated, followed by gm of species or age, divided by average size of fish yieldsg the estimated number of fish in original sampl

Dividing millions of fish from Roby et al 2009-2013 by estimated number in original sample yeilds the extroplation "rate" for each fish (Fig. 5).

Year	gm identifiable fish	# stomachs	% samonids	gm salmonids		gm of salmonid	proportion	# fish, minimum* in sample	Extrapolated millions of salmonids from Roby et al 2009-2013	average gm/fish, from Tillamook Bay 2012 workbook, or Lyons et al	gm/stomach	millions/ # of fish	1 fish =
2013	25,281	134	11%	2,781	92% id'd			"=ColK/ColO"	see ColB				
	juvenile salmonids comprised 10.7% of the diet												
	11.4 million sub-yearling Chinook smolts (95% c.i. = 6.9 – 15.9 million; 70% of total					1,947	0.700	162	11.4	12		0.070	70,275
	2.7 million coho salmon smolts (95% c.i. = 2.0 – 3.4 million; 17% of total smolt consumption),					473	0.170	16	2.7	29.1		0.166	166,196
	1.0 million steelhead smolts (95% c.i. = 0.8 – 1.3 million; 6%),					167	0.060	3	1	59.6		0.357	357,197
	0.9 million yearling Chinook salmon smolts (95% c.i. = 0.6 – 1.1 million; 5%),					139	0.050	5	0.9	25.7		0.166	166,348
	0.2 million sockeye salmon smolts (95% c.i. = 0.05 – 0.3 million; 1%; Figure 70).					28	0.010	1	0.2	19.3		0.139	138,803
					TOTAL	2,753	0.990	188	16		20.5	0.086	86,117
2012	21,331	134	19%	4,053									
	18.9 million smolts (95% c.i. = 14.0 – 23.8 million),												
	10.8 million smolts or 57% were sub-yearling Chinook salmon (95% c.i. = 6.8 – 14.8 million),					2,310	0.570	193	10.8	12		0.056	56,100
	4.8 million smolts or 26% were coho salmon (95% c.i. = 3.5 – 6.0 million),					1,054	0.260	36	4.8	29.1		0.133	132,555
	1.7 million smolts or 9% were steelhead (95% c.i. = 1.3 – 2.1 million),					365	0.090	6	1.7	59.6		0.278	277,772
	1.5 million smolts or 8% were yearling Chinook salmon (95% c.i. = 1.0 – 2.0 million), and					324	0.080	13	1.5	25.7		0.119	118,897
	0.1 million smolts or 0.6% were sockeye salmon (95% c.i. = 0.00 – 0.3 million;					24	0.006	1	0.1	19.3		0.079	79,367
					TOTAL	4,077	1.006	249	19		30.4	0.076	75,989
2011	24,788	135	19%	4,710									
	76% were sub-yearling Chinook salmon (best estimate = 15.6 million smolts; 95% c.i. = 10.6 – 20					3,579	0.760	298	15.6	12		0.052	52,299
	13% were coho salmon (best estimate = 2.7 million smolts; 95% c.i. = 2.1 – 3.4 million),					612	0.130	21	2.7	29.1		0.128	128,327
	6% were steelhead (best estimate = 1.2 million smolts; 95% c.i. = 0.9 – 1.4 million),					283	0.060	5	1.2	59.6		0.253	253,094
	4% were yearling Chinook salmon (best estimate = 0.9 million smolts; 95% c.i. = 0.7 – 1.1 millior					188	0.040	7	0.9	25.7		0.123	122,778
	0.4% were sockeye salmon (best estimate = 0.01 million smolts; 95% c.i. = 0.00 – 0.05 million					19	0.004	1	0.01	19.3		0.010	10,245
					TOTAL	4,681	0.994	332	20		34.7	0.061	61,407
2010	23,356	134	16.50%	3,854									
	2010 was 19.2 million smolts (95% c.i. = 14.6 – 23.8 million),												
	69.8% were sub-yearling Chinook salmon (best estimate = 13.4 million; 95% c.i. = 9.1 – 17.6 mill					2,690	0.698	224	13.4	12		0.060	59,779
	15.6% were coho salmon (best estimate = 3.0 million; 95% c.i. = 2.3 – 3.7 million),					601	0.156	21	3	29.1		0.145	145,214
	7.8% were steelhead (best estimate = 1.5 million; 95% c.i. = 1.2 – 1.8 million),					301	0.078	5	1.5	59.6		0.297	297,413
	6.8% were yearling Chinook salmon (best estimate = 1.3 million; 95% c.i. = 1.0 – 1.6 million),					262	0.068	10	1.3	25.7		0.127	127,493
	and 0.2% were sockeye salmon (best estimate = 0.03 million; 95% c.i. = 0.01 – 0.06 million;					8	0.002	0.4	0.03	19.3		0.075	75,122
					TOTAL	3,861	1.002	260	19		28.8	0.074	73,831
2009	21,830	133	9%	1,965									
	74% were sub-yearling Chinook salmon (best estimate = 8.3 million; 95% c.i. = 5.1 – 11.4 million					1,454	0.740	121	8.3	12		0.069	68,506
	12% were coho salmon (best estimate = 1.4 million; 95% c.i. = 1.0 – 1.7 million),					236	0.120	8	1.4	29.1		0.173	172,800
	7% were steelhead (best estimate = 0.8 million; 95% c.i. = 0.6 – 1.0 million),					138	0.070	2	0.8	59.6		0.347	346,691
	6% were yearling Chinook salmon (best estimate = 0.7 million; 95% c.i. = 0.5 – 0.8 million), and					118	0.060	5	0.7	25.7		0.153	152,610
	< 1% were sockeye salmon (best estimate = 0.02 million; 95% c.i. = 0.01 – 0.03 million; Figure 32					18	0.009	1	0.02	19.3		0.022	21,830
					TOTAL	1,963	0.999	137	11		14.8	0.082	81,857

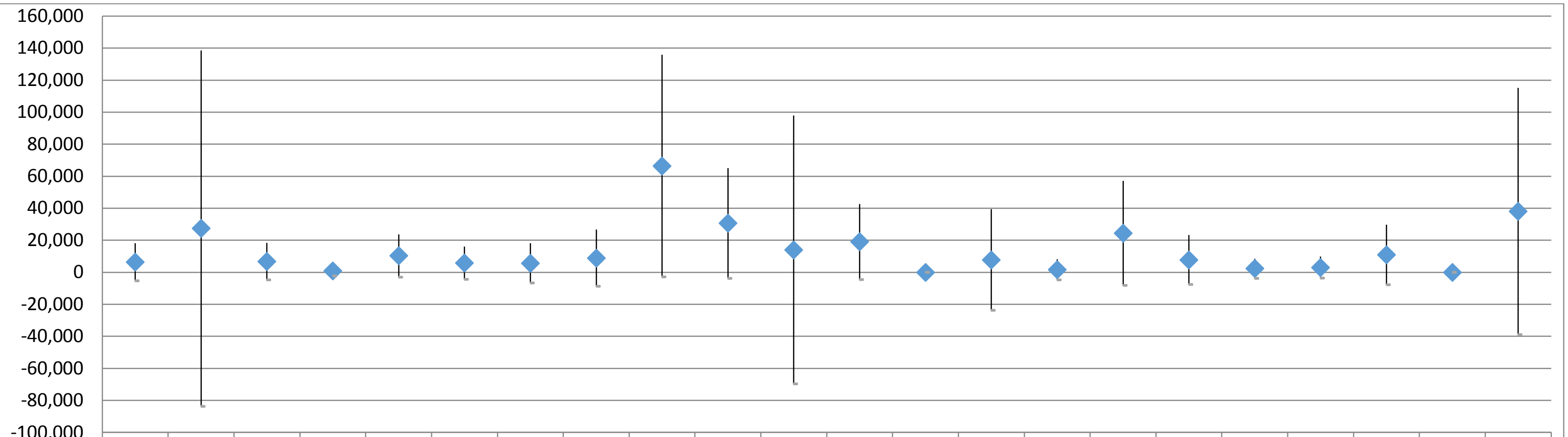
*from foregut, so fish mostly whole

Figure 1: From BRNW Bioenergetics Model workbook "2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx". Incorrectly computed confidence intervals using BRNW/OSU model showing that no intervals venture into negative territory because variation in values was grossly under represented. Compare to Fig. 2 for correct values.



	cutthroat	chum	Coho	unid salmonid	Steelhead	Herring, Sardine, Shad	Anchovy	Smelt	Surf Perch, Shiner Perch	Unid Nonsal	Stickleback	Sculpin	Sandlance	Gunnel	Snake Prickleback	Other Prickleback	Prickleback/Gunnel	Pipefish	Rockfish	Greenling	Cod	Crustaceans, insects
Midpoint of CI	7,264	22,512	7,989	913	11,399	6,751	7,408	11,004	67,615	33,524	13,559	17,893	0	8,455	1,920	27,284	8,634	2,223	3,320	8,794	0	28,238
+ 2 SDs	13,337	41,384	13,148	1,676	18,269	11,129	12,327	18,256	108,50	54,297	22,675	29,166	0	15,463	3,469	49,126	15,455	4,171	5,532	14,462	0	47,100
- 2 SDs	1,191	3,640	2,830	149	4,529	2,373	2,490	3,752	26,729	12,750	4,443	6,620	0	1,448	370	5,442	1,812	276	1,108	3,127	0	9,376

Figure 2. Predicting negative take of prey. Correctly computed 95% CIs using the corrected BRNW/OSU data from the Input Variable Value tab showing that the confidence intervals include a significant negative take for all prey categories and were 2-10x the original estimates. Although correctly computed in this example, a related issue was that proportions or percents, usually below .2 and above .8, need to be transformed to produce normalized values. This additional statistical problem was brought on by parsing data into too many categories, too many missing values in the raw data, and failure to understand basics statistics. This figure would make a humorous PowerPoint slide at professional meetings and reinforces the belief that modeling is useless when input variables are not controlled for quality and basic statistics are ignored.



	cutthroat	chum	Coho	unid salmonid	Steelhead	Herring, Sardine, Shad	Anchovy	Smelt	Surf Perch, Shiner Perch	Unid Nonsal	Stickleback	Sculpin	Sandlance	Gunnel	Snake Prickleback	Other Prickleback	Prickleback/Gunnel	Pipefish	Rockfish	Greenling	Cod	Crustaceans, insects
◆ Midpoint of CI	6,343	27,388	6,722	901	10,270	5,791	5,655	8,886	66,435	30,597	14,048	19,040	0	7,730	1,602	24,375	7,794	2,331	3,033	10,941	0	38,080
+2SDs	18,152	138,554	18,336	4,145	23,690	15,998	18,090	26,597	135,863	65,039	97,932	42,624	0	39,363	8,068	57,032	23,286	8,521	9,780	29,707	0	115,176
- -2SDs	-5,466	-83,778	-4,892	-2,343	-3,151	-4,416	-6,780	-8,826	-2,992	-3,845	-69,836	-4,544	0	-23,903	-4,865	-8,283	-7,698	-3,859	-3,713	-7,825	0	-39,016

Figure 3. Percent difference in prey proportions as reported on Input Tab and Input Variable Values tabs vs what was used based on back calculations from Output Biomass by Time Period (by prey type) tab in from BRNW Bioenergetics Model workbook "2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx". The numerical differences in the proportions are small but because of the extrapolations, predicted numbers can be large. There should be no differences and the inability to back calculate values suggests there is an internal inconsistency in the BRNW/OSU model.

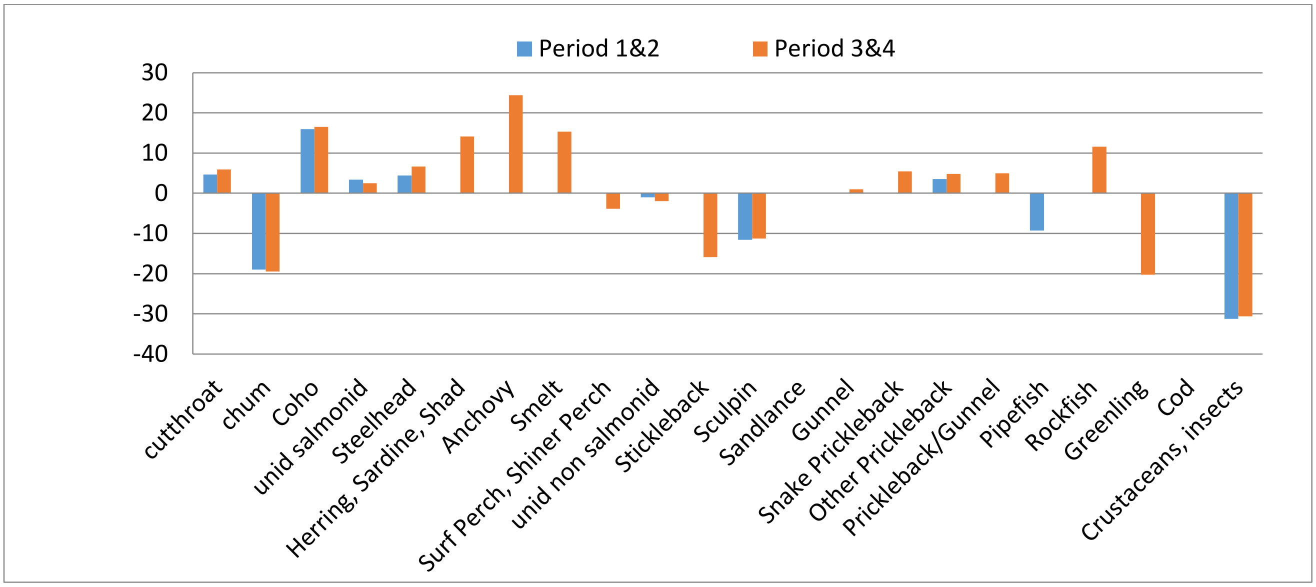


Figure 4. 2012 DCCO Tillamook Bay Genetic Samples, protocol for converting binary data to quantitative data and incorrect proportions.

Numbers denoted as 6a-9a are incorrect and 6b-9b are corrected. See text for explanation of sequence, 1 is not shown.

GWS notes: MTD15 3 samples, same species; TD22 2 samples same species, TD7 2 samples same species

w data (2)

Cou nt	Sample #	Samp Type	Colony	Collection Date	Sample No. NWFSC	Species ID
1	TD10a	Stomach	Tillamook	04/25/12	90569-TD10a	omykiss
2	TD10b	Stomach	Tillamook	04/25/12	90569-TD10b	clarki
3	TD10c	Stomach	Tillamook	04/25/12	90569-TD10c	unid
4	TD11	Stomach	Tillamook	04/25/12	90569-TD11	clarki
5	TD12	Stomach	Tillamook	04/25/12	90569-TD12	clarki
6	TD15	Stomach	Tillamook	04/26/12	90569-TD15	omykiss
7	TD15b	Stomach	Tillamook	04/26/12	90569-TD15b	omykiss
8	TD15c	Stomach	Tillamook	04/26/12	90569-TD15c	omykiss
9	TD1a	Stomach	Tillamook	04/12/12	90569-TD1a	omykiss
10	TD1b	Stomach	Tillamook	04/12/12	90569-TD1b	coho
11	TD22a	Stomach	Tillamook	05/07/12	90569-TD22a	chum
12	TD22b	Stomach	Tillamook	05/07/12	90569-TD22b	chum
13	TD2a	Stomach	Tillamook	04/12/12	90569-TD2a	omykiss
14	TD2b	Stomach	Tillamook	04/12/12	90569-TD2b	coho
15	TD38	Stomach	Tillamook	05/17/12	90569-TD38	omykiss
16	TD43	Stomach	Tillamook	05/17/12	90569-TD43	coho
17	TD45	Stomach	Tillamook	05/17/12	90569-TD45	coho
18	TD7a	Stomach	Tillamook	04/18/12	90569-TD7a	omykiss
19	TD7b	Stomach	Tillamook	04/18/12	90569-TD7b	omykiss

→ Frequency of occurrence (FO)

Frequency of occurrence (FO) parsed (3)

Sample #	Date	cutthroat	chum	coho	unid	steelhead		
1	04/12/12			0.5		0.5		
2	04/12/12			0.5		0.5		
7	04/18/12					1		
10	04/25/12	0.33333			0.3333333	0.33333		
11	04/25/12	1						
12	04/25/12	1						
15	04/26/12					1		
22	05/07/12		1					
38	05/17/12					1	7	
43	05/17/12			1			4	May n
45	05/17/12			1			11	total n
(4) Summed FO		2.33	1.00	3.00	0.33	4.33		
(5) Relative FO (pooling all samples)		0.21	0.09	0.27	0.03	0.39		
(GWS note, not used)								
april samples		0.33	0.00	0.14	0.05	0.48		
may samples		0	0.25	0.5	0	0.25		
								G. Shugart notes
assumed biomass (g)		45	5	28.1	20	61.1		original sticky notes, red upper right commets by Don L
(6a) Relative FO weighted by biomass		9.545	0.455	7.664	0.606	24.070	42.3	chum .6 gm as entered on the Input Tab, rather than 5 g
(7a) Proportions used to apportion to overall salmonids mistakenly using 45 gm for Cutthroat and 5 gm for chum, see below		0.225	0.011	0.181	0.014	0.568	1.0	check
biomass from Input Data tab (g)		40	0.6	28.1	20	61.1		
(6b) FO weighted biomass using IVV tab		8.485	0.055	7.664	0.606	24.070	40.9	
(7b) Proportional breakdown by biomass using 40 gm for cutthroat and .6 gm for chum		0.208	0.001	0.187	0.015	0.589	1.0	check

From the "Model" worksheet Input Data tab, note row 29 above is identical to cols L & N 31-35.
From here they apply these proportions to .616 & .091 salmon in the diet.

1. Compute salmonid vs non-salmonid proportions based on individual stomach proportions (not shown)
2. Genetic Id of some of the salmonid samples, 11 of 14 in Tillamook Bay 2012
3. Populate afrequency of occurrence (FO) matrix parsed by the number categories found (e.g., if two species or categories were found, each is assigned a FO of 0.5)
4. Sum FO by category
5. FO expressed as proportions of all summed FOs
6. FO proportions were weighted by average weight of fish
7. Weighted FO were expressed as proportions of the total weighted FOs
8. Weight FO proportions were used to apportion the overall salmonids to category
9. Use proportions from 8 to apportion Total kJ/ energy density (kJ/gm) to get biomass, then /average mass (gm) to get the number of fish in each category.

			Period 1-2 (Apr)	Period 3-4 (May)	
Diet					
fish watch % observed salmonid			0.616	0.091	Over all salmonid proportions from Input Data tab, note .616 is fro
% cutthroat		cutthroat	0.225	0.225	From Row 26, incorrect relative FO's weighted by biomass
% chum		chum	0.011	0.011	From Row 26, incorrect relative FO's weighted by biomass
% coho		Coho	0.181	0.181	From Row 26, incorrect relative FO's weighted by biomass
% unid salmonid		unid salmonid	0.014	0.014	From Row 26, incorrect relative FO's weighted by biomass
% steelhead		Steelhead	0.568	0.568	From Row 26, incorrect relative FO's weighted by biomass
			1.000	1.000	
(8a) Prey number		Prey species	% of diet by number fish watch	% of diet by number fish watch	Example of salmonid apportioning cell N35 x cell N36 = cell N 46 — 0.616 0.225 0.139
Prey 1	Salmonida	cutthroat	0.139	0.021	Incorrect values used in the Tillamook Bay 2012 simulation
Prey 2		chum	0.007	0.001	Incorrect values used in the Tillamook Bay 2012 simulation
Prey 3		Coho	0.111	0.017	Incorrect values used in the Tillamook Bay 2012 simulation
Prey 4		unid salmonid	0.009	0.001	Incorrect values used in the Tillamook Bay 2012 simulation
Prey 5		Steelhead	0.350	0.052	Incorrect values used in the Tillamook Bay 2012 simulation

Corrected values

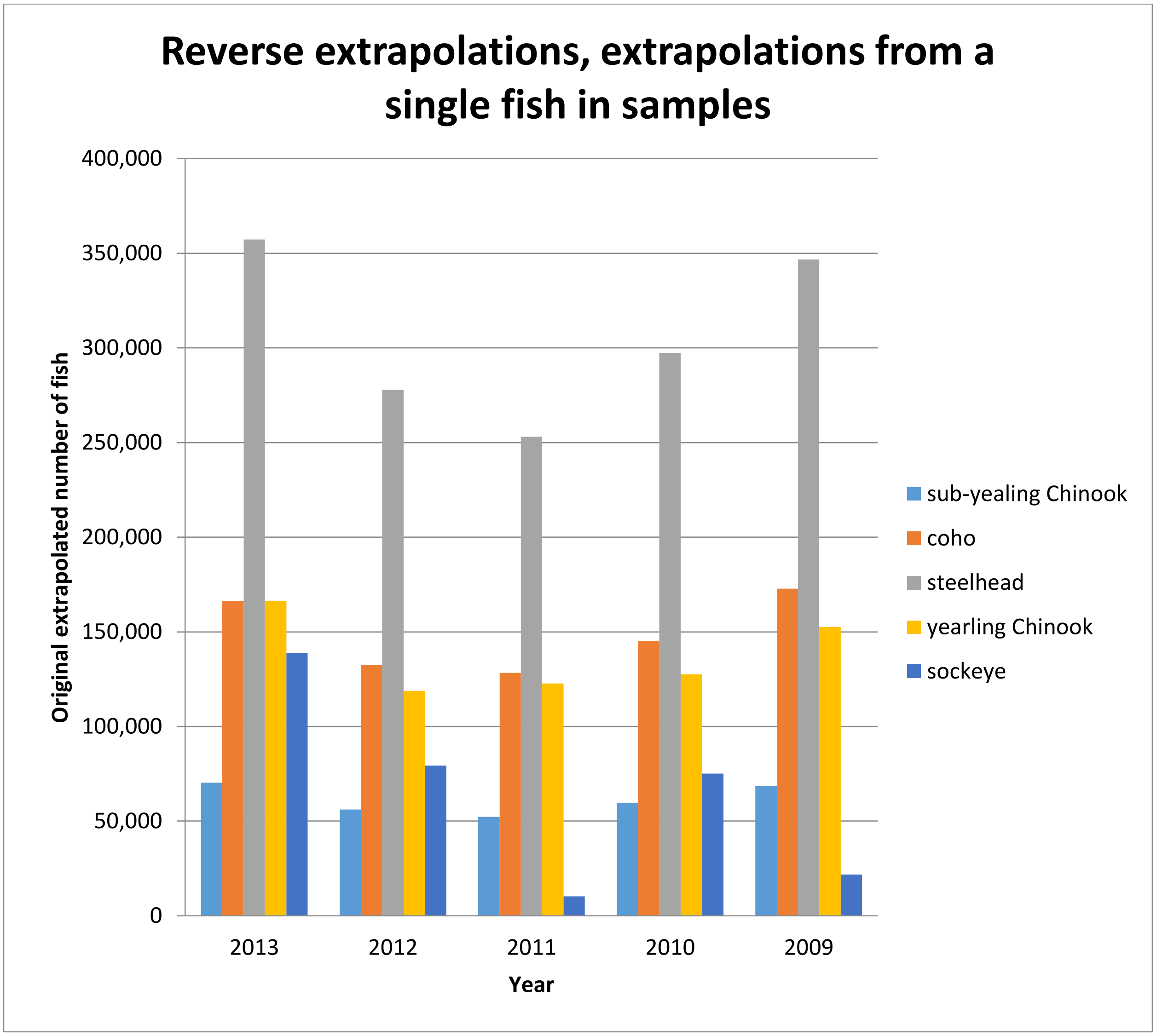
(8b)			Period 1-2 (Apr)	Period 3-4 (May)	
Diet					
fish watch % observed salmonid			0.616	0.091	
% cutthroat		cutthroat	0.208	0.208	From Row29, corrected values
% chum		chum	0.001	0.001	From Row29, corrected values
% coho		Coho	0.187	0.187	From Row29, corrected values
% unid salmonid		unid salmonid	0.015	0.015	From Row29, corrected values
% steelhead		Steelhead	0.589	0.589	From Row29, corrected values
			1.000	1.000	
Prey number		Prey species	% of diet by number fish watch	% of diet by number fish watch	
Prey 1	Salmonida	cutthroat	0.128	0.019	Corrected proportions
Prey 2		chum	0.001	0.000	Corrected proportions
Prey 3		Coho	0.115	0.017	Corrected proportions
Prey 4		unid salmonid	0.009	0.001	Corrected proportions
Prey 5		Steelhead	0.363	0.054	Corrected proportions

Number of fish eaten by category

	Category	(9b) Corrected	(9a) Original Lyons' calculations
Salmonidae	cutthroat	6,245	7,264
	chum	3,432	22,512
	Coho	7,332	7,989
	unid salmonid	913	913
	Steelhead	11,595	11,399
	Total	29,517	50,077

Figure 5. Computed from summary data from Roby et al. 2009-2013, see Table 5. Each fish in DCCO foregut samples was extrapolated to the number on the y-axis illustrating the tenuous

nature for original projection. Reverse extrapolations were necessitated in the absence of raw data.



Appendix A. Excerpt from: Using unverifiable and simulated data to managing piscivores: An example from Tillamook Bay 2012 with general comments on the Bird Research NW Bioenergetics model and management of Columbia River piscivores.
(draft as of 19 July 2014 latest)

Summary: Foregut sampling of Double-crested Cormorants (Ph*alacrocorax auritus*) was done in Tillamook Bay, Oregon in April-May 2012 to estimate the consumption of salmonids. Consumption was simulated using Bird Research Northwest's Bioenergetic Model (BRNWM) The model generated confidence intervals of consumption and used midpoints of the intervals as estimates of consumption. Findings were that cormorants consumed about 50,000 salmonids, which represented midpoints of relatively huge putative 95% confidence intervals. In reviewing the input and output from the model, I found it was deficient in many respects. Most importantly the take of salmonids was overestimated by 40% due to a mistake in apportioning salmonids. In the addition, the simulated numbers of salmonid consumed was based on an estimated 29.7 salmonids found in 11 of 45 stomachs over a two-month period that were then used to extrapolate to a total of ~50,000 (corrected to ~29,000) salmonids over four seemingly independent two-week periods. Many of the inputs were simulated due to inadequate sampling or in order to minimize confidence intervals. The standard deviations, and resulting standard errors, used in the simulations were critical inputs for generating the confidence intervals, but were extremely conservative or incorrectly computed. If done correctly, standard errors were greater than the mean values in many cases and confidence intervals contain negative values. Data used to calculate proportional take of salmonid prey were incorrectly computed as noted, but in addition, the resulting values were enigmatically pooled into one two-month period for individual salmonids, two one month periods for other prey and overall salmonid proportions, then calculations were done as if these were independent data for four two-week periods. The salmonid consumption data were treated in an idiosyncratic manner in attempt to convert binary data from genetic id to quantitative data for salmonid categories. Finally there appears to be an inconsistency or a bug in the model calculations based on failure of internal checks.

The BRNWM has been used extensively to guide management of piscivores in the Columbia River Estuary. Based on this overview and assuming the model as used for Tillamook Bay 2012 was representative, the entire effort needs review. Such a review should first include proofing for internal consistency of the code used to generate consumption numbers. Secondly, the assumptions regarding the input values, erroneously in many instances referred to as means, need to be clearly stated, and corrected SEs need to be incorporated in reruns of the simulations. In addition the code and input and output data should be published as appendices or workbooks such as that provided to ODFW for Tillamook Bay 2012. Finally the raw sample data should also be published and place in the public domain. These steps should be sufficient to allow a full review. In general, the Tillamook Bay 2012 calculations indicate that the BRNWM used to manage piscivores lacks statistical and scientific rigor.

Appendix A, Table 1. Input values for BRNW/OSU Bioenergetics Model workbook "2012 Tillamook Bay DCCO Salmonid Consumption 2013 06 21.xlsx highlighting some of the deficiencies resulting in a "garbage in, garbage out" example of ecological modeling. Each values referred to as a mean and the standard errors were used as seed values to generate 1,000 values

Input Variable	Population size	Daily Energy Expenditure	Assimilation Eff	Days	Proportions of non-salmonids vs total salmonids	Proportions of salmonids	Energy Density	Biomass/prey
Value expressed as a mean	Counts (N=4,4,4,2), but converted to pairs, adjusted by Ass Eff, too few	7 males, 3 females, nonstandard day length during 2001-2006, used grand mean unweighted by difference in sample size for sexes	apparently from literature	3-15 & 1-16 day period	Variable, zero filled, eg, 4 based on a single stomach	Qualitative genetic data (Yes/No) converted to quantitative data using Rube Goldberg like protocol	Empirically derived and simulated	Empirically derived and simulated
Standard Errors for generation of 1000 iterations	Simulated as 1.5 pair, should have been 17.1, 18.9, 60.8, 1.5 pairs (indexed), latter based on 2 counts, for four periods, respectively.	Simulated, ~ 5 times too low	see Population Size	no variation, constant for 1,000 iterations	Simulated using non-standard or mistaken calculation	Simulated using non-standard or mistaken calculation	Empirically derived and simulated using non-standard or mistaken calculation	Empirically derived and simulated using non-standard or mistaken calculation

COMMENTS ON Draft Environmental Impact Statement (DEIS)
Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary
Public Notice CENWP-PM-E-14-08
June 19, 2014

Submitted by:
Kenneth L. Stromborg, Ph. D.
Certified Wildlife Biologist
Denmark, Wisconsin

comments noted

I am a professional Certified Wildlife Biologist®, now retired after more than 30 years employment by the Fish and Wildlife Service (FWS). I have more than 25 years of hands on experience conducting research on double-crested cormorants in the United States and Canada, including a continuing project on the population ecology of several breeding colonies in Wisconsin that is entering its 15th year. More than 30,000 cormorants have been banded under my banding permit. I have published several peer-reviewed papers on this topic and made many professional presentations at scientific meetings. I am deeply concerned with the implications for migratory bird management in North America of FWS issuing a depredation permit as proposed in the preferred alternative in the DEIS. This permit would reduce an entire flyway population of a native species by amounts approaching 50%. This population is still far below historic levels and is only now recovering from the deleterious effects of human persecution and environmental pollution during the 20th century. Such a radical departure from the precepts underlying migratory bird management is disheartening and offensive. Colonial waterbird species were at the heart of the conservation movement at the beginning of the 20th century. Today, it appears that FWS is concerned only with preventing the most drastic declines in these populations and is willing to allow them to be driven to the point where their long term persistence is threatened before acting to conserve and protect them.

The DEIS is another sadly defective government document that attempts to justify decisions made for political reasons. It is obvious that all of the information presented has been selectively chosen to support the decision to kill a staggering number of double-crested cormorants at East Sand Island in order to reduce the number of salmonid smolts eaten by piscivorous birds. Somehow, that is supposed to be connected to increasing the harvest of adult salmonids, which appears to be the actual goal of the biological management program in this ecosystem. As some prior comments have identified, there is no serious effort to document and measure the
G-4 → compensatory mortality factors affecting salmonids in this system and seizing on predation by a single species as an important management tool is unsupported by the evidence in the DEIS. The various agencies involved in this project should be concentrating their attention on this overall relationship instead of rushing into a program of killing vast numbers of cormorants. Once again,
G-16 → cormorants are being singled out as scapegoats for the environmental problems that are the real drivers in fisheries management. Killing an unpopular species is politically expedient, relatively cheap, and provides a very visible smoke screen for the real problems with the Columbia River ecosystem. It also satisfies the blood lust of vocal user groups that demand immediate action to lash out at some perceived threat to their ability to harvest salmon.

Figure 3-16 provides a very compelling illustration of the problem here. The industrialization of the Columbia River basin over the past 70 years is the problem, not the abundance of cormorants. The argument that nothing can be done about dams interrupting fish passage, horrid land use G-2 practices in the watershed, human disturbance of the ecosystem, etc. is specious. Singling out one species, or a suite of species, as the cause and potential salvation of salmon stocks is wrong. Historically, avian predators and salmon coexisted with humans on a sustainable basis. Today, the demand for harvestable salmon has overwhelmed the capacity of the system to absorb human predation pressure and other resource uses regardless of other species' requirements. It is the human dimension that is out of control in this system, not the intrinsic biology of the component parts. The decision that must be addressed is resource allocation, not single species management goals. No matter what management plan is instituted, there will never be enough salmon to satisfy an unlimited human demand.

The technical details of this DEIS analysis are seriously flawed by limited consideration of alternatives to mass killing. No real management scale research has been conducted on various G-10 non-lethal approaches to managing cormorant predation on salmonid smolts. Exploratory studies were apparently conducted and the successful results were rejected in favor of the quick fix of mass killing. Whatever is done in the Columbia estuary, there will have to be a perpetual commitment to management and there is no reason to rush into quick fixes. The survival gap G-5 analysis is a pitiful application of what Richard Feynman labeled "Cargo Cult Science" and obfuscates rather than clarifies issues. There is nothing special about using a commercial spread sheet program to collect data and manipulate them to generate an answer. The real goal should be collecting relevant data, using them in rigorous models, and subjecting the entire process to intense critical scientific review by independent scientists. Just because something looks fancy does not give it any particular gravity in arriving at reliable predictions or descriptions of nature. The value of any model lies in the validity of the propositions used to construct it. The details of FEIS App. C these propositions are missing from the DEIS and further, the actual data used are inaccessible except to those who have both the time and experience to dig into unpublished files. Before proceeding with selecting any alternative, a thorough critical review of the data has to be undertaken by competent independent professionals who are being compensated for undertaking the arduous review required. In addition, there has been no consideration of the G-3, G-4 potential ecosystem effects of removing cormorant predation from other species in this system. Salmonids are only a small proportion of cormorant diets in most years and if that is a significant detriment to salmonids, it follows that more important dietary components might be similarly affected if cormorant predation is significantly reduced. The history of management of the Columbia River basin is replete with such unintended consequences. Conducting a more complete analysis of the entire trophic structure of this system is essential to avoid repeating the errors of the past.

In particular, it looks to me like equating the cormorant take of smolts to losses from a single major dam misses the critical point that there are multiple dams and barriers and other hazards to smolts during their outmigration. These multiple losses are cumulative and surely far exceed G-2 the loss to cormorants. Superficially, it looks like there is an extremely strong relationship between the breeding location of a distinct population segment and the number of obstacles it has to overcome from outmigration to breeding. There is also a distinct lack of recognition that G-16 predators, including cormorants, exert a very positive force on prey populations. Predators provide an irreplaceable selective force maintaining the genetic viability of prey populations, and, they also selectively remove diseased and injured prey.

If indeed cormorant population reduction at East Sand Island is required to meet a management objective, then at least it should be done in the most humane, effective manner. Alternative C was chosen by the agencies as the best alternative, but the reasoning focuses on short term results rather than ecological reality. The "problem" has blossomed since the completion of the Bonneville Dam project in the 1940s. A rush to solve this kind of problem in a time frame measured in years is simply ridiculous. Reducing the cormorant population by 60%+ will not solve anything. It is important to recognize that active management of any wildlife population to a human imposed level is a perpetual commitment. Whatever is done at East Sand Island will require effort forever. Reducing the number of breeding cormorants by killing nesting adults might result in immediate results to the local cormorant breeding population, but it will most likely result in spreading cormorants across the broader landscape as has happened repeatedly in the Interior population. Instead of the brute force approach in Alternative C, the focus should be directed toward reducing the reproductive rate, and consequently population size, by the very simple alternative of removing eggs without stimulating renesting behavior. If a single viable egg is left in each nest, most adults will continue to incubate. I suggest removing eggs instead of oiling because at the scale anticipated, it will be easier to make sure that all nests have been treated by removal rather than oiling. This will immediately reduce the potential production of young by at least 50%, probably more, even if some areas of the colony containing non-target species are left untreated. Even though results will not be seen in the breeding population for several years, the population will decrease. There will be an immediate reduction in energetic requirements related to the reduction in numbers of viable offspring. This should be reflected in reduced predation and the hypothesis that cormorant reduction is effective can be probed over a succession of years. Nest abandonment should be minimal depending on the skill of the technicians tasked with removing eggs (much less complicated than training sharpshooters). Egg removal should be done every three weeks (based on incubation times for cormorant eggs), at night, under minimal light conditions (centered on new moons) to minimize nest destruction by predators and consequent renesting. Given the numbers in the DEIS for the kill under Alternative C, approximately one ton of eggs will have to be removed per visit in order to keep clutches to a single viable egg. Shooting cormorants off of nests twice a week (inferred from the description in the EIS) would require collection and disposal of approximately one ton of dead birds per event. There is about a 6 to 1 advantage of removing eggs (once every 3 weeks) as opposed to killing adults (twice a week for 3 weeks), using the metric of just the effort required to collect biomass. That advantage is particularly important in minimizing repeated disturbance of the colony. In addition, egg removal can be done at night, but searching for and removing carcasses would have to be done during daylight. The expenditure of effort by teams of skilled sharpshooters is in addition to the simple task of collecting biological material. If some of the non-lethal alternatives that were shown to be effective in preliminary tests are also incorporated, progress would be much quicker and noticeable population reductions should be seen relatively quickly.

G-30, FEIS Section 2.2.4, Section 2.5

The real advantage of actively manipulating reproduction is that shooting adults is inherently inhumane. No matter how expert the sharpshooters, many birds will be crippled and suffer lingering deaths. The proposal in the DEIS also does not seem to recognize that killing adults after the very first egg in a colony hatches will result in orphaned nestlings that will starve, overheat, or die from lack of water. None of these fates is particularly attractive and should be avoided on ethical grounds alone regardless of the need to reduce the population. Adopting a killing strategy that focuses on 20% adult mortality before the first egg hatches squeezes the window of management and increases the amount of highly trained manpower needed to accomplish the task. The lack of any consideration of ethical imperatives in the DEIS is extremely

G-15, G-16, G-17

offensive. Lethal control as a technique for reducing conflicts with wildlife should be the very last resort, never the starting point.

The most serious flaw in this Draft EIS is the complete lack of a detailed plan to measure the effects of cormorant management on the variable that is actually driving the action. There is no serious discussion of a plan to connect reducing the cormorant population to changes in the adult salmonid populations of the Columbia estuary, or more importantly, increases in reproductive output of distinct population segments. This alone should invalidate the entire process and send it back to the drawing board. It is an example of faith based management run riot. The reasoning is that if cormorant predation on salmon smolts is reduced during outmigration, that means there will be more adults years later when they return and consequently, more reproduction. No empirical evidence for this is presented, no justification, just a belief that this is true. Ecological systems are much more complex than this, and any management plan has to recognize and respond to the data needs necessary to evaluate effectiveness. Under the preferred alternative C, the first hypothesis that should be put to test is that reducing cormorant predation, by whatever mechanism chosen, increases outmigration success. The next test is of the proposition that such an increase in outmigration results in measurably increased return of adults attributable specifically to reductions in cormorant predation. Testing the proposition that an increase in adult return caused by reduced cormorant predation during outmigration results in a measurable increase in reproductive output of individual population segments completes the cycle. If these various propositions cannot be tested empirically, the decision process is fatally flawed and management resources will be committed based on faith alone, not rational scientific thought.

G-2, G-12

G-3, G-4

This Draft EIS is seriously biased and should be rejected as insufficient. As a starting point, a new DEIS should be structured around the principles for large scale population manipulation articulated by Norton and Warburton (J. WILDL. MANAGE. 73(1):158–164; 2009) for lethal control activities. Their principles apply much more broadly than to lethal control activities. Only by approaching this management question as an opportunity to learn from our actions can we avoid further misguided, ineffective, costly mistakes like those afflicting management of cormorants east of the Rocky Mountains. At a minimum, an independent scientific review including fisheries and wildlife scientists, and environmental ethicists, should be conducted before proceeding.

COMMENTS ON:
Public Notice number CENWP-PM-E-14-08
USACE Draft Environmental Impact Statement
To Reduce Double-crested Cormorant Predation of Juvenile Salmonids in the Columbia River Estuary, June 19, 2014.

Submitted by:
Linda R. Wires, MS & MA
Conservation Biologist
Minneapolis, MN

These comments respond to the U.S. Army Corps of Engineers (USACE), Portland District, Double-crested Cormorant management plan to reduce predation of juvenile salmonids in the Columbia River Estuary.

comments noted

I have been monitoring the status and distribution of cormorants in eastern North America since 1998. I was the lead author of the 2001 North American Double-crested Cormorant Status Assessment completed under contract with the USFWS. I have also reviewed and commented on all of the Environmental Assessments and Environmental Impact Statements for DCCO management that have been developed since 2003. In 2014, I published a book on Double-crested Cormorants (hereafter DCCO) entitled, *The Double-Crested Cormorant, Plight of a Feathered Pariah*. This work included detailed reviews of the science underlying assessment of fisheries impacts from DCCOs, and management of this species under the two depredation orders in states east of the Mississippi River. Although most of my work with cormorants has been in the eastern U.S., I am familiar with the issues surrounding DCCOs in western North America. To gain a broader understanding of issues specifically in the Columbia River estuary and help provide informed comments on the USACE DEIS, I also visited the East Sand Island (ESI) colony in July of 2014. During this visit I was able to spend time at the colony and also interact with many of the biologists, managers, and resource professionals involved in this issue.

After reviewing the available science surrounding the conflict at ESI, and spending some time at the site, I am writing to strongly encourage the USACE to pursue a less aggressive, nonlethal approach to resolving conflicts with cormorants. I believe Alternative C (the Preferred Alternative) is inappropriate for several reasons, which are described below.

G-5, G-7, FEIS Section 1.2, App. D

1. **"Survival gap" analysis and population objective for cormorants**. The population objective of ~ 5,600 pairs of DCCOs is based on a "survival gap" analysis completed by NOAA Fisheries that relies on 3 essential datasets: estimates of smolt consumption, estimates of cormorant population, and estimates of smolt population sizes. To have confidence in these estimates, each needs to be based on robust methods, but from what is presented in the DEIS (Appendix D), many of them clearly are not. Therefore, the population target for cormorants is based on an analysis that is not scientifically rigorous enough to inspire confidence and clearly demonstrate that the chosen population target is appropriate. Some issues:

Smolt abundance. The estimates of smolt abundance rely on "memos" that can't be readily accessed for review. Additionally, the original purpose of the estimates recorded in the memos are for use by NOAA's permit office on proposed actions that would occur in a given upcoming year. As such, the estimates are predictions, and generally not verified afterwards using any empirical measurements. The actual data collected are relatively sparse and many of the component estimates are little more than back of the envelope calculations…in some cases little more than educated guesses. So we have the following combination of problems: estimates based on a very data-sparse foundation; methodology that is not readily accessible, nor independently peer-reviewed (never published in a journal or even a peer-reviewed technical memo); no attempt to understand or quantify the uncertainty/error associated with the estimates; no empirical measurements to assess the accuracy of the estimates; and estimates generated for a very different purpose than their use in the DEIS. Considering the scale of lethal culling and population reduction that the DEIS proposes, using imprecise, uncertain estimates like this to quantify the management objective is unacceptable.

G-7, FEIS App. D

Estimates of smolt consumption. The "survival gap" analysis was conducted at the species level for steelhead and sockeye salmon, and for a particular age-class of Chinook salmon. However, estimates of predation rates are available at the level of the conservation units listed under the ESA, ostensibly the reason for considering management of DCCOs. I am referring here specifically to NOAA Fisheries' data on smolt PIT tag recoveries collected at the DCCO colony on East Sand Island. These data measure stock-specific predation impacts, and the estimates have greater precision and specificity to the conservation units of interest, estimate uncertainty, and take into account possible variation in predation rates due to rearing and migration history. It is not clear why these data, acknowledged repeatedly in the DEIS, were not used in developing the cormorant management objective. Furthermore, the DEIS states on p. 32, Chapter 4, "This EIS adopts NOAA Fisheries analysis (see Chapter 1, section 1.2) and associated survival gap estimates, but proposes to use PIT tag recoveries in the future to evaluate management actions. PIT tags provide ESU or DPS specific estimation of predation rate, consistent with NOAA Fisheries (2014) directive to obtain stock-specific data when possible. Predation rates on ESA-listed Columbia River Basin ESUs or DPSs, using PIT tag recoveries on the East Sand Island DCCO colony over the last ten years, are provided in Chapter 3, section 3.2.5 and Appendix C." This acknowledges that the PIT tag data are available and are more appropriate for the analysis. Thus, in this regard, the best science available was not used in NOAA Fisheries' survival gap analysis.

G-3

Variability in cormorant diet. Research by Lyons et al. (2014) to evaluate potential benefits to salmon recovery from different DCCO management scenarios demonstrated that the annual consumption of juvenile salmonids by DCCOs varied widely from year-to-year. For instance, in 2005 DCCOs consumed about 2 million salmonid smolts, while in 2011 they consumed 20 million. These vastly different consumption rates occurred when cormorant numbers were quite similar, indicating that factors other than just cormorant numbers influence consumption rate. Therefore, reductions in cormorant numbers may not lead to the presumed benefits expected when an average consumption rate of 11 million salmonids is presumed. Moreover, lower levels of predation that are acceptable to NOAA may occur without reductions in colony size. The analysis does not take into account either of these possibilities.

G-5

Extrapolation to base period and estimated predation rate. The analysis also extrapolates data collected during 1998-2012 to the period from 1980 to 1997 to determine rates of salmonid consumption (and abundance). But the data presented in the DEIS (as noted above) demonstrate that very large inter-annual variation in cormorant consumption rates of salmonid smolts characterize cormorant diets. This great variation makes it impossible to determine how close the extrapolation to the earlier period comes to reality. Since this extrapolation is very important in defining the management objective for DCCOs, it is critical to have greater confidence in this information. The increase in DCCO predation from the base period to the current period is used to define the necessary DCCO reduction to return to a lower predation rate, but there is no way to interpret the biological relevance represented by this level of reduction in DCCO predation. This is another weak aspect of the analysis.

G-4, FEIS, App. C, Section 4.6.5

Compensatory mortality and uncertainty. The analysis dismisses the importance of compensatory predation mortality by arguing that the extent to which it may occur doesn't influence the management objective to return to a prior level of predation. However, potential benefits arising from cormorant management do not necessarily equal potential benefits arising from management to reduce mortality due to other factors (e.g., at a dam), despite similar smolt mortality rates, due to likely differences in the proportion of mortality that is compensatory. The DEIS points out that smolt mortality caused by cormorant predation is generally comparable to the mortality induced by one mainstem dam. While that may be true, smolt mortality due to cormorant predation is more often focused on less fit fish compared to mortality at dams (e.g., turbine passage), which likely affects all fish regardless of their condition. Due to these differences in the extent of compensatory mortality between predation and dam passage, the benefit of cormorant management is not appropriately assessed in the context of other recovery actions. Furthermore, the DEIS states on p. 33-34 (Chapter 4) that even once colony size is reduced to targeted levels, "smaller increases in juvenile salmonid survival than are presented in Tables 4-2 and 4-3 could occur, depending on the actual degree to which DCCOs greater than the target colony size can be completely excluded from the estuary and to the degree mortality is compensatory (see Chapter 4, section 4.6.5 for more discussion)." This clearly acknowledges the fact that reductions in cormorant colony size may not directly correlate with targeted increases in salmonid survival rates, due at least in part to unpredictable levels of compensation. In section 4.6.5 the DEIS discusses the issue of compensatory mortality and uncertainty, and states "the purpose and need of this EIS is to reduce depredation damage caused by DCCO predation of juvenile salmonids, which is a well-studied and documented source of mortality. Constraining management due to unknown and speculative amounts of compensatory mortality would allow a known source of significant mortality of juvenile salmonids within the Columbia River Estuary to continue unaltered." While cormorant predation may be a well documented source of mortality, this statement does not diminish the importance of the fact that some portion of the mortality due to cormorants may be completely meaningless if it is replaced by some other mortality factor, and DCCO reduction does not ultimately lead to an increase in the number of adults that return to spawn. Therefore, I do not think this issue has been adequately addressed relative to salmon recovery and cormorant population size.

G-2, FEIS Section 1.1.5, 4.2.5

Relationship of cormorant predation on salmonid smolts to salmon recovery. The role of cormorant predation and the relationship of increasing survival of listed salmonid smolts in the estuary to numbers of adults returning to spawn is not addressed. However, returns of adult salmon and a self-sustaining population are the ultimate measure of salmon recovery. Some evidence that reducing cormorant predation on smolts is going to lead to significantly increased salmon recovery should be presented. At the very least the relationship of smolt survival to returning adults should be explored in more detail, so that the role of cormorant predation can be understood in a broader context. If these fish experience high mortality in the marine phase of their lifecycle, to what degree is reducing cormorant predation in the estuary going to contribute to the number of adult salmon returning? For instance, on p. 3-41, the DEIS reports "that subyearling [Lower Columbia River] Chinook are particularly vulnerable to cormorant predation, with average annual consumption estimates of 7.8 million (range = 1.9-15.6) subyearling Chinook during 2004-2013." On the same page the DEIS also states that "between 50 and 100 million [Chinook] subyearlings [have been] released annually into the Lower Columbia River Basin since the 1990s (NOAA 2011a)." Yet, on p. 3-39, the DEIS states that in the Columbia River Basin, many populations of salmonids "have been declining since the late nineteenth century, with documented losses to harvest, habitat degradation, hydropower development, and other anthropogenic causes (Gresh et al. 2000; Lichatowich 2001; NOAA 2014a)…. Before industrialized development occurred, numbers of adult salmon in the Columbia River Basin were estimated to be around 10 to 16 million adult fish per year (Gresh et al. 2000). Currently, less than two million adult salmon return to the Columbia River Basin annually (FPC 2014)." If only two million adults salmon are returning to the basin annually, what else is happening to all the other tens of millions of fish that are apparently present (due to a combination of hatchery releases and natural reproduction) that so few make it back? Of the fish avoiding cormorant predation in the estuary, how many survive only to be consumed later by other predators in the ocean? To what extent does the mortality that occurs there diminish benefits of reducing cormorant consumption of smolts in the estuary? This is a big picture question fundamental to the whole effort, and nothing presented in this DEIS has demonstrated that killing cormorants in the estuary is going to ultimately result in substantial increases in the numbers of adult salmon returning to spawn.

G-5
G-7,
FEIS
Section
4.2.5

Conclusion for #1. While there may be a need to limit DCCO predation on ESA-listed salmonid species, NOAA Fisheries' "survival gap" analysis does not demonstrate that the cormorant population needs to be limited to the extent the analysis proposes. Rather, the presumed level of improvement to salmonid survival rates from proposed reductions to cormorant numbers is highly questionable. Notably, the survival gap analysis has not been peer-reviewed, nor did it utilize scientific information provided by Lyons et al. (2014) on potential benefits to salmonid recovery expected from reducing the numbers of breeding DCCOs in the estuary. I believe that submitting this analysis to a more rigorous evaluation by a panel of objective experts would highlight the flaws described above, and would substantiate that the best available science was not used to arrive at the DCCO population objective. This is a serious oversight, as the decision to reduce the population size by two-thirds will affect tens of thousands of birds and has the potential to negatively impact the entire western DCCO population. A proposal to eliminate cormorants to this magnitude should warrant a much more formal and rigorous analysis than what appears to have been done in these Excel spreadsheet calculations, and one that is supported by the peer review process. Moreover, the extent to which reducing cormorant predation on smolts will contribute to salmon recovery as measured by adult salmon returns remains unaddressed, and ultimately may be minimal if salmon spared from cormorant predation ultimately experience higher mortality rates once they leave the estuary. Finally, in a broader context, one of the important conclusions from my book (Wires 2014) is that most cormorant management either is not science-based, is based on poor-quality science, or is contrary to what scientific studies indicate. Based on my observations and concerns described above, the same conclusion is emerging for the management alternative advocated by the USACE in the DEIS.

G-10,
G-11,
G-23,
FEIS
App G,
Section
1.1.6

2. **Lethal activities to resolve conflicts.** The USFWS is tasked not only with managing migratory birds, but also protecting them. To this end, relative to issuing depredation permits, the agency clearly states on its website: "You DO need to demonstrate substantial non-lethal methods such as harassing/hazing, exclusions, habitat management, and cultural practices prior to applying for a permit (http://www.fws.gov/pacific/migratorybirds/Permits/dprd.html)." In recognition of this requirement, the DEIS indicates that nonlethal approaches have been employed to try to resolve conflicts with cormorants over ESA-listed salmonids. The Corps argues these methods failed, and therefore a more aggressive lethal approach is advocated. However, after reviewing what has actually been done in this regard and engaging in discussions with USGS researchers studying nonlethal approaches, I believe this statement misrepresents how and why nonlethal approaches have been employed to resolve the conflict in the Columbia River estuary. Therefore, I do not think the requirement that substantial nonlethal methods first be employed has been met. Moreover, I think nonlethal methods, if employed at the appropriate scale and intensity, are entirely feasible in reducing cormorant consumption of salmonid smolts in the Columbia River estuary. Several major points support this conclusion.

G-11, G-10, FEIS App. G Section 1.1.6, 2.3

Habitat enhancement and social attraction studies. Work by Suzuki (2012) reports successful and encouraging results on habitat enhancement and social attraction techniques for relocating nesting DCCOs to alternative colony sites in the Columbia River estuary. But to be effective, these techniques should be employed at sites where cormorants have some previous history of nesting or roosting. In the Great Lakes region, research indicated the presence of other nesting colonial waterbirds was also very important in site colonization by DCCOs (Wires and Cuthbert 2010). Additionally, these attraction techniques must be accompanied by concurrent efforts to discourage nesting at nearby active colonies to provide incentive for cormorants to shift to the attraction site. These attraction sites may also need to be maintained to keep cormorants at a new site. In the cases that the DEIS mentioned where these techniques did not work, the requirements of previous use and incentive to leave nearby sites were either not met or the attraction methods were not maintained. Essentially, the design of the attraction and enhancement of cormorant colonies was done in an *experimental context* to test whether restoring colonies or attracting cormorants to different sites would be feasible, not in an actual *management context* with the goal to establish long-term colonies. Thus the portrayal of these methods as ineffective misrepresents the feasibility of the habitat enhancement and social attraction techniques, and creates the false impression that these methods had been employed to achieve management goals, when in fact these methods were only tried to investigate their potential.

Reducing available nesting habitat. The DEIS also indicates that cormorant nesting habitat was reduced on ESI, but despite these reductions cormorant numbers increased. Again, this is very misleading and is used to discredit the potential of Alternative B and to satisfy the requirements for a depredation permit. In fact, work by USGS researchers during 2011-2013 demonstrated that the area used as nesting habitat could be reduced to limit the size of the colony (Roby et al. 2012, 2013, 2014), all through nonlethal actions. But again, efforts to reduce available nesting habitat were not undertaken at a scale that would cause large numbers of DCCOs to emigrate from East Sand Island and reduce colony size. Reducing the area of nesting habitat on the island sufficient to reduce numbers of nesting DCCOs would require significant management actions, and thus an EIS. Therefore, the DEIS needs to distinguish between the application of nonlethal methods in the experimental and management contexts. These methods have not been tried in a management context….doing so would require a much larger scale effort that addresses multiple components as described above.

G-8, G-10

Dispersing birds to areas where other or potentially greater conflicts will occur. The DEIS expresses concern that if birds are dispersed from ESI they may cause problems elsewhere. First, birds may or may not move to areas where additional problems will occur. Second, if they do, research again indicates that they could easily be dissuaded from colonizing new sites where there is concern about potential impacts (Roby et al. 2012, 2013, 2014). In this regard, I point to management conducted in Denmark,

G-10

where similar conflicts with fisheries occur due to Great Cormorants. Denmark has a long-term policy to manage cormorants through nonlethal means and to disperse them when they try to colonize new sites. This approach is also being used in several other European countries. To obtain more information on the Danish experience, I contacted a Danish colleague, Dr. Thomas Bregnballe, who has studied cormorants and been involved in managing them in Demark for decades. Dr. Bregnballe wrote that in Denmark, "The major philosophy is that the cormorants, as central place foragers, will tend to forage near to their colony, and therefore cormorant predation pressure on fish will decline with increasing distance from the colony. Therefore, hindering cormorants from founding new colonies near hitherto unexploited food resources will limit the birds in their access to food resources…We believe that this strategy has worked as intended in Denmark. The cost of this approach is, of course, that you need some manpower to be ready to disturb the birds as soon as they try to found a new colony (thus it is far easier to keep cormorants off a hitherto un-colonized site if the birds are hazed in the earliest phases of breeding and before the birds have experienced that it is possible to breed with success at the site). Although G-10 Denmark has many small islets where cormorants could breed, they are generally rather slow in trying to colonize new sites into use as breeding colonies. So the task has not been that demanding in Denmark."

Dr. Bregnballe also commented on the application of this approach to the situation in the Columbia River estuary: "Concerning the specific situation in Oregon, I would guess that heavy disturbance early in G-8, G-10, the breeding season would 'provoke' many of the birds scared from the existing sites to start looking for suitable alternatives nearby, as well as more distant sites where they could found new colonies. There would also be birds that continue to try to return and breed at the site where they successfully bred in earlier years, so the scaring would have to be carried out during most of the season and in subsequent seasons. But my guess would also be that you could lower the number of cormorants foraging in the estuary if you ran a scaring programme in the existing colonies as well as at the nearby sites where birds try to form new colonies. Again the success of the scaring is likely to be highest if carried out in the very earliest phases of breeding – before egg-laying and if some manage to lay eggs then avoid that the birds are allowed to incubate for weeks. From an ethical point of view these actions are not very nice, but if the alternative is to shoot (and wound) large numbers of cormorants annually, then this would be a more 'humane' approach."

Some of this work is published in Danish, and there is one extended abstract in English. I have attached numerous citations at the end of this document to identify this work for your consideration (Bregnballe G-10 and Eskildsen 2002, 2009; Bregnballe et al. 2013). Contrary to the concern expressed in the DEIS, the success of the Danish experience suggests managing for the selection of DCCO nesting locations (and by extension, foraging locations) once DCCOs disperse from ESI is quite feasible. For a smaller-scale and more local example, I also point to the management program that was developed for Oneida Lake in New York State. This program successfully limited cormorant nesting and foraging by migrant birds mostly through an intensive hazing program and other nonlethal methods (see Coleman 2009 and DeBruyne et al. 2013 for management history). Again, such work demonstrates that a hazing program and a nonlethal approach can be very effective management strategies for cormorants.

comment noted *Conclusion for #2*. The USFWS is a cooperating partner on this DEIS and is faced with an enormous challenge relative to issuing a depredation permit that would allow the removal of such a large number of birds and such a significant percentage of the western population. East of the Mississippi the establishment of the depredation orders has resulted in a 19th century approach to cormorant management: A pattern of destroying cormorants in huge numbers once again prevails. Since the depredation orders were established, more than half a million cormorants have been killed and hundreds of thousands of nests destroyed. In the Great Lakes, where most of the breeding birds targeted have been destroyed, cormorants have a diet that consists largely of round goby, an invasive species, and there is very little scientific evidence that this management is necessary or benefits valuable fisheries (Wires 2014). But the model of killing as the approach to cormorant management has become entrenched, and a pattern is now established....this is just what we do with cormorants, especially relative to fisheries with a long history of poor management...despite the irrationality and G-16 ethical concerns that underlie this approach. We now destroy birds at NWRs, Federal Wilderness Areas and the moment they fly off of privately owned islands bought by NGOs for their protection (Wires 2014). The USFWS should consider that by issuing a depredation permit in support of Alternative C, it is opening the door for establishing a similar pattern of destruction west of the Mississippi. In so doing it is not upholding its responsibilities to protect these birds, which so greatly need protection given the level

G-9 FEIS App. G, Section 1.1.6

of hatred and misunderstanding that surrounds them. The fact that the nonlethal methods that have been employed to reduce cormorant predation on salmonid smolts can be easily challenged as legitimate efforts to resolve this problem should make the USFWS pause and consider more carefully the application of nonlethal techniques in a management context before killing large numbers of birds. There is a team of experts right at the agency's fingertips…the USGS research team led by Dan Roby at OSU… that could help with the design and implementation of these techniques. The agency must contemplate just what it will be getting into and the precedent it will set if it migrates the pattern of cormorant killing from East to West. Essentially, the agency is at a crossroads: It can perpetuate the negative image that cormorants have, the belief that they need to be killed, and lock in this approach as not just an eastern policy but a national one, or it can show some leadership and establish a new pattern for resolving conflicts with fish-eating birds, conflicts that have resulted from the mismanagement and degradation of fisheries due to human actions.

G-18, S-34

3. **Numbers of birds that would be removed.** Alternative C indicates that killing ~ 16,000 birds would reach the cormorant population target by 2018. Based on several factors, however, I think this number has not been realistically considered or accurately calculated.

ESI DCCO population assumed to be at carrying capacity. The population model presented for cormorants (Appendix E-2) assumes the ESI colony is at carrying capacity, but the fact that a large increase occurred in 2013 discredits this assumption. If the colony is not at carrying capacity, losses due to killing birds may to some extent be offset by recruitment and immigration. This means more birds (possibly many thousands more) will have to killed above the 16,000 proposed.

Experience with lethal operations in the East indicates much greater levels of destruction must be employed than just the difference between current and targeted colony size. There are several clear examples from the Great Lakes basin indicating that the number of birds killed that was necessary to reach and maintain population targets greatly exceeded the difference between starting and target population sizes. Some examples: In Michigan, control was initiated in 2004 when the state population size was ~ 30,000 pairs. To reduce numbers, combined strategies of culling and egg oiling were employed. During 2004 - 2010, ~ 42,000 birds were killed and somewhere between 35,000 – 75,000 individual nests were oiled. These actions resulted in a reduction of only about 10,000 pairs in the state as of 2011 (USFWS 2014; Cuthbert and Wires, unpubl. data, Great Lakes biennial cormorant monitoring). Current population size is not yet available, but in 2011 and 2012 another 19,000 birds were killed under the Public Resource Depredation Order, bringing the total birds killed in Michigan under this order during 2004 – 2012 to 61,091 (USFWS 2014). Thousands of nests were also oiled. More birds were killed in 2013 and 2014 (and more nests destroyed), but these numbers are not yet available. In Minnesota, lethal control was initiated at Leech Lake in 2005 to reduce this colony by 80% from ~ 2,500 pairs to 500 pairs (USDA 2005). To reach and maintain this target size, close to 20,000 birds were killed during 2005-2012 (USFWS 2014). In Ohio, lethal control was initiated in 2006 at West Sister Island to reduce this colony from 3,800 pairs to 1,500-2,000 pairs (USDA 2006). During 2006-2012, more than 10,000 cormorants were killed at this one location (D. Sherman, pers. comm.); again, more cormorants were killed in 2013-2014, but the data are not yet available. See also examples from Canada, summarized in Wires (2014); these examples include High Bluff Island, ON; Middle Island, ON; and Lac La Biche, AB). These examples provide ample evidence that (1) reaching and maintaining target population sizes involves killing and managing much larger numbers of cormorants than is implied by subtracting the population objective from current population size and (2) initiation of this type of activity results in long-term and repeated culling programs to maintain objectives.

G-20 FEIS 4.2.2, 4.4

Risk to western North American population. Reducing the cormorant population through lethal means by the magnitude proposed has implications for the entire western North American population of DCCOs. The ESI colony constitutes more than 40% of the western population (Roby et al. 2014). The DEIS implies that this reduction will not negatively impact the population because the western population was sustainable at 1990 levels (p. 14). However, it is not clear that the population was sustainable at 1990 levels (particularly since the population has been in a recovery mode during most of the 20^{th} and 21^{st} centuries). In fact, a review that examined the status of DCCOs in western North America (Carter et al. 1995) documented various conservation problems that existed for DCCOs in the 1990s. This paper indicated that while cormorants were recovering in this region from losses experienced in the 19^{th} century, local declines were still occurring due to habitat loss, pollution, human disturbance, and predators. Moreover, Carter et al. (1995) indicated that increases in numbers of nesting cormorants in the Columbia River Estuary coincided with declines in British Columbia, Washington, and locations in interior Oregon. Thus it is not clear that the 1990s population was sustainable, at least not without a large and productive colony on East Sand Island. Furthermore, since the 1990s, declines have occurred at both coastal and other inland regions have occurred (Adkins et al. 2014; W.D. Shuford, pers. comm.), G-19 and these are not considered in the DEIS. Therefore, it is not at all apparent that the elimination of 16,000 birds from the most productive colony in western North America (Adkins et al. 2014) will not be detrimental to the western population.

G-18

Conclusion for # 3. More birds will likely be killed than predicted, which should be taken into account when considering the magnitude of impact to the cormorant population. Furthermore, the western population is not at all comparable in terms of abundance to the eastern population; therefore, comparable levels of take as occur in the East (proposed on p. 12 of the DEIS) should not be considered sustainable. The DEIS has understated both how many birds will need to be taken and the risk to the western population from a cull of such magnitude.

4) **Impacts to other birds, humane issues and ethical considerations.**

G-21, G-24 FEIS Section 4.2.4

Impacts to other birds. The DEIS acknowledges that under Alternative C there is a "…high potential for a substantial reduction in the size of the Brandt's Cormorant colony on East Sand Island…low to moderate potential for a substantial reduction in colony size of other species…" and that the breeding population of Pelagic Cormorants in the Columbia River Estuary could be reduced by as much as 20 percent as incidental take (p. 19). As noted above, I have visited this colony and nesting Brandt's cormorants are closely inter-mixed with nesting DCCOs. I think it will be impossible to avoid accidentally shooting many Brandt's cormorants while shooting up to 16,000 DCCOs. The DEIS does not address the potential biological impacts to these other bird species through potential reductions in their numbers through incidental take. Instead, Alternative C simply includes these species, along with DCCOs, as casualties of the mismanaged Columbia River ecosystem. I strongly urge the agencies to consider that incidental take could be avoided through nonlethal techniques. Avoiding impacts to other species should be a priority, especially given that that Brandt's and Pelagic cormorants are not implicated in salmonid declines and are not abundant.

G-22

Conversely, the concern about potential impacts to Streaked Horned Larks from dispersing cormorants (expressed repeatedly in the DEIS and used to justify the need for lethal control of cormorants at East Sand Island) appears unwarranted. Streaked Horned Larks use different habitat than cormorants, selecting sparsely vegetated areas rather than areas with trees, rocks, or artificial structures that are preferred by cormorants.

G-15, G-16, G-17

Humane issues. On pages 21-24 the logistics of culling are described, and there is absolutely no mention of the potential for humane issues to arise or contingencies to deal with wounded birds. Experience in the eastern U.S. with cormorant culling operations indicates that humane issues arise even under the best of circumstances (see summary in Wires 2014). Even with experienced sharp shooters, such as personnel with Wildlife Services, clean shots are not always made, and shooting from shotguns at birds in flight frequently results in birds being wounded, but not killed. Typically efforts are made to retrieve wounded birds and immediately euthanize them. This is not described as part of a contingency plan and I am not sure how this would happen on ESI without causing major and repeated disturbances. Further, if shooting takes place at night from blinds and tunnels, how will injured birds be handled? Again this is not described in the DEIS. Having visited the colony, I can't imagine injured birds could be easily retrieved in the dark. Trying to retrieve wounded cormorants during daylight would certainly cause enormous disturbance to nesting birds, which could lead to colony abandonment, as could walking through the colony picking up all the dead bodies. The fact that humane issues are not even mentioned in the document gives the impression that they either do not exist or, worse yet, that they are of no concern. The DEIS needs to acknowledge that shooting 16,000 birds is going to be a brutal activity with many birds experiencing some degree of suffering and trauma before death. The public needs to understand what shooting 16,000 wild birds really entails and have the option of commenting on whether or not these associated humane issues are acceptable.

G-17, FEIS 2.2

comments noted

Ethical consideration. In the development of cormorant policy for the Columbia River Basin, science is only part of the equation. The other key element is ethics, a less quantifiable but clearly recognizable consideration that should guide the decision-making process. Like science, ethics is a form of practical reasoning, and efforts to establish guidelines to govern behavior and decision-making have been recognized as formal disciplines. For example, the disciplines of bioethics and environmental ethics provide recognized forums for ethical issues and practical guidance for ethical decisions. As typical of cormorant management in the U.S., the USACE's DEIS is entirely devoid of any discussion of the ethical dimension of the decisions to be made for the Columbia River estuary. However, killing 16,000 DCCOs, and possibly many other birds, is inherently an ethical decision. In an important paper addressing the ethics of legal control for wildlife, Warburton and Norton (2009) suggest that all lethal control operations targeting nuisance wildlife should be first reviewed by an animal ethics committee. Researchers conducting trials that involve manipulations of animals at far smaller numbers are regularly subject to this evaluation. Thus, a management project at the scale of the one proposed for the Columbia River estuary certainly should be subject to rigorous ethical evaluation by a panel trained in this area, and one that represents *diverse* stakeholder views. To this end, I would like to note that there is precedent for the USFWS to bring in a trained ethicist to consider the ethical dimensions of culling wildlife, the ethics process and the need for moral review (see http://www.opb.org/radio/programs/thinkoutloud/segment/ethical-killing-barred-owls/). I encourage you to listen to the radio piece cited above and seriously consider that ethical reasoning is as integral to building strong environmental policy as is science.

comments noted

Final comments / recommendations. For the numerous reasons stated above, I strongly urge the USACE and its cooperators to reconsider its Preferred Alternative, and go with a modified version of Alternative B. I say "modified" because I am not convinced that the population objective proposed for DCCOs in the Columbia River estuary is the correct one. I am also not sure what benefits, if any, reducing cormorant numbers will bring to salmon recovery efforts. Therefore, if measures must be taken to reduce cormorant consumption on salmonid smolts, I recommend this be done through nonlethal methods, which are entirely feasible. Concurrently, I suggest that a more rigorous analysis be undertaken to determine a more defensible population objective for cormorants. Finally, I recommend consultation with a diverse group of stakeholders and the inclusion of a team of experts that can provide ethical guidance in the decision-making. Without these actions, DCCOs and potentially many other birds will just become additional casualties, along with the array of salmonids, of the mismanaged Columbia River ecosystem.

References

Adkins, J. Y., D. D. Roby, D. E. Lyons, K. N. Courtot, K. Collis, H. R. Carter, W. D. Shuford, and P. J. Capitolo. 2014. Recent population size, trends, and limiting factors for the double-crested cormorant in western North America. Journal of Wildlife Management 78:000-000; doi: 10.1002/jwmg.737

Bregnballe, T. & Eskildsen, J. 2009. Scale and effects of intervention measures in Danish cormorant colonies in Denmark 1994–2008. (Bregnballe, T. & Eskildsen, J. 2009. Forvaltende indgreb i danske skarvkolonier i Danmark 1994-2008. – Omfang og effekter af oliering af æg, bortskræmning og beskydning. Danmarks Miljøundersøgelser, Aarhus Universitet. 46 s. – Arbejdsrapport fra DMU nr. 249. http://www.dmu.dk/Pub/AR249.pdf

Bregnballe, T., Hyldgaard, A.M. & Therkildsen, O.R. 2013. Danmarks ynglebestand af skarver i 2013. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 30 s. - Teknisk rapport fra DCE - Nationalt Center for Miljø og Energi nr. 26 http://dce2.au.dk/pub/TR26.pdf

Bregnballe, T. & Eskildsen, J. 2002: Menneskelige indgreb i danske skarvkolonier 1994-2001. Naturovervågning. - Danmarks Miljøundersøgelser. 65 s. -Arbejdsrapport fra DMU, nr. 162.

Carter, H. R., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends, and conservation problems of the double-crested cormorant on the Pacific coast of North America. Colonial Waterbirds 18:189–215.

Coleman, J. T. H. 2009. Diving behavior, predator-prey dynamics, and management efficacy of double-crested cormorants in New York State. PhD diss., Cornell University.

DeBruyne, R. L., J. T. H. Coleman, J.R. Jackson, L. G. Rudstam and A. J. VanDeValk. 2013. Analysis of prey selection by double-crested cormorants: A 15-year diet study in Oneida Lake, New York. Transactions of the American Fisheries Society 142: 430–446.

FPC (Fish Passage Center). 2014. Fish Passage Center Adult Passage Date. Available on-line at www.fpc.org.

Gresh, T., J. A. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: Evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fisheries 25:15-21.

Lichatowich, J. 2001. Salmon without rivers: A history of the Pacific salmon crisis. Island Press, Washington, D.C. 317 pp.

Lyons, D.E., D.D. Roby, A.F. Evans, N.J. Hostetter, K. Collis, and S.H. Sebring. 2014. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony. Final Report to the U.S. Army Corps of Engineers – Portland District. U.S. Army Corps of Engineers, Portland, OR. 50 pp. (Available through internet: www.birdresearchnw.org)

NOAA (NOAA Fisheries). 2011a. 5-Year Salmon and Steelhead ESA Status Reviews. National Marine Fisheries Service, Northwest Region. Portland, Oregon. Available at: http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/salmon_steelhead_esa_status_reviews.html.

NOAA (NOAA Fisheries). 2014. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program. National Marine Fisheries Service, Northwest Region 246 pp.

NOAA (NOAA Fisheries). 2014(a). Office of Protected Resources. Overview of Endangered Species Act Listed Marine and Anadromous Fish. Available at: http://www.nmfs.noaa.gov/pr/species/fish/.

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, E. Dykstra, J. Harm, W. Mashburn, J. Tennyson, N. Ventolini, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, R.D. Ledgerwood, and S. Sebring. 2012. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2011 Annual Report to the Bonneville Power Administration and the U.S. Army Corps of Engineers, Portland, OR. 171 pp. (Available through internet: www.birdresearchnw.org)

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, A. Patterson, S. Collar, N. Banet, K. Dickson, G. Gasper, L. Kreiensieck, K. Atkins, L. Drizd, J. Tennyson, A. Mohoric, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, J. Zamon, and D. Kuligowski. 2013. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Final 2012 Annual Report to the Bonneville Power Administration and the U.S. Army Corps of Engineers, Portland, OR. 239 pp. (Available through internet: www.birdresearchnw.org)

Roby, D.D., K. Collis, D.E. Lyons, J.Y. Adkins, Y. Suzuki, P. Loschl, T. Lawes, K. Bixler, A. Peck-Richardson, A. Patterson, S. Collar, A. Piggott, H. Davis, J. Mannas, A. Laws, J. Mulligan, K. Young, P. Kostka, N. Banet, E. Schniedermeyer, A. Wilson, A. Mohoric, A. Evans, B. Cramer, M. Hawbecker, N. Hostetter, A. Turecek, J. Zamon, and D. Kuligowski. 2014. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2013 Annual Report to the U.S. Army Corps of Engineers and the Bonneville Power Administration, Portland, OR. 237 pp. (Available through internet: www.birdresearchnw.org)

Suzuki, Y. 2012. Piscivorous colonial waterbirds in the Columbia River estuary: Demography, dietary contaminants, and management. Ph.D. dissertation in Wildlife Science, Oregon State University, Corvallis, OR. 183 pp.

U.S. Department of Agriculture, Wildlife Services. 2005. Final Environmental Assessment: Reducing Double-crested Cormorant damage in Minnesota. USDA-Animal and Plant Health Inspection Service-Wildlife Services, St. Paul, MN. 145 pages. *http://www.aphis.usda.gov/regulations/ws/ws_environmental_ minnesota.shtml*.

U.S. Department of Agriculture, Wildlife Services. 2006. Final Environmental Assessment: Reducing Double-crested Cormorant damage in Ohio. USDA-Animal and Plant Health Inspection Service-Wildlife Services, Reynoldsburg, OH. 161 pages. http://www.aphis.usda.gov/regulations/ws/ws_environmental_ohio.shtml.

U.S. Fish and Wildlife Service. 2014. Draft Environmental Assessment: Management of Double-Crested Cormorants Under 50 Cfr 21.47 And 21.48. Division of Migratory Bird Management *in cooperation with* USDA / APHIS / WS. March 2014.

Warburton, B., & B. G. Norton. 2009. Towards a knowledge-based ethic for lethal control of nuisance wildlife. Journal of Wildlife Management 73: 158-164.

Wires, L.R. and Cuthbert, F.J. 2010. Characteristics of double-crested cormorant colonies in the U.S. Great Lakes island landscape. Journal of Great Lakes Research 36: 232–241.

Wires, L. R. 2014. The Double-crested Cormorant, plight of a feathered pariah. Yale University Press, New Haven, Connecticut. 349 pp.

From:	Rosamonde Cook
To:	Cormorant EIS
Subject:	[EXTERNAL] Cormorant EIS
Date:	Tuesday, August 19, 2014 12:00:07 PM

Plan added to FEIS Section 2.5

Dear Sir or Madam;

I am writing to comment on the proposal to kill 16,000 (25% of the global population) of Double-crested Cormorants in Oregon's Columbia River estuary. Double-crested Cormorants are covered by the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) because of their rarity in southern California. A primary goal of the MSHCP, which covers 1.2 million acres in inland southern California, is to ensure the maintenance of biological diversity, of which bird species are a vital component. The impacts that the lethal actions proposed under Alternative C of the Draft EIR would counter our efforts to conserve the species by reducing its numbers or eliminating it entirely from the Plan Area.

Salmon in the Columbia River are not endangered because of cormorant predation and killing cormorants will not save the salmon. I urge you to adopt Alternative A, no action, at this time, and build a strategy for salmon management that deals with the primary, systemic causes of their decline, one that is based on sound science and considers all non-lethal options for reducing predation.

Thank you.

Sincerely,

Rosamonde Cook, Ph.D.
Lead Biologist and Data Manager
Biological Monitoring Program
Western Riverside County Multiple Species Habitat Conservation Plan
4500 Glenwood Drive, Bldg. C Riverside, CA 92501
phone: 951-320-2168

I submit these comments on behalf of myself alone.

US Corp of Engineers Comment period extended for plan to cull 16,000 cormorants from Columbia estuary

Sondra Ruckwardt, project manager

Cormorant-EIS@usace.army.mil

EIS Info.

http://www.nwp.usace.army.mil/Missions/Currentprojects/CormorantEIS.aspx

To: Sondra Ruckwardt, project manager

am writing in opposition to Alternative C, which would result in the killing of 16,000 Double-crested Cormorants at East Sand Island. I favor Alternative A, no action, until such time as the Corps has reviewed and rebuilt its entire approach to avian predation by cormorants and other species at a regional scale, including the Columbia River basin and beyond. The following are factors that should be addressed in those considerations..

G-2, G-4, G-14, G-16

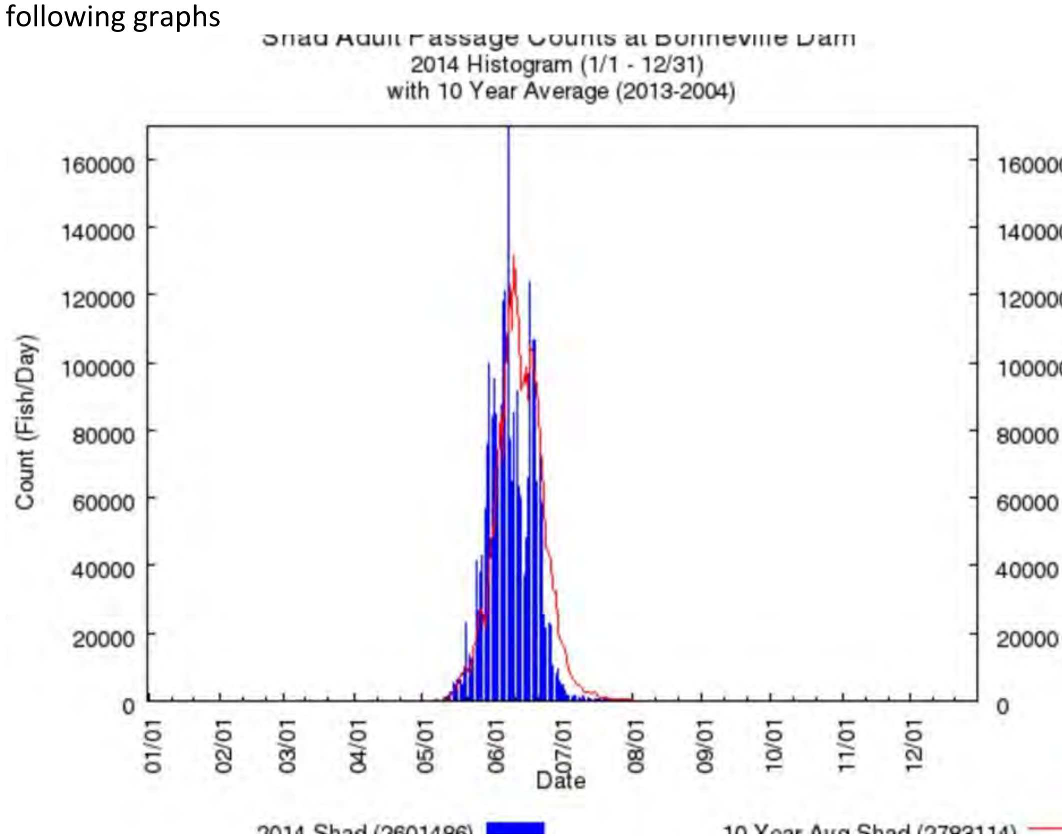
I. Invasive fish species should be considered as a management mechanism prior to reducing DBC populations.
   A. In spring, fish were the largest prey component for smallmouth bass downstream from Bonneville Dam (74%) and in the Snake River (70%)."
   B. If management programs have limited the take of juvenile salmonoids by reducing northern pike, why not do the same for smallmouth bass as well as other invasive species.
   C. In summer, fish contributed most (83%) to smallmouth bass stomach contents downstream from Bon. Dam
   D. Walleye stomachs contained over 99% fish prey regardless of reach or season.
   E. Fish prey were the largest component of northern pikeminnow gut contents in all three reaches in spring (70–86%) and summer (48–84%).
   F. The numerical frequency of chinook salmon greatly exceeded that of steelhead among identified salmonid prey consumed by all predator species
   G. Introductions of nonnative fish species have contributed to declines and local extinctions of indigenous fish populations throughout the western United States (Wydoski and Bennett 1981; Moyle et al. 1986; Miller et al. 1989)
   H. The consequences of introductions are particularly unpredictable where many native species appear to be persisting alongside many introduced species. Such is the case in the lower Columbia River basin, which supports a diverse assemblage of native and nonnative warm-, cool-, and

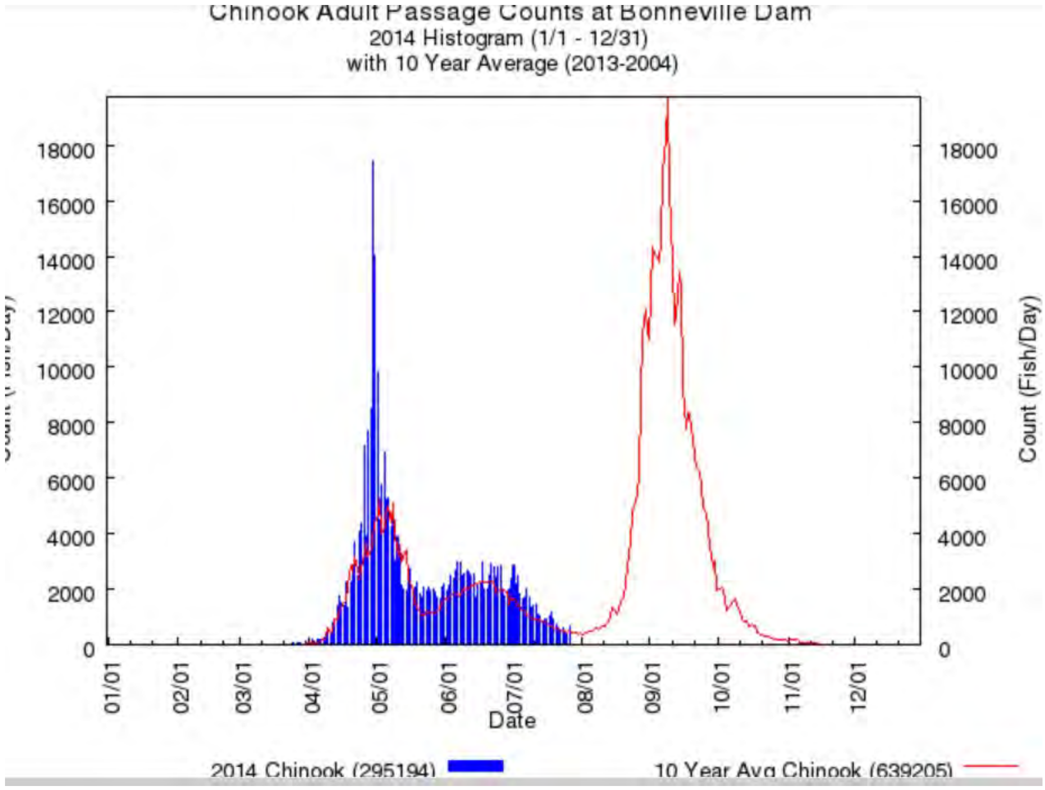
coldwater species (Wydoski and Whitney 1979; Farrand Ward 1993

I. The following document is a study in progress which seems to be an attempt to identify predation on salmoniods of the Columbia River Basin. My observation is that though this study does not include the lower Columbia from the ocean to Bonneville Dam those findings would also impact the entire river system. https://www.monitoringmethods.org/Protocol/Details/744
J. System-wide exploitation of northern pikeminnow during the Sport-Reward fishery was 10.8% (95% confidence interval; 6.9–14.7%). Exploitation rates were adjusted using an estimated tag loss of 1.1%. Using the model of Friesen and Ward (1999), we estimated that 2013 predation levels were 35% (range: 20–53%) lower than pre-program levels http://www.pikeminnow.org/wp-content/uploads/2014/03/2013-Pikeminnow-RME.pdf
K. Because juvenile American shad opportunistically feed on zooplankton and aquatic insects in other river systems where they are native, they are likely exploiting food resources similar to those used by subyearling Chinook salmon in the lower Columbia River. Craig A. Haskell1
L. . During our three years of trawling in John Day Reservoir, we collected 21,637 juvenile American shad from 205 trawls. Shad comprised over 98% of all fish captured in this study, and we only captured 161 subyearling Chinook salmon. Median and maximum juvenile American shad abundances were 0.95 fish per 1,000 m3 and 92.3 fish per 1,000 m3, respectively Craig A. Haskell1
M. The seasonal disappearance of Daphnia in John Day Reservoir is potentially deleterious for stocks of subyearling Chinook salmon listed under the Endangered Species Act (ESA) because Daphnia are a major food item in reservoir habitats (Rondorf et al. 1990) and numbers of American shad in John Day Reservoir are increasing Craig A. Haskell1
N. The number of adult American shad returning to McNary Reservoir increased 123% from 1980 to 1994 (the beginning of this study), and increased 143% from 1994 to 2004. Therefore, it is likely that if juvenile shad prey on the same food items in McNary Reservoir as they do in John Day Reservoir, the use of Daphnia prey by subyearling Chinook salmon as a food source has been increasingly disrupted Craig A. Haskell1

FEIS
Section 2.3

System Wide Detrimental water Flow Management Practice improvements in stage-specific and lifecycle survival may be Achievable through improved river outmigration conditions by increasing the proportion of river flow spilled over crests of dams and (or) water velocity. http://www.nwcouncil.org/ext%5Cdrop%5Cisab2014-2%5C2_Spill%20proposal%20CSS%20FPC%20and%20ODFW%20cited%20and%20supporting%20docs%5CSchaller%20et%20al.%202014%20CJFAS.pdf Looking at the above fact, "increasing the proportion of river flow spilled over crests of dams and (or) water velocity," is a huge consideration based on how this might improve salmon survival. When I read the Aug. 1, 2014 issue of the Daily Astorian, I was most encouraged reading "Spillway Idea Causes Credibility Concerns," http://www.dailyastorian.com/news/local/spillway-idea-causes-credibility-concerns/image_8879cd54-19aa-11e4-9196-001a4bcf887a.html/ . This 10 year plan should be pursed despite claims of credibility concerns expressed by opponents. Knowing reservoirs have drastically increased the number of invasive salmon species in the river system, faster moving water will return a more equitable balance. When I view that balance using the following graphs





particularly bothersome is the ever increasing populations of American Shad. These two graphs clearly demonstrate the advantage A.S. have attained in a rather brief time since dam development. On a daily basis this year shad outnumber Chinook returns by a margin of 10 to one. Granted we are having a record year for native/hatchery fish returns, which based on the data above represents a run 5 times more than what is normal. We should be considering what is happening on the estuary end of this complex issue & put on hold removing double crested cormorants until full consideration of the benefits this new spillwater plan plays out.

G-2, G-4

G-16

Productive Capacity contributions by Double Crested Cormorants

The following article indicates that the absences of Blue whales led to declining zooplankton populations of krill which thrived on the defucant from Blue whales. Is it not possible that these birds are providing a similar nutrient base for the endangered salmon? What has been discovered since the subsequent increase in Blue whales populations is a huge increase of krill. the http://www.antarctica.gov.au/about-us/publications/australian-antarctic-magazine/2011-2015/issue-21-2011/antarctic-science/oceans

FEIS @ Sections 4.2.1 & 4.4.1

A second example in which seabird defucant (known as guano in bird excretory mechanism) has shown increases in bioproductivity
http://www.int-res.com/articles/meps/32/m032p247.pdf
Seabird guano as a determinant of rocky intertidal community structure
A. L. Bosman & P. A. R. Hockey
Seabird guano has long been recognized as a powerful fertilizer, comprising some 14 % (dry weight) soluble organic compounds, and 3 % soluble mineral salts such as salts of Mg, K, Ca and Na (Galkina 1974). The composition of seabird guano is comparable between species (Burger et al. 1978, Bedard et al. 1980, Fugler 1985).
Being that the East Sand Islands have an already widely defined assemblage of birds it seems apparent that similar results have been most likely occurring. From the above source can be found the following:
"Terrestrial plants which are manured by seabird guano exhibit enhanced vitality, cover and production (Glllham 1977, Smith 1978).",
and research in the Barents Sea (74" 00' N, 36" 00' E) indicates that enrichment of nearshore waters by seabird guano deposited in the sea is associated with enhanced phytoplankton production. (Golovkin 1967, Zelickman & Golovkin 1972, Golovhn& Garkavaya 1975."

"They may also modify invertebrate and avian community structure, since the macro-algal beds present on island shores form a settlement substratum for mussels and gastropods, crustaceans and polychaete worms which provide an important food source for small shorebirds that visit the island shores (Hockey & Branch 1984)."
When you read the following report instead of declining salmon runs we have what is being described as at least above normal. Rather than negate these double crested cormorants, & their avian relatives, is it not time to consider the added benefits they create? Truly this appears to follow the old trickle down policy as never seen before
http://wdfw.wa.gov/weekender/
"Meanwhile, the popular Buoy 10 chinook salmon season runs Aug. 1 through Sept. 1 at the mouth of the Columbia River. A huge run of 1.5 million fall chinook is expected to return to the river this year, with expectations that anglers will catch about 45,000 of them – primarily between Buoy 10 near the mouth of the river and Rocky Point, 16 miles upstream, by Sept. 1." All signs point to a spectacular salmon fishery in the Columbia River," said Joe Hymer, a fish biologist for WDFW."

S-19, FEIS Section 4.2.1, Appendix B

Clean Water Act Violation
http://www.nwp.usace.army.mil/Media/Announcements/tabid/1887/Article/23921/draft-eis-double-crested-cormorant-plan-to-reduce-predation-of-juvenile-salmoni.aspx

In the above document I find the following part of your plan violate the Clean Water Act, relating to sand contaminated sand movement, "either along the shoreline and/or in upland areas where feasible to avoid impacts to delineated wetland." Talk about unintended consequences just another part of how extreme this entire management plan causes further escalation of problems. Starting with the dams extending through introduced species, including the creation of the never ending dredging spoils, the plan continues unabated with problems.

Contaminated Sediments

> Within the following study it was found that salmonoids apparently adjacent to both side of East Sand Island contained PCB residues 5 times to that which is considered safe. It follows that any disturbance of these sediments would further exacerbated already high levels of contaminants in this case polychlorinatedbyphenols (PCB's). http://www.nwfsc.noaa.gov/assets/25/152_09262005_142538_EstuaryTM69WebFinal.pdf "Studies suggest that, at least for some contaminants, exposure levels in juvenile salmon from the Columbia River estuary are approaching concentrations that could affect their health and survival. For PCBs, Meador et al. (2002) estimated a critical body residue of 2,400 ng/g lipid for protection against 95% of effects ranging from enzyme induction to mortality. They based this on a range of sub lethal effects observed in salmonids in peer-reviewed studies conducted by NMFS and other researchers. On a wet weight basis, the threshold would be 24–48 ng/g for fish with lipid content of 1–2%, typical of juvenile salmon from the Columbia River. Mean PCB body burdens in juvenile salmon analyzed by the NWFSC (Johnson et al. 2004) were at or above the 2,400 ng/g threshold at 7 of 10 sites sampled in the lower Columbia. Of individual fish analyzed from sites within the estuary, approximately 60% had PCB body burdens at or above this threshold." Point of emphasis, is why by this action would you further expose at risk PCB levels to potentially reach the supersaturation levels & unintended increased mortatily rates?

I truly appreciate this opportunity of being included in this discussion regarding the potential using the avian species, double crested cormorant, as a scapegoat remedy to improve fish runs. It is time for at least in the estuarine sector that no further intrusions be made into the already complex web.

[redacted]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ECOSYSTEMS, TRIBAL AND
PUBLIC AFFAIRS

August 19, 2014

Ms. Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant Draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary Draft Environmental Impact Statement
EPA Region 10 Project Number: 14-0032-COE

Dear Ms. Ruckwardt:

The U.S. Environmental Protection Agency has reviewed the Draft EIS for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. We are submitting comments in accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act. Thank you for the opportunity to offer comment on the proposed action.

In response to Reasonable and Prudent Alternative Action 46 (RPA 46) of the 2014 Supplemental Federal Columbia River Power System Biological Opinion prepared by NOAA Fisheries, the Corps proposes to reduce the double-crested cormorant (DCCO) population on East Sand Island in the Columbia River estuary from approximately 14,000 breeding pairs to approximately 5,600 breeding pairs[1]. In addition to the No Action Alternative A, the DEIS presents 3 action alternatives that would reduce the DCCO population using a combination of non-lethal and lethal methods. Alternative B would emphasize non-lethal hazing, habitat modification, and limited (lethal) egg take. Alternative C (the Corps Preferred Alternative) would emphasize lethal take (shooting) of approximately 16,000 DCCOs and limited egg take followed by terrain modification and hazing to allow nesting of DCCOs (at or below target population levels) within a reduced designated area. Alternative D would apply lethal take (shooting) of approximately 16,000 DCCOs, followed by terrain modification, hazing, and egg take to remove all DCCOs from East Sand Island and disperse the remaining approximate 5,600 breeding pairs away from the Columbia River Estuary.

[1] A colony size of ~ 5,600 breeding pairs could remain, but no management actions would be taken to ensure a minimum colony size (Exec. Sum. p. 10).

Based on the information provided in the DEIS, we are rating the DEIS as EC-2, Environmental Concerns, Insufficient Information. An explanation of the EPA rating system and detailed comments are enclosed. The reasons for this rating are as follows:

- G-9, G-10 → We believe that additional analysis is needed to more fully evaluate non-lethal population control alternatives.
- EPA(1) → The proposed action does not adhere to the Guiding Principles established by the Pacific Flyway Council regarding Avian Predation on Fish Resources[2].
- G-21, S-45 → The proposed lethal take of approximately 16,000 double-crested cormorants would also likely lethally take many non-target bird species, all of which are native and integral to the natural ecosystem and processes of the Columbia River Estuary.
- G-19, G-20 → The Preferred Alternative would reduce the East Sand Island DCCO colony by 56%. This would eliminate 25 to 26% of the western population of DCCOs (Ch. 4, p. 12-13), which, except for the East Sand Island population is in substantial decline (Ch. 3, p.3).
- G-20 → Additional information is needed to support the conclusion that 1990 western population levels of DCCOs, reduced as a result of implementing the Preferred Alternative, would be viable and sustainable.
- EPA(1) #4 → A DCCO western population viability analysis is needed. Among other viability and mortality factors, the analysis would need to identify current and likely future habitat availability for DCCOs within the range of the western population that factors in current and projected future climate change conditions.
- G-4, EPA(2) → The analysis of economic benefits from reducing DCCO predation on juvenile salmonids per RPA 46 may overstate the benefits and understate the costs. Also, the analysis does not incorporate compensatory mortality and recent science on this subject.
- G-2 → To put this proposed action in context, the EIS should include discussion of other means available to the Corps to assist recovery of ESA-listed salmonids.

We acknowledge and respect NOAA Fisheries' expertise, authority and effort to restore salmonid populations, and likewise acknowledge USFWS' expertise and authority for managing DCCO and other migratory bird populations. We encourage the collective responsible agencies to continue to pursue and use all appropriate, applicable science to select actions that will best maintain viable populations of these species.

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[2] Pacific Flyway Council. 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55pg.

Thank you for the opportunity to offer comment on the proposed Cormorant Management Plan. We look forward to continued involvement in the NEPA process for this project. If you have questions or would like to discuss our comments, please contact me at (206) 553-1601 or via electronic mail at reichgott.christine@epa.gov, or Elaine Somers at (206) 553-2966 or via electronic mail at somers.elaine@epa.gov.

Sincerely,

Christine B. Reichgott

Christine B. Reichgott, Manager
Environmental Review and Sediment Management Unit

Enclosures

1. Detailed Comments on the DCCO Management Plan
   to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary Draft EIS
2. EPA Rating System

EPA(1) #1

G-2, G-6, EPA(1) #2

U.S. Environmental Protection Agency
Detailed Comments on the DCCO Management Plan
to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary Draft EIS

Guiding Principles of the Pacific Flyway Council regarding Avian Predation on Fish Resources
The PFC guidance[3], which includes six main principles and their subparts, states that, "Inherent in this policy is the recognition that management of avian predation must be implemented in a manner and at a scale consistent with the conservation of migratory bird populations and the fish populations with which they interact." The guiding principles direct that non-lethal control actions that result in no direct take of nongame migratory fish-eating birds should be attempted first. Information in the DEIS does not support PFC guidance principles such as:

- Principle 4: Responses to perceived avian predation issues are based on sound science – (c) Expectations of how management actions will reduce impacts to affected fish populations are explicitly addressed; (d) Expected outcomes of management actions on affected avian populations are clearly understood.
- Principle 5: Important considerations when evaluating the need for management action in response to avian predation of fish resources – (a) Assessment of population-level impacts for both migratory birds and fish; (e) Cost-benefit analyses for proposed management strategies.
- Principle 6: Methods for reducing avian predation on fish resources are always implemented within existing regulatory frameworks – (b) Non-lethal control actions that result in no direct take of nongame migratory fish-eating birds should be attempted first.

NOAA Fisheries used the 1990s level DCCO population as a base for calculating their 2014 gap analysis, which is a point in time used to show change in potential DCCO fish consumption; it does not represent a scientific assessment of what would be considered a viable population size for DCCOs. The DEIS also states that NOAA's calculation of fish eaten by DCCOs is based upon PIT tags and a bioenergetics model. However, no information about the bioenergetics model is provided in the DEIS or its appendices.

NOAA's Biological Opinion for the FCRPS prescribes a 56% reduction in the ESI DCCO colony, resulting in a reduction of 25 to 26% of the western population of DCCOs, which are currently an order of magnitude lower than historical populations. DCCOs are still rebounding from severe decline resulting from impacts such as unregulated hunting, harassment, and DDT-induced reproductive failure.

The DEIS acknowledges uncertainties associated with the Preferred Alternative and that the proposed action could be taken without a clear understanding of the consequences. For example, the DEIS states (Ch. 4, p. 15) that while there are examples elsewhere of DCCO and great cormorant populations increasing after lethal management, those populations are an order of magnitude larger than the western population of DCCOs, and there is more uncertainty in how the western population of DCCOs could respond to the proposed levels of culling. There have not been large-scale culling programs within the western population of DCCOs, the western population exhibits little to no growth except for East Sand Island. ESI is not within a connected matrix of other large breeding colonies within the affected

[3] Pacific Flyway Council. 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55pg.

environment, and additional annual authorized take is occurring elsewhere within the western population (Ch. 4, p. 16).

Recommendation: Conduct further studies and gather scientific information that support decisions regarding DCCO predation reduction and maintenance of a viable western population of DCCOs.

G-4, EPA(2)

Cost-benefit analysis and Compensatory Mortality
The DEIS (Ch. 4, p. 38-40) projects the maximum potential regional economic benefits that can be derived from implementing the DCCO predation reduction program would be $1.5 million, a 3.1% increase in revenue. The significance of this increase on a per capita basis when spread among the many commercial fishermen, recreational fishing-related businesses, and tribes has not been quantified and thus is not clear. In addition, this maximum possible increased revenue may be overestimated because neither compensatory mortality[4] nor the costs of implementing the DCCO predation reduction program nor potential increased costs outside the Columbia River Estuary that may be incurred from DCCO dispersal have been factored into this estimate. Should the DCCO predation reduction efforts and related direct and indirect impacts result in ESA listings of the western DCCO population and/or non-target species populations, the costs for ESA-related expenditures to local, state, federal governments, tribes, and other entities would need to be added to the costs of the proposed DCCO predation reduction program.

Based on these factors and other information[5], the costs could potentially outweigh economic benefits of implementing the proposed program. Other unanticipated ecosystem effects may trigger additional direct and/or indirect costs, loss of ecosystem integrity and services[6].

Recommendation: In the Final EIS, factor the additional costs of elements such as those discussed above, including compensatory mortality, into the analysis of economic effects. Acknowledge the potential for additional costs that cannot be quantified or fully predicted due to the complexity and uncertainty of ecological effects from the proposed action.

EPA(3)

Ecosystem Health and Process Considerations
We have concerns regarding an apparently increasing tendency to set population objectives for cormorants and other fish-eating birds, fish, and other wildlife (such as, Caspian terns, pinnepeds, and pike minnows) based disproportionally on fishery or other human interests. We agree with Wires and Cuthbert[7] that population objectives should be based on species biology, regional ecology, ecosystem health and process "that recognize humans, fish and cormorants as three components of a complex system driven by many species and dynamic interactions."

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[4] Compensatory mortality occurs when reduced juvenile salmonid mortality from DCCOs is replaced by another source of mortality (Ch.4, p.93)

[5] For example, the cessation of research, monitoring, dissuasion, and other disturbance to the DCCO colony would reduce number of DCCOs at the Astoria Bridge, which increased during dissuasion experiments (Ch. 4, p. 43), thereby reducing need for maintenance and USDA-Wildlife Services at transportation and other facilities.

[6] Consider, for example, "Reef-eating threatened fish force scientists to take whole-system approach to conservation", http://www.eenews.net/greenwire/2014/07/30/stories/1060003773

[7] Wires, Linda R., Cuthbert, Francesca J. *Historic Populations of the Double-Crested Cormorant (Phalacrocorax auritus): Implications for Conservation and Management in the 21st Century.* Waterbirds: The International Journal of Waterbird Biology. Vol. 29, No. 1 (March, 2006), pp. 9-37

Birds are considered to be good indicators of the health of the ecosystem[8]. Based on information presented in the DEIS (Chapters 3 and 4), the DCCO western population is either static or in decline throughout its range except for East Sand Island. Recent growth in the western DCCO population is attributed almost entirely to the ESI population. The ESI population is growing as a result of immigration from other locations, as well as through reproductive success. This is largely due to the stable food supply afforded by forage fish and hatchery releases of juvenile salmon below Bonneville Dam. Studies reveal that juvenile salmonids comprise an average of only 10 to 15% of the DCCO diet on East Sand Island. The majority of DCCO diet consists of forage fish. Diet tends to shift to juvenile salmonids when high river flows and hatchery fish releases occur in spring. The lower fitness of hatchery fish makes them susceptible to predation.

In the Salish Sea and throughout the west, fish eating waterbirds are experiencing severe declines. East Sand Island is one of few locations where DCCOs and a wide variety of other waterbirds, shorebirds, and waterfowl are thriving, such that the Island has been designated a Globally Important Bird Area (IBA) by both the Audubon Society and the American Bird Conservancy. Because DCCOs are highly philopatric, DCCO immigration to ESI may indicate that conditions for survival are likely unsuitable elsewhere. This should be factored into any DCCO management plans, as well as the fact that even with the increasing DCCO population on ESI, the population of ESA-listed salmonids has been increasing.

Recommendation: Since RPA 46 is discretional,[9] fully investigate non-lethal alternatives and the other means available to the Corps to support recovery of listed fish populations.

EPA(4)

Impacts to non-target species

We are concerned that the proposed action would result in the take of non-target species due to misidentification, night shooting, direct and indirect effects of disturbance, and incidental crushing of eggs, chicks, and fledglings. Eighty-four species of birds have been identified on the 60-acre East Sand Island. It supports the largest breeding population of Caspian terns and cormorants in the world, and the largest post-breeding roost site for Brown pelicans on the West Coast. The Streaked horned lark, recently listed as threatened under the ESA, also uses the island. Both Audubon Society and the American Bird Conservancy have designated East Sand Island as a Globally Important Bird Area. Brandt's and pelagic cormorants are the non-target bird species of most concern with respect to lethal take because they are easily misidentified and Brandt's cormorants nest among DCCOs (Ch. 4, p. 48). Streaked horned larks are of most concern off East Sand Island where hazing in the Columbia River Estuary may become more intensified.

Recommendation: Because East Sand Island is identified as high value bird habitat, we recommend selection of an alternative that fully minimizes impacts to migratory and resident species.

[8] Declines in marine birds trouble scientists: Encyclopedia of Puget Sound. http://www.eopugetsound.org/articles/declines-marine-birds-trouble-scientists?utm_source

[9] http://www.fws.gov/endangered/what-we-do/faq.html

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements Definitions and Follow-Up Action*

Environmental Impact of the Action

LO – Lack of Objections
The U.S. Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC – Environmental Concerns
EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO – Environmental Objections
EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU – Environmentally Unsatisfactory
EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 – Adequate
EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 – Insufficient Information
The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 – Inadequate
EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

Comment in Opposition of Alternative C of the Cormorant EIS
Public Notice Numer CENWP-PM-E-14-06

7/21/14

Dear Portland District of the US Army Corps of Engineers,

comments noted

I have become increasingly aware of the Corps predation management proposal to improve survival of young salmonids in the Lower Columbia River Estuary. I understand the need to protect endangered salmon populations using the Columbia River and that the Corps, as a federal agency whose actions have significant impacts on these populations, is obligated to follow the management recommendations outlined in the reasonable and prudent alternatives of the NOAA Fisheries' Biological Opinion. However, I find the preferred alternative described in the Corp's Draft Environmental Impact Statement crude, unethical and unbalanced. Having said this, I believe the Corps has enormous potential to fulfill its responsibilities under the Endangered Species Act to improve salmonid populations that use the Columbia River. NOAA Fisheries' Biological Opinion presents several other actions besides large scale culling of Double Crested Cormorants that should prove very effective in salmon management.

G-2

Thus, I strongly support the "No Action" Alternative of the Draft EIS, or "Alternative A." In addition to predator management along the Lower Columbia River Estuary, the Biological Opinion also includes improving fish passage at dams, managing flow, improving tributary and estuary habitat, and reforming hatchery practices. The Corps has already seen some degree of success in improving survival rates of salmon migrating past hydroelectric dams by building fish ladders and other structures that ease fish passage and by lowering reservoir levels during migration to decrease migration times. The Corps should further pursue these effective management alternatives and other promising improvements to breeding habitat, captive breeding programs, and perhaps tighter regulations on non-tribal fishing even in years when salmon populations increase.

According to the EIS, under Alternative A, the Corps would need to achieve an improvement of 3.6% in salmonid survival through implementing a combination of other management alternatives besides predator management. Given how much salmonid survival rates have already increased at hydroelectric dams without the use of predator management, achieving this additional 3.6% without cormorant culling doesn't seem so unreasonable. There exist so many reasonable solutions that it is difficult to believe how refraining from meeting one predation management RPA could seriously impair your ability to meet your obligation to improve salmon populations under the ESA. Please put forth the effort to identify and evaluate other alternatives to predator management. The brutal nature of such culling necessitates the additional effort to fully evaluate all other options.

G-3, G-5

The Corps has correctly noted that Cormorants do eat marine fish. However, the EIS pointed to a 72% increase in cormorants on East Sand Island since the base period. However, in the July 21st webinar, I learned that cormorant consumption of steelhead has only increased by 4% since the base period. Once again, it seems implausible that the scale of reduction in salmon depredation will justify the scale of destruction the Corps proposes to effect on the East Sand Island Cormorant colony.

G-3, G-14

I must also note that in the July 21st webinar I heard Mr. Grays from NOAA Fisheries mention that it would be difficult to distinguish effects of cormorant culling on salmon recovery from effects from other management actions with the same goal or even the natural fluctuations due to varying ocean conditions. The Corps' preferred management alternative is severely lacking without this capability. If the Corps wishes to act so harshly on the Cormorant colony at East Sand Island, it should at least be able to determine whether those actions were successful or not in improving salmon survival.

Alternative C, or the preferred alternative, would indeed be very effective in reducing populations of Double Crested Cormorants in the Lower Columbia River Estuary. However, this alternative would result in elimination of 25% of the cormorants' western population, and it is objectionable when considered under the lens of wildlife management ethics.

G-2

Please consider the fundamental cause of decline in populations of Chinook Salmon and Steelhead over the twentieth century. After completion of the full Federal Columbia River Power System, survival estimates for yearling salmon decreased to 16% for Chinook Salmon and 11% for Steelhead. In 1977, no yearling salmon survived the gauntlet of hydroelectric turbines impeding their migration to the ocean. Other causes of these populations' listing under the Endangered Species Act include logging operations near tributaries that degrade spawning habitat and anthropogenic overfishing. It seems that our own actions have been primarily responsible for the current state of salmon in the Columbia River. By investing so much of the Corps' energy and time in reducing bird populations rather than reversing the hardships we have placed on breeding salmon, Alternative C disregards our responsibility for the problem and diverts the burden of solving it onto a breeding colony of waterbirds. This is irresponsible and unfair. While the Corps is still in the planning stages of this project, there is time to investigate other alternatives to improve salmonid survival.

comments noted

Of course Cormorants have an impact on salmon populations, especially a breeding colony as successful as the one described on East Sand Island. The EIS notes that the East Sand Island colony reduces salmonid survival by more than the Bonneville Dam does. However, there are 31 dams that make up the FCRPS. This colony of breeding birds cannot come anywhere close to the combined impact of all these dams on salmonid survival. Furthermore, this breeding colony doesn't seem to threaten humans in any significant way. While I can understand culling animals that are either non-native or pose a direct threat to humans, I cannot appreciate the necessity of killing such a massive number of cormorants simply for eating fish.

Knowing the years of effort the Corps put into researching methods of non-lethal cormorant management, I strongly considered writing in support of Alternative B. However, East Sand Island has been designated as an Important Bird Area by the American Bird Conservancy and the National Audubon Society, and it is home to up to 60,000 individual birds of multiple species during the breeding season. The hazing techniques and terrain modifications called for in Alternative B would have serious potential to completely displace breeding activity of Brandt's Cormorants and some other species of colonial nesting birds. Most importantly, under Alternative B, the Corps would invest indefinite resources into dissuading cormorants from nesting in the Lower Columbia River Basin—which would yield less than 100% effectiveness in short term improvements to salmonid survival—when the Corps could instead be investing finite amounts into other, more certain management plans under Alternative A.

I must reiterate my very reasonable and just request, that the Corps opt for Alternative A. Regardless of the stipulations and recommendations provided by the ESA and NOAA Fisheries' Biological Opininon, we are in no position to favor one species over another in this particular situation. Alternative C is unethical because it includes shooting nearly 16,000 birds. This is wrong regardless of whether it will result in a threatened or endangered status.

As humans, we should take ethics seriously, so an ethically-based argument is a "substantive" one. Thank you for considering my comments!

Sincerely,

[redacted]

P.S. While I derived the vast majority of my argument from the Executive summary of the Draft Environmental Impact Statement, here are some of my additional sources:

"Salmon Recovery in Washington." *Salmon Recovery*. Washington State Recreation and Conservation Office, 1 Jan. 2010. Web. 16 July 2014. <http://www.rco.wa.gov/salmon_recovery/>.

Williams, John G., S. G. Smith, W. D. Muir, B. P. Sandford, S. Achord, R. McNatt, D. M. Marsh, R. W. Zabel, and M. D. Scheuerell. 2004. Effects of the Federal Columbia River Power System on salmon populations. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Fish Ecology Division. Seattle, WA.

Williams, J. G., S. G. Smith, and W. D. Muir. 2001. Survival estimates for downstream migrant yearling juvenile salmonids through the Snake and Columbia rivers hydropower system, 1966-1980 and 1993-1999. North American Journal of Fisheries Management 21(2):310- 317.

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July 31, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS

Sent electronically to: cormorant-eis@usace.army.mil

Dear Ms. Ruckwardt,

comments noted

I am Manager of Ferry County Public Utility District #1, a Northwest Requirements Utilities (NRU) member, and am writing regarding the Corps' "Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary".

BPA has long maintained that about one third of the wholesale Power rates BPA charges are associated with direct program costs or foregone power generation revenues tied in one manner or another to the BiOp for the Federal Columbia River Power System, to the tune of over $14 billion of fish mitigation related to the Columbia Hydro system. As a 'full-requirements' customer of the BPA, our ratepayers are affected directly and substantially by these costs.

None of us want to see the end of Columbia River salmon but at some point there needs to be either a claim of success or failure of the preservation and mitigation efforts. A never ending and ever increasing expenditure in this area is unreasonable and will meet, or already has met, the point of diminishing returns. Additionally, this never ending crisis has numbed many people to the fisheries issues generally, since it is often seen as just another entrenched bureaucracy rather than a legitimate effort to correct a problem. I am convinced that this has created a lack of respect for endangered species protection programs in general. Add to this the effect of increasing electrical rates on our consumers in an area which is already reeling from the loss of our major industries, logging, mining and agriculture, and we have a recipe for turning Ferry County into a collection of ghost towns and history, rather than a thriving rural community looking to the future.

The Draft EIS includes several alternatives. Of these, I am of the opinion that the Corps of Engineers preferred plan, alternative 'C' "Culling with Integrated Non-Lethal Methods" is also likely the most effective option that can realistically be implemented and, under that circumstance, I would support their choice. I believe personally that Alternative 'D' "Culling with Exclusion of Double-crested

Cormorant" has the best chance of controlling the problem, but I understand the issues that could prevent its implementation.

It is my understanding that reducing the Salmonid predation by Cormorants will limit, though certainly not end, this area of expense and effort and I feel that these efforts need to begin as soon as reasonably possible. Though the overall effect on rates from this one action will be small, it is a step in the right direction if we are to retain control of the pace of increases in electricity rates to Pacific Northwest residents.

Thank you for the opportunity to comment.

Best Regards,

John Friederichs, Manager

EXPLOITERS FRIENDS of ANIMALS

August 19, 2014

VIA ELECTRONIC MAIL (cormorant-eis@usace.army.mil) AND U.S. MAIL

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Comments on Double-crested Cormorant Draft Environmental Impact Statement

Dear Ms. Ruckwardt,

Friends of Animals ("FoA") submits these comments on the US Army Corps of Engineers' ("Corps") Draft Environmental Impact Statement ("Draft EIS") for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary.[1]

G-2, G-19, G-20

FoA asserts that the double-crested cormorant management options evaluated in this Draft EIS would severely damage the double-crested cormorant colony and its ecosystem on East Sand Island, while also failing to address the entire range of causes contributing to high salmon mortality rates in the area.[2] While FoA understands the importance of salmon recovery in the Columbia River estuary, it does not support the double-crested cormorant management options that have been devised thus far.

G-10

FoA urges the Corps to consider the ethical and legal implications of its management options and to conduct research into *all* significant causes of salmon mortality in the area. FoA also urges the Corps to implement solely nonlethal management options and to reconcile its target population goals with those of historically-represented populations of double-crested cormorants along the Pacific Coast.

THE US ARMY CORPS OF ENGINEERS MUST CONDUCT RESEARCH TO UNCOVER ALL FACTORS CONTRIBUTING TO HIGH SALMON MORTALITY RATES

In the Draft EIS, the Corps situates double-crested cormorant predation as the fundamental problem to be solved through the management plan, when in fact, the real

[1] FoA is a nonprofit animal advocacy organization, incorporated in New York since 1957. With nearly 200,000 members worldwide, FoA advocates for the just treatment of animals, both domestic and free-living.

[2] *Salmon* is used throughout this letter to refer to the juvenile salmonids discussed in the Draft EIS.

NATIONAL HEADQUARTERS • 777 POST ROAD SUITE 205 • DARIEN, CT 06820 • T 203 656 1522 • F 203 656 0267
NEW YORK OFFICE • 1841 BROADWAY SUITE 350 • NEW YORK, NY 10023 • T 212 247 8120 • F 212 582 4482
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FRIENDSOFANIMALS.ORG

G-2

issue at hand is the high juvenile salmon mortality rates. These increased rates have been caused by a combination of factors, not just double-crested cormorant predation. The EIS claims that double-crested cormorant predation is a "significant source" of salmon mortality, but yet it does not define what qualifies as "significant," nor does it discuss any of the other sources of salmon mortality in detail. *See* Draft EIS Executive Summary at 1, *available at* http://www.nwp.usace.army.mil/Portals/24/docs/announcements/EIS/DRAFT_Double-Crested_Cormorant_Plan_Reduce_Predation_Columbia_River_Estuary_EIS.pdf.

G-2, G-3, G-4, FEIS Section 1.2

Additional sources of salmon mortality are many. For instance, the Corps has previously stated that, "Cormorants are one of many factors, such as water quality, hydropower dams, aquatic habitat, and angler catch that can affect fish populations. *See Columbia River Estuary double-crested cormorants FAQ*, U.S. Army Corps of Engineers (Portland District) (no date), *available at* http://www.nwp.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/2043/Article/6018/columbia-river-estuary-double-crested-cormorants-faq.aspx (last visited Aug. 19, 2014). Due to this myriad of contributing factors, the Corps cannot say with any certainty that decreasing or dispersing the double-crested cormorant population of East Sand Island will decrease the mortality rates of juvenile salmon migrating through the area.

Further, double-crested cormorant predation habits vary greatly. Draft EIS Executive Summary at 4. One of the reasons why double-crested cormorant predation varies so greatly is due to variable environmental factors. *Id.* Some of these factors listed in the Draft EIS are the availability of fish and forage for cormorants, nesting success, and large-scale climactic events. *Id.*

comments noted

Chapter four of the Draft EIS lists many effects that climate change can have on both double-crested cormorant predation trends and salmon mortality rates, including the effects of discharge on prey availability, effects of climate change on timing of juvenile salmon migration, effects of increased water temperature on prey availability, effects of precipitation, flooding, and storms on nesting, and effects of sea level rise on habitat availability. Draft EIS Chapter 4, 68-71. All of these climate change-induced situations could have effects on one or both of the species *and* their interactions.

Moreover, a study out of Oregon State University shows that the overall parasite load in a body of water can greatly contribute to salmon health levels and decrease their ability to survive. *See generally* Ferguson, J. A., Romer, J., Sifneos, J. C., Madsen, L., Schreck, C. B., Glynn, M., & Kent, M. L. (2012), Impacts of multispecies parasitism on juvenile coho salmon (< i> Oncorhynchus kisutch</i>) in Oregon, *Aquaculture, 362*, 184-192. "Understanding why certain salmon populations are heavily infected with these parasites, which likely are driven by landscape characteristics, could help in management or recovery planning, given that our data indicates that severity of these infections are associated with survival." *Id.* at 91. The area in Oregon tested in the Oregon State study could have overlapping results with the neighboring Washington state. Therefore, tests should be completed in the waters surrounding East Sand Island and the waters used as salmon migration routes in order to determine if parasitic activity is a contributing factor to high salmon mortality rates there.

G-2 FEIS Section 2.3

G-2

Along with environmental variables, human activities also affect the salmon populations and their migration through the lower Columbia River basin and estuary. Hydropower dams in the vicinity play a role in high salmon mortality rates. Salmon are very vulnerable to predation as they pass through dams and spill back out into the water; salmon concentrate in one area when passing through the dams, and after exiting, they often get disoriented, remaining close to the surface. Draft EIS Chapter 3 at 61. These facets of dam passage make the salmon an easy target for waiting predators.

There are currently six hydropower plant dams in the Lower Columbia River area of the Federal Columbia Power System, many of which various juvenile salmon must traverse in order to arrive at the Pacific Ocean.[3] *See Federal Columbia River Power System*, U.S. Army Corps of Engineers, Bonneville Power Administration, & Bureau of Reclamation (2003), *available at* http://www.bpa.gov/power/pg/fcrps_brochure_17x11.pdf (last visited Aug. 19, 2014). A 2000 report from Science Magazine concludes that the construction of dams in the lower Snake River in the 1960s and 1970s did in fact lead to an increase in salmon mortality rates. *See* Kareiva, P., Marvier, M., & McClure, M. (2000), Recovery and management options for spring/summer chinook salmon in the Columbia River Basin, *Science*, *290*(5493), 977-979. However, dam passage improvements have decreased the mortality rates since then. *Id.* at 977. The Army Corps should make sure that complete dam passage improvements are being implemented on a large scale throughout the entire Columbia River basin. Evaluation of hydropower dams' effects on salmon mortality rates in the Columbia River basin should be researched, and a willingness to rethink and revise current dam design and use should be included as part of any comprehensive management plan.

A final biological opinion issued by NOAA Fisheries in 2008 found that "salmon are endangered because of problems with habitat, harvest and hatcheries, as well as the hydropower system. The solution must address these problems as well." *See 2008 FCRPS BiOp*, Federal Caucus-- salmonrecovery.gov (2008, May 5), *available at* http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp.aspx (last visited Aug. 19, 2014). An in-depth study encompassing all causes of increased salmon mortality rates is imperative in order for the Corps to determine and mitigate the entire range of factors contributing to high salmon mortality rates. Only with all of the contributing factors in mind can the Corps craft the most effective management plan possible and ensure the highest rates of survival for both juvenile salmon and double-crested cormorants.

G-18, G-19, G-20

THE DRAFT EIS MUST RECONCILE ITS TARGET DOUBLE-CRESTED CORMORANT POPULATION WITH THOSE OF HISTORICALLY-ACCEPTED LEVELS

Research has proven that double-crested cormorant populations along the Pacific Coast were historically much larger than they are today. *See* Wires, L. R., & Cuthbert, F. J.

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[3] Note also that juvenile salmon may take many different routes to the ocean, often passing through dams not listed here. See the illustration on page six of the Federal Columbia River Power System report for hydropower plants located in the Upper Columbia River and Snake River.

G-18, G-20

G-3, G-4, G-8, G-10

(2006), Historic populations of the double-crested cormorant (Phalacrocorax auritus): implications for conservation and management in the 21st century, *Waterbirds*, *29*(1), 9-37 at 29. Due to the contamination of the double-crested cormorants' environment and their direct persecution, double-crested cormorant populations were severely reduced for much of the mid-21st century. *Id.* Now that double-crested cormorant populations have regained some of their numbers, many believe there is an over-abundance of them today; however, there is not. *Id.* The double-crested cormorants are simply recovering to their previous population levels after suffering from years of environmental and human threats. Additionally, Wires and Cuthbert state that current double-crested cormorant populations are *not* over-extending their biological carrying capacities. *Id* at 30.

The double-crested cormorant management plan, under Alternative C, the preferred alternative, could end up reducing the double-crested cormorant population on East Sand Island from 40% of the total western double-crested cormorant population to 24% of the total western population. Draft EIS Executive Summary at 13 and 18. Without considering historical double-crested cormorant population numbers in the formulation of its management plan population targets, the Corps runs the risk of taking too many double-crested cormorants and altering the East Sand Island and surrounding ecosystems to an unnatural point. This could have unforeseen effects on other birds in the area, on the vegetation and land, and on other area species. Given this uncertainty, research must be conducted as to the effects of removing large amounts of double-crested cormorants from the area, both through dispersive and lethal methods.

THE DRAFT EIS MUST CONSIDER A WIDER ARRAY OF NONLETHAL ALTERNATIVES FOR DOUBLE-CRESTED CORMORANT MANAGEMENT

Friends of Animals believes that double-crested cormorant predation is being treated as a much more severe problem than is justified, due to the extremely variable nature of double-crested cormorant predation. The number of salmon consumed by double-crested cormorants had a large range over the 2003-2013 measurement period reported in the EIS: a range of 2.4 to 20.5 million salmon consumed each year. Draft EIS Chapter 1 at 9. Also, the number of salmon eaten decreased substantially in 2013. *See graph, id.* at 10.

Further, the EIS states, "It is important to note that double-crested cormorant predation can differ dramatically within a given year and between years." Draft EIS Executive Summary at 4. The Corps also states, "[Cormorants] are opportunistic and generalist feeders, preying on many species of fish, but concentrate on those that are easiest to catch. Because the ease of catching a fish depends on a number of factors including distribution, relative abundance or behavior, the composition of a cormorant's diet can vary considerably from site to site and throughout the year." U.S. Army Corps of Engineers (Portland District) "FAQ".

Any type of double-crested cormorant management plan implemented must be flexible and perceptible to these variations within the predation trends. It is unreasonable to implement a strict, multi-year plan to manage the double-crested cormorant population when its predation habits will not be the same from year-to-year. It is also impossible to conclude that double-crested cormorants are the sole main source of salmon mortality when the double-crested cormorants themselves consume greatly different amounts of salmon each year, and even during different parts of the year.

THE EIS MUST COMPLY WITH FEDERAL REGULATIONS TO DISCLOSE ALTERNATIVES AND ENVIRONMENTAL CONSEQUENCES

G-27

The EIS is not in compliance with several NEPA regulations. First, Section 1502.14, on alternatives, states that agencies must "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." 40 C.F.R. § 1502.14. While the Draft EIS does offer four alternatives, including an alternative of "no action," no alternative is considered in which actions to rejuvenate salmon populations are not solely focused on the reduction of double-crested cormorants. Simply put, there is no integrated approach to salmon rejuvenation mentioned in the Draft EIS alternatives section.

FEIS Section 6.1

Sec. 1502.6 states that, "Environmental impact statements shall be prepared using an inter-disciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts (section 102(2)(A) of the Act). The disciplines of the preparers shall be appropriate to the scope and issues identified in the scoping process (Sec. 1501.7)." 40 C.F.R. § 1502.6. The alternatives proposed in this EIS are not interdisciplinary nor integrated. In order for decision-makers and citizens alike to make informed decisions about the state of juvenile salmon mortality in the lower Columbia River estuary, they must be presented with alternatives that target all sources of salmon mortality, not just double-crested cormorant predation.

G-29

Second, Section 1502.16 of the regulations calls for discussion of environmental consequences possible from the proposed alternatives. "The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented." 40 C.F.R. § 1502.16. The removal of large amounts of the double-crested cormorants on East Sand Island could have adverse effects on the local ecosystem, which are not discussed in the EIS as possible environmental consequences.

S-46, G-16

Finally, Executive Order 13186 on Responsibilities of Federal Agencies to Protect Migratory Birds opens with these lines: "Migratory birds are of great ecological and economic value to this country and to other countries. They contribute to biological diversity and bring tremendous enjoyment to millions of Americans who study, watch, feed, or hunt these birds throughout the United States and other countries." Executive Order 13186, 2001. The order even calls on Federal agencies to "recognize and promote economic and recreational values of birds, as appropriate." *Id.* The EIS fails to address the inherent value of the double-crested cormorants, as well as their role in their natural habitat and in the lives of many American outdoor enthusiasts. The Draft EIS management alternatives must be revised in order to reflect the value of these migratory birds.

Due to the possible severity of their effects if left unaddressed, all of these issues with the Draft EIS must be reconciled before any management plan can move forward.

FRIENDS OF ANIMALS ASKS THE CORPS TO CONSIDER THE ETHICAL REASONS NOT TO TAKE DOUBLE-CRESTED CORMORANTS

G-15, G-28

It is time for the Corps to recognize that individual animals have intrinsic value, and this in turn demands that the Corps incorporate ethics into its consideration of wildlife management activities on public lands. There is a growing recognition among conservationists and biologists that ethics must play a greater role in wildlife policy. See, e.g., Fox & Bekoff, Integrating Values and Ethics into Wildlife Policy and Management—Lessons from North America, *Animals* 2011, 1, 126-143. But as Fox and Bekoff point out: "[w]hile many agree that ethics must play a central role in any project involving [animals], it is often interesting to note that in many books on human-animal interactions . . . there is often no mention of ethics. This needs to change." *Id.* at 129. The same must be said for the regulation of animals.

Undoubtedly, discussions in the context of policy development about ethics and animals can make some people uncomfortable. But, of course, just a generation ago it was also unheard of for an agency to even incorporate the humane treatment of animals into its decision-making process. This has changed dramatically. Our generation must now adopt the same approach to educating the decision-makers and the public as to the role of ethics in making wildlife management decisions. Indeed, it is our jobs as conservationists, animal advocates and scientists "to work toward public education and information dissemination to address real and perceived fears held" by others. *Id.* at 128. What is missing in the Corps' current regulations, policies, and environmental analysis is the viewpoint of the animals. Again, from Fox and Bekoff:

> The growing body of literature on animal cognition and emotions demonstrates undeniably that animals have interests and points of view. Like us, they avoid pain and suffering and seek pleasure. They form close social relationships, cooperate with other individuals, and likely miss their friends when they are apart. Emotions have evolved, serving as "social glue," and playing major roles in the formation and maintenance of social relationships among individuals. Emotions also serve as "social catalysts," regulating behaviours that guide the course of social encounters when individuals follow different courses of action, depending on their situations. If we carefully study animal behaviour, we can better understand what animals are experiencing and feeling and how this factors into how we treat them.
>
> *Id.* at 131.

In preparing the final EIS, the Corps should not merely focus the attention of the public and the decision-maker on the human perspective of the wildlife-human relationship. Instead, it must include a legitimate discussion of ethics, and the rights of wildlife, to assist the reader in fully considering the best alternative to choose to help manage wildlife-human interactions. This is approach would be consistent with the purposes of NEPA. An EIS should provide full and fair discussion of the issues and inform decision makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment. *See* 40 C.F.R. § 1502.1.

comments noted

G-21, G-22

G-9, G-10, G-11 FEIS Section 2.3, App. G

FRIENDS OF ANIMALS CALLS FOR AN ALTERNATIVE, COMPLETELY NONLETHAL MANAGEMENT OPTION

Through double-crested cormorant management, there is the possibility that several other bird species could be misidentified and targeted if lethal double-crested cormorant management actions are used. This is particularly concerning for threatened streaked horn larks in the area around East Sand Island. The streaked horn larks could be adversely affected by shooting and hazing in the area. "Islands identified as potential dispersal and hazing locations (i.e., Rice, Miller Sands Spit, Pillar Rock; see Table 2-3) and other islands in the Columbia River Estuary and locations along the Washington coast were recently designated critical habitat for the streaked horned lark (50 CFR 17.95(b))." Draft EIS Chapter 4 at 28.

ESA Section 7 requires federal agencies to evaluate expected impacts to listed species and designated critical habitat before authorizing, funding, or taking any discretionary action. 16 U.S.C. § 1536(a)(2). When a proposed agency action is likely to adversely affect a listed species, the agency must prepare a biological opinion. Biological opinions must be based on the best available science and must analyze whether the proposed agency action is likely to jeopardize any listed species or adversely modify any designated critical habitat. 16 U.S.C. § 1536(a)(2). If a proposed agency action will jeopardize a listed species or adversely modify designated critical habitat, the agency must suggest reasonable and prudent alternatives that will avoid jeopardy and adverse modification of designated critical habitat. 16 U.S.C. § 1536(b)(3)(A).

The double-crested cormorant management plan could allow for the accidental take of the endangered streaked horn lark, which is illegal under the ESA. The Corps must prepare a biological opinion and submit alternatives to avoid jeopardizing the larks and their critical habitat. The use of solely nonlethal management techniques on East Sand Island would decrease the risk of harming the larks, as well as ensure the ethical treatment of double-crested cormorants.

As such, FoA proposes an alternative plan of action for the double-crested cormorant management program. FoA would like to see Alternative B's nonlethal hazing strategies integrated with changing hatchery practices, such as varying salmon release times and barging more salmon to dispersal areas, revising dam design in regards to salmon flow, cleaning up waterways, and using social attraction methods to disperse some of the double-crested cormorants from East Sand Island. The EIS shows that social attraction techniques in the immediate area have been effective in dispersing double-crested cormorants; more attempts must be made in order to facilitate new, long-distance double-crested cormorant nesting. Draft EIS Chapter 1 at 11.

FoA feels that changing aspects of the fish hatchery industry is necessary in order to preserve the integrity of both juvenile salmon and double-crested cormorants, as well as other area species. Staggering the release times of hatchery salmon could allow more salmon to survive the migration, as less concentrated groups of salmon would be passing through double-crested cormorant territory. Modification of hatchery processes could allow for measures to be taken in order to release salmon at times that do not coincide with peak double-crested cormorant nesting times.

With a combination of the activities listed in this section, double-crested cormorant, salmon, and human communities can be positively affected by the management plan.

G-2

Successful communities necessitate successful ecosystems as their backbone. To lethally diminish the double-crested cormorant colony on East Sand Island without analyzing all possible contributions to salmon mortality rates *or* the invaluable contribution of double-crested cormorants to the Columbia River ecosystem could prove to be an irreversible mistake.

We appreciate the opportunity to comment on this plan and to be a part of the process of preserving our nation's natural life. FoA advocates for the alternative, completely nonlethal measures described in the preceding section to be considered, and for additional research to be done concerning salmon mortality rates, before the EIS is finalized.

Sincerely,

Edita Birnkrant/K.D.

Edita Birnkrant,
Campaigns Director
Friends of Animals

Referenced Works

Statutes

16 U.S.C. § 1536

40 C.F.R. § 1502

Other

Executive Order No. 13186, Fed. Reg. Vol. 66 No. 11 (2001).

Federal Caucus-- salmonrecovery.gov. (2008, May 5). *2008 FCRPS BiOp*. Retrieved from http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp/2008FCRPSBiOp.aspx (last visited Aug. 19, 2014).

Ferguson, J. A., Romer, J., Sifneos, J. C., Madsen, L., Schreck, C. B., Glynn, M., & Kent, M. L. (2012). Impacts of multispecies parasitism on juvenile coho salmon (< i> Oncorhynchus kisutch</i>) in Oregon. *Aquaculture, 362*, 184-192.

Fox, C.H., & Bekoff, M. (2011). Integrating values and ethics into wildlife policy and management—lessons from North America. *Animals*, 1(1), 126---143.

Kareiva, P., Marvier, M., & McClure, M. (2000). Recovery and management options for spring/summer chinook salmon in the Columbia River Basin. *Science, 290*(5493), 977-979.

U.S. Army Corps of Engineers, Bonneville Power Administration, & Bureau of Reclamation. (2003). *Federal Columbia River Power System*. Retrieved from http://www.bpa.gov/power/pg/fcrps_brochure_17x11.pdf (last visited Aug. 19, 2014).

US Army Corps of Engineers (Portland District). 2014. *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary: Draft Environmental Impact Statement [Draft EIS]*. Retrieved from http://www.nwp.usace.army.mil/Portals/24/docs/announcements/EIS/DRAFT_Double-Crested_Cormorant_Plan_Reduce_Predation_Columbia_River_Estuary_EIS.pdf (last visited Aug. 19, 2014).

US Army Corps of Engineers (Portland District). *Columbia River Estuary double-crested cormorants FAQ*. Retrieved from http://www.nwp.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/2043/Article/6018/columbia-river-estuary-double-crested-cormorants-faq.aspx (last visited Aug. 19, 2014).

Wires, L. R., & Cuthbert, F. J. (2006). Historic populations of the double-crested cormorant (Phalacrocorax auritus): implications for conservation and management in the 21st century. *Waterbirds, 29*(1), 9-37.

Grant County
PUBLIC UTILITY DISTRICT

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August 15, 2014

Ms. Sondra Ruckwardt
US Army Corps of Engineer District, Portland
ATTN: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Subject: Response to Public Notice CENWP-PM-E-14-08

Dear Ms. Sondra Ruckwardt,

The Public Utility District No. 2 of Grant County, Washington (Grant PUD) welcomes and appreciates the opportunity to review and comment on the draft Environmental Impact Statement (EIS) for Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary in Clatsop County Oregon. Grant PUD appreciates the U.S. Army Corps of Engineers (ACOE) efforts in developing a plan that attempts to address the very complex issue of avian predation and its effects on juvenile salmonids in the Columbia River Estuary and is generally supportive of the activities outlined in the draft EIS which will reduce the Double-crested Cormorant colony size on East Sand Island and limit their dispersal within the Columbia River Estuary.

comment noted

Based on the facts that the double-crested cormorant colony on East Sand Island has increased from 100 breeding pairs in 1989 to nearly 15,000 breeding pairs in 2013 with an estimated consumption of 18 million salmonid smolts, smolts that belong to every evolutionary significant unit (ESU) from throughout the Columbia River Basin, **Grant PUD agrees with and supports the Corps' preferred Management Plan of Alternative C – "Culling with integrated non-lethal methods including limited egg take".** Alternative A – "no action" will not achieve the Corps' requirements under reasonable and prudent alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion and does not address the issue of avian predation on ESA listed salmonid smolts. As suggested in studies conducted from 2008 thru 2013, the effectiveness of non-lethal methods to dissuade double-crested cormorants from nesting on East Sand Island proved ineffective at reducing the population of double-crested cormorants in the Columbia River Estuary and even East Sand Island itself, thus Alternative B – "non-lethal management" shows little promise to meeting the requirements laid out in your 2014 Supplemental Federal Columbia River Power System Biological Opinion.

As seen most recently in South Carolina, along with seven other states, culling is an accepted and reliable methodology used for population management of double-crested cormorants. With a 72% increase in the number of double-crested cormorants breeding along the west coast of North America in the last decade, with the greatest population growth seen at the East Sand Island colony, management of the breeding

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grantpud.org

population is definitely needed. **Alternative C**, as presented in the draft Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary EIS, is the only logical and fiscally responsible approach to manage the East Sand Island double-crested cormorant breeding population and meet the requirements of Corps' 2014 supplemental Biological Opinion for the Federal Columbia River Power System.

Like the federal action agencies, Grant PUD has invested considerable time, effort, and financial resources in recovering Columbia Basin salmon and steelhead populations in recent years. While we have made considerable progress, we believe avian predation remains a serious threat to achieving a full and sustained recovery for species such as UCR steelhead and spring Chinook. We urge the ACOE and the other federal action agencies to consider the magnitude of the threat that double-crested cormorants pose to the overall health of these populations and implement measures that are commensurate with that threat.

Sincerely,

Thomas J Dresser Jr.
Fish, Wildlife and Water Quality Manager
Public Utility District No 2 of Grant County, Washington
30 C Street SW
Ephrata, Washington 98823

CITY OF CANNON BEACH

U.S Army Corps of Engineers
PO Box 2946
Portland, OR 97208
Attn: Cormorant EIS

G-19

I am writing to express strong opposition to the preferred Action Alternative C - Culling with Integrated Non-Lethal Methods including Limited Egg Take, as described in the draft environmental impact statement. Due to the current state of the western population of double-crested cormorants, this alternative may have unforeseen implications for the health of the entire western population of double-crested cormorants, a protected species under the Migratory Bird Treaty Act of 1972. Studies show that double-crested cormorant breeding populations are declining in all locations on the West Coast besides the breeding colony on East Sand Island. "The number of coastal colonies to the north of East Sand Island has declined by approximately 50% since the early 1990s, and numbers nesting at the remaining northern coastal sites have also declined, resulting in a 66% decline in number of breeding pairs within this sub-population…Because of the unique characteristics of the double-crested cormorant colony at East Sand Island and the tenuous status of the colonies elsewhere, the future of this colony will likely influence the entire western population" (Adkins et al. *Double-Crested Cormorant Population Trends*. The Journal of Wildlife Management. June 2014).

comments noted

Alternatives A and B should be more closely examined and considered to reduce salmonid mortality in the Columbia River Estuary. The summary of actions on page 9 of the EIS, explains that if no action is taken "survival improvements for juvenile salmonids would need to be made up with other actions within the purview of the Federal Columbia River Power System". Anthropogenic causes of salmon mortality including dams, habitat loss and hatcheries need to be address by US Army Corps of Engineers alongside the reduction of predation at East Sand Island. Increased avian predation rates are the result of the stabilization and expansion of East Sand Island by the US Army Corps. Terrian modification and inundation of the island should be considered to reduce the population of double crested cormorants on the islands. These non-lethal methods allow adult breeding pairs to reestablish elsewhere, limiting the further decline of the western population of double-crested cormorants.

In conclusion, I urge the US Army Corps of Engineers to reexamine the draft environmental impact statement for the double-crested cormorant management plan to consider the impacts on the western population of double-crested cormorants if the cull was to be implemented, and to address issues such as the current state of salmonids (most populations are considered stable or increasing, according to the 2014 Supplemental BiOp), compensatory mortality, and hatchery fish. Without these additions, an appropriate and environmentally sound action cannot be taken to reduce predation on juvenile salmonids.

Thank you,

Samantha Ferber

Samantha Ferber
B.S. in Biology
Haystack Rock Awareness Program Coordinator

HUDSON MOHAWK BIRD CLUB

The Hudson-Mohawk Bird Club

5 Jennifer Rd.
Scotia, NY 12302
August 4, 2014

Portland District Public Affairs Office
U. S. Army Corps of Engineers
P.O. Box 2946
333 SW First Ave.
Portland, OR 97208-2946

To: U.S. Army Corps of Engineers, Portland District

comments noted

On behalf of the Hudson-Mohawk Bird Club, a group of 350 members located in the New York State Capital Region, I am writing in opposition to Alternative C, which would result in the killing of 16,000 Double-crested Cormorants at East Sand Island in the misguided attempt to reduce avian predation on endangered salmon.

East Sand Island is a globally-significant Important Bird Area (IBA) in Oregon's lower Columbia River estuary, and home to Double-crested Cormorants. Placing the blame on fish-eating birds for low salmon populations is unreasonable and unscientific, especially when human activity such as dam-building, pollution and habitat loss continues unchecked.

Alternative C is an unacceptable approach. It will result in the loss of more than 25 percent of the entire western North American cormorant population, which is continuing to decline and is now below historic levels in some areas.

G-2

Slaughtering one species in order to "save" another is unrealistic, inhumane, and does not address the problem at its core, which is human disturbance. It is the responsibility of the Corps to address the actual cause of low salmon populations and pursue non-lethal measures. I strongly urge you to favor Alternative A, which is ***no action***, and actively pursue a humane and balanced solution.

Thank you.

Sincerely,

Patti Packer

Patti Packer
Interim Conservation Chairperson, Hudson-Mohawk Bird Club

CC: Jory Langner, President, Hudson-Mohawk Bird Club

THE HUMANE SOCIETY
OF THE UNITED STATES

August 19, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
P.O. Box 2946
Portland, OR 97208-2946
By electronic mail: cormorant-eis@usace.army.mil

RE: Draft Environmental Impact Statement for Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, CENWP-PM-E-14-08

Dear Ms. Ruckwardt:

On behalf of The Humane Society of the United States (HSUS) and its supporters, I am writing to express our grave concern over the U.S. Army Corps of Engineers (the Corps) proposal to control double-crested cormorants (*Phalacrocorax auritus)* on East Sand Island (*Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary,* 6 June 2014). The draft Environmental Impact Statement's (DEIS) preferred alternative calls for the killing of upwards of 16,000 cormorants to mitigate predation on juvenile salmonids in the Columbia River system. We are unequivocally opposed to this proposal. comments noted

While we understand the complexity of the issue before the agency and the need to balance the interests of many different stakeholders, ranging from recreational anglers to Native Americans seeking to engage in traditional and culturally significant practices, we do not believe that an extensive culling of a native and protected bird species is warranted. We are deeply troubled by the recent trend of federal agencies utilizing widespread culls of one species to aid another species. Utilizing this type of cull does not address the root cause of the problem -- i.e., anthropogenic influences -- and does not provide a long-term solution to a larger problem.

Neither the ethical foundation nor the moral acceptability of this planned depopulation has been vetted in a manner that is acceptable to the animal protection community; thus we would only support Alternative B (Non-lethal Management Focus with Limited Egg Take) as an interim measure until the G-15

Corps could assemble an Ethics Panel to review the moral acceptability of a massive culling program. The U.S. Fish and Wildlife Service assembled such a panel when it proposed culling experiments on Barred owls after recognizing their removal posed both ethical and scientific issues which the Agency should address when developing an EIS. We would urge the Corps to make the same type of recognition in this instance. Moreover, we cannot continue to manage our wildlife using the kind of model proposed in this DEIS. It is not only unsustainable, but simply not right.

We appreciate the opportunity to comment on this proposal. I can be reached at (301) 258-1532 if you have any questions concerning these comments.

Sincerely,

Nicole Paquette
Vice-President, Wildlife Protection

Ilwaco Charter Association

P. O. Box 9
Ilwaco, WA 98624

July 29, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

comments noted

The Ilwaco Charter Fishing Association (ICA) is the oldest and biggest charter association at the mouth of Columbia River. We are based out of Ilwaco, WA, but we also have members from the Oregon side of the river. We support Alt. C by a unanimous vote of all our members! Although we feel it doesn't go far enough to control the millions of Salmon that are eaten each year it's a start. Columbia River salmon supports commercial, sport, and Tribal fishers from California to Alaska and all the coastal communities in between. We have spent billions of dollars in salmon recovery only to watch ESA listed salmon get eaten from a man - made island 2 miles away from the ocean. These salmon are the strongest of the strongest and these salmon have made it through all the dams and traveled hundreds of miles just to be picked off 2 miles away from getting to the ocean.

The Army Corps has allowed groups to make this island an oasis for these salmon eating birds by having study groups building artificial structures and killing up to 200 seagulls each year that prey on the nesting birds and also killing raccoons, coyotes and other prey animals that make the swim over to the island. The Corps has to take some responsibility for getting things back in balance. By controlling the population of the cormorants it will be one of the fastest things we can do to recover salmon. For example between the cormorants and terns these birds eat up to 25 million smolts each year, that is almost 200,000 returning adult salmon that come back to the Columbia River that are being Killed! There is nothing we could do that would recover salmon faster than start controlling avian predators. We think it is very unfair to the people of the Northwest that have spent billions of dollars in salmon recovery and Coastal Communities that have lost millions of dollars in fishing times for the sake of the salmon to let this travesty go on any longer!! So please pick, Alt C and lets really get serious about saving salmon.

Thanks
Butch Smith pres
Ilwaco Charter Assoc.
360-642-3333 coho@willapabay.org

IN DEFENSE OF ANIMALS

August 11, 2014

Sondra Ruckwardt, Project Manager
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208

Sent via email: Cormorant-EIS@usace.army.mil

Dear Ms. Ruckwardt,

Please accept the following comment on behalf of In Defense of Animals and our more than 150,000 supporters internationally and 7,000 in Oregon regarding the draft Environmental Impact Statement (EIS) developed by the U.S. Army Corps of Engineers in cooperation with several other wildlife-related agencies, "to reduce predation of juvenile salmon and steelhead by double-crested cormorants in the Columbia River Estuary."

comments noted

We appreciate the opportunity to provide a comment, however, we are quite shocked at the proposed action to kill up to 16,000 protected and native double-crested cormorants (herein, cormorants) over the course of four years in order to increase populations of protected and native trout and salmon (herein, salmonids). We are equally appalled at the single-track approach that seeks to blame one bird species for the decline in salmonid populations without considering any of the human-caused factors that are likely contributing to fish mortality.

Guided by a rather mechanistic worldview, the Army Corps has already spent millions of tax payers' money on its myopic, yet futile approach to *manipulate and control* the behavior of these bird populations. Methods used in the past years include hazing the birds with lights, reducing nesting habitat, and "using human presence to flush double-crested cormorants off potential nesting sites," *reducing* habitat, by "installing barrier fences and using human hazers to flush birds from the non-designated nesting area," and equipping some of the birds with either satellite transmitters or leg bands to get information about their movements. And now, after all these efforts to *manipulate, dissuade, and control to reduce* cormorant populations have failed, the Army Corps deems it time for sacrificial mass killing, despite the fact that cormorants are protected under the Migratory Bird Treaty Act and are native to the Columbia River Estuary.

The Army Corps' biased approach—the preference for a large-scale slaughter of thousands of birds— in favor of an increase in salmonids— is apparent in their choice of language used to present the issue to the public: the Army Corps' website uses terms like "predation" that conjures negative images rather than the more natural description of cormorants' "feeding" behavior needed to survive. Furthermore, the website draws people's attention to the fact that cormorants have consumed millions of juvenile salmonids per year. Clearly, with the East Sand Island cormorant population being the largest colony representing nearly 40% of the
G-2 western population, a large amount of feeding on fish is to be expected. Nowhere can one read about the cormorants' feeding behavior placed in context with other, human-caused factors

leading to salmonid mortality. Finally, the simultaneous labelling of cormorants as "predators" and "juvenile" (meaning: vulnerable) salmonids particularly while omitting the fact that cormorants and salmonids have been in co-existence for millions of years, is apparently being used to create antipathy against this bird species.

G-19, G-20

Furthermore, calling the size of the East Sand Island cormorant population as having increased to a "record size of approximately 14,900 nesting pairs in 2013" without placing these numbers in either a historical (how do present numbers compare to past numbers) or a broader landscape context (how do cormorant populations along the west coast compare to the East Sand Island cormorant population, i.e., is there indication that the East Sand Island population may compensate for populations elsewhere that are currently being (or have been) lethally reduced whether legally or illegally) only furthers an incorrect and unfair presentation of a complex situation of which the cormorants a mere part of.

FEIS Section 1.4

Finally, the Army Corps has been working with "its cooperating agencies, the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, the Oregon Department of Fish and Wildlife, and the Washington Department of Fish and Wildlife to develop the EIS." Instead of a holistic approach to manage for the integrity and health of entire ecosystems, each of these agencies has a single-species focus and a history for a preference for lethal control. Also, instead of including nonprofit bird conservation and animal welfare organizations, the Army Corps limits its scope of input to agencies, many of which have an interest in the commercial use, thus favor some (fish) species over other (bird) species without any perceived commercial value.

In summary, the draft EIS is insufficient in that it does not consider the following:

G-16

1. What is known about the potential *positive* impacts of cormorants on salmonids?

G-19 G-20

2. What is the status (population trends and dynamics) of cormorants throughout the species' west coast range considering the fact that some of these populations have been drastically reduced in recent years?
3. What are cumulative current and future threats to the cormorant populations?
4. What are anticipated effects of the proposed mass killing on surviving cormorants and other avian populations in terms of stability, and breeding and nesting abilities?
5. How will the proposed mass killing effect the welfare of targeted cormorants on the individual and population level?
6. How does the proposed mass slaughter of the East Sand Island cormorant population affect the species throughout their range, considering other ongoing potential mortality causes including persecution from humans, changing climate and subsequent changing ocean conditions (water salinity or acidification at times), pollution and contaminants, the 30 major dams on the Columbia River system blocking salmon runs, presence of and impact from salmon farms (aquaculture) and associated concerns about the spread of disease potentially impacting salmonids, overfishing, and other factors that could lead to a decrease in fish size, which in turn, would lead to the need for cormorants to feed on more fish?

G-2 Federal agencies have a broad mandate to work for the protection of all species, and not to favor one over the other. The proposed plan to kill up to 16,000 cormorants is extremely biased in terms of its single-minded focus and blame of a rather unknown bird species in favor of economic interests of commercial fisheries and the small interest group of recreational anglers. The EIS ignores important questions and omits addressing crucial concerns about other, human-caused factors leading to salmonid mortality.

Thus, In Defense of Animals strongly opposes the proposed massacre of cormorants for the insufficiencies pointed out above, and for the simple reasons that this proposed action is biologically unbalanced and ecologically reckless, drastic, and simply unethical.

We strongly encourage the Army Corps to abandon this ill-conceived plan and develop a more holistic approach that does not rely on mass killing native birds in a sacrificial manner. This is a complex issue that requires a lot more consideration than what has been done so far. Basic information about potential *positive* impacts of cormorants on salmonid populations is not even considered but need to be.

Thank you for your consideration of our comments.

Sincerely,

Anja Heister

Anja Heister
Director, Wild and Free – Habitats Campaign
In Defense of Animals
406-544-5727
www.idausa.org

From: [redacted]
To: Cormorant EIS
Subject: [EXTERNAL] Draft Cormorant EIS
Date: Friday, August 01, 2014 3:13:44 PM

While I support the "Preferred Alternative" in the USACE's draft EIS for control of the double-crested cormorants on East Sand Island, I have three concerns about the methods planned to be used: Safety, Wastage, and Expense.

S-20

* The information I got at the Open House indicated that the "small caliber, non-toxic, subsonic ammunition" they plan to use in "suppressed" firearms is .223 caliber (center fire, reduced load M16 ammunition). I expect that ammunition will retain sufficient energy to cause damage, injury, or death even after ricocheting from sand or water to approximately a mile. To use that ammunition "safely" would require (at least) restriction of boat traffic in the estuary, and, possibly vehicle traffic on Highway 101, not to mention beaches near the town of Chinook. The USACE has not discussed this with the Coast Guard, nor are they prepared to waive the government's right to choose whether it can be sued for any damage or injury that may result from these activities.

comment noted

* I suggest that the use of shotguns, even during daylight hours, is safer and more humane.
* I'm not particularly concerned whether that would "displace" the double-crested cormorants from the island. That might cause a temporary increase in their populations elsewhere, but, unless the populations elsewhere are increasing (the "carrying capacity" of their habitat elsewhere has not been reached), displacing birds from East Sand Island (i.e. by hunting them on the island by day with shotguns) would eventually remove those birds, or an equivalent number of birds elsewhere from the breeding population, due to habitat limitations (e.g. predators, availability of food and/or nesting sites).
* If the population of double-crested cormorants is increasing throughout the region, then a much broader approach should be considered, such as modifying the International Migratory Bird Treaty to allow the double-crested cormorant to be considered a "game bird" at least in areas which require "damage control" makes much more sense. A comparable example might be the crow, which has a hunting season set to allow hunting of "resident" crows only, since the crow is sacred to some Mexican natives, unless the crow is "in the act of depredation". Crows "in the act of depredation" can be hunted at any time.

G-26

comment noted, standard conditions of permits will be followed

* Cormorants are good to eat. They are a game bird and served in restaurants in Iceland, and are eaten by aboriginal peoples elsewhere. There are recipes for cormorant from Iceland, Scotland, and even from the head chef to the king of France! Contrary to popular belief, they taste more like squab than "fishy". Even if they did taste "fishy", they would make fine sausage or jerky. The Oregon Department of Fish and Wildlife has tested cormorants, and, while there is evidence of some bioaccumulation of toxins, it is minor, and they are safe to eat. Thus, regardless of how the cormorants are "culled", I am concerned that provisions have not been made to allow their consumption.

* I suggest that, like eating a "poisonous" tomato on the courthouse steps, publication of some recipes, and/or a cormorant recipe tasting event would remove the cormorant's undeserved stigma as poor table fare.
* I, for one, would have no hesitation about eating double-crested cormorants.

G-26

* Hiring "professionals" to cull the double-crested cormorants involves considerable expense relative to using "trained volunteers" as have been used elsewhere. Restructuring East Sand Island to eliminate nesting habitat may be more expensive than negotiating changes to the International Migratory Bird Treaty, especially considering the world-wide state of declining fish populations, since a change to allow limited "hunting" of double-crested cormorants to control their population, would likely benefit all the signatories. It does not make sense that reducing the population by destruction of habitat is preferable to limited hunting to control the population.

* I suggest that revision of the International Migratory Bird Treaty to allow limited "hunting"

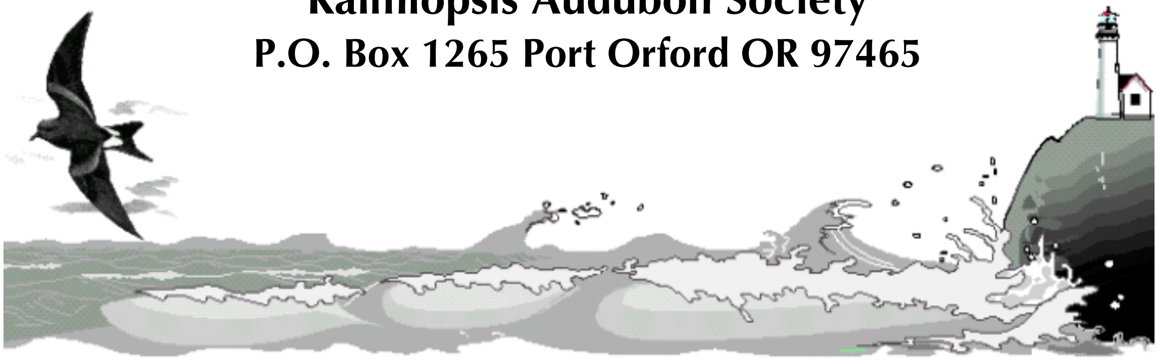
of double-crested cormorants for the purpose of damage control should be pursued at least in parallel with the efforts put forth in the EIS, if not instead of them.

* Controlled hunting administered by the states with the approval of the USFWS would be the least expensive, and most effective way or controlling the population of double-crested cormorants.

Thanks,

[redacted]

Kalmiopsis Audubon Society
P.O. Box 1265 Port Orford OR 97465



July 7, 2014

Sondra Ruckwardt. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208-2946

Re: DEIS, Double-crested cormorant plan to reduce predation of juvenile salmonids

Greetings:

I am writing on behalf of the Kalmiopsis Audubon Society. Our group has more than 200 members who are concerned about birds, fish and wildlife. For that reason, we strongly oppose your proposal to lethally control such a large number of Double-crested cormorants on East Sand Island (CENWP-PM-E-14-08). Killing cormorants should not be an acceptable routine action to make up for human mismanagement of imperiled fish and their habitats.

G-18, G-19, G-20 → It's important to recognize that West Coast Double-crested Cormorant populations are already estimated to be an order of magnitude lower than they were historically. Aside from at East Sand Island, populations are actually declining.

G-17 G-21 → In addition, we are especially concerned that the birds you intend to target nest in the midst of other breeding seabirds birds, including Brandt's cormorants, Caspian terns, and California brown pelicans. Brown pelicans were only recently removed from the Endangered Species list, but now they are once again facing very big problems owing to unprecedented nest failures at most of their other breeding colonies. Your Draft EIS is inadequate because it does not adequately explain how federal marksmen will shoot the double crested cormorants during breeding season without disturbing the other breeding birds that nest on the island, including the now struggling brown pelicans.

G-2, G-3 G-4 G-10 → The DEIS is also inadequate because it does not address compensatory mortality, the role of hatchery fish in "setting a table," and the wildly fluctuating salmon returns. It does not provide adequate research on non-lethal alternatives to dispersing cormorants.

We urge the Corps to recognize the manmade causes of salmon decline, including dams, habitat loss and fish hatcheries –and to focus recovery efforts on addressing these problems rather than to try to pin the blame onto the back of cormorants.

Sincerely,

/s/ *Ann Vileisis*
President

Karuna Law

August 18, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
PO Box 2946
Portland, OR 97208-2946

VIA FIRST-CLASS MAIL AND EMAIL,
cormorant-eis@usace.army.mil

RE: Comments on Draft Environmental Impact Statement on the Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary, Docket No. CENWP-PM-E-14-08

Dear Ms. Ruckwardt:

As a private public-interest law firm with offices in Portland and deep concerns for the survival and stability of species and habitat in the Pacific Northwest, Karuna Law respectfully submits these comments on the Draft Environmental Impact Statement ("Draft EIS") for a Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary ("Estuary") by Double-Crested Cormorants (Phalacrocorax auritus) ("Cormorant" or "DCCO") issued June 12, 2014, by the United States Army Corps of Engineers, Portland District ("Corps").

The Draft EIS fails to adequately consider alternatives to the proposed action as required under the National Environmental Policy Act ("NEPA"), 42 U.S.C. §§ 4331 et seq. Adequate consideration requires development of new alternatives based on studies that should be subject to public scrutiny. Consequently, the Corps should conduct appropriate studies, analyze and consider the data that they provide, and issue a revised draft EIS for public review and comment before proceeding to a final EIS.

I. Project Background

The Cormorant colony nesting in the Estuary at East Sand Island is part of the species' Western Population, which numbers approximately 29,240 breeding pairs in British Columbia and all U.S. states west of the Continental Divide[1] ("Western Population"). "Of this current estimate, approximately 41% nest at East Sand Island." The draft EIS currently identifies killing of approximately 61% of these birds as the Corps' preferred alternative.[2]

G-2,
G-3,
G-4,
FEIS
Section
4.2.5,
4.4

The current preferred alternative—an unprecedented lethal take from the Western Population of a native species that has co-existed with salmon successfully for generations—will hardly reverse

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[1] Jessica Y. Adkins & Daniel D. Roby, A Status Assessment of the Double-Crested Cormorant (Phalacrocorax Auritus) in Western North America: 1998-2009 (2010), http://www.birdresearchnw.org/Adkins et al._2014_early view.pdf) [hereinafter *Status*].

[2] *See generally* Draft EIS 2:20 (describing "total take of 15, 956 DCCOs in all years").

the long history of salmon decline in the Columbia River, which is wholly unrelated to any avian predation. "For the past century, the overall trend in salmon abundance has been one of decline, reflecting a myriad of factors that undermined the natural productive capacity of the Columbia River basin."[3] The "decline in Columbia River Basin salmon and steelhead is probably the result of a combination of factors, including harvest, habitat degradation, hydroelectric development, an emphasis on hatchery supplementation, and climatic and oceanic conditions."[4] The effect of the hydroelectric system cannot be understated. The fish that the proposed action seeks to affect "must pass a number of [Federal Columbia River Power System ("FCRPS")] dams on their journey to the sea and suffer a very high mortality rate in doing so, sometimes as high as 92%."[5]

Nevertheless, the draft EIS asserts that even when compared with hydropower dams, "DCCO predation can be a significant source of mortality for some Columbia River . . . salmonid[s]."[6] Its stated purpose is therefore to "to reduce DCCO predation . . . to levels identified in the environmental baseline (base period) of the 2008/2010 FCRPS Biological Opinion (NOAA 2008, 2010)"[7] ("BiOp"). The Corps' preference for this approach appears to perpetuate a misguided assumption that the Estuary "is a simple migration corridor or bottleneck, where predation and other mortality factors must be controlled, rather than a productive nursery ground, where the varied habitat needs of diverse populations and life history types must be protected."[8]

II. The Current Preferred Alternative Would Not Result in a Significant Improvement in Salmonid Survival.

G-3, G-4, FEIS Section 4.2.5

According to the draft EIS, in the context of other FCRPS "efforts and survival requirements, DCCO predation can be a significant source of mortality for some Columbia River [evolutionarily significant unit ("ESU")] or [distinct population segment ("DPS")] salmonid groups."[9] Cormorant predation, however, has at most a marginal impact on salmon relative to other impacts throughout the Columbia River system—even during years when its impact is greatest. "[S]molt consumption

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[3] D.L. Bottom et al., *Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon*. U.S. Dep't Commerce, Nat'l Oceanic & Atmospheric Admin., NOAA Technical Mem. NMFSNWFSC-68 (2005)[hereinafter *Bottom*].

[4] Phaedra Budy & Gary P. Thiede, E*vidence Linking Delayed Mortality of Snake River Salmon to Their Earlier Hydrosystem Experience*, 22 N. Am. J. of Fisheries Mgmt. 35, 35 (2002).

[5] *Nat'l Wildlife Fed. v. Nat'l Marine Fish. Serv.*, 422 F. 3d 782, 788-89 (9th Cir. 2005).

[6] Draft EIS 1:17.

[7] *Id.* at 1:16.

[8] *See generally Bottom*, *supra* note 3.

[9] Draft EIS 1:17.

FEIS, Section 4.2.2, App. E

and predation rates vary considerably on an annual basis even within a single cormorant colony, making it difficult to predict impacts in any given year, regardless of colony size."[10] The presence of a colony of birds that "occup[y] a place high in the food web, similar to top predatory fish such as walleye and pike"[11] may appear to represent an "obvious" threat to salmonid mortality. Against the threats posed by the FCRPS, however, it is simply not a factor "significant" enough to warrant killing close to half of the Western Population.[12]

G-4, FEIS Section 4.2.5, 4.6.5

G-5

A recent study of predation rates concluded that "[p]otential increases in the average annual population growth rate (λ) for complete elimination of predation by double-crested cormorants nesting on East Sand Island . . . ranged from 0.4 – 1.1% for Chinook salmon ESUs, was 1.6% for the Snake River sockeye salmon ESU, and *ranged from 1.8 – 2.1% for steelhead DPSs*.[13] These "estimates represent the theoretical *maximum possible benefits for salmonid populations if cormorant management is maximized* . . . ."[14] Despite these marginal increases even with complete elimination of the East Sand Island colony, however, the draft EIS concludes that the preferred alternative's massive lethal take will "restore juvenile steelhead survival to the environmental baseline . . . level[of approximately 6.7%]."[15] The Corps' conclusion has no ascertainable basis in fact.

G-4, FEIS Sections 4.2.2 4.6.5

The maximum possible benefit levels described above "assume that no other mortality factors compensated for this reduction in mortality due to cormorant predation . . . ."[16] Because this assumption is unreasonable—and benefits would likely be *less than the maximum*—the flaws in the draft EIS's conclusion become even more apparent.

"[C]ompensatory mortality is one type of mortality largely replacing, or "compensating" for another kind of mortality, but the total mortality rate of the population remains constant."[17] "For example, if avian predators are disproportionately consuming dead, diseased, injured, or otherwise

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[10] Donald E. Lyons et al., *Benefits to Columbia River Anadromous Salmonids from Potential Reductions in Predation by Double-Crested Cormorants Nesting at the East Sand Island Colony in the Columbia River Estuary* 25 (2014) [hereinafter *Lyons*].

[11] Linda R. Wires, The Double-Crested Cormorant: Plight of a Feathered Pariah 24 (Yale 2014) [hereinafter *Wires*].

[12] *See generally* Draft EIS 2:20 (describing "total take of 15, 956 DCCOs in all years").

[13] *Lyons*, *supra* note 10, at 28 (2014)(emphasis added).

[14] *Id.* (emphasis added).

[15] *See generally* Draft EIS 1:16 (describing need for action and explaining that "[s]ince steelhead appear to be more susceptible to DCCO predation (compared to other salmonid species and in the context of the [BiOp]), they are used to describe survival improvement targets that could be achieved through DCCO management").

[16] *Id.*

[17] *Id.* at 4:93.

moribund fish relative to healthy fish, [then] efforts to reduce avian predation will not result in commensurate increases in smolt survival."[18] Conversely, additive mortality results when one source of mortality is added to another for a combined total effect.

G-4, G-14 FEIS, Sections 4.2.5 4.4, 4.6.5

The draft EIS acknowledges, as it must, that current knowledge supports the conclusion that cormorant predation is neither completely additive nor completely compensatory.[19] Even so, it fails to consider any possible effects of compensatory mortality on its estimates of the salmonid survival improvement that it asserts will occur under the current preferred alternative. It fails to do so "because the degree to which avian predation . . . is compensatory versus additive is currently unknown [and] predation of juvenile salmonids . . . is a well-studied and documented source of mortality."[20]

As a result, the current preferred alternative promises results that it is certain to fail to deliver. Adjusting benefit levels to reflect a range of between 25% and 75% compensation by mortality sources other than the Cormorant would "represent a biologically more likely range of potential benefits . . . ."[21] Additionally, considering "a range of possible compensatory mortality . . . [would overcome[] . . . the major assumption . . . that increases in [salmonid] survival at a particular life-history stage are independent of changes in survival elsewhere in the life history."[22]

G-2, FEIS Section 4.4

The Draft EIS must overcome that assumption if it is to adequately inform decision makers of the effects of the proposed action. Basing projected increases in survival rates solely on decreases in predation is no substitute for the rigorous analysis that NEPA requires. It is "unclear whether the high rates of salmon predation by . . . marine birds in the [E]stuary is a significant factor affecting salmon recovery or an ecological symptom of . . . [other changes including] alteration of estuarine habitats, simplification of the geographic structure of salmon populations, and reduced variation in salmon rearing and migration behaviors."[23] "Complex ecological changes in the capacity of the [E]stuary to support salmonids . . . are difficult to quantify and cannot be simulated as readily as the physical variables that regulate habitat opportunity, such as changes in water elevation or current

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[18] Allen F. Evans et al., *Systemwide Evaluation of Avian Predation on Juvenile Salmonids from the Columbia River Based on Recoveries of Passive Integrated Transponder Tags*, 141 Transactions of the Amer. Fisheries Soc'y 975, 986 (2012) [hereinafter *Evans*].

[19] Draft EIS 4:93.

[20] Draft EIS at 4:94.

[21] *Lyons*, *supra* note 10, at 23.

[22] *Id.*

[23] *See generally Bottom*. *supra* note 3, at 202.

velocity. The assumption that food or predation . . . limits juvenile salmon productivity and estuarine carrying capacity has never been rigorously tested."[24]

Rather than testing these critical assumptions, the Draft EIS simply dismisses the effect of compensatory mortality, unreasonably distorting the projected benefits of the current preferred alternative. Under NEPA, the Corps cannot justify such distortion by pointing to uncertainty in the precise degree of compensatory mortality to apply:

> "[T]basic thrust of NEPA is to require that agencies consider the range of possible environmental effects before resources are committed and the effects are fully known. Reasonable forecasting and speculation is thus implicit in NEPA, and [courts] must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as 'crystal ball inquiry.'"[25]

III. The Draft EIS's Analysis of Cumulative Effects of the Current Preferred Alternative on the Western Population of Double-Crested Cormorants is Inadequate.

comments noted

NEPA requires an agency preparing an EIS to take a detailed "hard look" at the environmental impact of and alternatives to the proposed action.[26] This required analysis serves to ensure that "the agency will not act on incomplete information, only to regret its decision after it is too late to correct."[27]

A cumulative impact analysis cannot satisfy NEPA's hard look standard unless the proposed action's effects are viewed clearly against the backdrop of past and present activities. Assessing a proposed action's impacts in the context of existing and foreseeable effects in the same area yields "a realistic evaluation of the total impacts" and ensures that an EIS does not impermissibly "isolate a proposed project, viewing it in a vacuum."[28] This is important because "even a slight increase in adverse conditions that form an existing environmental milieu may sometimes threaten harm that is significant. One more factory . . . may represent the straw that breaks the back of the environmental camel."[29]

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[24] *Bottom*, *supra* note 3, at 127.

[25] *Center for Biological Diversity v. Bureau of Land Mgmt.*, 937 F. Supp. 2d 1140, 1157 (N.D. Cal. 2013) (citing *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975) (internal quotations omitted)).

[26] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989).

[27] *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 371 (1979).

[28] *Grand Canyon Trust v. Fed. Aviation Admin.*, 290 F.3d 339, 342 (D.C. Cir. 2002).

[29] *Id.* at 343 (citing *Hanley v. Kleindienst*, 471 F.2d 823, 831 (2d Cir. 1972)).

G-25 →

The magnitude of lethal take proposed under the current preferred alternative makes NEPA's cumulative effects analysis particularly important in this case. Under the Migratory Bird Treaty Act, a "control action that would individually, or a succession of such actions that would cumulatively, kill more than 10 percent of the double-crested cormorants in a breeding colony . . ." may be prevented as "a threat to the long-term sustainability of double-crested cormorants . . . ."[30] Here, other than under the no action alternative, the Draft EIS proposes killing some 61% of the East Sand Island colony, or about 27% of the Western Population.

G-18, G-19, G-20, FEIS Sections 4.4.2, 4.4.3, App. E →

The Draft EIS notes in passing that the cumulative effects of the current preferred alternative on the Western Population would likely be significantly adverse. But it fails to provide any detailed or quantified data to support its apparent conclusion that these effects do not compel another alternative. Instead, it offers only vague assurances unsupported by and contrary to available data. This treatment of cumulative impacts falls short of NEPA's requisite comprehensive analysis of "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."[31]

According to the Draft EIS, "[a]bundance of the western population of DCCOs would likely be less than baseline conditions during the next decades."[32] Nevertheless, "future growth of the western population of DCCOs over time *could* return to rates similar to baseline conditions,"[33] which would still represent a population that is an order of magnitude below its historic level. The possibility that the Western Population will return to even such a baseline is purportedly based on "generalist foraging and nesting behavior and adaptability . . . , past growth rate of the western population . . . , environmental, regulatory, and waterbird management changes favorable to DCCO population expansion over the past decades, and prior examples of DCCO culling programs throughout the U.S. and Canada and great cormorant populations in Europe . . . ."[34]

Although these assurances are represented as an analysis of cumulative effects, they are not. The Draft EIS buries in Appendix E of its 422 pages the admission that it "is unknown whether or not the western population would be capable of that increase if the East Sand Island colony would be

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[30] 50 C.F.R. § 21.48 (d)(9)(i)—(ii).

[31] *See* 40 C.F.R. § 1508.7 (defining cumulative impact); *see also Oregon Natural Res. Council Fund v. Brong*, 492 F.3d 1120, 1132–33 (9th Cir. 2007) ("One of the specific requirements under NEPA is that an agency must consider the effects of the proposed action in the context of all relevant circumstances, such that where 'several actions have a cumulative . . . environmental effect, this consequence must be considered . . . .") (quoting Neighbors of Cuddy Mountain v. U.S. Forest Serv., 137 F.3d 1372, 1378 (9th Cir. 1998)).

[32] Draft EIS at 4:60.

[33] *Id.* (emphasis added).

[34] *Id.*

maintained at the target size."[35] "Growth of the Western Population since the late 1990s has been uneven and, rather than occurring throughout the range, has been largely the result of growth at East Sand Island."[36] Declines have been attributed primarily to depredation, human disturbance, and immigration to East Sand Island.[37]

Because the colony there "represents approximately 40% of the breeding pairs belonging to the western North America population . . . destructive control measures that have been used to reduce numbers of double-crested cormorants at breeding colonies in interior/eastern North America . . . would have a disproportionately large impact on the western North American population . . . ."[38] Any action affecting the East Sand Island colony should be approached cautiously and reversibly.[39]

The Western Population's historic growth rate further demonstrates that the conclusion that growth would increase after the East Sand Island colony—the only colony in the region at which the population appears to be thriving—is substantially reduced is untenable:

> "By the late 1800s and early 1900s, the DCCO had experienced substantial decline and loss of breeding colonies along several portions of its Pacific Coast range. The species was heavily persecuted by humans, and breeding birds were shot at colonies and nests destroyed. In addition, habitat was lost due to agricultural and water developments."[40]

Conditions have not generally improved for the Western Population since. "Tremendous loss and degradation of wetlands and coastal habitats have occurred throughout . . . the Pacific Flyway, and the continued, competing demands for water and land in support of agriculture, development, and

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[35] Draft EIS App. E-2 at 9.

[36] Karen N. Courtot et al., *Colony Connectivity of Pacific Coast Double-Crested Cormorants Based on Post-Breeding Dispersal From the Region's Largest Colony*, J. Wildlife Mgmt. (2012) [hereinafter *Courtot*].

[37] *Id.*

[38] Yasuko Suzuki, Piscivorous Colonial Waterbirds in the Columbia River Estuary: Demography, Dietary Contaminants, and Management 161 (Jan. 13, 2012) (unpublished Ph.D. dissertation, Oregon State University), http://www.birdresearchnw.org/SuzukiYasuko2012.pdf#page=135 [hereinafter *Suzuki*].

[39] *Id.* at 166.

[40] Linda R. Wires & Francesca J. Cuthbert, *Historic Populations of the Double-crested Cormorant (Phalacrocorax auritus): Implications for Conservation and Management in the 21st Century*, 29 Waterbirds 9, 14 (2006) [hereinafter *Wires & Cuthbert*].

recreation are the greatest threat to regional waterbird populations."[41] A "number of DCCO colonies within the Western Population experienced declines of nesting pairs during the late 1990s and early 2000s . . . and few new colonies were established."[42] Colony declines were documented over much of southern Alaska, British Columbia, Washington, and southern California.[43]

Similarly, the draft EIS understates the likely cumulative effects of the proposed action in the context of similar actions currently being undertaken or expanded that adversely affect the Western Population. Its analysis included lethal take of "936 DCCOs each year . . . in addition to the annual take levels on East Sand Island . . . [, suggesting that a]ctual take levels from this potentially authorized amount could be lower."[44] Available data, however, indicates that additional take would be greater, and probably much greater.[45]

G-19

On the Oregon coast, for example, the "Avian Predation Program is currently funded for work during the 2013-2015 biennium. Hazing [of cormorants] is expected to continue in all estuaries that currently have programs . . . . *Additional estuaries of interest include the Umpqua and Rogue systems. ODFW is considering hazing, surveys, and diet studies in these areas.*"[46] In Montana, the Upper Missouri River Reservoir Fisheries Management Plan calls for determining "the impacts of . . . cormorants to Canyon Ferry fish populations[and recommends c]onsider[ing] active bird management strategies *if research shows significant impacts* to fish populations."[47]

USFWS has no reasonably foreseeable plans for expanding depredation orders to western states. FEIS Section 4.4

It is also likely that the Public Resource Depredation Order ("Order")[48] will eventually expand to include DCCOs in the western United States. The Order "targets birds allegedly affecting public

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[41] Pacific Flyway Council, *A Framework for the Management of Double-Crested Cormorant Depredation on Fish Resources in the Pacific Flyway* 6 (2012).

[42] *Id.* at 9.

[43] *Id.*

[44] Draft EIS app. E-2, at 10.

[45] *See Wires, supra* note 11, at 297 ("Although cormorant numbers on the Pacific Coast are probably still below historical levels, the preparation of [the Pacific Flyway Council's plan for managing cormorant numbers and distribution at the Pacific Flyway scale and the Draft EIS] indicates that cormorants west of the continental divide have gained a similar nuisance status to those in the eastern portion of the range.").

[46] Lindsay Adrean, Or. Dep't of Fish & Wildlife, Avian Predation Program 2012 Final Report 10 (2013) (emphasis added).

[47] Montana Fish, Wildlife, & Parks, Upper Missouri River Reservoir Fisheries Management Plan 2010-2019, at 38 (2010), *compare also with* Draft EIS at 1:17 (describing DCCO as "significant source of mortality").

[48] 50 C.F.R. § 21.48.

resources and redefines all the essential elements for life as off-limits to cormorants."[49] It is "the most important challenge to any sort of protection the [cormorant has] gained through either the Migratory Bird Treaty Act or the designation of sites as protected areas."[50] Although the Order is currently in force only in 24 states, "recent developments in the western United States suggest that [its] reach . . . may expand to include birds in that portion of the country.[51] The U.S. Fish and Wildlife Service is reportedly considering revisions to the . . . provisions of the current Depredation Order to include states west of the Continental Divide."[52]

FEIS Section 4.4

The Draft EIS notes that the human population in the region is "presently expanding and is likely to continue to grow in the foreseeable future."[53] Given "expanding human populations along the coast and the increasing perception that double-crested cormorants represent a threat to sport and commercial fisheries throughout the range of the Western Population . . . ,"[54] the likelihood of effects adverse to the Cormorant increasing well beyond those included in the analysis of the current preferred alternative is considerable.

G-19, FEIS Section 4.4, App.E

The Draft EIS falls further short of NEPA's hard look requirement by replacing real analysis of the cumulative effects of the current preferred alternative with broad comparisons to culling programs in other regions. "Little interchange occurs between Pacific Coast colonies and regions east of the Continental Divide."[55] "[U]ncertainty in how the western population of DCCOs would respond [to the proposed massive lethal take] is greater than that of interior DCCO populations, and this should be given consideration when comparing culling programs from these regions."[56] Even so, the Draft EIS recommends an alternative calling for "take rates [that] are similar or higher than take rates proposed and implemented nationally and among states for DCCO management."[57]

G-2, G-3, G-4, G-5

Research is still needed to "determine whether reductions in smolt losses to avian predation [in the Estuary would] translate into commensurate increases in smolt survival and, ultimately, adult

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[49] *Wires*, *supra* note 11, at 278.

[50] *Id.*

[51] *Id.* at 298.

[52] *Adkins*, *supra* note 1, at 2.

[53] Draft EIS at 4:53.

[54] *Adkins*, *supra* note 1, at 30.

[55] *Courtot*, *supra* note 36, at 7-8.

[56] Draft EIS at 4:15-16.

[57] *Id.*

salmonid recruitment."[58] Despite the absence of such data, however, the Draft EIS and BiOp cite examples such as a lethal take plan implemented at Little Pelican Island on Leech Lake in Minnesota to predict that implementing a similar approach at East Sand Island under the preferred alternative would result in a "successful cormorant-damage management action . . . ."[59]

According to the BiOp, at Leech Lake:

> "loss of walleye to double-crested cormorants was determined to be a significant limiting factor to the local walleye population . . . . [T]he double-crested cormorant population . . . had grown to approximately 10,000 individual birds . . . in 2004. During the first five years of implementation . . . , approximately 3,000 individual cormorants were removed from the lake annually . . . . The action was considered a success in helping to curb declining populations of walleye and contribute to record . . . walleye harvest rates."[60]

But neither the BiOp nor the Draft EIS explain that agency "biologists on Leech Lake failed to isolate the variables, such as an unexplained natural walleye reproductive decline and overfishing . . . , instead outright excluding them, and simply [finding] the cormorants to blame."[61] "Detailed diet studies initiated along with management have indicated that in the years studied, the [Leech Lake] cormorant diet . . . included very few walleye, ranging from 0.5 to 3.3 percent of the number of fish eaten."[62] Of this small percentage, most of the walleye "were small or young-of-year fish, suggesting that most cormorant predation constituted compensatory mortality."[63]

The walleye population on Leech Lake has increased *despite* high numbers of cormorants, supporting the conclusion that cormorants likely had an insignificant effect on the fish. Increases in walleye after the first year of management "far exceeded the increase expected from cormorant control alone, suggesting that other factors were influencing recovery."[64] Moreover, although cormorant

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[58] *Evans*, *supra* note 18, at 986.

[59] National Oceanic and Atmospheric Administration National Marine Fisheries Service, Endangered Species Act Section 7(a)(2) Supplemental Biological Opinion, Consultation on Remand for Operation of the Federal Columbia River Power System (Jan 17, 2014) [hereinafter *BiOp*].

[60] *Id.*

[61] Dennis Wild, The Double-Crested Cormorant: Symbol of Ecological Conflict 208.

[62] *Wires*, *supra* note 11, at 237.

[63] *Id.*

[64] *Id.*

breeding population targets were achieved, fish population increases occurred despite "the presence of subadult and nonbreeding birds . . . result[ing] in cormorant numbers on the lake that are about twice the level of that predicted necessary for fish recovery . . . ."

"The DCCO population objective was reached in 2010. Catch rates and year class strength of walleye have increased to levels not observed since the late 1990s, even before the DCCO population objective was reached."[65] Even so, refinements to the Cormorant population objective have not been made.[66] Leech Lake is an example of artificially circumscribing a population that would almost certainly never be naturally maintained solely to protect fisheries resources for intense human use.[67] It does not support the Draft EIS's conclusion that the preferred alternative would not have an adverse cumulative effect on the Western Population.

G-2, G-27, S-12 FEIS Section 2.3

IV. The Draft EIS Fails to Properly Consider Purpose, Need, and Reasonable Alternatives.

The alternatives analysis presented in the Draft EIS does not satisfy NEPA's requirements. An EIS must "[r]igorously explore and objectively evaluate all reasonable alternatives" to a proposed action.[68] An agency preparing an EIS must "to the *fullest* extent possible . . . consider alternatives to decision making public can neither avoid environmental harms nor assess environmental trade-offs.

NEPA's alternatives requirement "seeks to ensure that each agency decision maker has before him and takes into proper account all possible approaches to a particular project (including total abandonment of the project) which would alter the environmental impact and the cost-benefit balance" and "allows those removed from the initial process to evaluate and balance the factors on their own."[69] Because alternatives are so central to decision making and mitigation, "the existence of a viable but unexamined alternative renders an environmental impact statement inadequate."[70]

Other than the "no action" alternative, the Draft EIS limits itself to alternatives involving efforts to directly reduce the size of the colony on East Sand Island to the target range set in the BiOp (5,380 to

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[65] U.S. Fish & Wildlife Serv., Draft Envtl. Assessment, Management of Double-Crested Cormorants Under 50 C.F.R. 21.47 and 21.48, at 30 (2014).

[66] *Wires*, *supra* note 11, at 237.

[67] *Id.* at 284.

[68] 40 C.F.R. § 1502.14(a).

[69] *Id.* at 1114.

[70] *Oregon Natural Desert Ass'n v. Bureau of Land Mgmt.*, 625 F.3d 1092, 1100 (9th Cir. 2010) (internal alterations and citations omitted).

5,939 breeding pairs).[71] The proposed target is set forth by the BiOp, the "first focus of [which] is . . . improving the survival of salmon and steelhead migrating in the mainstem Columbia and Snake rivers."[72] Despite acknowledging that this goal "can be addressed with any actions that improve productivity . . . ,"[73] however, the BiOp drives the Draft EIS toward an arbitrary target range that reflects no real understanding of the East Sand Island colony's relationship to the salmon and steelhead whose survivability is at issue.[74]

The Draft EIS rejects management of the East Sand Island colony at any larger size *not* on the ground that such a size would exceed the estuary's carrying capacity but because any larger size would purportedly mean that "[e]fforts to improve juvenile salmonid survival to FCRPS baseline levels would need to be accomplished through . . . habitat improvement, increased fish passage at dams, [and] management of other avian and mammalian predators." But there is no evidence that reaching the target population size will result in significant long-term improvements in salmonid survival. This "all or nothing" approach improperly "set[s] population objectives based entirely on human interests rather than species biology and regional ecology."[75] It risks significantly effecting the Western Population and fails to give adequate consideration to "a unified conservation philosophy based on knowledge of historical populations and policy decisions founded on sound science."[76]

"Predation on juvenile salmon in the estuary by piscivorous fishes, marine mammals, and birds has always been a mortality factor. Yet there are no data to compare historical and modern predation rates or predator populations."[77] "Emphasis on estimating predation rates alone . . . may lead to inappropriate salmon recovery proposals unless these results are evaluated in a broader historical and ecological framework."[78]

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[71] Draft EIS at 2:5.

[72] *BiOp*, *supra* note 59, at 35.

[73] *Id.* at App. E-3.

[74] *See Draft EIS Proposes Culling Thousands Of Cormorants To Reduce Salmonid Predation*, Columbia Basin Bulletin (June 13, 2014) (noting that BiOp "supplements a 2008 assessment of salmon and steelhead species survival probabilities, which calculated predation losses with a much smaller cormorant colony size" and quoting Ritchie Graves, head of NOAA Fisheries' Columbia Hydro Division, as stating that "If you have twice as many hungry mouths, you're going to have twice as many fish eaten").

[75] *See generally Wires & Cuthbert*, *supra* note 40, at 31-32 (explaining that cormorant "conservation strategies [should be] based on ecosystem health and process that recognize humans, fish and cormorants as three components of a complex system driven by many species and dynamic interactions.

[76] *See generally id.*

[77] *Bottom*, *supra* note 3, at xxii.

[78] *Bottom*, *supra* note 3, at xvii.

G-9, G-10, G-11

Either the no-action alternative or an alternative based on identifying and improving suitable Cormorant relocation sites combined with reductions in East Sand Island habitat would therefore be preferable to the current preferred alternative. But the Draft EIS fails to adequately consider social attraction combined with habitat reduction, citing only failed efforts to establish the colony outside of the Estuary[79] during periods when habitat reduction was not undertaken and a single study of an effort to attract other DCCOs to a new East Span of the San Francisco-Oakland Bay Bridge, which was completed in September 2013.[80]

The Draft EIS relies on limited data showing that Cormorants were not attracted from East Sand Island as justification for largely rejecting social attraction as an alternative to massive lethal take. During 2007-2009, for example, attempts were made to attract Cormorants to test plots outside the Estuary at Fern Ridge Wildlife Area near Eugene, Oregon ("Fern Ridge") and at Foundation Island in the mid-Columbia River ("Foundation Island"). "Neither of these efforts at using habitat enhancement and social attraction to either establish a new cormorant colony or expand an existing arboreal colony succeeded during a three-year trial period."[81] During 2004-2008, social attraction did successfully attract Cormorants to Miller Sands Spit, a dredged-material disposal island approximately 30 km up-river from East Sand Island with no prior history of successful nesting.[82] According to the Draft EIS, however, there have been no documented DCCO nesting attempts at Miller Sands Spit since 2009.[83]

But these social attraction experiments occurred *before* significant habitat modification was attempted at East Sand Island. "If these methods were used to induce cormorants from East Sand Island to nest elsewhere, the habitat would likely need to be reduced further, such that the available nesting habitat on East Sand Island became limiting."[84] It is thus apparent that the Corps has not adequately considered an alternative under which social attraction correlates with habitat reduction.

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[79] Draft EIS at 2:30.

[80] Memorandum from Eric Lichtwardt, Bird Monitoring Team Leader, LSA Assoc., Inc., to Cal. Dep't of Transp. (July 9, 2014), http://www.biomitigation.org/reports/.

[81] *Suzuki*, *supra* note 38, at 141-42.

[82] *Id.* at 122-23; 128.

[83] Draft EIS at 1:11.

[84] *See* Bird Research Northwest, Project Background, Columbia River Estuary, http://www.birdresearchnw.org/project-info/project-background/columbia-river-estuary/ (last visited Aug. 118, 2014) ("Nest dissuasion experiments conducted during 2011-2013 were successful in progressively limiting the available nesting habitat on the western end of East Sand Island from a total of 16 acres in 2010 down to just 4 acres in 2013. Despite this, the available nesting habitat during the nest dissuasion experiments was not reduced to the point where nesting habitat became limiting for cormorants on the western end of East Sand Island.").

The Draft EIS's reliance on the example of the Bay Bridge proves that point. Although DCCOs admittedly do not yet appear to be nesting on the new bridge, the Draft EIS neglects to note that construction delays left the *old* bridge—with its existing colony site—largely intact during nesting season.[85] "Double-crested cormorants generally exhibit fidelity to their colony site."[86] Thus, it is unsurprising that they continued to use the old bridge rather than establish a new colony site and does not support a finding that redistribution of at least a significant portion of the East Sand Island colony could not be effective. Indeed, "[m]anagement efforts aimed at redistributing [East Sand Island] cormorants across western North America (e.g., social attraction or dissuasion techniques) [would likely be effective if] allocated to areas or sites known to be used by tagged cormorants, particularly those sites with an established nesting history."[87]

G-2, G-8, G-9, G-10

Since it is unknown whether the effect of DCCO predation on salmonids, if any, is significant in the FCRPS context, this reversible approach to management of this protected bird is a better choice than the current preferred alternative. The Corps should study the carrying capacity of existing colony sites and identify new sites that could be effective in attracting cormorants if combined with reductions in East Sand Island habitat.

The Draft EIS's inadequate consideration of alternatives can be cured only with the submission and analysis of new studies that should be subject to public scrutiny. Accordingly, the Corps should gather the missing data, perform new analyses, and issue a revised draft EIS for public review and comment before issuing a final EIS.

V. Conclusion

An environmentally and ethically responsible approach to salmon restoration should *not* be based on a determination to eliminate a majority of the Western Population of a co-existent species. The current preferred alternative is "a single-minded focus on impacts to salmonids."[88] What is instead needed is a broad focus on "biological carrying capacity [and] ecological integrity."[89]

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85 Phillip Matier & Andrew Ross, *Caltrans Scrambles to Lure Cormorants to New Bay Bridge Span*, S.F. Chron., Apr. 7, 2014, *available at* http://www.sfgate.com/bayarea/matier-ross/article/Caltrans-scrambles-to-lure-cormorants-to-new-Bay-5381205.php.

86 *Courtot*, *supra* note 36, at 8.

87 *Id.*

88 Letter to Sondra Ruckwardt, Project Manager, U.S. Army Corps of Engineers, Portland District, from Bob Salinger, Conservation Director, Portland Audubon Society (Dec. 21, 2012), *available at* http://audubonportland.org/files/urban/cormorants-dec2012.

89 *Wires*, *supra* note 11, at 284.

The relationship between the cormorant and the salmon has lasted far longer and been far less contentious than that between the cormorant and man. The Draft EIS does not properly consider this complex relationship between birds, fish, and people. It simply prioritizes human interests over all others. In so doing, and particularly in failing to adequately consider any real alternative to unprecedented levels of lethal take, the Draft EIS contains significant deficiencies.

Because the effect of Cormorant predation on salmonid survival is relatively inconsequential compared with the effects of the FCRPS, while the effect of the current preferred alternative on the Western Population would be serious and potentially irreversible, the Corps should reconsider the no-action alternative. If it determines that action is warranted, the Corps should conduct additional analysis of the proposed management plan and its environmental impact and issue a revised draft EIS for public review and comment before proceeding to a final EIS.

Respectfully submitted,

KARUNA LAW, LLC

Dane E. Johnson

DEJ/ejl

August 19, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Dear Ms. Ruckwardt:

As an independent researcher studying the historical and current distribution of Double-Crested Cormorants across San Diego County since 2009, I appreciate this open opportunity to comment on this draft environmental impact statement (draft EIS) from the Army Corps of Engineers on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. The subspecies *albociliatus* of Double-crested Cormorant is declining in Southern California (Adkins and Roby 2010) and a severe reduction in population at colonies with consistent success on an annual basis is a serious concern for the entire western population. Proposed Alternative C, which would result in the culling of 16,000 individual Double-crested Cormorants, will directly affect the total population at a time where birds in the southernmost range of *albociliatus* face declining habitat in San Diego County and Imperial County, which I will expand about below.

G-19, G-20

California is experiencing a severe drought (Figure 1) and it has been demonstrated that reduced water levels affect the breeding of *albociliatus* on a short term scale in the southern region. Sweetwater Reservoir at the San Diego National Wildlife Refuge, one of only three colonies established in San Diego County, has held the highest number of recorded nests in San Diego County at 150 nests in 2010 (Famolaro 2013, unpublished data). However, the success of breeding has been driven by the presence of water and if there is little water at the reservoir, the birds will not nest or experience nesting failure. According to remote sensing analysis of Landsat data across San Diego County evaluating bodies of water (Handa 2012, unpublished data) and field observations earlier this year at Lake Morena, reservoirs are being emptied at an alarming rate in San Diego to alleviate the problems of water distribution throughout the state. This is a concern not only during breeding as it negatively affects colony success at inland locations, but during the rest of the year as well, as this translates into reduced habitat available to Double-crested Cormorants to breed, winter in the county during the height of the annual population numbers (Handa 2012, unpublished data) and use as a stopover site during migration through San Diego County.

The effects of the California drought at the Salton Sea is major concern as well, as this location significantly contributes towards the population of *albociliatus* in Southern California on a larger scale. The highest record of nests in Southern California have been documented at the Salton Sea, however, it should be noted that there are years where nesting failure occurs and the success of breeding does not occur annually (Adkins and Roby 2010). Long term predictions of higher temperatures will contribute towards the increase in salinity of the Salton Sea, occurring through high evaporation rates, low rainfall, and continuing discharge of saline agricultural wastewaters into the lake (White and Hart 2014). Tilapia has been suspected as the major driver of the reproductive success of the Double-crested Cormorant at the Salton Sea (Adkins and Roby 2010) and increased salinity levels will negatively affect the presence of Tilapia (*Oreochromis mossambicus)* which are particularly sensitive to high levels of salinity and temperature (Sardella et al. 2007). Recent research has indicated that Tilapia is reaching the upper limit of tolerance for salinity at the Salton Sea (Waters 2014), and an excessively saline environment in the future may create a hostile environmental detrimental towards the reproductive success of Tilapia. Without an abundant supply of Tilapia, the breeding of Double-crested Cormorant at the Salton Sea may be adversely affected and population of *albociliatus* in Southern California may decline further.

G-2, G-9, G-10

Alternative C is unwarranted due to a paucity of investigative research on approaches to manage avian predation on salmon smolts, the absence of testing non-lethal control methods prior to lethal methods of control and ultimately, because this action will negatively impact the total population of *albociliatus* in North America. At a time where quality of habitat within the geographical range of *albociliatus* is declining, it is a risky strategy to reduce a population by 25% and rely upon colonies that have demonstrated inconsistent breeding success from year to year, such as at Sweetwater Reservoir and at the Salton Sea. I strongly urge you to choose Alternative A or "no action" at this time to allow for further investigation toward different solutions to this problem. Thank you for your time and consideration.

Respectfully,

Lesley Handa
Independent Researcher
GIScience M.S. Candidate, SDSU
Pacific Seabird Group Member

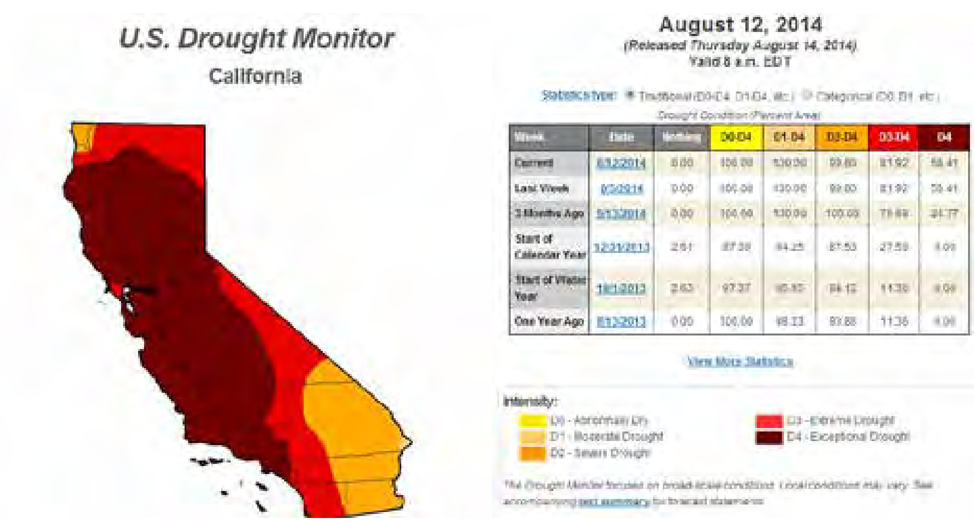

Figure 1. Current state of drought in California as of August 19, 2014.
http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA

Literature Cited

Adkins, J. Y., D. D. Roby et al. 2010. A status assessment of the double-crested cormorant (*Phalacrocorax auritus*) in western North America: 1998-2009. Technical Report to the U.S. Army Corps of Engineers, Portland, OR. 69 p.

Sardella, B. A., V. Matey, and C. J. Brauner. 2007. Coping with multiple stressors: physiological mechanisms and strategies in fishes of the Salton Sea. Lake and Reservoir Management 23:518-527.

Waters, S. C. 2014. *Does exposure to high salinity result in reduced reproduction in Salton Sea tilapia (Oreochromis mossambicus x O. urolepis hornorum)?* (Doctoral dissertation).

White, M.D. and C.M. Hart. “Salton Sea Management Project Evaluation of Salinity and Elevation Management Alternatives.” Ogden Environmental and Energy Services Co., Inc. Web. Accessed 18 August, 2014. http://www.sci.sdsu.edu/salton/ss_management_project_summ.htm

Lower Columbia Fish Recovery Board

August 19, 2014

U.S. Army Corps of Engineers
Portland District
Via Email: cormorant-eis@usace.army.mil

LCFRB staff have completed our review of the Draft Environmental Impact Statement (DEIS) and are supportive of the strategy presented in the Preferred Alternative/Management Plan (Alternative C). The LCFRB supports the strategy that employees culling and limited egg take to immediately reduce the size of the double-crested cormorant colony on East Sand Island. The LCFRB further supports the strategy of habitat modification to limit size of breeding area East Sand Island. The LCFRB also supports hazing to occur in other areas of the Lower Columbia River to ensure that the double-crested cormorant colony on East Sand Island does not colonize another location in the Lower Columbia River. All three of the actions proposed in the preferred alternative are necessary to ensure that there is a reduction in mortality of listed salmonids resulting from predation by double-crested cormorants.

added to Section 2.5 of FEIS

The goal of the preferred alternative/management plan is to reduce the number of double-crested cormorants residing in the Lower Columbia River for the expressed purpose of reducing predation on listed salmonids. This goal is consistent with the Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010) that takes an ecosystem approach to recovery of Lower Columbia Salmon and Steelhead listed under the Federal Endangered Species Act (ESA). The Lower Columbia Recovery Plan identifies seven threat categories and calls for a reduction in the negative impact from each one of these threat categories. Ecological Interactions is one of those threat categories, and avian predation is a large part of that threat category. The strategy presented in the preferred alternative/management plan would reduce impacts from avian predation as called for by the Lower Columbia Recovery Plan.

G-6

While the LCFRB supports the strategy provided in the preferred alternative/management plan, there would be support for further reducing in the size of the double-crested cormorant colony on East Sand Island to less than the target of approximately 5,600 breeding pairs. The Lower Columbia Recovery Plan uses 1998-1999 as the baseline for describing conditions and threats to populations at the time of listing. The Lower Columbia Recovery Plan identifies the negative impact that a given threat has on the productivity and abundance of each listed salmonid species. The Lower Columbia Recovery Plan then sets goals or interim benchmarks for what that negative impact should be in out years (1-49+).

The table below summarizes the predation impact information from the Lower Columbia Recovery Plan.

Species	Baseline (1998-1999)	Years 13-24 (2013-2025)
Spring Chinook	22%-27%	11%-22%
Fall Chinook	9%-14%	3%-11%
Chum	3%	2%
Coho	14%-19%	8%-12%
Steelhead	20%-30%	12%-30%

Data presented in the DEIS indicates that the size of the double crested cormorant population on East Sand Island was about 5,600 breeding pairs in 1997-1998, which would correspond to the baseline time frame for the Lower Columbia Recovery Plan. As presented in the table above the Lower Columbia Recovery Plan predation impacts benchmark suggests the need for further reduction in the East Island Colony to below the baseline number of 5,600 breeding pairs.

The LCFRB staff has reviewed all alternatives presented and has the following comments:

comments noted

Alternative A: No Action. This alternative is not consistent with the Lower Columbia Recovery Plan because it does not achieve the threat reduction set forth in the Lower Columbia Recovery Plan. Under Alternative A the double-crested cormorant colony on Sand Island could continue to expand in size and increase the negative impacts through predation on ESA listed salmonids. The LCFRB cannot support this alternative because it makes not progress towards reducing the negative impact of avian predation on ESA-listed Lower Columbia River salmonids.

Alternative B: Non-Lethal Management Focus with Limited Egg Take. Concerns regarding this alternative focus primarily on the full dependence on dispersal of the population to reduce the size of the colony on East Sand Island. Without culling to reduce the size of the East Sand Island colony it is likely that a portion of those birds will recolonize in other locations. Hazing throughout the Lower Columbia River to eliminate relocation of the colony members to other locations in the Lower Columbia may limit recolonization to some extent, but it is unlikely that is will completely eliminated it. For this reason this alternative will likely not achieve the threat reduction target set forth in the Lower Columbia Recovery Plan. The LCFRB is not supportive of this alternative because the certainty of success is low.

Alternative C: Culling with Integrated Non-Lethal Methods Including Limited Egg Take. This alternative incorporates a strategy that utilizes several actions to achieve the targeted reduction in the size of the East Sand Island colony, which substantially increases the likelihood for success. Initial culling activity will immediately reduce population size and make progress towards achieving threat target reductions set forth in the Lower Columbia Recovery Plan. Following the culling actions with habitat management actions to reduce available nesting habitat will increase certainty of colony size reduction remaining in place for future years. Finally, hazing throughout the Lower Columbia River will assist in limiting recolonization of double-crested cormorants to other locations in the Lower Columbia River. As mentioned earlier in this letter we are supportive of this alternative but would recommend that the target colony size be something less than 5,600 breeding pairs, consistent with the threat reduction target set forth in the Lower Columbia River.

Alternative D: Culling with Exclusion of Double-crested Cormorant Nesting on East Sand Island in Phase II. This alternative has a colony reduction target that exceeds Lower Columbia Recovery Plan expectations; however, the method to achieve this target will allow for dispersal into other locations. In Phase II the plan depends on excluding double-crested cormorants from East Sand Island, which will allow the birds to recolonize in other locations inside or outside the Lower Columbia River. While this alternative does include hazing activities in the Lower Columbia River during Phase II, there is still the potential for recolonization to occur. LCFRB staff would be supportive of this alternative if Phase II included some culling to reduce potential for recolonization.

In conclusion, the LCFRB supports the actions being proposed under the preferred alternative. As stated earlier it would improve the plan if the target population was less than 5,600 breeding pairs to be consistent with the Lower Columbia Recovery Plan. We appreciate the opportunity to comment on the DEIS.

Sincerely,

Jeff Breckel
Executive Director

From: [redacted] on behalf of Janet Ellis
To: Cormorant EIS
Subject: [EXTERNAL] Comments on the Double-crested Cormorant draft EIS
Date: Tuesday, August 19, 2014 10:51:52 AM

Dear U.S. Army Corps of Engineers, Portland District,

comments noted

Please accept the following comments from Montana Audubon on the Draft Environmental Impact Statement (DEIS) on Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (CENWP-PM-E-14-08) under consideration by the Portland District of the Army Corps of Engineers.

Montana Audubon opposes the US Army Corps' DEIS Alternative C, which emphasizes lethal control of 16,000 Double-crested Cormorants. This lethal control would kill more than 25 percent of the entire western North American cormorant population, in an effort to reduce predation on endangered salmon. The impacted Double-crested Cormorant population lives and nests on East Seal Island, a globally-significant Important Bird Area (IBA). The IBA Program is a global initiative to identify, monitor, and protect a network of sites critical for the conservation of birds. Since 1995, the National Audubon Society has taken the lead in implementing the IBA Program in the United States.

G-16

While cormorants do prey on salmon, these fish are endangered because of dams, pollution, habitat loss, and an array of other factors—not because of the cormorants. Blaming predators in this way makes no sense biologically.

Montana is also the home to Double-crested Cormorants. Another reason we are concerned about this action—which is not backed up by sound science—is that it will encourage other states to initiate lethal controls of birds (with no sound scientific backing up these actions). Montana fishery biologists—also with no science to back up their “hunches”—have examined ways to reduce both Double-crested Cormorant populations and White Pelican populations. We really believe that the actions taken by the Corps in the Portland District could start a national, very misguided trend.

comment noted

Instead of adopting Alternative C, we request that the US Army Corps conduct a review of its entire approach to managing birds in the Columbia Estuary. Consequently, we favor the DEIS Alternative A, the ‘no action’ alternative. If the no action alternative is adopted, the Corps and Columbia Estuary partners can then review and rebuild their strategy for management of avian predation on fish on a regional scale. This new management strategy needs to be based on sound science, fully employ and evaluate non-lethal measures of reducing avian predation, and consider a full range of alternatives beyond manipulation and control of native wildlife.

Thank you for considering these comments.

Montana Audubon is the coordinating entity for the nine Audubon Society Chapters in Montana. Currently there are approximately 4,000 Audubon members in the state. Although our membership is diverse, there is a consistent deep concern for wildlife in the state—especially birds. The long-term conservation of birds and their habitats is a major goal of Montana Audubon, and central to this goal is protection of Important Bird Areas. You may receive comments from other members in the Society.

Please contact me if you have questions about our comments.

Sincerely,

Janet Ellis

--
Janet Ellis, Program Director
Montana Audubon
PO Box 595, Helena, MT 59624
email: jellis@mtaudubon.org
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Facebook: www.facebook.com/MontanaAudubon

Audubon

18 August 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Dear Ms. Ruckwardt:

This letter concerns the draft environmental impact statement (draft EIS) from the Army Corps of Engineers on the *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary*.

comments noted

Double-crested Cormorants or other avian predators are not responsible for the fact that many salmonid stocks in the Columbia River basin are threatened or endangered, but the National Audubon Society nonetheless understands and supports a multifaceted approach to the recovery of Columbia River salmonids. Audubon, however, opposes Preferred Alternative C, which emphasizes lethal control within a globally-significant Important Bird Area (East Sand Island) that supports the world's largest colony of Double-crested Cormorants[1]. This alternative does not represent the "balanced approach" sought by the Army Corps. To be clear, Audubon is not categorically opposed to limited lethal control of avian predators, but:

bullet points addressed in following pages

- the "survival gap analysis" is weak and the benefits of the preferred alternative to recovery of ESA-listed salmonids are uncertain;
- the preferred alternative emphasizes lethal control before non-lethal means have been genuinely attempted;
- there are significant issues pertaining to the depredation permit required under the Migratory Bird Treaty Act;
- the impact of the preferred alternative on the western North America population of Double-crested Cormorants is too great; and
- no mitigation is provided in the way of safe and suitable nesting habitat for Double-crested Cormorants outside the Columbia River estuary but within the range of the western North America population.

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[1] East Sand Island has been designated by BirdLife International and the National Audubon Society as an Important Bird Area due to the presence of > 1% of the global Caspian Tern population and North American populations of Double-crested Cormorants and Glaucous-winged Gulls.

comments noted

In Preferred Alternative C, the Army Corps proposes to shoot 15,995 (about 16,000) individual Double-crested Cormorants over a 2-4 year period to reduce the size of the East Sand Island Double-crested Cormorant colony from a three-year (2011-2013) average of 26,840 cormorants to 11,200 (about 5,600 pairs). In addition to and concurrent with the culling, hazing and limited egg take would occur to prevent colony expansion on the island, along with land- and boat-based hazing and efforts to prevent the dispersing cormorants from relocating elsewhere in the Columbia River estuary.

Among the current alternatives, Audubon supports Alternative A, No Action, which would enable the Army Corps to:

- review and revise its approach to managing avian predation on salmonid smolts in the Columbia River estuary in the context of an integrated range-wide management, conservation and mitigation plan for Double-crested Cormorants, Caspian Terns, and other avian species, including Brandt's Cormorants, affected by the proposed actions;
- complete a rigorous, survival gap analysis for juvenile salmonids, taking into account inter-annual variability in cormorant predation levels;
- subject all of the action alternatives to a science-based analysis of the benefits that would likely accrue to ESA-listed salmonids from management of Double-crested Cormorants, thus establishing a scientifically defensible management objective for the size of the cormorant colony on East Sand Island;
- conduct a *bona fide* population viability analysis on Double-crested Cormorants that could then be used as a basis for defining a minimum viable population, both in terms of the overall population size and the distribution and size of breeding colonies across western North America; and
- implement and evaluate non-lethal management actions for dispersing significant numbers of Double-crested Cormorants from East Sand Island and determine whether the dispersers, in fact, cause the problems predicted in this draft EIS.

<u>The Survival Gap Is Weak and Benefits are Not Analyzed</u>

G-5

The proposal to reduce the East Side Island colony of Double-crested Cormorants to 5,600 pairs rests entirely on a National Marine Fisheries Service (NMFS) comparison of smolt survival and consumption by cormorants between arbitrarily defined base (1983-2002) and "current" (2003-2009) periods. This analysis resulted in a finding that survival of juvenile steelhead, the salmonid species most susceptible to cormorant predation, was 3.6 percent lower in the current versus base period. The proposal to reduce cormorants to 5,600 pairs on East Sand Island is aimed at erasing this "survival gap." We have the following concerns about this analysis, which is critical to the selection of appropriate and effective management strategies:

G-7 →

- NMFS did not obtain external peer review (G. Fredricks, NMFS, pers. comm.) on the survival gap analysis, nor does it use the best available science.

G-5 →

- The analysis applies a fixed average per capita cormorant predation rate on "annual estimated estuary smolt population levels," which are preseason forecasts of the numbers of smolts that survive the dams and other challenges during out-migration to reach the estuary. These forecasts are developed with unknown accuracy and precision and are not confirmed with empirical data from the estuary.

G-3 →

- Only the smolt estimates and numbers of Double-crested Cormorants nesting in the Columbia River estuary are allowed to vary, ignoring high inter-annual variability in cormorant predation rates on juvenile salmonids. Environmental conditions, such as the volume of freshwater discharge, strongly influence predation rates (Lyons et al. 2014), yet these influences were not taken into account.

G-5 →

- There are no actual data on Double-crested Cormorant diets or predation rates on salmonid smolts before 1999, and data on numbers of cormorants in the Columbia estuary during the base period are limited. The lack of cormorant data from the base period makes it difficult, if not impossible, to characterize either the cormorant population or smolt predation rates with any confidence.

G-7 →

- The NMFS analysis does not use data from salmonid smolt PIT tags recovered on the East Sand Island cormorant colony. These data would have allowed far more accurate stock-specific assessments of predation rates and would have supported an analysis of benefits of different management alternatives on recovery of particular ESA-listed ESUs/DPSs of salmonids.

The bottom line is that the survival gap has a serious credibility gap. The analysis is inadequate as a basis for a decision for the extreme lethal control of Double-crested Cormorants proposed in the preferred alternative. In fact, it is entirely possible that with a more scientifically sophisticated and reliable analytical approach, there may be no survival gap at all.

Non-lethal Controls Have Not Been Implemented and Evaluated

According to the NOAA guidance under Section 120 of the Marine Mammal Protection Act, before a California sea lion eating threatened salmonids in the Columbia River can be "removed," it must "[h]ave been subjected to but not responded to non-lethal hazing" (retrieved at http://www.dfw.state.or.us/fish/sealion/index.asp). In its framework for management of Double-crested Cormorant depredation on fish resources, the Pacific Flyway Council (2012) recommends the same approach: i.e., non-lethal means should be implemented and evaluated before employing lethal controls.

G-23 For the reasons outlined below, implementation of Preferred Alternative C—and issuance of a depredation permit by USFWS—without first fully implementing non-lethal measures would be inappropriate:

G-9

- The draft EIS indicates that the Army Corps has already used and rejected non-lethal approaches. For example, on p. 6 the draft EIS states: "Despite annual reductions in the amount of available nesting habitat, double-crested cormorants nested successfully on East Sand Island every year."

- In fact, what is described in the draft EIS is a series of investigations, begun in 2008 and continued through 2013, in which researchers experimented with various non-lethal means of dissuading Double-crested Cormorants from nesting on parts of the East Sand Island cormorant colony and successfully demonstrated that privacy fences, nest destruction, and hazing were feasible methods of preventing cormorants from nesting in previously-used areas.

- These efforts to dissuade Double-crested Cormorants from nesting on East Sand Island during 2008-2013 (Roby, Collis et al. 2014) were conducted solely and explicitly on an experimental basis and were not intended to implement a management strategy, which not incidentally, would have required additional steps to comply with the National Environmental Policy Act.

- After an initial period of dispersal, nearly all of the Double-crested Cormorants hazed in 2013 were able to relocate and nest in the area on East Sand Island that was maintained as cormorant nesting habitat. Fully 96 percent of the tagged cormorants (73 or 76 birds; 4 transmitters stopped functioning) returned to East Sand Island and nested in the colony (Roby, Collis et al. 2004). Had there been an intent to actually reduce the number of nesting cormorants as a management action, additional reductions in habitat would have been required.

G-10 Contrary to what is implied in the draft EIS, the research on non-lethal measures at East Sand Island demonstrated that such measures can be highly successful, and—if coupled with sufficient reduction in available nesting habitat and continuation of hazing efforts elsewhere in the estuary—would result in fewer nesting cormorants and reduced cormorant predation on juvenile salmonids in the Columbia River estuary. It is relevant here to note that for several years the Oregon Department of Fish and Wildlife has supported a program of non-lethal hazing of cormorants (e.g., ODFW news release retrieved at http://www.dfw.state.or.us/news/2013/april/040513.asp) in key estuaries for the purpose of protecting outbound juvenile salmonids.

Though not explicitly stated in the draft EIS, what is clear is that no one—with possible exception of Washington (see below)—wants the Double-crested Cormorants now nesting on East Sand Island. Hence, rather than disperse the cormorants through non-lethal means, the Army Corps simply proposes to shoot them on the colony. This
S-33 approach ignores the fact that most of the initial growth in the cormorant colony at East Sand Island was by immigration—i.e., the birds emigrated from somewhere else—and were not apparently causing significant problems at the locations from which they emigrated.

In this regard, Courtot et al. (2012) reported that 75 percent (38/51) of satellite-tagged Double-crested Cormorants that left the Columbia River estuary after the breeding season visited 19 current and historical cormorant colonies, demonstrating clear knowledge of and connectivity to alternative breeding sites throughout the cormorants' West Coast range. The colonies outside the Columbia River estuary with the greatest
G-8 connectivity to East Sand Island are to the north: e.g., 43 percent of satellite-tagged cormorants visited locations within the Puget Sound/Salish Sea region (Courtot et al. 2012). These data demonstrated strong connectivity to a region that the Washington Department of Fish and Wildlife describes as of "moderate management concern and could tolerate some increase in DCCO numbers if closely monitored" (Chapter 3–p. 49).

G-10 There is no scientifically sound basis to conclude that the only or best alternative is to shoot 16,000 or more Double-crested Cormorants when non-lethal measures have not been implemented or evaluated as a management strategy. Further, there is no substantive evidence that dispersing rather than shooting the East Sand Island cormorants—when coupled with hazing and other non-lethal measures in the Columbia River estuary and on the Oregon coast—will result in significant new issues for fisheries resources at other locations. In fact, there is substantive scientific evidence that dispersing cormorants from the East Sand Island colony can be done efficiently, effectively, and without transferring or magnifying impacts on fisheries that the draft EIS is designed to address.

Depredation Permit May Be Problematic

S-44 Migratory Bird Treaty Act regulations for Depredation Permits at 50 CFR 21.41(c)(3) prohibit use of "blinds, pits, or other means of concealment, decoys, duck calls, or other devices to lure or entice birds within gun range." Yet, the draft EIS (Chapter 2 – p. 22) indicates that:

> Culling on-island would include multiple individuals shooting from observation points (ground or elevated) and **existing structures** [emphasis added] on East Sand Island using small caliber rifles.

The only existing structures within the Double-crested Cormorant colony on East Sand Island are blinds and tunnels that are intended to conceal the people conducting research in the colony. This proposed use of "existing structures" as concealment for the lethal control of cormorants does not square with the prohibition on use of blinds for activities conducted under a MBTA depredation permit.

The draft EIS acknowledges that, due to misidentification, there "is high potential for a substantial reduction in the size of the Brandt's Cormorant colony on East Sand Island" (Executive Summary – p. 19). Pelagic Cormorants will likely also be shot due to misidentification. This is a very different situation than, for example, culling of Double-crested Cormorants in eastern North America, where there is little chance of misidentifying
S-45 the targets. How does the U.S. Fish and Wildlife Service intend to handle the incidental take of non-target avian species *vis a vis* the depredation permit for Double-crested Cormorants? This is an important issue for conservation of the non-target species, and the approach chosen is also important in terms of an example and precedent under the MBTA. Will Brandt's and pelagic cormorants and their nests be monitored on their respective colonies and are the Army Corps and U.S. Fish and Wildlife Service prepared to stop the culling of Double-crested Cormorants if losses of non-target species are too great? What threshold of mortality to non-target migratory birds will be used as a trigger for cessation of culling Double-crested Cormorants in the Columbia River estuary?

Population Impact Is Too Great and The Baseline is Shifting

The proposed lethal removal of at least 16,000 Double-crested Cormorants—and
G-18, G-19, G-20 possibly many thousands more—to reach the target of 5,600 pairs at East Sand Island is an extreme measure to apply to a native North American migratory bird. Consider the following:

- The Double-crested Cormorant population in western North America was estimated in 2009 to consist of 62,400 individual adults, which means that the population is probably an order of magnitude smaller today than it was historically (Wires and Cuthbert 2006).

- Although the western Double-crested Cormorant population may have grown since 2009, any increase likely was driven by immigration to and the subsequent high productivity of cormorants at East Sand Island. The East Sand Island colony alone now accounts for more than 40 percent of the entire western North America population.

- At the same time, nesting colonies of Double-crested Cormorants on the coasts of Washington and British Columbia, in the Potholes region of eastern Washington, in the Upper Klamath Basin of Oregon/California, in coastal southern California, and in the Salton Sea have declined or been abandoned. In British Columbia, the Double-crested Cormorant is on the provincial "blue list," indicating concern or uncertainty about the status of this species.

- The proposed lethal removal of cormorants at East Sand Island would eliminate at least 25 percent of the western population. Given the recent size of the colony (14,900 pairs in 2013), thousands more cormorants may actually have to be killed to reach the target of 5,600 pairs, thus driving up the proportional impact on the western North America population.

- If there are unexpectedly high immigration rates of cormorants to the East Sand Island colony before the target of 5,600 pairs is reached, even more cormorants will need to be killed, and there is risk that all of the human activity will result in complete abandonment of the colony.

G-20

The draft EIS presents two population analyses (Appendices E – 1 and 2) on the impact of the culling in Preferred Alternative C on Double-crested Cormorants breeding on East Sand Island and in the western North America population. The Army Corps and its cooperating agencies, including the U.S. Fish and Wildlife Service, propose that the western North America population of Double-crested Cormorants is sustainable at its estimated 1990 level of about 41,660 individuals, and that after implementation of Phase I of Preferred Alternative C the population will be about 5,000 individuals higher than the 1990 level (Appendix E – 2, p. 10). Sustainable is defined as "a population that is able to maintain numbers above a level that would not result in a major decline or cause a species to be threatened or endangered."

Given that the estimated population in 1990 preceded the rapid growth in the East Sand Island colony, it is very convenient to conclude that the 1990 level is sustainable. However, the choice of the 1990 population as sustainable is wholly arbitrary and represents a shifting baseline. Further, while we appreciate the modelling efforts presented in the two E appendices, these analyses appear to fall far short of a full population viability analysis[2], which would seem warranted given the extreme nature of what is proposed in Preferred Alternative C.

S-25, EPA(1) #4,

S-41

The draft EIS assumes that "large-scale environmental, regulatory, and management changes that have occurred over the past decades could allow for carrying capacity of the western population of DCCOs in the future to be similar to or greater than current levels" (Appendix E – 2, p. 9). This assertion does not comport with the actual status of Double-crested Cormorant colonies throughout the range of the western population, such as the abandonment of what had been a very large Double-crested Cormorant colony on Mullet Island in the Salton Sea, the extended drought in much of the West, declines in colony sizes in British Columbia and Washington, and the active hazing of this species on the Oregon coast. In this regard, the discussion of climate change in Chapter 4 of the draft EIS focuses on salmonids and impacts on cormorants in the Columbia River estuary and does not address projections for freshwater supplies and fish in the western interior. Such information is essential for evaluating the future sustainability of Double-crested Cormorants in the western North America population.

Traditionally, resource managers—including at the U.S. Fish and Wildlife Service—have sought to avoid population level impacts on native wildlife species. It now appears that there has been a paradigm shift in which it is somehow acceptable to actively reduce through culling a distinct, native, migratory bird population—which in this case is not even remotely at a level of overabundance—by as much as one third at the scale of all western North America.

S-46

Executive Order 13186 is aimed at federal agencies "taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations." In Appendix B (p. 4), the Army Corps suggests that it is "unclear" whether the resulting Memorandum of Understanding (MOU) between the Department of Defense and the U.S. Fish and Wildlife Service applies to "Civil Works." This may or may not be the case, but a plain reading of the executive order and the MOU makes it clear that the

[2] A full population viability analysis should take into account: (1) demographic stochasticity, (2) genetic uncertainty, (3) environmental stochasticity, and (4) natural catastrophes (Beissinger and McCullough 2002).

underlying intent is to avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions. Reducing the western North America population of Double-crested Cormorants by at least 25 percent without having first fully implemented and evaluated non-lethal means of reducing cormorant predation does not fulfill this intent.

No Mitigation is Proposed

S-35

Regardless of the means chosen to reduce cormorant predation in the Columbia River estuary, the draft EIS should include an explicit strategy for mitigation of impacts to the western population of Double-crested Cormorants and its nesting habitats. Where can this species find suitable and safe places to nest outside the estuary? What will be done to restore degraded nesting habitats—for example, in the Salton Sea—that previously attracted large numbers of cormorants? There is no scientifically based evidence of an overabundance of this species in the western population, and any control measures implemented in the Columbia River system should be balanced by active mitigation elsewhere such that there is no net loss of cormorants in the West.

Conclusion

comments noted

The National Audubon Society understands the need to take action to recover threatened and endangered salmonid stocks in the Columbia River system, and we appreciate that avian predation, including by Double-crested Cormorants, is one of many sources of mortality to juvenile salmonids. However, Audubon opposes Preferred Alternative C as an extreme overreach because we find that this alternative is unjustified by the science presented in the draft EIS, is premature as a management strategy given that demonstrably successful non-lethal measures have not been implemented and evaluated, and has too great an impact on the western North America population of Double-crested Cormorants. Reliance on the ca. 1990 number of cormorants in the western population as sustainable is arbitrary, especially given that the population—then and today—is likely an order of magnitude smaller than historical levels. Finally, the Army Corps and its cooperating agencies offer nothing to mitigate the population and habitat impacts of either lethal or non-lethal control measures at East Sand Island. There should be no net loss of Double-crested Cormorants in the western North America population as a result of management actions taken at East Sand Island.

We appreciate that representatives of the Army Corps, U.S. Fish and Wildlife Service and National Marine Fisheries Service have made themselves available to discuss the draft EIS and that the Army Corps has provided opportunities to visit East Sand Island.

We should appreciate your consideration of these comments on the draft EIS and are available for further conversation about this topic.

If you have questions about these comments, please contact Stanley Senner, Audubon's Director of Bird Conservation, Pacific Flyway, at ssenner@audubon.org.

Sincerely,

Michael Sutton
Vice President, Pacific Flyway
99 Pacific Street, Suite 200F
Monterey, California 93940

Literature Cited

Beissinger, S.R., and D.R. McCullough (eds.). 2002. Population viability analysis. University of Chicago Press, Chicago, IL.

Courtot, K.N., D.D. Roby, J.Y. Adkins, D.E. Lyons, D.T. King, and R.S. Larsen. 2012. Colony connectivity of Pacific Coast double-crested cormorants based on post-breeding dispersal from the region's largest colony. Journal of Wildlife Management 76:1462–1471.

Pacific Flyway Council. 2012. Pacific Flyway Plan: A Framework for the Management of Double-crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55 pg.

Roby, D.D., K. Collis, et al. 2014. Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River. Draft Annual Report to Bonneville Power Administration, U.S. Army Corps of Engineers, and Grant County Public Utility District. Accessed online at www.birdresearchnw.org

U.S. Army Corps of Engineers. 2014. Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. Draft Environmental Impact Statement CENWP-PM-E-14-08, U.S. Army Corps of Engineers, Portland District, 422 pg.

Wires, L.R., and F.J. Cuthbert. 2006. Historic populations of the Double-crested Cormorant (*Phalacrocorax auritus*): Implications for conservation and management in the 21st century. Waterbirds 29:9-37.

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August 1, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS

Sent electronically to: cormorant-eis@usace.army.mil

Dear Ms. Ruckwardt,

I am writing as the Board President of Northwest Irrigation Utilities regarding the Corps' "Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary". Northwest Irrigation Utilities is a non-profit trade association of public power utilities with significant end use customer irrigation loads and that rely upon the Bonneville Power Administration (BPA) as their primary or exclusive supplier of wholesale energy. The cost of electricity associated with irrigation is a significant component in the overall cost of production for our members' involved in the agricultural sector.

As you may know, about one third of the wholesale Power rates BPA charges is associated with direct program costs or foregone power generation revenues tied primarily to the Biological Opinion for the Federal Columbia River Power System, Tribal and State Accords and related mitigation programs of the Northwest Power and Conservation Council. While the costs of these related mitigation measures are substantial, and unprecedented nationally, we have been willing to pay such costs so that the federal generation facilities can be in compliance with the provisions of the Endangered Species Act and Clean Water Act. Following the lead of NOAA Fisheries, the Federal Action Agencies have done everything they can to increase passage of endangered or threatened salmon and steelhead species through the FCRPS facilities.

These investments, combined with favorable ocean conditions have promoted robust and improving adult returns of salmon and steelhead for many, but not all, of the various species. However, more needs to be done to protect migrating smolts. Several of the reasonable and prudent alternatives (RPAs) from the 2008 FCRPS Biological Opinion that provided such mitigation were revised in 2014. RPA 46 directly addresses the Double-crested Cormorant problem on East Sand Island because of their impact on ESA-listed salmon and steelhead in the Columbia River Estuary. In addition to monitoring, the RPA requires the development and implementation of an action plan by the Corps of Engineers to decrease predation rates. As parties that have followed the Bi-Op litigation over the years, we are struck by the importance to implement the RPA measures, particularly those which by any reasonable standard will have a demonstrable impact on improving the survival of the smolts in the estuary, before they journey into the ocean.

The pictures of the Cormorant colony on East Sound Island, (such as figure ES-3) in the DEIS, basically tell the whole story. A man-made island with no natural predators continues to attract and propagate an exploding population of Double-crested Cormorants. The Corps reports that the number of breeding pairs increased from 100 in 1989 to approximately 15,000 in 2013. In recent years these cormorants are reportedly consuming an estimated 18.5 million juvenile salmon. The Corps references documentation from NOAA Fisheries showing the migrating smolt mortality caused by the Double-crested Cormorants is similar to or higher than mortality related to Bonneville dam, and in some years 3 – 4 times higher. Clearly something has to be done immediately to reverse this growing problem! RPA 46 of the FCRPS Bi-Op is scheduled to begin by the spring of 2015 and achieve its stated objectives by the end of 2018.

NIU has examined the four alternatives included in the Management Plan to reduce predation by Double-crested Cormorants of juvenile salmonids in the Columbia River Estuary. Our comments are as follows:

comment noted

Alternative A "No Action" is entirely unacceptable. The Corps would fail to meet its statutory responsibilities for implementing RPA 46 in conjunction with the FCRPS BiOp. While the document states that survival improvements for juvenile salmonids would need to be made up by other "actions within the purview of the Federal Columbia River Power System", such as assertion is only wishful thinking. The additional measures are "unspecified." The FCRPS has already done what it can for mitigation measures that have cost BPA customers over $14 billion over time. The only other measure that could make a meaningful improvement on the number of returning adults is harvest, but that whole issue is outside the purview of FCRPS Action Agencies.

Alternative B "Non-Lethal Management" likely won't work. The Corps has already tried to disperse the cormorant colony, with no success. Conversely we are experiencing a rapidly growing bird population on East Sand Island. Limited removal of eggs, reduction in acreage, and hazing doesn't get to the root cause of the problem. There are simply too many birds. Pursuing Alternative B is not much better than the no action alternative, because it creates the perception that something effective is being done to address the underlying problem, when in all likelihood the situation may not improve. (The Corps recognizes this possibility in the narrative of the draft EIS). Thus salmonid predation will likely continue at unacceptably high levels. We doubt that using Alternative B measures the reduced colony target size of 5,600 breeding pairs could be reached over the four year period.

Alternative C "Culling with Integrated Non-Lethal Methods" is the Corps' Preferred Management Plan. NIU supports the rapid culling of the population to ~ 5,600 breeding pairs, but in a period of 2 – 3 years under Adaptive Management, rather than 4 years. A 20% reduction per year in the size of the colony is too small, and there is no compelling reason not to move more quickly. Along with the culling, NIU supports hazing and egg take to prevent the colony from expanding. The Corps' documents show that Alternative C is more effective than B in reducing predation, and will have less of an impact on other bird species on East Sand Island. We note that culling of predatory birds has recently been employed when necessary to protect other ESA listed species, for example, the taking of Bard owls to help protect the Spotted owls in Oregon. Even with a reduction to 5,600 breeding pairs, back in 1989, the 100 breeding pairs represented less than 2% of what the new reduced population would be. NIU supports a lower target than 5,600 breeding pairs. While 5,600 pairs may have been part of an "environmental baseline" used by NOAA Fisheries, there is no reason to conclude that a lower number of birds nesting on East Sand Island would not result in further improvements in the survival of migrating smolts, particularly the steelhead, which are most at risk.

Alternative D "Culling with Exclusion of Double-crested Cormorant" is also an option that NIU supports. East Sand Island is man-made. Even with complete removal of the birds from the island, there are still multiple foraging and nesting opportunities within 25 kilometers of East Sand Island. This option makes practical sense and would have the most favorable impact on ESA listed salmonids and steelhead smolts. However, we are willing to support Alternative C, assuming that the Corps is at least willing to pursue a reasonably aggressive culling of the Double-crested Cormorant population.

comment noted →

NIU strongly supports the Corps moving forward to implement RPA 46 of the FCRPS BiOp as amended in 2014 to aggressively reduce the Double-crested Cormorant population on East Sand Island within 2 – 3 years. We understand that there may be multiple parties with varying views on this issue. We recognize that these birds are protected under the Migratory Bird Treaty Act. However their colony is the largest of any in the United States and represents 40% of their west coast population. At the end of the day common sense needs to prevail in the form of a balanced approach that serves the region's interests. We need to protect ESA listed salmonid and steelhead smolts pursuant to the FCRPS BiOp. We need to recognize the importance of returning adult fish stocks to the northwest economy in general, as an icon of our diverse cultures, and for recreational purposes. Finally, we need to understand that the FCRPS generation facilities (which are all renewable non carbon emitting resources) have basically done all they can to provide protection for smolt passage through and around the dams as well as off-site mitigation measures.

Thank you for the opportunity to comment. If you have questions regarding NIU's recommendations, please let me know (541 573-2061) or contact John Saven, our Executive Director jsaven@nru-nw.com.

Best Regards,

Randy Whitaker

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General Manager, Harney County Electric

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Sent electronically to: cormorant-eis@usace.army.mil

Dear Ms. Ruckwardt,

comments noted

Introduction

I am writing on behalf of Northwest Requirements Utilities (NRU) regarding the Corps' "Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary". NRU is a non-profit trade association of 54 public power utilities that rely upon the Bonneville Power Administration (BPA) as their primary or exclusive supplier of wholesale energy. In general, the cost of wholesale power supply from BPA represents about half of the costs the NRU members have to pass on to customers for electrical service. Thus the NRU members have a vested interest in the cost of the federal hydro-electric system and related mitigation measures.

These comments have been circulated in draft to the membership and represent the general collective views of NRU. However, individual members are encouraged to submit their own views or supplemental materials to the Corps as they deem appropriate.

General Background

According to materials we have seen from BPA, about one third of the wholesale Power rates BPA charges are associated with direct program costs or foregone power generation revenues tied primarily to the Biological Opinion for the Federal Columbia River Power System, BPA's Accords and programs of the Northwest Power and Conservation Council. Over the years the region has spent over $14 billion of fish mitigation related to the FCRPS facilities. These costs are unprecedented nationally. Our members have been willing to pay such costs so that the federal generation facilities can be in compliance with the provisions of the Endangered Species Act and Clean Water Act. Following the lead of NOAA Fisheries, the Federal Action Agencies have done everything they can, based on the best available science, to increase passage of endangered or threatened salmon and steelhead species through the FCRPS facilities.

The NRU members enjoy the benefits of relying upon carbon free resources, primarily the FCRPS hydro-electric dams as well as the output of Columbia Generating Station. However, we recognize that the BPA rates for cost based power from the FCRPS are very close to the current price of power from the market. Thus NRU urges BPA to control costs, using sound business principles, and in conformance with all statutory requirements. One of the key areas of controlling costs is for the federal action agencies to protect migrating salmon and steelhead smolts from excessive predation throughout the Columbia river system.

Several of the reasonable and prudent alternatives (RPAs) from the 2008 FCRPS Biological Opinion that provided such mitigation were revised in 2014. RPA 46 directly addresses the Double-crested Cormorant problem on East Sand Island because of their impact on ESA-listed salmon and steelhead smolts in the Columbia River Estuary. The RPA requires the development and implementation of an action plan by the Corps of Engineers to decrease predation rates. We recognize the importance to implement the RPA measures, particularly those that will have a demonstrable impact on improving the survival of the smolts in the estuary.

The Corps reports that the number of breeding pairs of Double-crested Cormorants increased from 100 in 1989 to approximately 15,000 in 2013. In recent years these cormorants are reportedly consuming an estimated 18.5 million juvenile salmon. The Corps also references that the migrating smolt mortality caused by the Double-crested Cormorants is similar to or higher than mortality related to Bonneville dam.

<u>Consideration of the Alternatives in the Draft EIS</u>

NRU has reviewed the four alternatives included in the Management Plan to reduce predation by Double-crested Cormorants of juvenile salmonids in the Columbia River Estuary.

comments noted

- Alternative A "No Action" is unacceptable because it fails to address the growing problem of predation and it also fails to comply with the Corps' responsibility to implement RPA 46 as part of the FCRPS BiOp.

- Alternative B "Non-Lethal Management" likely won't be effective in addressing the problem of predation. The draft EIS recognizes that this alternative simply may not work. The Corps has already tried to disperse the cormorant colony, with no success. Limited removal of eggs, reduction in acreage, and hazing doesn't get to the root cause of the problem. There are simply too many birds. We doubt that by relying on Alternative B measures, the reduced colony target size of 5,600 breeding pairs could be reached over the four year period.

- Alternative C "Culling with Integrated Non-Lethal Methods" is the Corps' Preferred Management Plan. NRU supports this option, but would ask the Corps to consider accomplishing the reduction in breeding pairs to 5,600 over a 2 – 3 year period under Adaptive Management, rather than 4 years. Proceeding at a faster pace will protect more migrating smolts. NRU also supports the recommended partial inundation of East Sand Island. The Corps' documents show that Alternative C is more effective than B in reducing predation, and will have less of an impact on other bird species. Even with a reduction to 5,600 breeding pairs, the population of Double-crested Cormorant breeding pairs would still be 50 times larger than initially reported in 1989.

- Alternative D "Culling with Exclusion of Double-crested Cormorant" is also an option for the Corps to consider. The issue here is how far does the Corps need to go to comply with RPA 46? This is a topic for the Federal Action Agencies and NOAA Fisheries to address.

Conclusion

NRU supports the Corps moving forward to implement RPA 46 of the FCRPS BiOp as amended in 2014 to reduce the Double-crested Cormorant population on East Sand Island within 2 – 3 years. We understand that there may be multiple parties with varying views on this issue. We recognize that these birds are protected under the Migratory Bird Treaty Act. However the colony on East Sand Island is the largest of any in the United States. We need a balanced approach that serves the region's interests. Currently the situation is out of balance, as recognized in the 2014 BiOp. BPA customers are willing to pay for mitigation measures based on sound science to protect ESA listed species as part of an overall management plan that must include reasonable control of predators. We appreciate the Corps addressing this issue and expect you will find broad support within the region for implementing Alternative C in the draft EIS.

Thank you for the opportunity to comment and for seeking public input. If you have questions regarding NRU's recommendations, please let me know.

Best Regards,

John D Saven

John Saven
Chief Executive Officer

CC: Members of Northwest Requirements Utilities
Lori Bodi, Bonneville Power Administration
Terry Flores, Northwest RiverPartners
Scott Corwin, Public Power Council

August 4, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E-14-08/Double-crested Cormorant DEIS

Dear Ms. Ruckwardt:

comments noted

Northwest RiverPartners (NWRP) appreciates the opportunity to provide comments on the Army Corps' Draft EIS (DEIS) Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary". The DEIS identifies alternatives to reduce Double-crested cormorant predation on salmon and steelhead, including those populations listed for protection under the Endangered Species Act and responds to the Reasonable and Prudent Alternative number 46 in the Federal Columbia River Power System (FCRPS) Biological Opinion. NWRP supports Alternative "C" in the EIS, the preferred alternative, because it is the most effective in the short term, provides the most certainty, minimizes impacts on other bird species and is the least costly means to accomplish the goal of reducing double-crested cormorant predation on listed salmonids.

NWRP's member organizations include more than 40,000 farmers, 4 million electric utility customers, northwest ports, and small and large businesses that rely on the economic and clean energy benefits of the Columbia and Snake rivers and federal hydro system. We are a defendant intervener in support of the federal agencies in the Oregon District Court litigation over FCRPS operations. Our members and their customers pay for the regional Fish and Wildlife Program through their wholesale power purchases from BPA, which reports that about one-third of those charges are due to fish and wildlife commitments.

The regional Fish and Wildlife Program is the largest and most expensive restoration effort anywhere in the nation. Massive structural and operational modifications have been made to the federal hydro dams on the Columbia and Snake rivers to protect listed salmon with overall costs totaling $14 billion. Such an unprecedented investment requires aggressive measures to better manage and control avian predation, including double-crested cormorants, to ensure the investments and actions being taken to protect and restore listed salmon and steelhead are not wasted or undermined.

As stated in the Draft EIS, over the last fifteen years, double-crested cormorants on East Sand Island have consumed approximately 11 million juvenile salmon and steelhead per year. The

Draft states: "when compared to other known mortality factors, this predation is considered a significant source of mortality to juvenile Salmonids" The Draft also notes that: "Thus, for some salmonid groups, average double-crested cormorant predation impacts can be similar to or exceed the mortality experienced at a hydropower dam in the FCRPS, and, in some years, can be three to four times higher."

Despite the Corps' efforts in the last ten years to understand the dynamics of the colony on East Sand Island and to control it through a variety of non-lethal techniques (redistribution, hazing and visual deterrents, reductions in nesting habitat), double crested cormorant predation continues to have a significant and unacceptable impact on salmon. Alternative "A" in the DEIA would continue the status quo and would not reduce cormorant numbers. Attempting to reduce breeding pairs on the island to 5,600 through the methods identified in Alternative "B" have been tried and failed and would not meet RPA 46 requirements.

NWRP supports Alternative C which includes both "culling" and nonlethal methods because it meets RPA 46 requirements while maintaining the western population of double-crested cormorants as a whole in keeping with the Migratory Bird Treaty Act. Even with a reduction to 5,600 breeding pairs, the population of double-crested cormorants would still be 50 times higher than initially reported in 1989. Alternative "C" also increases the probability of success, minimizes impacts on other bird species and is the least costly means to accomplish the goal of reducing double-crested cormorants predation on listed salmon and steelhead.

NWRP appreciates the Corps' research and efforts over the years to address avian predation and urges it to move forward quickly to implement Alternative "C". We further urge the Corps implement Alternative "C" in a shorter timeframe of 2-3 years instead of the 4 years identified in the DEIS. Only swift and decisive action will help protect salmon and steelhead as well as the massive investment in salmon restoration being made by Northwest families and businesses.

Thank you for your consideration of these comments and don't hesitate to contact me if you have any questions or comments.

Sincerely,

Terry Flores

Terry Flores, Executive Director

Cc: John Saven, Northwest Requirements Utilities
Scott Corwin, Public Power Council
Rock Peters, Army Corps
Lorri Bodi, Bonneville Power Administration

comments noted

TESTIMONY FOR CORMORANT HEARING 7-10-14

For the record, my name is Brad Halverson, I reside in Hillsboro, OR and am speaking on behalf of the Association of NW Steelheaders. We are present today to ***demonstrate our support*** for the proposed program by the United States Army Corps of Engineers to remove a portion of the estimated 15,000 pairs of Double Breasted Cormorants currently nesting on East Sand Island. This association, as well as other coalition partners and public officials have been working over three years to bring us to this point.

These birds have shown to be an effective predator for salmon and steelhead smolts as they migrate through the Columbia estuary, acclimating to their future environments. Studies indicate this avian predation consumes an estimated ***20 MILLION juvenile*** steelhead and salmon each year.

Millions of dollars are invested annually to mitigate mortality impacts to these anadromous salmonids on their journey from spawning beds to the ocean; only to provide a consumptive staple for birds waiting in ambush at the most vulnerable stage of their life cycle, near the end of their fresh water journey. Not to mention the commensurate ***negative economic impact*** to local communities as a result of diminished angling opportunities. And, while these stocks remain near historically low population levels, the cormorant population continues to grow unabated.

Because this is a man-made problem, it will require a man-made solution. And, that is why we are here today to support the US Army Corps of Engineers plan as a critical step in the salmon recovery process on the Columbia River.

Thank you for providing this opportunity for public testimony, and for your thoughtful consideration of our concerns.

Oregon
John A Kitzhaber, MD., Governor

Department of Fish and Wildlife
Office of the Director
4034 Fairview Industrial Drive SE
Salem, OR 97302
(503) 947-6044
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August 19, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E/Double-crested cormorant draft EIS
P.O. Box 2946
Portland, OR 97208-2946

Dear Ms. Ruckwardt:

As a cooperating agency, the Oregon Department of Fish and Wildlife (ODFW) has participated in portions of the development of the Draft Lower Columbia River Double-Crested Cormorant Environmental Impact Statement (DEIS). Unfortunately, many of our prior comments have yet to be addressed, including those presented in a letter dated February 5, 2014 (attached). Furthermore, the release of the DEIS allowed for the first comprehensive review by both the fish and wildlife divisions of ODFW, which has raised new concerns.

comments noted

ODFW supports Alternative C because it strikes an acceptable balance between double-crested cormorant (DCCO) conservation and benefits to Oregon's fisheries. However, we are concerned about two broad elements of the DEIS. First, we believe that some stated effects of avian predation on salmonids are overly simplified or are otherwise not properly represented in the DEIS. Second, we consider the dispersal of DCCOs from the Columbia River estuary to be a reasonably likely outcome of Alternative C. Such dispersal could be a serious threat to Oregon's fisheries and the recovery of species of conservation concern. We would like to take this opportunity to outline all of our concerns with the hope that we can work together toward a satisfactory final EIS.

Impact of DCCO Predation on Columbia River Salmonids and Potential Benefits of Proposed Management

G-4, S-43
ODFW(1)
#1

1) The EIS should place double-crested cormorant predation in a life-cycle context.

Consistent with Oregon's comments on the 2014 FCRPS Supplemental BiOp and on the Action Agencies' Implementation Plan, we are concerned that the DEIS

S-17, S-39, ODFW(1) #2

G-4, G-2, ODFW(1) #3

G-5, G-7, ODFW(1) #4

continues a pattern of focusing on compartmentalized mortality rates and failing to consider the effects of the FCRPS on the entire life cycle of salmon and steelhead. This compartmentalization does not consider the effects of increased travel time and predation, the depletion of energy reserves, and delayed arrival at the Columbia estuary and the ocean. The final EIS should place double-crested cormorant predation in a life-cycle survival context by discussing its effect on smolt to adult returns (SARs).

2) The EIS should commit to meaningful action-effectiveness monitoring.

The EIS should commit to assessing the degree to which FCRPS fish passage operations may influence predation rates and juvenile fish mortality as part of action-effectiveness monitoring and evaluation. Avian predation rates are likely higher due to juvenile fish injury and stress related to dam passage. Further, because juvenile fish transportation (including barging and trucking) quickly moves smolts to the estuary prior to full smoltification, their susceptibility to predation may be increased. Thus, predation is likely a delayed mortality mechanism associated with FCRPS passage. The magnitude of this effect should be assessed by examining the fish dam passage experiences (spill, turbines, bypass, and barging) learned from PIT-tags recovered in bird colonies and in bird diet studies.

3) The EIS should consider the potential for compensation as part of action-effectiveness assessments.

The DEIS does not assess the effects of compensatory mortality on the outcomes of avian predation management. The DEIS states that this decision is based on the assumption that compensation equally affects base, current and future analytical periods, and it is therefore unnecessary to make allowances for it. However, this assumption is flawed because it does not adequately consider that improvements in passage could reduce predation vulnerability or improve migrant fish condition. Assumptions about compensation should be evaluated and considered in more detail as part of action-effectiveness assessments.

4) The EIS should discuss how precision and assumptions may affect the resulting predation rate and mortality estimates.

The overall population predation rates in the DEIS are founded on NOAA Fisheries' annual estimates of smolt abundance below Bonneville Dam. This estimate is developed for ESA take permit purposes, and does not provide a measure of precision. Additionally, this population estimate is based on a set of assumptions that include spawning fish sex ratios, spawning success rates, by-pass and transportation rates, in-river mortality rates, and adipose fin-clip rates. Many of these assumptions are unsubstantiated. To ensure that the EIS establishes a sound basis for assessing the effectiveness of management actions toward recovery of depressed fish populations, the EIS should discuss how the precision and assumptions in initial smolt population estimates may affect the resulting predation rate estimates.

Disproportionate tagging rates and tagged fish numbers between populations in the Lower Columbia River and those upstream from Bonneville Dam may bias mortality rate estimates in the EIS. This may overestimate predation on upstream fish groups and underestimate predation on Lower Columbia River fish groups. The EIS should discuss how tagging rates may affect the resulting predation rate estimates.

ODFW (1)#5

5) The EIS should correct inaccuracies or provide appropriate citations related to at-the-dam performance standards.

The EIS Executive Summary should present at-the-dam performance standards in the correct context for each fish population group, and not selectively present those that portray the least mortality at hydropower dams. The performance standards are 96% survival (4% mortality) for juvenile steelhead and yearling Chinook, and 93% survival (7% mortality) for sub-yearling Chinook (2014 supplemental BiOp section 3.3.3.2 Juvenile Dam Passage Survival, p. 358). The EIS Executive Summary should also provide a citation for the estimate of 97.5% steelhead survival (2.5% mortality). In recent presentations to Oregon's Governor's Natural Resources Office, the USACE has indicated that survivals at Bonneville Dam were: 96.5% for juvenile steelhead in 2011, 95.9% for yearling Chinook in 2011, and 95.8% for sub-yearling Chinook in 2012.

Potential Unintended Consequences of Management Actions:

G-8, ODFW (2)#1

1) The EIS should assess the probability of DCCO dispersal based on appropriate data.

ODFW does not agree with the Corps' conclusion that disturbed DCCO will necessarily remain in the Columbia River estuary. The non-lethal dissuasion studies conducted on East Sand Island consolidated the available nesting area and caused DCCOs to increase nesting density, but did not restrict available nesting habitat or disturb DCCOs enough to lead to dispersal. A study conducted by Courtot et al. (2012) used satellite tags to track only post-breeding cormorants from East Sand Island. It remains unclear how DCCOs with a drive to breed will respond to more aggressive dissuasion or lethal take methods.

Hazing or culling a single colony of ground-nesting DCCOs at the annual scale proposed has never been attempted. The studies cited in the DEIS as supporting the feasibility of Alternative C involved culling at many discrete colonies, relied heavily on oiling the eggs of ground nests rather than culling adults, or involved much lower rates of adult take than proposed by Alternative C. One of the very papers the Corps cites as supporting the feasibility of Alternative C (Bedard et al. 1997) describes the impossibility of culling adult DCCOs from ground nests because of the wariness of adults.

Thus, available data does not seem to support claims in the EIS that dispersal of DCCOs from the Columbia River estuary is unlikely. Therefore, ODFW believes there is a reasonable likelihood that the preferred alternative will displace an unknown number of DCCOs from the Columbia River estuary, possibly into Oregon.

ODFW(2) #2

2) The EIS should include specific actions that will be taken in case of partial or complete colony abandonment as a result of management.

The USACE should specify a minimum amount of annual take for Alternatives C and D. If that level is not met in the Columbia River Estuary (CRE) as a result of colony abandonment, and DCCOs disperse to areas that have been identified as unacceptable by cooperating agencies, then lethal take should be conducted in areas outside of CRE.

The EIS should specify that the depredation permit that is needed to perform either Alternatives C or D will need to include dispersal locations outside of the Columbia River estuary, including all counties along the Oregon Coast.

ODFW(2) #3

3) Alternative C should include a more conservative threshold for suspension of culling activities.

The DEIS states that culling would cease only if fewer than 70% of the expected DCCO remain on East Sand Island after a culling event. In 2013, there were approximately 7,000 DCCOs on East Sand Island by the third week of April. Dispersal of 30% of that number would equal 2,100 cormorants. This is ten times the number of foraging cormorants that are counted in Tillamook Bay during April and May, and is not an acceptable amount of dispersal. Furthermore, it is unclear how accurate counts will be obtained during the early part of the breeding season when culling would commence. At this time the colony is growing rapidly and dispersal of early arriving birds could go unnoticed.

ODFW requests a minimum threshold of 90% to prevent accidental dispersal of large numbers of birds.

ODFW(2) # 4

4) The EIS should include new data that suggest dispersal of DCCOs from East Sand Island to the Oregon Coast

In spite of limited opportunities for band resighting, ODFW has observed five banded DCCOs near the Oregon Coast during the last three years. In 2012, a DCCO was observed at a roost site on the Tillamook River that had been banded as a chick at East Sand Island in 2011. A DCCO with bands from East Sand Island was observed on Tahkenitch Lake in 2013. So far in 2014, three unique individuals have been observed in Tillamook Bay that were originally banded on East Sand Island. These sightings confirm our concerns that the Oregon Coast is a likely dispersal area for Columbia River estuary DCCOs.

ODFW(2) # 5

5) The EIS should adequately consider ongoing studies and new data showing DCCO predation at Oregon estuaries, and conduct research to fill data gaps.

The EIS does not sufficiently recognize mounting evidence that DCCOs depredate ESA-listed and State Sensitive Species across the Oregon Coast.

ODFW is actively studying the effects of DCCO predation at three Oregon estuaries. Unpublished data from all sampled areas (Tillamook Bay, Umpqua River estuary, Rogue River estuary) confirm DCCO predation on juvenile salmonids of conservation concern. Although this data is limited, it all suggests the same conclusion: DCCOs that disperse from the Columbia River estuary may contribute to fish conservation issues along the Oregon Coast.

To further show potential impacts to Oregon salmonids, the EIS should include requirements for the USACE to conduct diet studies in Oregon's coastal areas where data gaps exist. These areas include estuaries associated with the Nehalem, Nestucca, Yaquina, Alsea, Siuslaw, and Coquille Rivers, Coos Bay, and Tenmile Lake.

ODFW(2) #6

6) The EIS should adequately stress the potential conservation impacts of dispersing DCCOs on state-listed Sensitive Species.

State-designated sensitive species that could be impacted by DCCO dispersal to the Oregon Coast should be included in Chapter 3 of the EIS. These include chum salmon (Coastal Chum Salmon SMU/Pacific Coast ESU), Chinook salmon (Coastal Spring Chinook SMU, Rogue Spring Chinook SMU, Southern Oregon/Northern California ESU, fall run/Rogue Fall Chinook SMU), and steelhead (Oregon Coast ESU, summer run/Coastal Summer Steelhead SMU; Klamath Mountains Province ESU, Klamath Summer Steelhead SMU; Oregon Coast ESU, summer run/Coastal Summer Steelhead SMU; Oregon Coast ESU, winter run/Coastal Winter Steelhead SMU; Klamath Mountains Province ESU, summer run/Rogue Summer Steelhead SMU).

These species are of conservation concern on a state level, and could be at risk from increased mortality due to predation by DCCOs.

ODFW(2) #7

7) The EIS should adequately address the potential social and economic impacts of dispersing DCCOs in Oregon.

Salmon fishing is a defining element of the Oregon experience, and the availability of salmon for harvest across the Oregon Coast has immense social and economic value. In spite of this, the DEIS does not mention the impacts of potential DCCO dispersal on the availability of non-listed salmonids that are important for anglers, such as wild and hatchery steelhead and Chinook salmon along the Oregon Coast.

ODFW(2) #8

These potential negative social costs are tied to economic costs. Preliminary economic analyses conducted by ODFW indicate that if double-crested cormorant numbers in Tillamook Bay were to increase by 200 birds, economic losses could be in the minimum range of $142,000 - $568,000 per year as result of decreased angler participation.

To fill data gaps relating to economic impacts to all Oregon communities, ODFW requests that the USACE include a complete economic analysis of potential impacts to Oregon's coastal areas that could become DCCO dispersal sites. These are listed in #8 below.

8) Specific adaptive management strategies are not adequately discussed in the EIS.

ODFW believes a significant number of DCCOs may disperse into Oregon as a result of Corps' actions. Thus, we feel that specific adaptive management strategies should be clearly articulated in the EIS. These strategies should be implemented if specific DCCO breeding or occurrence thresholds are met.

The central element in any adaptive management plan should be USACE assistance with reducing impacts of dispersed DCCOs on juvenile salmonids. ODFW has been monitoring and non-lethally hazing cormorants to reduce mortality of juvenile salmonids since 2011, although hazing programs have been conducted in some estuaries since 1988. The ODFW hazing program does not have the resources to manage increased numbers of foraging DCCOs. Thus, USACE assistance would be required to expand hazing programs, and the USACE depredation permit may be required to perform hazing with lethal reinforcement if non-lethal hazing is ineffective. The following are sites of concern along the Oregon Coast—estuaries with current hazing programs are noted with an asterisk "*". There are currently no hazing programs in interior Oregon.

- Nehalem Bay*
- Tillamook Bay*
- Nestucca Bay*
- Alsea Bay*
- Yaquina River
- Siuslaw River
- Umpqua River
- Coos Bay
- Coquille River*
- Rogue River
- Coastal Lakes: Siltcoos, Tahkenitch, Tenmile

ODFW(2) #9

9) Baseline DCCO numbers in Oregon should be recognized as action thresholds.

The EIS should contain clear baseline numbers of DCCO on the Oregon Coast before management at East Sand Island takes place, similar to the "base period" the Corps uses to justify actions in the EIS. If population levels exceed baseline levels following management on the Columbia River estuary, ODFW expects the Corps to contribute programs and funding to reduce impacts to Oregon salmonids, including hazing and/or lethal take at new or expanding colony sites. Acceptable breeding pair thresholds based on coastal colony data from 1979 to 2013 are given in the following table.

	1979	*1988*	*2003*	*2006*	*2009*	*2012*	*2013*	*Mean*	*SD*	*+-95% CI*	*Breeding Pair Threshold*
North Coast	356	943	788	509	737	200	449	569	263	195	**764**
Mid Coast	12	182	52	27	31	12	64	54	60	44	**98**
South Coast	490	857	1354	1205	1616	1048	1424	1142	380	282	**1424**
Total	858	1982	2194	1741	2384	1260	1937	1765	536	397	**2162**

Number of double-crested cormorant breeding pairs in Oregon, by zone. The upper boundary of the 95% confidence interval was used for the breeding pair threshold. North Coast = Bird Rocks to Haystack Rock in Pacific City; Mid Coast = Yaquina Bay Bridge to Heceta Head; South Coast = Siuslaw River to CA border. Data from Carter et al. 1995., Adkins, et al. 2010, USFWS Oregon Coast National Wildlife Refuge Seabird Colony Database, and ODFW unpublished data. Full citations available upon request.

DCCOs dispersing from the Columbia River may not necessarily breed on the Oregon Coast, but may utilize estuaries for foraging. Therefore, immediate USACE assistance (hazing and/or lethal removal) is needed if the number of DCCOs in Oregon estuaries or coastal lakes exceeds one standard deviation above the 2012-2014 average. Such an average will be calculated in two week blocks. For areas where only one or two years of data are available, the threshold for foraging birds should be any level exceeding 20% above the high count for existing data.

ODFW expects the Corps to contribute programs and funding to manage DCCOs if populations in interior Oregon exceed 10% above historic levels.

The thresholds listed above should be considered interim thresholds that are subject to change based on completion of ODFW's statewide double-crested cormorant management plan. This plan is in development and expected to be completed in 2015.

ODFW(2) #10

10) The EIS should include commitment and resources from the Corps to continue productivity studies and leg banding of DCCOs at East Sand Island.

It is possible that productivity is density dependent and could increase if removal of DCCOs lessens nest site competition. Continued leg banding of adults and chicks would reveal survival and return rates at East Sand Island and reveal sources of population change.

ODFW(2) #11

11) The EIS should reflect a cooperative, team-based effort.

ODFW is very supportive of the Adaptive Management Team approach mentioned in the DEIS. Unfortunately, it is unclear how such a body could be considered a team if the USACE asserts complete decision-making control. We fully embrace a truly team-based approach, and therefore suggest that the DEIS be amended so that decision-making power is distributed more equitably.

To conclude, ODFW recognizes the effort put forth by the Corps in the difficult task of reducing predation on juvenile salmonids in the lower Columbia River estuary. We appreciate your consideration of our comments. If you have any further questions or concerns, please do not hesitate to contact either myself or Ron Anglin, Wildlife Division Administrator, at 503-947-6312 or Ronald.E.Anglin@state.or.us.

Sincerely,

Roy Elicker Director
Fish and Wildlife Programs

"Promoting Birding and Conservation as Community Educators, Volunteers, and Stewards"

P.O Box 502 Sequim, WA 98382

August 14, 2014

Sondra Ruckwardt, Project Manager
Attn: CENWP-PM-E-14-08
U.S. Army Corps of Engineers, Portland District
Sent by email: Cormorant-EIS@usace.army.mil

Subject: Comments on the Draft Environmental Impact Statement to reduce predation on juvenile salmon and steelhead in the Columbia River

comments noted

On behalf of the Olympic Peninsula Audubon Society (OPAS), we are writing to express our strong opposition to Alternative C, which would authorize the killing of 16,000 Double-crested Cormorants roosting and nesting on East Sand Island. OPAS supports and urges adoption of Alternative A, no action, until such time as the U.S. Army Corps of Engineers has reviewed and revised its entire approach to salmon restoration and stops proposing Band-Aid, expedient actions such as a mass species slaughter to create the appearance of treating a far larger problem. Killing Cormorants in the Columbia River Estuary is not a solution to salmon restoration.

East Sand Island is historically no more than a shifting sandbar that the US Army Corps of Engineers routinely used for depositing dredge spoils from the 1940s into the 1980s. Today the island encompasses nearly 60 acres and is a nesting and/or roosting site for important and diverse populations of water and shore birds.

The island contains the largest breeding colony of Caspian Terns in the world, with 10,700 breeding pairs at the colony's peak in 2008; the largest breeding colony of Double-crested Cormorants in North America, with 15,000 breeding pairs in 2013; and the largest post-breeding roost site for Brown Pelicans on the West Coast, made up of more than 10,000 individual birds. It also contains nesting sites for Brandt's Cormorants which are difficult to distinguish from the Double-crested species you propose to kill. Both the National Audubon Society and American Bird Conservancy have officially designated the island as an Important Bird Area.

Killing 16,000 Double-crested Cormorants represents approximately 50 percent of the breeding colony that currently exists on East Sand Island and approximately 39 percent of the total breeding population of Double-crested Cormorants west of the Rocky Mountains.

G-19, G-20

OPAS is concerned that Double-crested Cormorant populations are already estimated to be an order of magnitude lower than they were historically and that populations in the west outside of East Sand Island are declining.

G-2

The Draft Environmental Impact Statement is incomplete as it fails to adequately address issues such as dam operation, salmon habitat loss, hatchery fish competition with wild fish, unpredictably fluctuating salmon returns, human caused water pollution, creation and modification of dredge spoil islands, and provides inadequate research on cormorant dispersal patterns if non-lethal alternatives were adopted.

The DEIS identifies East Sand Island Double-crested Cormorants as a major cause for declines of salmon and steelhead when the declines are, undeniably, human-caused. Scapegoating and killing 16,000 native birds in an attempt to resolve fish decline caused by 100 years of human engineering and waterways modifications is a misconceived alternative. Rather, we would encourage you to restore more natural waterways, reengineer dredge spoil depositions, and dissipate the nesting density of fish eating birds over a larger array of nesting sites. Killing 16,000 birds may be thought to demonstrate to the public that the Corps is “doing something” about the loss of salmon, but it will almost certainly fail to bring significant improvement to the fisheries because the action does not address the fundamental causes of fish decline. Salmon in the Columbia River basin are not in trouble because of predation by birds, and the Corps and its agency partners have a responsibility to look more fully at what can be done to address root causes of low salmon populations.

Sincerely,

Mary Porter-Solberg
Bob Phreaner

Olympic Peninsula Audubon Society
Conservation Co-Chairs

Cc’s
Bob Sallinger, Audubon Society of Portland
US Fish and Wildlife, Pacific Region 1
Gail Gatton, Audubon Washington
Senator Patty Murray
Senator Maria Cantwell
Representative Derek Kilmer

Pacific Fishery Management Council
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Dorothy M. Lowman, Chair| Donald O. McIsaac, Executive Director

August 13, 2014

Ms. Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E / Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, OR 97208-2946

Re: Pacific Fishery Management Council Comments on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Dear Ms. Ruckwardt:

comments noted

Thank you for the opportunity to comment on the Draft Environmental Impact Statement (DEIS) on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. At its June 2014 meeting, the Pacific Fishery Management Council (Council) reviewed the DEIS and heard recommendations from its Salmon Advisory Subpanel. Although the DEIS was released shortly before the Council session, the Council was able to weigh the issues and provides the following comments and recommendations for your consideration.

The Council is keenly interested in the status and management of salmonids in the Columbia River. The Council works closely with the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service, the States of Oregon and Washington, Columbia River Treaty Tribes, stakeholders, and the public on sustainable fishery management of West Coast and Columbia River salmon stocks and the recovery of salmon stocks listed under the Endangered Species Act (ESA). The Council in encouraged by efforts such as this that address Columbia River salmon habitat and predation issues.

The Council reviewed the range of alternatives and recommends Alternative C: *Culling with Integrated Non-Lethal Methods Including Limited Egg Take* as the preferred alternative for meeting the objectives as described in the DEIS. The Council feels that Alternative C offers the most efficient option for achieving the proposed target population size of double-crested cormorants while minimizing the dispersal of birds and the potential of relocating heavy predation to other areas of the Columbia River or to other West Coast rivers.

G-6

The Council believes that reducing the double-crested cormorant population to 5,380-5,939 nesting pairs to coincide with a 1983-2002 base period population size is a good step towards addressing Lower Columbia River avian predation, but does not go far enough to restore habitat and piscivorous bird populations to conditions and levels in existence prior to the stabilization and manipulation of East Sand Island. The Council understands that the base period and corresponding population target was chosen by NMFS under the ESA as reasonable and prudent alternative number 46 (RPA 46) in the 2014 Supplemental Federal Columbia River Power System Biological

Opinion. Accordingly, the Council also requested that the enclosed letter be sent to NMFS West Coast Regional Administrator Mr. Will Stelle, expressing the Council's desire to revisit RPA 46 and its associated target population range. The Council feels that the recovery of ESA-listed salmonids in the Columbia River could be better served if habitat conditions and bird populations were restored to a more natural state as existed prior to the manipulation of the island to aid the maintenance of navigation channels.

Please let me know if our staff can be of any further assistance on this matter.

Sincerely,

D.O. McIsaac, Ph.D.
Executive Director

Enclosure: August 13 letter to Mr. Will Stelle Regarding Pacific Fishery Management Council Pacific Fishery Management Council Comments on Reasonable and Prudent Alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion Regarding Avian Predation of Salmonids

MDB:kma

C: Council Members
Salmon Technical Team
Salmon Advisory Subpanel
Habitat Committee

Pacific Fishery Management Council
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Dorothy M. Lowman, Chair| Donald O. McIsaac, Executive Director

August 13, 2014

Mr. Will Stelle, Regional Administrator
National Marine Fisheries Service, West Coast Region
7600 Sand Point Way NE, BIN C15700
Seattle, Washington 98115-0070

Re: Pacific Fishery Management Council Comments on Reasonable and Prudent Alternative 46 in the 2014 Supplemental Federal Columbia River Power System Biological Opinion Regarding Avian Predation of Salmonids

Dear Mr. Stelle:

At its June 2014 meeting, the Pacific Fishery Management Council (Council) reviewed a Draft Environmental Impact Statement (DEIS) on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary prepared by the U.S. Army Corps of Engineers (USACE). The Council reviewed the range of alternatives and directed me to send the enclosed comment letter to the USACE reflecting the Council's preference for Alternative C: *Culling with Integrated Non-Lethal Methods Including Limited Egg Take*. The Council feels that Alternative C offers the most efficient option for achieving the proposed target population size of double-crested cormorants while minimizing the dispersal of birds and the potential of relocating heavy predation to other areas of the Columbia River or to other West Coast rivers.

The Council believes that reducing the double-crested cormorant population to 5,380-5,939 nesting pairs to coincide with a 1983-2002 base period population size under Alternative C is a positive step towards addressing Lower Columbia River avian predation of salmon, but does not believe that this alternative goes far enough to restore habitat and piscivorous bird populations to conditions and levels in existence prior to the stabilization and manipulation of East Sand Island.

The Council understands that the base period and corresponding population target was chosen by NMFS under the Endangered Species Act (ESA) as reasonable and prudent alternative number 46 (RPA 46) in the 2014 Supplemental Federal Columbia River Power System Biological Opinion. This decision effectively sets the most critical element in addressing the problem, and was done without public input. The Council feels that the recovery of ESA-listed salmonids in the Columbia River could be better served if habitat conditions and bird populations were restored to a more natural state as existed prior to the manipulation of the island to aid the maintenance of navigation channels. Therefore, the Council requests a reopening of the RPA selection process to consider an RPA of a lower value, so that cormorant predation on salmon can return to contemporary historical natural levels by such activities as returning East Sand Island to its original size and habitat characteristics. The Council believes that reducing target nesting population size to levels observed prior to East Sand Island's enlargement by the USACE would greatly enhance Columbia River salmon recovery efforts. Lastly, the Council feels this process should not be viewed as mitigation for Federal Columbia River Power System impacts to ESA-listed salmon, but rather, an independent action associated with not adding additional population stress related to dredging and dredge spoil deposits.

Please let me know if our staff can be of any further assistance on this matter.

Sincerely,

D.O. McIsaac, Ph.D.
Executive Director

MDB:kma

Enclosure: August 13 letter to Ms. Sondra Ruckwardt Regarding Pacific Fishery Management Council Comments on the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

C: Council Members
Salmon Technical Team
Salmon Advisory Subpanel
Habitat Committee

Fish at Ilwaco

Pacific Salmon Charters, Inc.

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Aug 13, 2014

Sondra Ruckwardt
U S Army Corps of Engineers District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P O Box 2946
Portland, Or. 97208-2946

It is about time we get serious about saving **SALMON**. **Alt C** is a start to reducing the population of Cormorants instead of doing nothing and delaying recovery.

Reducing the population of Cormorants by 50% would help recover listed **Salmon** and help the Coastal Communities of Washington and Oregon recover economically.

We have spent billions of Dollars on studies and it is time to quit **wasting public funds** when every Salmon fisherman who makes a living fishing or sports fishermen knew this 10 years ago.

We employ 20 to 22 people in our business it is getting harder and harder to survive as well as other businesses in our community.

comment noted

The Cormorants also need to be removed from the protected list and it will help in the future problems throughout the USA. They have the same problem in Midwest and Northeast.

Sincerely

Milton C Gudgell
President

Pacific Seabird Group

DEDICATED TO THE STUDY AND CONSERVATION OF PACIFIC SEABIRDS AND THEIR ENVIRONMENT

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8 August 2014

Sondra Ruckwardt
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P.O. Box 2946
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Dear Ms. Ruckwardt:

comments noted

This letter is in response to the draft environmental impact statement (draft EIS) from the Army Corps of Engineers on the *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary*. The Pacific Seabird Group (PSG) does not support the Army Corps' Preferred Alternative C because: (1) the science supporting the 3.6 percent survival gap is incomplete and the benefits to salmon smolt survival by reducing cormorant predation have not been determined, (2) non-lethal control has not been fully tested and evaluated prior to lethal control, and (3) the estimated impact of the preferred alternative on the western North American population of Double-crested Cormorants is a serious concern.

The PSG is an international, non-profit organization that was founded in 1972 to promote the knowledge, study, and conservation of Pacific seabirds. It has a membership drawn from 14 nations, including Australia, Canada, China, Japan, Mexico, New Zealand, Peru, Russia, and the USA. PSG's members include biologists and scientists who have research interests in Pacific seabirds, government officials who manage seabird refuges and populations, and representatives of nongovernmental organizations and individuals, all of whom are interested in the science and conservation of marine birds.

In its Preferred Alternative C, the Army Corps and cooperating agencies propose to shoot 15,995 (hereafter, "about 16,000") Double-crested Cormorants over a 2-4 year period to reduce the size of the East Sand Island Double-crested Cormorant colony from a three-year average of 13,400 pairs to 5,380-5,939 pairs (hereafter, "about 5,600 pairs"). The lethal control would be coupled with oiling of some eggs, reducing the habitat available on East Sand Island for nesting cormorants in the future, and hazing of prospective nesters at East Sand Island and elsewhere in the estuary.

1) Supporting Science: Survival Gap and Benefits Analysis

According to the draft EIS, reducing the size of the Double-crested Cormorant colony in the Columbia River estuary to about 5,600 pairs is justified by a management objective to eliminate a steelhead smolt "survival gap" of 3.6 percent. The estimated survival gap is the difference between the average annual total consumption rate of smolts by
G-5, G-7, G-3
cormorants from two arbitrarily selected time periods: a base period, 1983-2002, and the "current period," 2003-2009 (Appendix D).

The analysis to support this management objective was not subject to external peer review (G. Fredricks, pers. comm., National Marine Fisheries Service), and appears to be based on incomplete scientific information: 1) There are no measurements of cormorant diet or predation rates in the Columbia River estuary prior to 1998 (four years before the start of the current period and near the end of the base period); 2) Data for the number of cormorants nesting or foraging in the estuary prior to 1997 are limited; and 3) In the analysis that generated the value of 3.6 percent for the survival gap, the only factors varied in the model were numbers of breeding cormorants and numbers of smolts entering the estuary[1]. Inter-annual predation rates on salmon vary by an order of magnitude and are not independent of environmental conditions. For example, the volume of freshwater outflow in the Columbia River has a strong influence on salmonid predation rates by cormorants (e.g., Lyons et al. 2014): when freshwater outflow is low, saltwater advances farther into the estuary, bringing alternative marine prey for cormorants (e.g., anchovies, smelt, sardines, herring). Thus, the survival gap analysis should address the inter-annual variability in environmental conditions that influences predation rates and capture the uncertainty due to lack of

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[1] The number of smolts entering the estuary is extremely challenging to estimate, and which in this case is based on a pre-season forecast without confirmation from empirical data collected in the estuary or measures of confidence.

data for diet and population numbers. With a more sophisticated analysis, the estimated survival gap may be significantly different (e.g., lower) than calculated in the DEIS, changing the management objective and magnitude of lethal control potentially required.

In addition to the incomplete analysis mentioned above, the Army Corps and its agency partners do not provide statistical, peer-reviewed evidence that reducing the number of cormorants will increase salmon smolt survival in the estuary. On the mid-Columbia River, a 3-year study by the University of Washington with the Chelan County Public Utitlity District found that thousands of avian predators (including Double-crested Cormorants) had a <1% effect on salmon smolt survival and the avian predators consumed significant quantities of northern pikeminnow, a native, piscivorous predator of juvenile salmon (Wiese et al., 2008). Although the pikeminnow is not a predator on juvenile salmonids in the estuary environment, Wiese et al. (2008) raise the issue of G-4 compensatory mortality, which the draft EIS (Chapter 4 – page 6; Appendix D – page 6) largely dismisses as not being relevant to the issue at hand. We conclude, however, that understanding the degree to which reductions in avian predation might be compensated for by other salmonid mortality factors is highly relevant to identifying appropriate management objectives and evaluating the actual benefit of those objectives (e.g., Lyons 2010).

S-16 The draft EIS proposes to reduce the East Sand Island cormorant colony to about 5,600 pairs as an all or nothing proposition, but what are the benefits for enhancing salmonid population growth over time under a range of target levels for cormorant control? What are the incremental gains and losses of reducing the cormorant colony size by different amounts, and how do these compare to, or interact with, other factors that influence smolt survival?

comments noted

There are multiple factors that influence the survival of Pacific salmon smolts including body condition (length and weight), availability of cover or habitat protection from predators, downstream timing, prey availability in the estuary, predator abundance, environmental conditions in the estuary, and the presence of high-head dams on the Columbia River (Zabel and Williams 2002, Williams 2008). Wiese et al. (2008) conclude that "identifying the strength of ecosystem interactions....represents a top priority when attempting to manage the abundance of a particular ecosystem constituent - and that the consequences of a single-species view may be counterintuitive, and potentially counterproductive."

2) Non-lethal Means of Reducing Cormorant Predation

G-9, G-10 G-11

Our second comment is that non-lethal methods have not been fully explored or tested. The Pacific Flyway Council's (2012) management framework for Double-crested Cormorants recommends that non-lethal measures be implemented first and the effects of these actions assessed before lethal controls of cormorants are implemented. The Council's guidelines were developed by member agencies, including the US Fish and Wildlife Service and several other agencies that cooperated in the preparation of the draft EIS. The draft EIS, as well as subsequent outreach materials and media accounts, would lead readers to conclude that the Army Corps has fully implemented and assessed non-lethal means of reducing the size of the East Sand Island cormorant colony prior to a lethal control proposal but this is not the case.

A non-lethal management approach intending to disperse some portion of the East Sand Island cormorant colony (e.g., Alternative B) would rely on three techniques: (i) habitat restriction and disturbance to limit the number of cormorants nesting on East Sand Island, (ii) understanding prospecting behavior and identifying prospecting locations, and (iii) hazing of cormorants away from any unacceptable prospecting locations, such as alternative sites in the Columbia River estuary. With support from the Army Corps, recent experimental work on Double-crested Cormorants suggests that success in each of these techniques is feasible and certainly has not been demonstrated to be infeasible. Comments on these three non-lethal techniques are listed below:

i) Habitat Restriction and Disturbance: Experiments conducted during 2011-2013 used privacy fences, nest destruction, and hazing to examine how cormorants might respond to this disturbance with the result that cormorants temporarily left the island and returned to nest in undisturbed areas. In order to evaluate how this type of disturbance might be used to reduce the number of nesting birds, additional reductions in habitat, and additional NEPA compliance, will be required. There is every reason to expect that habitat restriction can successfully reduce the size of the colony using the non-lethal methods in the 2011-2013 experiments and the draft EIS presumes this in Alternative C (i.e., the estimated lethal control is based in part on a scenario where the island carrying capacity is incrementally reduced during Phase I of the proposed management). Thus, the next step is to implement and evaluate the effectiveness of this management strategy before considering lethal control.

G-8

ii) Understanding Prospecting Behavior and Identifying Prospecting Locations: Tracking experiments conducted by Oregon State University during 2012-2013 indicated that cormorants that leave East Sand Island do not randomly explore alternative habitats. Cormorants showed a predictable dispersal pattern: frequent visitation of active or historical colony sites, repeated use of communal roosts, and greater use of the lower Columbia River and estuary and select areas of coastal Washington. Tracking experiments advanced our understanding of cormorant prospecting behavior and identified specific sites that cormorants might use for nesting, developed a robust technique to identify other possible sites based on their behavior. Tracking experiments can address some of the concerns about using a non-lethal approach; for example, future tracking studies can study dispersal after habitat restriction and disturbance. Currently, there is little evidence that the Oregon coast would be substantially used by East Sand Island cormorants.

iii) Hazing at Undesirable Dispersal Locations: The draft EIS does not discuss any experiments that have been conducted to evaluate the difficulty of hazing cormorants away from possible dispersal sites. Based on the success of hazing at preventing nesting in select areas of the East Sand Island colony, where cormorants have an individual history of nesting and the large colony provided an immense social attraction, one can reasonably conclude that hazing at prospecting sites would be comparatively easy. Additionally, double-crested cormorants are well known to be susceptible to human disturbance—a factor known or suspected to have caused abandonment of multiple colonies in both coastal Washington and British Columbia. Consequently, there is reason to think hazing at undesirable dispersal locations could successfully prevent colony initiation or growth. There is no empirical evidence to suggest hazing would not work in this capacity.

To summarize this section, the Army Corps and its partners have neither implemented nor tested a full-scale non-lethal approach to reducing the presence of Double-crested Cormorants on East Sand Island. To choose Preferred Alternative C before doing so would be inconsistent with the Pacific Flyway Council guidelines.

3) Impact on the Double-crested Cormorant Population

G-20 → Finally, we note that the impact of lethal control to the western population of Double-crested Cormorants is estimated to be significant. In 2013, about 29,800 Double-crested Cormorants (~ 14,900 pairs) nested on East Sand Island, which is now the world's largest colony for this species. In 2014, nesting data are still being analyzed and there is no reason to think that fewer cormorants were present. According to Alternative C, the Army Corps wants to reach a target of 5,600 nesting pairs at East Sand Island, so it may G-18 → be necessary to actually kill 18,600 cormorants (9,300 pairs), not 16,000--this is 60 percent of the world's largest Double-crested Cormorant colony.

G-17, G-21

Lethal control has several problems that need to be mitigated or accounted for, including disturbance and incidental mortality. Lethal control (shooting and salvaging dead birds), whether by day or night, will result in considerable disturbance to all birds nesting on the island and may cause additional egg loss, chick mortality, or abandonment of the colony by cormorants or other species. The East Sand Island colony contains the largest Brandt's Cormorant colony in Oregon (about 1,500 pairs) and one could expect disturbance and accidental death from misidentification to this species. Additionally, if cormorants are shot away from the East Side Island colony, their breeding status will be unknown (e.g., non-breeding individuals), meaning that more cormorants may be shot than necessary to reach the Army Corps' reduction target.

S-40

G-19, G-20

Of great concern is the unknown impact to the western population of this species. In 2009, the entire western North America population of Double-crested Cormorants was estimated to be 64,200 individuals (31,200 breeding pairs), of which about 39 percent nested at the East Sand Island colony. A reduction of 16,000 to 18,600 cormorants at East Sand Island would reduce the western population by more than 25 percent at a time when many colonies on the Washington and British Columbia coasts have declined. Some major colonies, for example, Mullet Island in the Salton Sea, have been abandoned and in British Columbia, the Double-crested Cormorant is Blue listed (watch list) because of concern about its status (http://a100.gov.bc.ca/pub/eswp/search.do;jsessionid=VhCmT0VLNc51p9vQZ71G0BQ2G1vRZKbW00gf63c23Ym1jQfwNDG6!234374013).

The current size of the western North American population of Double-crested Cormorants is at least an order of magnitude below historical levels. The selection of the estimated cormorant population in 1990 as a desired, sustainable level is wholly arbitrary and represents a "shifting baseline" (*sensu* Pauly 1995).

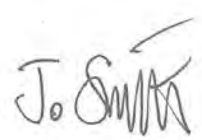
comments noted

The PSG understands the importance of protecting Pacific salmon species for the health of commercial and recreational fisheries, ecological integrity of the Columbia River and Pacific Ocean ecosystem, and cultural heritage of Pacific Northwest tribes and communities. However, the purposeful reduction of more than 25 percent of the entire western population of a native, North American, non-game bird is an extreme measure that currently cannot be justified by relevant national policy (e.g., Pacific Flyway Council), available science, or best practices in ecosystem-based management.

In conclusion, the PSG urges the Army Corps and its cooperators to choose Alternative A, "no action", at this time and to revisit its approach to managing avian predation and other sources of mortality to salmonid smolts in the Columbia River basin. Management of Double-crested Cormorants and other avian predators should be considered and addressed on a range-wide, ecosystem scale, as it is clear that the problems related to salmon smolt survival and the impacts of the Army Corps' proposed solutions extend far beyond the Columbia River estuary.

We appreciate this opportunity to comment on the draft EIS and would be pleased to engage in further conversations about alternatives to Preferred Alternative C.

Thank you,



Jo Smith
Chair

cc: Robyn Thorson, Director
USFWS Region 1

<u>Literature Cited</u>

Lyons, D. E. 2010. Bioenergetics-based predator-prey relationships between piscivorous birds and juvenile salmonids in the Columbia River Estuary. Ph.D. dissertation, Oregon State University, Corvallis, Oregon. 331pp. Available at: www.birdresearchnw.org.

Lyons, D.E., A.F. Evans, N.J. Hostetter, A. Piggot, L. Weitkamp, T.P. Good, D.D. Roby, K. Collis, P.J. Loschl. And B. Cramer. 2014. Factors influencing predation on juvenile salmonids by double-crested cormorants in the Columbia River estuary: A retrospective analysis. Report prepared for the U.S. Army Corps of Engineers – Portland District, Portland, OR. 30 pp.

Pacific Flyway Council. 2012. Pacific Flyway Plan: A framework for the management of double-crested cormorant depredation on fish resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55 pg.

Pauly, Daniel. 1995. Anecdotes and the shifting baseline syndrome of fisheries. Trends in Ecology and Evolution **10**:430.

Roby, D.D., K. Collis, et al. 2014. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft Annual Report to Bonneville Power Administration, U.S. Army Corps of Engineers, and Grant County Public Utility District. Accessed online at www.birdresearchnw.org

Wiese, F.K., J.K. Parrish, C.W. Thompson, and C. Maranto. 2008. Ecosystem-based management of predator-prey relationships: piscivorous birds and salmonids. Ecological Applications. 18(3): 681-700

Williams, J.G., 2008. Mitigating the effects of high-head dams on the Columbia River, USA: experience from the trenches. Hydrobiologia 609: 241-251.

Zabel, R.W., and J.G. Williams. 2002. Selective mortality in Chinook salmon: what is the effect of human disturbance? Ecological Applications. 12(1): 173-183.

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August 4, 2014

Comments on Draft Environmental Impact Statement (EIS): Double-crested cormorant plan to reduce predation of juvenile salmonids in the Columbia River Estuary

Submitted Via U.S. Mail & Email

Dear Ms. Ruckwardt:

G-9, G-10

These comments are submitted on behalf of Public Employees for Environmental Responsibility (PEER). The thrust of our comments is that the analysis justifying the preferred alternative offered by the Portland District of the U.S. Army of Engineers (Corps) is based upon major misrepresentations of the available scientific research. These misrepresentations are so blatant and one-sided that they appear to be intentional efforts to fabricate a supporting record for a pre-determined preferred course of action.

These comments will outline three major scientific misrepresentations underpinning the Corps' rationale for its preferred alternative. In addition, the DEIS assumptions about the extent and effect of Double-crested Cormorant (DCCO) predation are not well supported.

This extensive manipulation of scientific data appears to be in violation of the National Environmental Policy Act[1], Data Quality Act[2] and the Department of Defense policy on Scientific Integrity[3]. For this reason, as detailed below, PEER urges the Corps to withdraw this DEIS in its entirety.

The preferred alternative calls for dramatic reductions in the largest DCCO colony on the planet. Such an unprecedented removal of wildlife to obtain a management objective should be

[1] 42 U.S.C.§ 4321 *et seq*
[2] Section 515 of the Fiscal Year 2001 Treasury and General Government Appropriations Act, Pub. L. No. 106-554
[3] Department of Defense INSTRUCTION NO.3200.20

thoroughly understood and all alternatives fully considered before it is undertaken. That is demonstrably not the case with this DEIS.

G-9, G-10, G-11, G-23

I. The Corps Has Not Tried Non-Lethal Means to Reduce Predation.

In its DEIS, the Corps states that it has used non-lethal management approaches to reduce DCCO predation but those techniques did not work, stating that when it reduced nesting habitat on East Sand Island by 70% in 2013, the colony size increased by 15% and concluding that "despite annual reductions in the amount of available nesting habitat, double-crested cormorants nested successfully on East Sand Island every year."[4]

A. In fact, these habitat reductions were explicitly not designed to reduce colony size below the amount necessary to accommodate the entire DCCO colony. Indeed, these studies showed that non-lethal techniques (primarily privacy fences and human hazing) would prevent DCCO nesting in areas of East Sand Island which had an extended record of DCCO nesting. In that regard, the studies successfully demonstrated that habitat reduction could reduce the size of the colony.

By mischaracterizing the research it had supported, the Corps falsely discounts the non-lethal alternative of further reducing colony size.[5]

FEIS Section 2.3, App. G

B. While these studies did explore habitat reduction, they did not extensively utilize take of DCCO eggs. This well-established population control technique is also not explored by the DEIS as an alternative to lethal removal of nesting adults.

G-9, G-10, G-11 FEIS Section 2.3, App. G

C. Similarly, the Corps dismisses DCCO redistribution as a viable alternative without adequate analysis. In the DEIS, the Corps states that "social attraction techniques" (setting up decoys and broadcasting audio playback of bird calls to encourage nesting) were tested within and outside the Columbia River Estuary for several years as a possible method to redistribute the East Sand Island double-crested cormorant colony." [6]

The DEIS adds "during 2004–2008, social attraction was also employed on Miller Sands Spit and Rice Islands with limited success as a means to easily redistribute a large portion of the East Sand Island colony. Since 2009, there have been no documented DCCO nesting attempts at Miller Sands Spit or Rice Islands."[7]

This analysis conveniently ignores that

- Social attraction efforts ended in 2008. Prior to that time they had been successful in attracting DCCO nesting;

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[4] Executive Summary Page 6
[5] Alternative B
[6] Executive Summary, Pages 5-6
[7] In Section 1.1.6 (Page 11)

G-8, G-9, G-10, G-11 FEIS Section 2.3, App.G

G-8, S-26 FEIS Section 3.1, Tables 3-1; 3-2

- None of the social attraction efforts was coupled with efforts to discourage nesting at nearby DCCO colonies in order give an incentive for DCCOs to relocate; and

- Social attraction had its greatest success in drawing DCCOs to sites where prior successful breeding had occurred, suggesting that a carefully calibrated relocation plan would likely work.

In short, the Corps suggestion that habitat enhancement and social attraction techniques are not viable techniques for redistributing DCCOs appears to be inaccurate.

II. Dispersal Has Not Been Shown to Be Counterproductive

A major premise of the DEIS is that dispersal of DCCOs from east sand island would only cause them to establish breeding colonies elsewhere in the Columbia Basin with no reduction in their impact upon juvenile salmonids. In the words of the DEIS, "dispersal of double-crested cormorants has the potential to cause greater impact to juvenile salmonids if they move to upriver locations in the Columbia River Estuary where juvenile salmonids compose a higher proportion of their diet."[8]

A. This conclusion ignores the extensive research showing that that nesting DCCOs are highly sensitive to human hazing and can be easily dispersed from nesting at sites targeted by resource managers. Rather than try to drive DCCOs from all alternative sites throughout the Columbia River estuary, as the DEIS proposes,[9] the Corps should consider the alternative of choosing locations where DCCOs would be allowed to nest in the Columbia River estuary.

The type and intensity of hazing that the Corps proposes may be utterly impractical and unduly expensive while at the same time be far less effective than targeted relocation.

B. On one hand, the DEIS claims that where DCCOs dispersed from East Sand Island would resettle is unpredictable[10]. At the same time, the DEIS then predicts that where the DCCOs resettle would cause greeter harm to listed salmonid populations.[11]

Setting this contradiction aside, the DEIS ignores a large body of scientific literature showing the pattern of dispersal when combined with hazing and other non-lethal techniques. Thus, the Corps claims that the DCC)s should be killed because where they would otherwise go cannot be predicted is questionable, at best.

C. As proof that dispersed DCCOs would stay in the Columbia Basin, the DEIS states that "during efforts to restrict DCCO nesting on East Sand Island during the 2011–2013 breeding seasons, nearly all satellite-tagged DCCOs relocated to the Astoria-Megler Bridge or other

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[8] Executive Summary, Page 7
[9] Chapter 2, Page 12
[10] Chapter 4, Page 92
[11] Chapter 1, page 14

nearby areas to East Sand Island immediately following hazing events, and there was little evidence of permanent emigration…"[12] But the DEIS offers no evidence that the DCCOs are nesting at this nearby location or are merely foraging.

D. The proclivity of DCCOs to nest on man-made structures has been frequently observed. Not only can managers use established techniques (such as netting) to keep DCCOs from nesting on these structures but managers can also designate or even create structures where dispersed DCCOs could be encouraged to nest.

G-21, G-22

E. The DEIS assertion about relocated DCCOs potential adverse effect on listed Streaked Horned Larks ignores the fact that because nesting habitat for the two species is very different there is very little prospect of adverse effect.

III. DEIS Assumption of Sustainable DCCO Population Unsupported

A central premise of the DEIS is that its unprecedented culling will leave a DCCO population in western North America at sustainable levels.[13]

A. The DEIS makes unsupported assumptions about population which ignore –

G-18 G-19, G-20, EPA(1) #4

- The fact that East Sand Island colony today makes up a much larger proportion of the western population (more than 40%) compared to the proportion of the eastern population made compared in the DEIS. Thus, the effect on the overall western population of a massive East Sand Island cull may be radically different than hypothesized; and

- How the status and population trends of the DCCO colonies in western North America, have changed since 1990 – the year on which Corps assumptions are based.

In short, the Corps estimate that only 5,600 breeding pairs left on East Sand Island is sustainable is little more than a guess.

B. The DCCO population model used in the DEIS[14] assumes that the colony at East Sand Island is at carrying capacity. Yet the DEIS offers no evidence that the current population are anywhere close to carrying capacity. If anything, the large recent growth in the size of the East Sand island colony suggests the population may be nowhere near carrying capacity.

C. If the East Sand Island colony is still growing, the number of DCCOs which must be dispatched to reach the DEIS' desired quota may be underestimated by thousands of birds. That would mean that perhaps tens of thousands of birds would be have to be removed in a very short period of time – a task that may be as unmanageable as it is inhumane.

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[12] Chapter 3, Pages 1-2
[13] Chapter 4, Page 14
[14] Appendix E-2

IV. Management Benefit Not Quantified

The management objective the preferred alternative is designed to meet is premised on the National Oceanic & Atmospheric Administration "survival gap analysis."[15]

G-5

A. This "survival gap analysis" was not independently peer-reviewed. Although the Council on Environmental Quality regulations do not require the use of peer-reviewed methodologies, they do require "that environmental information is available to public officials and citizens," and demand that "[t]he information…be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA."[16]

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If this analysis is not appropriate for scientific research that comports with principles of scientific integrity, it is inappropriate in an Environmental Impact Statement, draft or final.

G-5, G-7

B. The analysis turns on smolt abundance estimates that are highly variable and speculative. Nor is it all clear that the best available scientific information was used to formulate this analysis.

As a consequence, the need for the preferred alternative cannot be quantified with any scientific rigor.

In summary for the reasons articulated above, PEER urges the Corps to withdraw this DEIS and to reconsider its options for achieving its stated management goal.

Sincerely,

Jeff Ruch
Executive Director

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[15] Executive Summary, Page 3

[16] 40 C.F.R. § 1500.1(b) and 40 C.F.R. § 1502.24

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July 31, 2014

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The Port of Ilwaco is located at the mouth of the Columbia River where we offer moorage facilities for up to 800 boats representing both commercial and recreational fishermen.

comments noted

Our Port and local community is highly dependent on all fisheries, specifically salmon. Our local Economic Development Council did a study in 2013 indicating Port related business activities account for nearly 20% of our County's economic activity. Our coastal communities struggle with some of the highest unemployment rates in the State and the economic value of our fisheries is critical our economic health.

The significant effort, expense and regulatory burden imposed on communities throughout the Northwest to recover salmon has shown positive results yet it is estimated up to 25 million smolts are eaten by predatory birds each year at the mouth of the River resulting in a loss of up to 200,000 returning adult salmon.

We are in support Alternative C. and believe better management is in the best interest of our coastal communities and taxpayers.

Sincerely,

Guy Glenn, Jr.
Manager

August 19, 2014

Ms. Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

Dear Ms. Ruckwardt:

On behalf of Audubon Society of Portland, Audubon Society of Corvallis, Audubon Society of Lincoln City, East Cascades Audubon Society, Kalmiopsis Audubon Society, Lane County Audubon Society, Salem Audubon Society, Umpqua Valley Audubon Society and Rogue Valley Audubon Society (Henceforth "Audubon"), this letter is in response to the draft environmental impact statement ("DEIS") from the Army Corps of Engineers ("Corps") on the *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary*.

comments noted

Audubon strongly opposes the preferred alternative (Alternative C) and instead urges the USACOE to adopt Alternative A, the "no action alternative." We believe that the Corps has failed to take the requisite "hard look" at available options as is required in an environmental impact statement (and that the selection of Alternative C would be arbitrary and capricious and not in accordance with the facts. We further believe that the implementation of Alternative C would violate other wildlife laws including the Migratory Bird Treaty Act and the Endangered Species Act and could threaten the continued existence of Double-crested Cormorants in the Western United States.

Overview:
First we would like to begin with some "myth busting." The narrative put forward by the Corps in the popular media and some political circles would have it that Double-crested Cormorant (hereafter abbreviated as "cormorant(s)") populations have "exploded" and that the birds associated with the colony at East Sand Island are consuming federally listed salmonid smolts at such a high rate that it is thwarting recovery efforts and jeopardizing the continued existence of Columbia River salmonid stocks. Further, Corps rhetoric suggests that the only way to address this issue is to kill approximated 16,000

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cormorants because other management strategies would result in displacement to other locations that could be even more problematic.

G-20, FEIS Section 3.2.2

G-5, G-7

G-2

The facts tell a very different story: The preferred alternative recommended by the US Army Corps of Engineers calls for extensive lethal control of a native wildlife species that has coexisted with salmon and steelhead since time immemorial. As many as 16,000 birds, 25% of the breeding population of cormorants in the Western United States, would be slaughtered using shotguns to kill birds over water and rifles to kill birds at close range on their active nest sites. Due to persecution and environmental contaminants, populations of cormorants in the Western United States are already an order of magnitude smaller than they were a century ago[1] and have been declining throughout much of their range in the Pacific Northwest in recent decades (Adkins and Roby 2010, Pacific Flyway Council 2012). The science describing cormorant impacts on listed salmon and steelhead, the efficacy of other alternative strategies for reducing predation on listed salmonids, and the alleged benefits of the preferred alternative for salmonid recovery is incomplete, inconclusive and for the most part, not peer reviewed. Some critical data for assessing the modelling is not even available for public review. Most importantly, federal courts have repeatedly rejected strategies developed by the Corps and other federal agencies to address one of the primary causes of salmon declines in the Columbia River Basin – the existence and operation of federal dams. Further, the Corps and other federal agencies have been slow to take steps to minimize or eliminate myriad other adverse impacts on salmon habitat undertaken or approved by these agencies. In this light, the proposal to kill cormorants on East Sand Island represents the worst kind of scapegoating---a plan that demonizes and harms a native species while diverting attention from the difficult but necessary steps needed to recover listed salmonid species in the Columbia River.

comments noted

Background:
East Sand Island is a remarkable place. Historically no more than a shifting sandbar, the US Army Corps of Engineers stabilized the island and used it to deposit dredge spoils from the 1940s until the 1980s. Today the island encompasses nearly 60-acres and is home to a remarkable assortment of birds, including the largest breeding colonies of Caspian Terns (10,700 breeding pairs at its peak in 2008) and cormorants (approximately 15,000 breeding pairs in 2013) in the world, and the largest post-breeding roost site for Brown Pelicans (>10,000 in individuals) on the West Coast. Federally listed Streaked Horned Larks have also been observed on the island, although no nesting has been documented. The

[1] Historic numbers of DCCO in the western population were at least magnitude higher than they are today (current population is estimated at around 31,200; Adkins in press). As a case in point, in the early 20th Century just one colony in Baja numbered >300,000 birds. This former colony alone represents more than nine times the current western population of DCCOs (Wires and Cuthbert 2006).

island has been recognized an officially designated Globally Important Bird Area (IBA) by both the Audubon Society and the American Bird Conservancy.

In the Preferred Alternative C, the Corps proposes to shoot 15,995 cormorants over a three year timeframe in order to reduce the East Sand Island cormorant colony population from a three year average of 13,400 pairs to 5,380-5,939 pairs. Cormorants would be killed using shotguns over water and, to the degree that lethal quotas could not be attained via this method, also shot on their nests after the onset of nesting. Nestlings and eggs from those active nests would then be destroyed.[2] Phase 2 of Alternative C would also include oiling of eggs and significant reduction of the available cormorant habitat on East Sand Island. Additionally, significant cormorant hazing would occur on other islands in the Columbia Estuary to ensure that cormorants were not able to establish colonies in other proximal locations.

Audubon remains deeply concerned about the status of Columbia River salmonid populations listed under the Federal Endangered Species Act ("ESA"). However, we do not believe that the Corps has made a compelling case that large-scale lethal control of cormorants at East Sand Island is a necessary or effective strategy for salmonid recovery. Nor do we believe the Corps and other partner agencies have done enough to address the primary causes of salmonid declines: management of the Federal Columbia River Power System (FCRPS), habitat loss and fragmentation, and management of hatcheries. Beyond the ethical and economic implications of the proposed alternative, this recommendation has a high potential to do little or nothing to help recover salmonid populations while seriously harming cormorants.

Our specific concerns include the following:

items 1-8 addressed in following pages

1. The DEIS fails to adequately assess the cumulative impacts of the proposed lethal control on cormorant populations in the Western United States;
2. The Corps has failed to identify alternative sites for nesting cormorant colonies in the Pacific Northwest or to set minimum viable population levels for cormorants;
3. The science describing cormorant predation on listed salmonid species supporting the preferred alternative is weak and lacks peer review, and the DEIS fails to make a compelling case that lethal control of cormorants will result in significant benefits for listed salmonid species;
4. The DEIS fails to adequately address impacts on non-target species, including federally listed (threatened) Streaked Horned Larks;
5. The Corps fails to make a compelling case as to why it cannot pursue non-lethal alternatives;
6. The preferred alternative potentially threatens the continued existence of Double-crested Cormorants in the Western United States and would violate provisions of the Migratory Bird Treaty Act;

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[2] Personal phone communication with Kevin Christianson, USDA Wildlife Services

7. The DEIS fails to consider an adequate range of alternatives to improve survival of juvenile salmonids listed under the ESA.
8. It is time for a full review of Corps' management strategies for piscivorous birds along the Columbia River.

Specific Concerns with the Environmental Impact Statement:

1. **The DEIS fails to adequately assess the cumulative impacts of the preferred alternative on Double-crested Cormorant populations in the Western United States and fails to set scientifically credible minimum populations levels:**

The Proposed 2- 4-year lethal strategy described in Alternative C is expected to result in a 25%-26% reduction in the population of cormorants in the Western United States (DEIS at 4-13). The Corps seeks to return western cormorant populations to ca. 1990 levels and argues that western populations "could remain static thereafter since most of the growth since 1990 occurred on East Sand Island" (*id.)* The decision to set population targets at 1990 levels is completely arbitrary especially since the western population of cormorants is already at least an order of magnitude smaller than it was historically. The date seems to have been chosen exclusively because it corresponds to the start of cormorant population increases on East Sand Island as opposed to any sort of modelling or analysis demonstrating that this actually represents a scientifically valid or stable minimum population target.

G-20

The Corps predicates its support for Alternative C on an assumption that cormorant populations outside of the Columbia Estuary are relatively stable. It concludes that the major factors that led to cormorant declines over the past century -- including persecution by humans, egg collecting, colony disturbance and environmental contaminants (Primarily DDT) -- have been resolved, that current laws are sufficient to protect cormorant populations, and that FWS will issue no more than 936 additional lethal take permits on an annual basis going forward. However, these assumptions by the Corps are inaccurate for several reasons:

G-19

- Cormorant populations in the Western United States remain at least an order of magnitude smaller than historic populations. There is simply no credible case to be made that cormorant populations have fully recovered from historic threats. The Pacific Flyway Council writes the following in its report: *A Framework for the Management of Double-crested Cormorants Depredation on Fish Resources*:

  DCCO (Double-crested Cormorants) were reduced in numbers and range during the 19th and early 20th centuries due to human encroachment and persecution, and widespread use of chlorinated hydrocarbons (e.g., DDT and its metabolites). Since the 1960s, DCCO numbers have increased with better environmental regulations and protection under the Migratory Bird Treaty Act….Population growth within the Pacific Flyway is largely attributed to the population increase of the East Sand Island colony in the Columbia River estuary, now the largest DCCO colony in the world. However, declines of DCCO colonies have been documented over much of southern Alaska, British Columbia, Washington, and southern California. Overall DCCO abundance in the Pacific Flyway is much smaller than it was *historically….DCCO population on the Pacific Flyway is at least an order of magnitude smaller than it was historically."* (Framework at pp 1 and 8)

G-19

- Outside of East Sand Island, populations continue to decline in most areas of the Pacific Northwest. Specifically, populations are declining in British Columbia, Coastal Washington, and Coastal Northern California. In British Columbia, cormorants are a "blue-list species" (species of special concern) due to their declining populations. Long-term trends for interior populations in Oregon and Washington, which make up a relatively small percent of the western population, are unclear, but there is no indication that they have increased significantly. Two of the largest interior colonies in Oregon at Malheur National Wildlife Refuge and Upper Klamath Lake have declined significantly in recent years, and Malheur may be producing no cormorants at all (DEIS at 3-24).
- The Oregon Coast represents the one location outside the Columbia River Estuary that the Corps can identify with some certainty as supporting a stable cormorant population in recent years. However, the Oregon Coast population outside the Columbia River Estuary represents a total of 2,463 breeding pairs, less than 8% of the total western population. It is also under relentless pressure from the Oregon Department of Fish and Wildlife, which is currently hazing cormorants at six locations along the Oregon Coast including the Nehalem River, Nestucca River, Coquille River, Tillamook Bay, Alsea Bay and Astoria[3]. ODFW has also received permits to take up to 50 cormorants each for research purposes at Tillamook Bay and the mouths of the Umpqua and Rogue Rivers, and has applied for depredation permits kill cormorants at three coastal estuaries[3]. ODFW has even developed a partnership with Emory-Riddle Aeronautical University to develop a drone "capable of flying to cormorant colonies on offshore rocks to take photographs….but applications could be made such as hazing of foraging cormorants."[4]

S-18

- Other large colonies outside the "affected environment" analyzed in the DEIS are also experiencing significant cormorant declines, most notably at Mullet Island in the Salton Sea. We question the decision to restrict the affected environment to not include the entire western population of cormorants given data demonstrating that East Sand Island may be drawing emigrants from throughout the western populations.[5]A significant decline in cormorant populations triggered by the proposed actions at East Sand Island could have regulatory and economic implications across the entire Western United States, especially if cormorant populations require additional protections to recover populations.
- Adkins *et al* list a variety of existing threats to cormorant population in the Western United States including predation, human disturbance, environmental contaminants, oil pollution, development impacts, disease and decline of the bird's forage base. (Adkins and Roby at 31-32)

G-19

The DEIS fails to adequately address any of these threats in the Pacific Northwest. Given the magnitude of the proposed population reduction and the permanent habitat limitations that will be implemented at the only cormorant colony that is currently adding substantively to cormorant populations in the Western United States, all of these threats require careful consideration. To the degree that threats may pose a significant risk to cormorant populations

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[3] http://www.dfw.state.or.us/news/2014/march/032414.asp

[4] Testimony of Ron Anglin before the Oregon Legislature https://olis.leg.state.or.us/liz/2013R1/Downloads/CommitteeMeetingDocument/26137

[5] Adkins et al.

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across the Western United States, cormorants' precarious status across this area would favor a dispersal-based management strategy as described in Alternative B rather than a lethal control-based strategy as described in the preferred Alternative C. In particular we urge the Corps to focus extra attention on the following:

G-19

- Bald Eagle predation and harassment: Increases in coastal bald eagle populations are putting unprecedented pressure on a variety of colonial nesting birds along the coasts of Oregon and Washington, including at East Sand Island. This has implications for cormorant colonies along the entire coastline, but the Corps should focus on whether reducing the size of the East Sand Island population increases the vulnerability of the remaining population to predation by bald eagles and other species such as gulls and crows that may take advantage of flushing caused by bald eagles.

S-36

- Disease: Newcastle Disease may have played a significant role in the collapse of the large colony at Mullet Island in the Salton Sea and has now been identified within the population at East Sand Island. The Corps should assess the potential for significant disease outbreaks to drive cormorant population levels below targets identified in the DEIS.

FEIS Section 4.4.3

- Forage Fish Populations: How might changes in ocean conditions associated with climate change affect cormorant populations over the next several decades?

G-16, G-20

G-19

- Human Disturbance: The animosity directed at cormorants has reached a remarkably high pitch. The Corps has itself suggested at meetings with environmental stakeholders, including Audubon, that failure to act to curtail fish predation due to birds on East Sand Island could result in deliberate unauthorized efforts to release predatory species onto the island or other illegal activity intended to reduce bird populations. Roby et al. (2010) in the *Status Assessment 1999-2009* note several instances where cormorant colonies have been impacted by human disturbance and write, "with expanding human populations along the coast and the increasing perception that cormorants represent a threat to sport and commercial fisheries throughout the range of the Western Population, human disturbance could pose a significant threat to this population in the future, especially in the absence of new rules and restrictions. Nesting colonies on artificial habitats (e.g., bridges, dredge spoil islands, navigational markers, power towers) used by humans or accessed for maintenance may be particularly vulnerable." (Status Assessment at 28). The EIS should provide a clear assessment of the vulnerability to anthropogenic disturbance of significant cormorant colonies in the Pacific Northwest and the implication of the potential loss of these colonies for cormorant populations in the coming decades.

FEIS Section 4.4

- Hazing and Harassment: The DEIS fails to assess the implications of increased hazing and harassment of cormorant populations in the Western United States. Hazing and harassment of cormorants prior to the onset of nesting is legal and requires no permit from the U.S. Fish and Wildlife Service. It is possible that legal and undocumented harassment is already causing population reduction and abandonment at existing colonies. ODFW is partnering with and training non-profit organizations and sport fishing groups to harass cormorants in order to amplify the agency's existing ability to conduct harassment activities, and is exploring the potential to use drones to augment its harassment capabilities on more remote coastal islands.[6]

G-18

- There is significant potential that in order to achieve target cormorant populations on East Sand Island, the Corps will have to kill far more birds that the 16,000 specified in the DEIS. Emigration is identified as one of the causes of cormorant population increases on East Sand Island. It is possible, even likely, that as hazing and control activities increase elsewhere in the Pacific Northwest, cormorants will continue to immigrate to East Sand Island and thus continually replenish the population. It is also entirely possible that, as with Caspian Terns, cormorants will prove to be adaptable to more dense nesting concentrations than has been previously documented. The Corps could be faced with a situation in which cormorants continue to immigrate to East Sand Island from declining populations elsewhere, only to be subject to lethal control upon arrival. East Sand Island could therefore turn into the proverbial sinkhole for cormorant populations in the Western United States.

S-37, EPA (1) #4

2. The Corps and other partnering federal and state agencies have failed to set minimum population thresholds for Double-crested Cormorants or identify nesting sites in either Oregon or Washington where existing or new Double-Crested Cormorant nesting colonies would be welcome.

In their comments on prior cormorant EAs and the public scoping process for the current DEIS associated with East Sand Island, conservation groups, including Portland Audubon, have repeatedly urged the Corps and partnering state and federal agencies to develop a credible cormorant management plan that
a) identifies minimum population thresholds;
b) describes how those populations will be distributed; and c)establishes sites where cormorant colonies would be welcome and likely to persist over time. These steps are crucial, and would go a long way toward lending credibility to cormorant reduction efforts on East Sand Island, especially given that population increases on East Sand Island are at least partially the result of emigration of cormorants from colonies that have declined or disappeared elsewhere. The DEIS completely fails to address these concerns and instead relies on an unsupported assumption that cormorant populations outside of the Columbia Estuary will remain stable (see issue #1 above).

Map of DCCO Management Concern Areas (From the DCCO DEIS, Figure 3-14)

The degree to which cormorants have become unwelcome throughout the Pacific Northwest is exemplified by a map included in the DEIS (Figure 3-14) and displayed at an open house informational

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[6] https://olis.leg.state.or.us/liz/2013R1/Downloads/CommitteeMeetingDocument/26137

meeting on the DEIS hosted by the Corps in Portland on July 10, 2014. The map used data produced by ODFW and WDFW to identify areas of high, moderate, and low management concern regarding cormorant breeding colonies. The Map of Oregon depicts virtually the entire State of Oregon, including the entire coastline, as an area of high concern regarding cormorants. The remaining portion of the state is ranked as being of moderate concern. All but two of the colonies in the State of Oregon are located in areas of high concern. Washington fairs slightly better, but still with the entire coastline south of Aberdeen ranked as being of high management concern.

G-3, G-4, G-5, G-7, FEIS App. C

3. The science describing Double-crested Cormorant predation on listed salmonid species and the benefits that would be derived by implementing Double-crested Cormorant population control actions is weak and lacks peer review

The decision to kill 16,000 native birds and 25% of the western population of a species is an extraordinary decision, and the public should be able to have confidence that the science supporting such a decision is strong and was held the highest level of rigor. To the contrary, much of the science supporting this DEIS is remarkably weak and speculative and has not been scrutinized through the peer review process.

The proposal to reduce the East Side Island colony of cormorants to 5,600 pairs rests entirely on a National Marine Fisheries Service (NMFS) comparison of smolt survival and consumption by cormorants between arbitrarily defined base (1983-2002) and current (2003-2009) periods. This analysis resulted in a finding that survival of juvenile steelhead, the salmonid species most susceptible to cormorant predation, was 3.6 percent lower in the current versus base period. The proposal to reduce cormorants to 5,600 pairs on East Sand Island is aimed at erasing this "survival gap." We have the following concerns about this analysis, which is critical to the selection of appropriate and effective management strategies:

- The survival gap analysis performed by NMFS has not been externally peer reviewed,nor does it use the best available science.
- Only smolt estimates and numbers of cormorants nesting in the Columbia River estuary were allowed to vary. All other variables remain static. This is problematic as it ignores high inter-annual variability in cormorant predation rates on juvenile salmonids. Volume of freshwater discharge, other environmental factors, and biotic factors strongly influence predation rates (Lyons et al. 2014), yet these influences were not considered.
- The smolt estimates are derived from preseason forecasts that estimate survival upstream (from dams and other out-migration challenges prior to reaching the estuary). Although these estimates are allowed to vary in the model, the forecast estimates do not include an estimation of accuracy or precision nor are they confirmed with existing data from the estuary.
- Compensatory mortality was ignored in the analysis because it was assumed that compensatory mortality rates were stable during both the base period (1982-2001) and current period (2002-2009). It is surprising that this assumption was made given the dynamically changing Columbia Estuarine system and the fact that the dataset spans nearly a 30 year period. When a 50% compensatory mortality is assumed, the annual estimated avian take of salmonids is further reduced (1.6% loss of steelhead smolt, 0.6% loss of Chinook) (Lyons et al. 2014), further casting doubt on population level impacts to salmonids due to cormorant predation.

- Data from the arbitrarily assigned "base period" are lacking or absent. Cormorant diet and predation rates have only been assessed since 1999 and much of the data on cormorant numbers in the Columbia estuary during the base period are limited. Because of the paucity of empirical data from the base period it is difficult (nearly impossible), to have any confidence in the cormorant population or smolt predation rates used in the analysis.
- It is unclear why the salmonid smolt PIT tag data recovered on the East Sand Island cormorant colony was not used in the gap analysis. These data would have allowed a much more accurate stock-specific assessments of predation rates.

S-38

- The DEIS fails to provide meaningful analysis of what percentage of cormorant take is comprised of non-listed hatchery fish. This is important because studies have shown that hatchery fish are more vulnerable to predation.

S-39

- The DEIS fails to meaningfully address the fact that injured or otherwise unhealthy fish are more susceptible to predation (DEIS at 4-93). A significant percentage of the listed fish being consumed at East Sand Island may have been made vulnerable to predation by their passage through dam turbines and their loss attributable as much to dam operation as to bird predation.

S-10

- The Corps has refused public requests to release the raw data that went into the bioenergetics modeling. Without this data, it is impossible for reviewers assess the validity of the bioenergetics models.

G-2

- Finally it is important to note that overall populations of listed salmon have increased in the current period as compared to the base period despite the apparent increase in avian predation. This shows that avian predation is not an important source of overall salmon mortality. Rather, improvements in dam configuration and operation, together with efforts to restore salmon habitat, have allowed salmon to begin to recover despite any increases in the cormorant population. This suggests that the focus should remain on dam operations and habitat restoration as opposed to lethal control of native predators.

G-2, FEIS Section 4.2.5

The ultimate goal of the EIS and underlying NOAA BiOp is to protect listed salmonid runs from continued declines due to cormorant predation. Yet, the BiOp analysis in the EIS[7] does not substantiate that the estimated 3.6% annual loss of steelhead smolt and 1.1% annual loss of Chinook (attributed to cormorant predation) will have a significant impact on population growth trajectories.

The analysis presented in the DEIS and supporting documents is inadequate as a basis for a decision to reduce the East Sand Island cormorant colony by more than half and the western North American population by at least 25 percent. In fact, it is entirely possible that with a more scientifically sophisticated and reliable analytical approach, there may be no survival gap.

G-21, S-45

4. The DEIS fails to adequately address the issue of non-target take of protected species and individuals:

Above and beyond the massive scale of intended take under Alternative C, there is also significant potential for take of non-target species as well as non-target Double-crested Cormorants above the threshold set in the DEIS. We believe that the DEIS underestimates the threat to both Pelagic and

[7] Double-crested Cormorant Estuary Smolt Consumption BiOp Analysis / gap analysis – Appendix D in the EIS

Brandt's Cormorants, both of which are found in the vicinity of East Sand Island and are easy to mistake for Double-crested Cormorants. Given that many of these birds will be shot over water and difficult to retrieve, we question how the Corps and FWS will accurately account for the non-target take of these species.

G-17, G-21 FEIS 2.2.3, Chapter 5

We are also concerned that lethal take of nesting birds within the East Sand Island colony could result in far greater impacts on Double-crested Cormorants than is allowed under the terms of the DEIS. For all its length, the DEIS does a surprisingly poor job of describing and analyzing how take will occur within the colony. These details should be clearly described and circumscribed in the DEIS to allow for meaningful evaluation. We question whether it is truly feasible to kill birds on their active nests using rifles within a densely occupied colony without causing some level of flushing, abandonment, and opportunistic nest predation of non-target birds. We also question how the Corps and U.S. Fish and Wildlife Service would monitor and quantify these impacts, especially if this work is done at night. There is significant potential for non-target take of cormorants that will go undocumented.

G-21, 2014 USFWS SHLA Biological Opinion for Corps placement of dredged material

The Corps also fails to adequately assess the potential non-target impacts on Streaked Horned Larks (*Eremophila aipestris strigata*). Streaked Horned Larks were listed as threatened under the Endangered Species Act in 2013. Justification for not listing them as Endangered relied largely upon the current status of the remaining populations found in Oregon. Along the Columbia River, Streaked Horned Larks nest primarily on dredge spoil islands. Today fewer than 100 breeding adults are found in the Columbia River Estuary. Streaked Horned Larks have been observed on East Sand Island but no nesting has been documented. There has been documented nesting on Rice Island and Miller Sands Spit. (EIS at 3-33) At this point in time, no recovery plan has been produced for Streaked Horned Larks. In addition, neither the U.S. Fish and Wildlife Service, nor the Corps can point to any substantive document describing how the Corps will manage dredge spoil islands to protect and enhance Streaked Horned Lark populations.

G-21 G-22, FEIS Section 2.2, 4.2.4

The Corps' treatment of Streaked Horned Larks in the EIS is cursory at best. Unfortunately, this is consistent with past EAs associated with East Sand Island written by the Corps. [8] The Corps writes "Potential (under alternative B) for cormorant dispersal to and the need for cormorant hazing at islands designated as an important streaked horned lark nesting area would be high. For example, Rice Island is and important streaked horned lark nesting area and former cormorant nesting colony in the Columbia River Estuary." (EIS at 4-29). The Corps notes that under phase 2 of Alternative C, dispersal to and hazing on these important Streaked Horned Lark breeding islands could also occur, but the Corps makes the assumption that because cormorant numbers would be lower, hazing activities would also be lower on

[8] Audubon comments on a 2013 EA to conduct lethal control of Glaucus Winged/Western Gulls on East Sand Island and a 2012 EA to restrict Caspian Tern nesting habitat on East Sand Island both highlighted the Corps failure to address potential impacts of associated hazing activity on Rice Island, Miller Sand Spit, and other island in the Columbia River Estuary. The 2012 EA was withdrawn and the 2013 EA resulted in the adoption of the No Action Alternative.

these islands. There is no logical basis for this assumption. The incremental increase in hazing will be dictated by a variety of factors, including the locations where the cormorants attempt to nest and the timing and persistence in their nesting attempts as well as the number of birds involved. The Corps provides no explanation as to why the hazing activities associate with removing 100 cormorants from a Streaked Horned Lark nesting island would cause any less disturbance than the hazing activities associated with removing 500 or 1000 cormorants. The preferred hazing strategies including use of dogs and ATVs could cause nest failure or abandonment for Streaked Horn Larks regardless of the number of cormorants involved. The Corps seems to justify Alternative C on the basis that it may not be as bad for Streaked Horned Larks as Alternative B, but there is no evidence that in fact it would be any less adverse and moreover the basis for evaluation should not be a comparison with some other hypothetical approach, but rather a modeling of its likely actual impacts.

G-21, FEIS Section 4.2.4

FEIS 4.7

Until the Corps and USFWS conduct a section 7 consultation and devise a science-based and legally binding management plan for Streaked Horned Lark on Columbia Estuary dredge spoil islands, the Endangered Species Act protections afforded to Streaked Horned Larks could preclude implementation of all of the action alternatives described in the DEIS and this issue is going to remain a major obstacle of piscivorous bird management in the estuary. Current Corps hazing activities on important Streaked Horned Lark nesting islands and in designated critical habitat appear to be done with little consideration or understanding on the impacts on Streaked Horned Larks -- yet the Corps returns year in and year out with new proposals that would potentially expand these hazing activities. There is little reason to have confidence in USFWS' ability to protect and recover this species if, in addition to a very permissive 4(d) rule, it continues to approve activities that adversely affect the species throughout its remaining range.

G-22, G-23 2014 USFWS issued Biological Opinion FEIS-4.2.4

We recommend the following with regards to Streaked Horned Lark:

a) USFWS and the Corps need to conduct systematic surveys of Streaked Horned Larks to identify all nesting locations on Columbia River dredge spoil islands managed by the Corps, including East Sand Island.
b) USFWS and the Corps need to develop a science based, legally binding management plan for Streaked Horned Larks on Columbia River dredge spoil islands managed by the Corps that includes specific protected areas (potentially on a rotational basis) and local population targets.

5. The Corp fails to adequately explore non-lethal strategies to reduce salmonid predation in the Columbia River Estuary and inaccurately asserts that it has determined that non-lethal strategies would not be effective at reducing fish predation in the Columbia River Estuary:

The Corps has suggested that the decision to kill 16,000 cormorants on East Sand Island is a direct result of the National Marine Fisheries Service 2014 Supplement for the 2008 Federal Columbia River Power System Biological Opinion (BiOp). However, the 2014 supplement in no way requires that the action taken involve lethal control. The BiOp requires the Corps to "…develop a cormorant management plan (including necessary monitoring and research) and implemented warranted actions to reduce cormorant

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predation in the estuary to Base Period levels (no more than 5,380 to 5,939 nesting pairs on East Sand Island."(DEIS at Executive Summary-3)

It is the Corps itself that asserts that non-lethal options such as restricting habitat on East Sand Island and dispersing cormorants to other locations (Alternative B) will not be effective because the birds are likely to simply move to other nearby islands within the estuary which could result in even higher levels of predation than occur on East Sand Island. However, this assertion is based on conjecture and there is evidence in the scientific literature to suggest that in fact cormorants may relocate outside the estuary.

G-8 →

- Satellite tracking data of cormorants from East Sand Island demonstrated the following: *"(There is a) direct connectivity between the double-crested cormorant colony at East Sand Island...and colonies to the north (e.g., outer-coastal Washington and Puget Sound, WA colonies) and to the south (e.g., San Francisco Bay, CA and Mullet Island, Salton Sea, CA colonies) that have experienced declines over the same time period. Based on the observed dispersal of satellite-tagged individuals following the 2008 and 2009 breeding seasons, cormorants from East Sand Island have the greatest connectivity with active and historical colony sites to the north in the Salish Sea region, followed by colonies to the south in northern California*." (Courtot et al. 2012, Adkins and Roby 2010 at 29).

G-9, G-10 FEIS Section 2.3, App. G →

- Contrary to assertions in the DEIS, the Corps has never attempted to manage the cormorant colony on East Sand Island using non-lethal dissuasion techniques. The Corps conducted a series of studies to determine whether dissuasion techniques such as privacy fencing and human hazing would be effective in preventing cormorants from nesting in certain areas within the East Sand Island nesting colony (Roby, Collis et al. 2014). In all years however, the overall size of the colony was not restricted to the point cormorants were unable to return and find suitable space to resume nesting. In fact, by design, enough space was left within the colony that cormorants could quickly relocate to areas of the colony where no dissuasion activity was occurring. The 2012 Draft Environmental Assessment, *Double-crested Cormorant Dissuasion Research on East Sand Island in the Columbia River Estuary, Clatsop County, Oregon,* states, *"*Nesting habitat on East Sand Island is not limiting, thus most hazed birds will likely attempt to nest elsewhere on the island."(EA at 26) and "It is expected that many DCCO would remain on ESI but would relocate to the area west of the dissuasion fence where no hazing is planned. (EA at 23-24). The research did in fact determine that dissuasion techniques were effective at causing cormorants to leave historic nesting locations concluding, "The results of the 2011 dissuasion research provided valuable insight and credence to using human presence as means to dissuade DCOO from a portion of their habitat." (EA at 16).

FEIS Section 2.5, EPA(1) →

- The Pacific Flyway Council strongly recommended in its *Framework for the Management of Double-crested Cormorant Depredation of Fish Resources in the Pacific Flyway* that non-lethal strategies to reduce depredation of listed salmonids be attempted prior to moving to lethal control strategies. The Framework states, "Non-lethal measures should be implemented first and the effects of these actions assessed." (Framework at 25).

G-9, G-10 FEIS Section 2.3, App. G →

No credible case can be made that the Corps has even attempted to study the potential for utilizing non-lethal dissuasion techniques to relocate cormorants outside the boundaries of the Columbia River Estuary, let alone that it has attempted to implement a non-lethal management strategy. The Corps has merely studied the effectiveness of dissuasion techniques to cause cormorants to abandon specific areas within the nesting colony, and those techniques have proven effective.

G-2 We note that the survival gap, to the degree that it actually exists, could be addressed entirely without manipulating cormorants on East Sand Island. Increasing the amount of habitat restoration or further modifying dam operations could remedy the alleged survival gap. It is particularly worth noting that federal agencies have been tied-up in litigation in federal court for nearly two decades due to their repeated failure to develop a BiOp that adequately addresses salmon mortality in the FCRPS. Four times since the 1990's federal courts have rejected Biological Opinions pertaining to management of the hydropower system as inadequate. In a 2011 opinion, Judge Redden chastised NOAA Fisheries for "abruptly changing course, abandoning previous [plans for protecting salmon], and failing to follow through with their commitments to hydropower modifications proven to increase survival." The 2014 supplement to the 2008 BiOp is currently being challenged in court. When it comes to making necessary modification to the operations of their dams, the Corps has stalled and obfuscated for nearly two decades, but when it comes to killing native birds persisting as they have done for thousands of years, the Corps is willing to move forward with the most extreme solution based on a remarkably weak scientific analysis.

6. Issuing Permits to conduct lethal control of Double-Crested Cormorants as proposed under Alternative C potentially violates provisions of the Migratory Bird Treaty Act (MBTA)

Double-crested Cormorants were protected under the Migratory Bird Treaty Act in 1972. A permit is required from the U.S. Fish and Wildlife Service for any management action that involves take as defined by 50 CFR 10.12. §704 of the MBTA allows the Secretary of the Interior to issue permits to "take" protected bird species based on the Secretary's determination that take is compatible with the Treaties' objectives. Additionally, FWS regulations lay out general permitting requirements for taking of all wildlife. 50 C.F.R. Part 13. These regulations establish that the FWS Director cannot issue a permit if "the authorization requested potentially threatens a wildlife or plant population." 50 C.F.R. § 13.21(b)(4) Based on the issues already raised in this letter, we believe that issuing a permit that would allow for the killing of 25% of the western population of cormorants would violate the prohibition against issuing a permit that potentially threatens a wildlife population contained in 50 C.F.R. §13.21(b)(4). Specifically we would point to the following: G-25

- Cormorant populations remain an order of magnitude smaller than historic levels;
- Cormorant populations are declining throughout much of their western range and East Sand Island represents the only location that is demonstrating significant population growth in the Western United States;
- The Corps has done an entirely inadequate job of assessing other threats to cormorant populations in the Western United States;
- Neither the Corps, nor the U.S. Fish and Wildlife Service have done an adequate job of identifying locations where cormorant populations will be allowed to persist, let alone increase over time;
- The scientific basis justifying the depredation permits is weak and much of it has not been peer reviewed;

- The salmon survival benefits associated with killing DC cormorants are in the Columbia Estuary are speculative and uncertain at best;
- The Corps has done an inadequate job of exploring non-lethal strategies to address cormorant depredation issues prior to moving to lethal strategies.[9]

G-2, G-27

7. The DEIS fails to consider an adequate range of alternatives to improve survival of juvenile salmonids listed under the ESA.

In our view, the DEIS mischaracterizes the purpose and need for the management action evaluated by the Corps. The Corps emphasizes that the agency's ultimate goal is to achieve recovery of threatened and endangered salmon and steelhead populations in the Columbia River Basin, an objective we enthusiastically support. However, it is far from clear that killing DC cormorants is necessary to achieve this aim.

The DEIS section entitled "The Need for a Management Plan" specifies that the Corps seeks to "reduce predation-related losses of juvenile salmon…and steelhead…from double-crested cormorants…nesting on East Sand Island in the Columbia River Estuary." (DEIS at Exec. Summary p. 1.) The Corps notes that it is exploring such action in response to a provision in the Reasonable and Prudent Alternative (RPA) in NMFS' 2014 biological opinion on FCRPS operations. This RPA element demands that the Corps reduce the cormorant population in the Columbia River estuary to approximately 1990 levels. NMFS based this provision of the RPA on an analysis by the agency that estimated the rate of cormorant predation on juvenile steelhead and yearling chinook salmon. NMFS determined that cormorants have caused increased mortality of juvenile salmonids at present compared to a "base period" of 1981-2000, creating what NMFS termed a survival "gap." NMFS then concluded that "[w]hile this shortfall (or gap) can be addressed with any actions that improve [salmon and steelhead] productivity, it is logical that cormorant management objectives assist in this goal." Double-crested Cormorant Estuary Smolt Consumption BiOp Analysis, Appendix E to the 2014 FCRPS BiOp at 3.

Assuming for the sake of argument that cormorant predation has increased at the rate determined by NMFS (*see* discussion of our concerns about the scientific basis of agency findings, *infra*), we strongly disagree that it is necessarily "logical" to reverse the population increase of cormorants in the Columbia River estuary as part of efforts to recover salmon and steelhead ESUs in the Columbia Basin. These native birds have lived in the Columbia estuary in much greater numbers than at present for thousands of years, and for all but a tiny fraction of that time period about 16 million wild salmon and steelhead spawned in the Basin. Environmental impacts and ecological changes caused by humans are responsible for the imperiled status of anadromous fish in the Columbia Basin, so it seems far more logical to address these human-caused changes in order to recover salmon and steelhead rather than to manage populations of predators that have co-existed with abundant fish runs for millennia. NMFS itself acknowledges this fact by noting that any actions

[9] The Fish and Wildlife Service specifies that "Capture or killing of birds cannot be the primary methods used to address depredation and will ONLY be authorized in conjunction with ongoing nonlethal measures." http://www.fws.gov/forms/3-200-13.pdf

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that improve salmon and steelhead production can compensate for current predation by a larger number of cormorants than existed in the Columbia estuary during the "base" period.

G-2, G-27

We therefore request that the Corps modify the purpose and need of its draft EIS to provide that the agency's goal is to carry out affirmative management actions to increase survival of juvenile salmon and steelhead. Alternatives that meet this purpose and need include various options for managing DC cormorant populations. In addition, however, the Corps should identify and evaluate in the final EIS additional alternatives that increase survival of juvenile or adult salmon and steelhead – beyond those presently set forth in the 2014 FCRPS BiOp RPA – to a level sufficient to result in the recovery of ESUs listed as threatened and endangered.

While the Corps should of course carefully consider the RPA actions set forth in NMFS' 2014 FCRPS BiOp, it is nonetheless not necessarily bound by the BiOp's RPA in identifying a reasonable range of alternatives for the EIS now being prepared by the agency. Most importantly, the current BiOp – like most of its predecessors – is most likely insufficient to comply with NMFS' and the Corps' duties under the ESA; a federal court is once again in the process of evaluating the BiOp. Moreover, a biological opinion is simply advice from NMFS as to whether the Corps is complying with its obligations under section 7(a)(2) of the ESA; Corps actions that do not involve managing DC cormorants but that still increase salmon and steelhead survival to levels consistent with the survival and recovery of listed ESUs would still comply with the Corps' responsibilities under section 7 of the ESA. Moreover, in our view the Corps *must* consider such alternatives to comply with its obligation under NEPA to evaluate a reasonable range of alternatives in its EIS.

8. It is time for a full review of the Corps management of piscivorous birds along the Columbia River:

comments noted

We urge the Corps to conduct a full review of its management strategies for piscivorous birds and other wildlife on the Columbia River. The Corps compares the impacts of cormorants to the impacts of dam (DEIS at 4). However, natural predation is fundamentally different from the hazards presented by fish-killing dam turbines. In most cases, predation should be considered a natural baseline condition that needs to be accounted for in assessing modifications to human-caused salmon mortalities rather than a threat to salmonids that needs to be controlled.

We are concerned about the growing trend towards investing huge sums of taxpayer dollars to control and manipulate native birds and other wildlife to benefit salmonid species that have become imperiled, not because of natural predation, but rather from human-caused mortality factors and habitat loss. While there are extreme circumstances where lethal control of one species to benefit another species may make sense on a limited basis, we question the sustainability, cost effectiveness and ecological integrity of applying this type of approach at larger and larger geographic scales, to a growing list of species, over increasingly long time frames such as is now occurring in the Columbia River Estuary.

It is important to note that cormorants are just one of several native species that are currently ensnared in the Corps ever-expanding net: The Corps has also spent millions of dollars relocating Caspian Terns from East Sand Island with limited success, put forward a proposal to lethally control Glaucus winged/Western Gulls on East Sand Island, and is already killing sea lions at the Bonneville Dam and displacing Caspian Tern Colonies at Goose and Crescent Islands further up the Columbia River.

G-2 → Conservation efforts should primarily target the human activities that are the key causes of species decline. In the case of Columbia Basin salmonids, the Corps should focus its efforts on improving the operation and configuration of the dams that account for the overwhelming percentage of juvenile salmonid mortality, protecting and restoring salmonid habitat, and improving hatchery management.

Conclusion:
Audubon strongly urges the Corps to adopt the No Action Alternative (Alternative A). The science simply is not there at this time to justify significant manipulation of the world's largest cormorant colony, let alone the slaughter of 16,000 birds representing 25% of the population west of the Rocky Mountains. Past manipulations of piscivorous birds in the Columbia River Estuary have cost the taxpayers millions of dollars and resulted at best in marginal benefits to salmon and too often in unintended consequences that actually exacerbated the problems that the actions were intended to resolve. Alternative C provides little confidence that the projected benefits to listed salmonid species would be realized, but raises serious concerns that the survival of the populations of cormorantswest of the Rocky Mountains could be placed in jeopardy.

The Corps should delay action until it can provide credible, peer-reviewed information that includes the following:

- Research and modelling that credibly depicts the impacts of cormorants on listed salmonid species in the Columbia River Estuary;
- Realistic and credible modeling of the benefits that are expected to accrue to listed salmonid species in the Columbia River Estuary;
- A plan that prioritizes non-lethal strategies for addressing management of avian predators;
- A management plan for cormorants in the Pacific Northwest that describes minimum viable populations levels, including a description of how those populations will be distributed on the landscape and specific sites where colonies will be encourages and allowed to persist;
- A management plan for Streaked Horned Larks on dredge spoil islands to ensure that actions associated with piscivorous bird management do not place this federally listed species in jeopardy.

The current DEIS fails on all five of these points. We urge you to select Alternative A, the No Action Alternative.

Thank you for your consideration of our comments.

Respectfully

Bob Sallinger, Conservation Director, Audubon Society of Portland

Joe Liebezeit, Avian Programs Director, Audubon Society of Portland

Dave Mellinger, President, Audubon Society of Corvallis

Jack Doyle, President, Audubon Society of Lincoln City

Ken Hashagen, President, East Cascades Audubon Society

Ann Vileisis, President, Kalmiopsis Audubon Society

Maeve Sowles, President, Lane County Audubon Society

Michael Babbitt, President, Salem Audubon Society

Diana Wales, President, Umpqua Valley Audubon Society

Linda Kreisman, President, Rogue Valley Audubon Society

Literature Cited

Adkins, J. Y. and D. D. Roby. 2010. A status assessment of the double-crested cormorants (*Phalacrocorax auritus*) in western North America: 1998-2009. Final Report to the U.S. Army Corps of Engineers. Available on-line at www.birdresearchnw.org.

Courtot, K.N., D.D. Roby, J.Y. Adkins, D.E. Lyons, D.T. King, and R.S. Larsen. 2012. Colony connectivity of Pacific Coast double-crested cormorants based on post-breeding dispersal from the region's largest colony. Journal of Wildlife Management 76:1462–1471.

Pacific Flyway Council. 2012. Pacific Flyway Plan: A Framework for the Management of Double Crested Cormorant Depredation on Fish Resources in the Pacific Flyway. Pacific Flyway Council, U.S. Fish and Wildlife Service, Portland, Oregon. 55 pg.

Roby, D.D., K. Collis, et al. 2014. Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River. Draft Annual Report to Bonneville Power Administration, U.S. Army Corps of Engineers, and Grant County Public Utility District. Accessed online at www.birdresearchnw.org

Lyons, D. E., D. D. Roby, A. F. Evans, N. J. Hostetter, and K. Collis. 2014. Benefits to Columbia River anadromous salmonids from potential reductions in predation by double-crested cormorants nesting at the East Sand Island colony: A report to the U.S. Army Corps of Engineers Portland District. Bird Research Northwest. Available on-line at www.birdresearchnw.org.

U.S. Army Corps of Engineers. 2014. Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. Draft Environmental Impact Statement CENWP-PM-E-14-08, U.S. Army Corps of Engineers, Portland District, 422 pg.

Wires, L.R., and F.J. Cuthbert. 2006. Historic populations of the Double-crested Cormorant (*Phalacrocorax auritus*): Implications for conservation and management in the 21st century. Waterbirds 29:9-37.

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November 24, 2014

Ms. Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946f

Dear Ms. Ruckwardt:

This letter is in response to the draft environmental impact statement ("DEIS") from the Army Corps of Engineers ("Corps") on the *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary*. The purpose of this letter is to supplement our comments dated August 19, 2014.

Audubon urges the Corps to consider the *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* ("*Estuary Module*") before issuing the final environmental impact statement on the proposed management plan. The *Estuary Module* is included as Appendix D in the *Recovery Plan for Lower Columbia River Salmon and Steelhead*, which was briefly discussed in the DEIS. DEIS at 2-42–43. The DEIS provides the link to all the recovery plans and the attached appendices, including the *Estuary Module*. DEIS at 2-43.

S-46

The *Estuary Module* provides further support for Audubon's argument that the DEIS fails to consider an adequate range of alternatives to improve survival of juvenile salmonids listed under the Endangered Species Act. The Corps must consider flow-related alternatives, including enhancing spring and summer flows in the lower Columbia River, because such operations will further the Corps' goal of recovering salmon and steelhead listed as threatened or endangered in the Columbia River Basin. In discussing salmon and steelhead recovery plans, the DEIS asserts that "[a]vian predation is generally acknowledged as a factor affecting certain listed [evolutionary significant units/distinct population segments], though not necessarily a factor contributing to their decline or limiting their recovery." DEIS at 2-42. It goes on to explain "[d]irect mortality from avian predation ([Double-Crested Cormorant] and Caspian terns) is identified as one of the secondary factors limiting viability for all Lower Columbia River coho and late fall and spring Chinook salmon and steelhead populations . . . ." DEIS at 2-42. These conclusions beg the question: Why is the Corps' EIS focusing exclusively on reducing Double-Crested Cormorant ("cormorant") predation to recover salmonid populations when cormorant predation is "not necessarily a factor contributing to the decline or limiting [salmon] recovery"?

In fact, the *Estuary Module* concludes that for salmon to recover, agencies "need to implement additional management actions in the estuary not directly related to predation." *Estuary Module* at ES-11. Specifically, it explains that while "tempting to pick and choose among the management actions, looking for the path of least resistance to achieve the desired survival improvements . . . , addressing [threats associated with predators] would improve survival primarily for the dominant life-history strategy displayed by stream-type salmonids; in terms of recovery of [evolutionary significant units], less dominant stream-type life history strategies also must be addressed." *Estuary Module* at ES-10–11. Thus, agencies must address a wide variety of management plans, including those not related to predation to work toward salmonid recovery.

The *Estuary Module* goes on to explain that managing for healthy ecosystems on which salmonids rely is likely the most important and most effective management strategy. The *Estuary Module* states that "the most important take-home message of the estuary plan module is that recovery of listed [evolutionary significant units] in the Columbia River may not be possible without properly functioning estuary and plume ecosystems" implying that without properly functioning ecosystems, other management actions, including reducing avian predation, are unlikely to result in salmonid recovery. *Estuary Module* at ES-11.

The Corps must consider alternatives that address flow- and dam-related limiting factors. Limiting factors are defined as "[p]hysical, chemical, or biological features that impede species and their independent populations from reaching viability status" with the top priority limiting factors "hav[ing] the greatest impact on both ocean- and stream-type" evolutionary significant units. *Estuary Module* 3-23. In prioritizing limiting factors, the *Estuary Module* concluded that the top priority limiting factors are primarily flow- and dam-related. They include (1) "Flow-related estuary habitat changes;" (2) "Flow-related changes in access to off-channel habitat;" (3) "Flow-related plume changes;" (4) "Water temperature;" and (5) "Reduced macrodetrital inputs." *Estuary Module* at Table 3-2. In contrast, "Native birds," including both Caspian Tern and cormorant predation, is categorized as a lower priority—high priority. *Estuary Module* at Table 3-2. Logically, because the limiting factor "native birds" includes predation by both Caspian Terns and cormorants among other bird species, the limiting factor for cormorants alone is likely to be lower than high priority. This step in logic is supported by the fact that "[s]tudies indicate that double-crested cormorants prey on salmonid juveniles in the estuary at a rate equal to or greater than the rate by Caspian terns." *Estuary Module* at 5-24. So, because cormorants are thought to contribute to only about half the avian predation affecting juvenile salmonids, cormorant predation is a lesser limiting factor than avian predation as a whole. Thus, flow-related limitations are top priority while cormorant limitations are most likely lower than high priority. Therefore the Corps must consider alternatives that address flow- and dam-related limitations.

Moreover, the top threats to salmonids relate to flow and filling activities. The *Estuary Module* prioritizes "flow regulation" and "dike and filling" as top threats to salmonid recovery (each with a threat index of 15 out of 15) while "altered predatory relationships" are considered lesser threats (with a threat index of 12 out of 15). *Estuary Module* at Table 4-2. Again, the threat of "altered predatory relationships" includes predation by Caspian terns, cormorants, and pisciverous fish including pikeminnow and shad. So, cormorant predation alone is likely a smaller threat—meaning that the threat index for cormorant predation alone is likely much smaller than 12 out of 15—than predation by all species that predate on salmonids. Given that flow regulation and dike and filling practices are the top threats while aggregate altered predatory relationships are a lesser threat, the Corps must consider alternatives that address these top threats rather than focusing solely on smaller threats.

Accordingly, addressing flow-related activities including flow regulation and dike and filling practices will further the Corps' goal of recovering salmonids in the Columbia River Basin. Under the National Environmental Policy Act, the Corps must consider all reasonable alternatives likely to further its purpose. 40 C.F.R. § 1502.14(a). Thus, the Corps must consider flow-related activities as alternatives to killing cormorants to further the goal of recovering salmonids. Failure to analyze all reasonable alternatives would result an in a decision that is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706.

Finally, to adequately assess the likely effects of each alternative, the Corps must consider studies that evaluate the impacts of cormorant predation on stocks of salmonid and steelhead species in the Columbia River Basin, including available salmonid smolt-to-adult return ("SAR") and smolt-to-adult survival rate ("SAS") studies that differentiate between listed and unlisted salmonid and steelhead species. If the SAR and SAS studies show that the preferred alternative will likely have a small or negligible impact on recovery of salmon and steelhead listed as threatened or endangered because cormorants generally target non-listed stocks when feeding, the selection of that alternative would be arbitrary and capricious under 5 U.S.C. § 706.

The current DEIS fails on both points.

Thank you for your consideration of our comments.

Respectfully,

Bob Sallinger
Conservation Director
Audubon Society of Portland

From: [redacted]
To: Cormorant EIS
Subject: [EXTERNAL] No to Cormorant Kill Plan on Columbia River Estuary
Date: Sunday, July 13, 2014 6:03:28 PM

Please accept these comments on the Army Corp of Engineer's plan to shoot 16 thousand cormorants on East Sand Island in the Columbia River Estuary.

G-2

Predator Defense goes on record firmly opposing the ill-advised plan to slaughter 16 thousand birds for eating their natural prey. Removing natural predator species in order to preserve more prey for human sport fishers is a poor reason to slaughter wildlife and fails to address the significant causes of salmon decline such as dams, pollution, habitat destruction, commercial and sport overfishing. If the root causes of decline were addressed, the salmon and the riparian ecosystem the birds and other aquatic species rely upon would flourish and prosper. At best cormorants may take 3 - 4% of the steel head population, while fisheries kill 12%. Squandering $6 million tax dollars to hiring federal trappers equipped with silencers to kill 4 thousand birds in the dead of the night every year for 4 years sounds like, and is, a bizarre, cruel and sick joke. We wish it were only that, a joke.

Spend that $6 million to clean up the Columbia River and restore it to health for the salmon, the cormorants and all the wildlife and people to enjoy. If you cut back on the fisheries take by a quarter, it would more than accomplish the same goal you aspire to by cruelly killing the birds and it would cost a fraction of the $6 million tax dollars. Your plan makes no sense, is cruel, ineffective, and a huge waste of tax dollars and lives. Do not implement the cormorant killing plan.

Sally Mackler
Oregon Carnivore Representative
Predator Defense

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August 12, 2014

U.S. Army Corps of Engineers, Portland District
ATTN: CENWP-PM-E/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, OR 97208-2946

Re: Public Power Council Comments on Draft EIS: Double-crested Cormorant Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary

Dear Project Manager:

comments noted

Thank you for the opportunity to comment on the Draft EIS Double-crested Cormorant Plan. The Public Power Council (PPC) represents over 100 consumer-owned utility customers of the Bonneville Power Administration. As the primary customers of BPA, PPC members fund regional fish and wildlife mitigation efforts totaling approximately $700 million annually and have a vested interest in ensuring these efforts are not inadvertently unwound by inaction or by a lack of addressing salmon mitigation comprehensively.

PPC appreciates the tremendous effort undertaken by the U.S. Army Corps of Engineers (Corps) to control animal populations that prey on juvenile salmonids in the Columbia River Basin, and we see that the regional investment for salmon and steelhead is working in many respects. While we are largely supportive of the Preferred Alternative (Alternative C) in the draft EIS, we believe the Corps should take a more expeditious and aggressive line on avian predation.

The development of this plan is a requirement of Reasonable and Prudent Alternative Actions 46 and 67 of the NOAA-Fisheries 2008 Biological Opinion (BiOp) for the Federal Columbia River Power System (FCRPS), as updated in 2010 and 2014. But, for six years since the 2008 BiOp release, predation by piscivorous birds in the Columbia River Basin has annually increased to a point where they are now consuming almost 25 million juvenile salmonids each year. A majority of these fish are from ESA-listed populations and a majority of these losses are a result of cormorant predation. This is alarming in light of the massive effort underway in all areas of the system to protect these fish.

With the region's salmon and steelhead mitigation costs amounting to nearly $700 million annually, it is disappointing to see minimal management of avian predation in the suite of mitigation actions. We are appreciative of the Corps' recent efforts, however, in addressing this important issue both in the estuary and on the Upper Columbia. Losing millions more salmon and steelhead to avian predation simply cannot continue.

PPC believes that the Corps is correct in attempting to control the exploding cormorant population and return balance to the mouth of the Columbia River. Prior to the Corps' own dredging effort that built East Sand Island, the island was no more than a sandbar, insufficient for nesting birds. Though we are supportive of healthy populations of all fish and wildlife, East Sand Island is an unnaturally created place where the overabundance of double-crested cormorants is dramatically detrimental to ESA-listed salmon and steelhead.

The Corps' Preferred Alternative C is certainly a step in the right direction in managing this population and bringing it back into balance in the region. PPC generally supports this Preferred Alternative but believes the Corps should go further and adopt Alternative D. Alternative D employs most of the same management, but excludes future nesting by cormorants on East Sand Island. This option appears to be the one most inclined to remedy the issue being addressed. If the Corps allows the cormorant population to continue to nest on the island, it seems that
G-18 continued culling would need to take place in order to maintain the target number of breeding pairs.

PPC implores the Corps to expedite these already long delayed management actions. As noted above, the requirement to manage fish losses due to piscivorous birds was included in the 2008 FCRPS BiOp. Yet, it is only now in 2014 that a draft management plan has been released. Further delay would potentially result in the loss of millions more juvenile salmon and steelhead.

As evidenced by the latest adult salmon and steelhead returns, we have seen that regional efforts of the past two decades are generally working well. Avian predation, however, continues to jeopardize these gains. While the Corps' Preferred Alternative is a great improvement over current management, we most support the expeditious implementation of Alternative D.

Thank you for the opportunity to comment.

Sincerely,

Bo Downen

Kevin Lanier

410 S. Hoquiam St. – Westport, Wa 98595 – 360-268-7477
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July 31, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
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G-6

The Puget Sound Anglers is the largest fishing club in the state of Washington. With over 9000 members that fish throughout the state, along the coast, and on the Columbia River we want to write and let our feelings be known. We very much support Alt. C! Even though it doesn't go nearly far enough to control the millions of Salmon that are eaten each year it's a start. Columbia River salmon supports commercial, sport, and Tribal fishers from California to Alaska and all the coastal communities in between. We have spent billions of dollars in salmon recovery only to watch ESA listed salmon get eaten from a man - made island 2 miles away from the ocean. These salmon are the strongest of the strongest and these salmon have made it through all the dams and traveled hundreds of miles just to be picked off 2 miles away from getting to the ocean.

noted

The Army Corps has allowed groups to make this island an oasis for these salmon eating birds by having study groups building artificial structures and killing up to 200 seagulls each year that prey on the nesting birds and also killing raccoons, coyotes and other prey animals that make the swim over to the island. The Corps has to take some responsibility for getting things back in balance. By controlling the population of the cormorants it will be one of the fastest things we can do to recover salmon. For example between the cormorants and terns these birds eat up to 25 million smolt each year, that is almost 200,000 returning adult salmon that come back to the Columbia River that are being Killed! There is nothing we could do that would recover salmon faster than start controlling avian predators. We think it is very unfair to the people of the Northwest that have spent billions of dollars in salmon recovery and Coastal Communities that have lost millions of dollars in fishing times for the sake of the salmon to let this travesty go on any longer!! So please pick, Alt C and lets really get serious about saving salmon.

Sincerely,

Kevin C. Lanier

Coastal Vice President Puget Sound Anglers

RICHLAND ROD & GUN CLUB
(INCORPORATED)
P. O. BOX 337
RICHLAND, WASHINGTON
99352

July 16, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E / Double-crested cormorant draft EIS
P.O. Box 2946
Portland, OR 97208-2946

Re: Draft EIS – Double-crested Cormorant Management Plan

Ms. Ruckwardt:

comments noted

Members of the Board of Directors of the Richland Rod and Gun Club (RRGC) have reviewed the Draft Environmental Impact Statement (Draft EIS) for the Double-Crested Cormorant Management Plan to reduce predation of juvenile salmonids in the Columbia River estuary. We appreciate the extensive effort required to prepare the draft document and the manner in which it is presented.

Our organization has long been concerned about the impacts of avian predation on juvenile salmonids in the Columbia River system, at the estuary and upstream throughout the Columbia River basin. We are familiar with some of the studies done by USACE and other parties over the past decade to evaluate the impacts of piscivorous birds on salmonids near islands and downstream of dams along the river. Our members have met with USACE, USFWS, WDFW, and tribal representatives on several occasions, back to at least 2004, to discuss potential solutions to heavy predation of salmonids by increasing populations of cormorants, terns, gulls, and pelicans. We have observed hazing activities currently being conducted by USDA Wildlife Services staff and talked to the involved employees. We believe that hazing efforts are very costly and largely ineffective. Populations of some avian predators have grown so dramatically along the Columbia River over the past few decades that action to limit (reduce) their numbers is long overdue.

The RRGC Board of Directors supports Alternative C of the Draft EIS as the preferred alternative to begin to control the excessive predation of juvenile salmonids near the Columbia River estuary. We believe that this culling effort is a necessary next step but that additional actions will be required at other locations along the Columbia River and for other avian species to reverse the imbalance created by population increases that have occurred due to excessive federal and state protection of some species of migratory birds.

Sincerely,

Kirby Hammond

RRGC President

cc: Mike Livingston, WDFW Region 3

Sandra Jonker, WDFW Region 5

Matt Monda, WDFW Region 2

CENWP-PM-E-14-08
To Sondra Ruckwardt, Project Manager
ATTN: Cormorants EIS
U.S. Army Corp of Engineers, Portland Oregon
P.O. Box 2946, Portland, Oregon 97208

I am writing in opposition to Alternative C, which would result in the killing of 16,000 Double-crested Cormorants at East Sand Island. I favor Alternative A, no action, until such time as the Corps has reviewed and rebuilt its entire approach to avian predation by cormorants and other species at a regional scale, including the Columbia River basin and beyond.

G-2

To propose killing 16,000 cormorants is an extreme measure, especially since the Army Corps of Engineers and its agency partners have not fully explored and evaluated non-lethal means of reducing predation on fish. Salmon in the Columbia River basin are not in trouble because of predation by birds, and the Corps and its agency partners have a responsibility to look more broadly at what can be done to address root causes of low salmon populations.

G-20

Killing more than 25% of the western North American population of Double-crested Cormorants is an unacceptable approach, especially when this population is far below historical levels and has been declining away from East Sand Island. Again, I favor Alternative A, no action, and ask the Corps to evaluate a more balanced approach.

G-2

The Army Corps must consider non-lethal measures such as taking down four dams on the Lower Snake River or increasing so-called spill -- sending more water over hydroelectric dams on the Columbia and Snake rivers to allow juvenile fish to swim past more easily and have a better chance of reaching the ocean.

comments noted

A demand for profit for the big oil tycoons drives this modern global economy, and fuels the insatiable quest for harvesting the salmon in our oceans and on the Columbia River which has been turned into an aquatic highway of ships, barges and boats equipped with the latest's technology to easily locate the fish. Many of these vessels come from exotic ports and carry non native species that can hitch a ride to the Pacific Northwest where they presently compete for resources and habitat space with wild native fish.

We must include all of the many forms of transport that expel CO2, microwave, chemical emissions, micro plastics, and other pollutants that will have a negative affect on salmon, reproductive, and habitat health.

The alternative c proposal of killing 16,000 nesting pairs of Double Crested Cormorants on East Sand Island comes from an archaic mind set not grounded in sound science. Nor is it holistic enough to sustain the market demands of the twenty first century. Funding an out dated policy of native predator removal instead of removing four dams on the lower

Snake River is out of step with current biological science that supports restoring habitat health as a critical first step in recovery for any species.

Alternative c does not make economical or biological sense to lethally remove the native predators. A better outcome of success has been shown through employing an Eco system—non- lethal based management approach to restoring habitat health that actually protects fish, and restores habitat which salmon so desperately need. This is why I support alternative "A" of this proposal.

G-16, G-2

The time is now for the Army Corp to discard this out of date and failing policy of native predator removal that has been shown to destroy bio diversity, waste tax payer money, and does nothing to restore habitat health. Removal of the native predators has been shown to actually weaken the web of life not enhance it. The Army Corps of engineers should employ an eco -system based management approach to the Double Crested Cormorants on East Sand Island that will be a benefit to the salmon and the birds.

G-16

The sea birds are native predators that increase the genetic strength of the fish and bio diversity of the fish species – Double Crested Cormorants eating fish are not the biggest detriment to the recovery of the salmon. The Army Corps of engineers must stop scapegoating the native predators and take some non lethal action like dam removal, and stop ODFW from dumping hatchery fish into the rivers.

These hatchery fish only know how to feed at the waters surface, and swim in tight schools making them easier to be preyed upon-- instead of spreading out and feeding at the bottom of the river like the wild native fish do, and they also compete with native wild fish for receding habitat resources.

G-2

The biggest predators to salmon and marine life are humans and their insatiable desire for salmon with their gas and oil burning maritime traffic and all of the dams. We can not discount the destruction from PCB's, dioxins, uranium, and barium pollution-- industry's toxic mix is having on these waterways, the animals, and the health of humans who eat the fish.

G-2

Protecting the profits of industry has been given more credence than protecting the safety of consumers or fish as shown currently in Washington State. No realistic safety consumption levels have been adopted to protect the public from toxins in fish, or to limit industry's poisons from going into the river. The tribes, consumers, and environmental groups demand a realistic and reflective human fish consumption level that sets regulation and limits on industry's ability to pollute.

This standard is needed to protect aquatic marine and terra life forms from industry destroying and eroding habitat health with various devastating, and crippling, reproductive poisons that some have a half- life of over a hundred thousand years.

By not adopting a stricter consumption level on fish is indicative of a business as usual for the status quo, and this mindset will kill more salmon, marine life and destroy the

G-10

G-2

G-16
G-2

economy. The damage is far greater and the threat more dominant than the lovely Double Crested Cormorants living on East Sand Island ever will be. Industry's pollution lingers and it will live on to kill more fish and lower their ability to reproduce and spawn. The threat this pollution causes for salmon and the economy is far greater the feathered inhabitants of East Sand Island eating subsidized hatchery fish.

So what can the Army Corps due about industry's pollution and the negative affects on salmon? What can the Army Corps do under these dire circumstances where industry comes first? Well a place to begin is to at least acknowledge and adopt a non lethal eco-system based management approach over the outdated failing policy of native predator removal. This is why I favor alternative A for this proposal.

We must acknowledge that the sea birds, yes, opportunistic at best while inhabiting East Sand Island are not out of step with nature's native design. Nor are they outside the natural web of marine life on the Columbia River estuary. Birds and fish reside together there. The East Sand Island is an Army Corps creation that has inspired the Double Crested Cormorants to nest and raise their young there.

Just like the Army Corps dredging of the Columbia River has made the river more opportunistic to oil & gas burning maritime traffic exploration to pollute and kill salmon with high tech gear, nets, hooks, and by the altering and removal of salmon spawning habitat.

The Army Corps embracing an eco- system based management approach to salmon recovery will require an acknowledgement that the biggest predator facing salmon today and the biggest hindrance to their sustainable recovery is mass human extraction.

The Army Corps currently has four dams on the lower Snake River that should be removed to mitigate habitat health, and to return the highly valuable-- free flowing river and gravel spawning beds back to the original inhabitants on the river-- the salmon.

Removing the four dams on the lower Snake River will help the economy and be more effective to aid salmon recovery than the killing of Double Crested Cormorants. The Army Corps should not adhere to a failing policy that seeks to scapegoat and kill native seabirds while ignoring the biggest non native threats to the species.

Ignoring the biggest most dominant threats to salmon will not aid recovery and is simply a waste of time, and simply, a waste of tax payer money. You must explore all of the non lethal methods first and take no lethal action against the cormorants.

Sea Birds by their nature are designed to eat fish. These native birds consume the non native fish like the walleye, bass, shad, pike minnow; whose populations now make up the majority of fish species now thriving in the warming polluted waters of the Columbia

River. Sea birds help the Army Corps by clearing habitat space for the salmon by consuming these non native fish along with hatchery fish that have become one of the dominant and biggest threats to wild salmon smolts and native run recovery.

The National Marine Fisheries study by Beth Sanderson March 2009 found that NIS –the majority of which are plants and fish—are present in all of the connected areas, with as many as 486 in some watersheds. Sanderson and colleagues assembled reports of predation by six of the 60 non indigenous fish species found in the region: catfish, black and white crappie, largemouth bass, smallmouth bass, walleye, and yellow perch.

The research estimates that NIS are now the majority, representing 54 percent, 50percent, and 60 percent of the fish species found in Washington, Oregon, and Idaho, respectively. ." A review of published and gray literature found 27 existing studies that quantified NIS predation to some degree.

The new article cites past research that documents NIS fish as being the dominant environmental threats to bio diversity, and causes the downfall 48 percent of the listed species overall, and 70 percent of the listed fish species, in the United States.

Another study pegged the NIS cost the US economy in 2005 alone $120 billion "and the occurrence and ranges of NIS are steadily increasing," the paper says.

The status of freshwater aquatic fauna is especially dire, Sanderson and colleagues report. In particular, non indigenous fishes compete with or prey on native fishes, posing a serious threat to the persistence of the natives

"Of those studies reporting the number of juvenile salmon eaten by individual NIS predators, we found values ranged from zero to 10.4 million (median value=5.2million), with many studies reporting hundreds of thousands of juveniles consumed by a SINGLE NIS predator species at a specific study site in the Columbia River Basin," the article says.

"At locations in the Columbia River, smallmouth bass and walleye consumed between 18,000 to 2,000,000 and 170,000 to 300,000,000 juvenile salmonids per year, respectively.

The paper concludes that broader assessments of NIS impacts are needed to help guide management that reduces predation on salmonids, according to Sanderson.

" Considering the percentage of funds allocated to NIS research and the results of our review of impacts, the level of attention given to NIS seems disproportionately small, given the magnitude of the potential threat that the NIS pose to native communities," the paper says.

A big portion of the budgets of fish managers goes towards predator removal like targeting important native predators like the cormorants or marine mammals' verses funding researchers to look at the negative affects of NIS predation on salmonids including hatchery fish impacts salmon.

The study fund that the mortality attributed to NIS predation may be similar to that associated with juvenile passage through each of the eight dams on the Columbia and Snake Rivers. Likewise it could match or surpass productivity declines attributed to habitat loss and degradation and to that estimated for in- river harvest.

Because no agency wants to take on the sport fishing industry, and hold them accountable for causing the decline of wild salmon runs. By ODFW's introduction of these non native fish into the Columbia River the salmon runs have declined due to dams and due to the introduction of non native species. This is another reason as to why I favor alternative A-- sadly dam removal and NIS impacts on salmon research has yet to be fully explored, or adequately funded.

So since there has been so much reliance on hatchery fish to supplement industry's harvest of salmon, and the hatchery fish have been proven to be detriment to the recovery of the wild salmon humans must stop dumping millions of hatchery fish into the Columbia River.

Humans must be required to share this highly subsidized forage fish with the native seabirds and marine mammals that have no other food choice if it is to continue. Since the Army Corps has so drastically altered the original fragile food web of life on the river. An eco system based management approach will assist the Army Corps in reaching their goals to sustain salmon and restore salmon spawning habitat.

The Army Corps must commit to build a better bridge to protect the fragile web of life on the Columbia River by removing the four dams on the lower Snake River. The removal will allow the river to flow and assist the salmon to migrate freely. This will increases the ability for migrating fish to return to their birthplace to spawn. Removing the four lower dams on the lower Snake River will also create employment opportunities for surrounding communities.

The Army Corps has the opportunity to return the river and spawning grounds back to the salmon for real mitigation from the years of decimation from human hubris, from dams, and from the blind reliance on technology operating for industry's growth and extraction.

The time for taking up Columbia River habitat space with non native and hatchery fish is over, and the time to share fish is now, if it is to continue! Now is the time for the Army Corps to give back to the Columbia River by restoring the fragile web of life that once produced enough for all—the Army Corps has so freely taken, altered and removed for their own gain river habitat and after all of these years are reluctant to change.

Give back the Columbia River estuary to the salmon and share fish with the seabirds and marine mammals that help support this fragile web of life not dismantle it. These sea birds have no other food source since the mussels of the Pacific North West have been poisoned by industry's pollution, and now the sea stars are dying off at alarming rate, as well, since, their food source has been poisoned.

Stop the proposed killing of Double crested Cormorants now, and simply take down the four dams on the lower Snake River, and this non lethal action alone will save more fish than the birds eat. Killing cormorants is a short sided out of step archaic policy that has brought us to this crossroads and native predator removal has through history left a trail of tears and empty nets.

Now the Army Corps has the opportunity to change the future for salmon and marine life for the positive by adopting an eco system based management approach to restoring habitat, and protecting the fragile web of life so interconnected in this amazing estuary and farther north up the mighty Columbia River.

Our beautiful feathered and flipper friends along with the iconic salmon for over ten thousand years can say they have survived together. But for the human narrative it is exploitive, opportunistic, and if our endeavors and good intentions are going to succeed that we must first acknowledge the eco system as a whole—not as independent parts—we must respect the fragile interconnectedness of the ecology and we must learn to swim together, work together and live together.

And for us to sustain and survive together that we must live within this biosphere and not dominate and dismantle it as if we are separate from it. To be dammed and diverted away from the original life source-- for it is the source of all life – water giving freely-- has allowed humans through the ages to get what they need to survive.

All cultures like all species must learn to "share" the fish. So dearly a gift of life for so many and sustenance for all must come before for mere sport and profit for a few.

Greed is a human trait and not found in the animal kingdom. It is not a life sustaining trait for the good of the populations as a whole and will derail the efforts towards sustainability or any real salmon recovery. We must remember that what we give away comes back to us twofold. It is imperative that we set a good example for our children, and share fish with all who rely on this fish for sustenance-- not just allocate fish for sport and fish for profit.

The time is now for the Army Corps to protect and preserve what is left of the natural Columbia River system. The Army Corps must allow fish for forage to the myriad of species that swim & fly up this busy maritime highway what humans call a GDP expanding river economy but what that the birds & animals call the river home.

The Columbia River estuary needs to be a sanctuary for wildlife not a war zone. The Army Corps can not lethally attack the birds or for making use of a good opportunity such as East Sand Island for a place to raise their young. The Army Corps created something good here, so the Army Corp should leave the birds alone and adopt Plan A of the proposal. There should be no money in the budget to lethally attack East Sand Island nursery and commit any lethal acts against these birds.

G-2, G-10

No tax dollars should be spent on such deplorable acts of violence that will not help the salmon and waste tax payer money. All non lethal measures must be explored first so adopting plan A of this proposal is what i hope you will support.

The native predator removal plan and policy must be eradicated and an ecosystem based management approach must be adopted by the Army Corps. Salmon the life source for so many animals must be allowed to swim free and meet their fate whatever that fate may be.

With all the perils these young fish face today-- a flock of Double Crested Cormorants are by far not the worst thing a young fish will encounter. These birds provide lesson to the naive fish to help build their genetic strength to survive the gauntlet of hooks, nets and dams they are facing up river and in the oceans.

In time the Army Corps will discover that taking down the four dams on the lower Snake River, and stop ODFW from dumping of millions of hatchery fish into the river was the best solution to employ to actually save the wild salmon.

Retro fitting hatcheries so they do not contain steel or iron rebar because it disrupts the memory mapping in migrating fish-- new research from OSU shows. This is an important non lethal step that should be explored if ODFW is going to keep dumping hatchery fish into the Columbia River.

These are just a few workable solutions that can assist the Army Corps in rebuilding habitat health—so important for salmon recovery. Removing the four dams on the lower Snake River will help the salmon recover and not to sweat the small stuff like bird predation which actually strengthens bio diversity and genetics memory to help make the fish smarter.

Over time the tax payers of Oregon, environmental and salmon lovers will love an eco system based management approach to salmon recovery as the best plan for the buck. The time is now to stop funding the archaic "failing" policy of scapegoating and removing native predators from the river habitat and adopt plan A of this proposal.

In the 21 century the Army Corps knows how to build structures to last, but nobody can outlast and out- produce Mother Nature when it comes to a healthy return of salmon. Our habitat resilience will depend upon our eco system based management support—not by dismantling it with native predator removal.

And the Army Corps employing an eco system approach is tax payer money well spent. The Army Corps must use funding for workable non lethal solutions and not take any lethal actions against the double crested cormorants. The Army Corps must look for non-lethal practical sustainable solutions for habitat health and salmon recovery.

Once all of the animal populations were in abundance and they all thrived together in the Columbia River estuary. The Columbia River estuary is a food system, and yet, humans have turned it into a diesel burning highway. Wild salmon caught on the Pacific North West will be destined for Japan and other buyers overseas. New reports show 80 % of the sea food eaten in the U. S. A. is imported. It is up to humans and the Army Corps to protect our Columbia River estuary as a interconnected biological system if our rivers, oceans and all aquatic and terra life forms are going to survive because they are currently eroding underneath us.

Last but not least the Army Corps can work with CREST installing fish screens on diverts and culverts in Oregon and Washington to prevent fish from dying in fields. Fish screens are as ODFW's director Roy Elicker has said are crucial to sustaining our fisheries and sustaining the species. Along with removing the micro plastics from the beaches, ceasing to dump NIS, hatchery fish into our rivers, and taking down the four lower dams on the Snake River are just a few alternatives of non lethal action that the Army Corps can use their brilliance on. And a good way to bring employment opportunities to the region in a constructive verses destructive way.

I hope you find these considerations, observation, and suggestions helpful. I request that the Army Corps of engineers approach and consider all non lethal suggestions with the highest of sincerity, integrity, and open mindedness approach as a proven method to "save" salmon.

Do not take any lethal action against 16,000 nesting Cormorants or any other bird families now living on East Sand Island. I favor alternative A of this heinous proposal and want NO further action-- all non lethal methods must be studied first. I request that the Army Corps explore a more balanced approach.

Thank You!

For the sea lions and the double crested cormorants

Ninette Jones
Portland, Oregon 97217

Skagit Audubon Society
P.O. Box 1101
Mount Vernon, WA 98273

August 4, 2014

Sondra Ruckwardt
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208-2946

Attn: CENWP-PM-E / Double-crested cormorant draft EIS

Dear Ms. Ruckwardt:

We are writing on behalf of Skagit Audubon Society to convey our comments on CENWP-PM-E / Double-crested cormorant draft EIS.

Over 400 families living in Skagit County north of Seattle are members of the National Audubon Society. Approximately 215 of these families also belong to Skagit Audubon, the local chapter of National Audubon and one of 25 Audubon chapters throughout Washington State. We share a common mission: to conserve and restore natural ecosystems, focusing on birds, other wildlife and their habitats for the benefit of humanity and the earth's biological diversity.

comments noted

Skagit Audubon opposes Alternative C of the draft Double-crested Cormorant Management Plan Environmental Impact Statement (EIS), which emphasizes lethal control with a proposed killing of 16,000 Double-crested Cormorants by a variety of means. This number represents more than 25% of the entire western North American population of a species in decline elsewhere in the West. The proposed action is doubly inappropriate because it would occur at an identified Important Bird Area designated as globally significant because of its importance to a large percentage of the population of several bird species. As you know, the island is home to the largest nesting colony of Double-crested Cormorants in western North America. Although there is no doubt that the cormorants prey on salmon, predation levels are highly variable and the fish are endangered because of dams, pollution, habitat loss and an array of other factors—not because of cormorants--in the Columbia River basin.

The plan to kill cormorants, which have coexisted with salmon for thousands of years, follows all too closely the centuries-old, misguided tendency to view cormorants as a species in perpetual conflict with human welfare. Skagit Audubon favors EIS Alternative A, the no action alternative. No action should be taken to reduce the Double-crested Cormorant population until the Army Corps and its partner agencies carefully and thoroughly review and revise their regional strategy for management of avian predation on fish.

G-2

We find that Alternative C inadequately considers the many human actions causing decline in salmonid populations; the familiar litany of habitat, harvest, hatcheries, and hydropower. We realize that correcting the effects on salmon populations of actions in these areas is far more complicated and expensive than killing fish-eating birds, but it is the only way to truly address the problem of salmonid decline. In this bigger picture, cormorants, terns, and other fish-eaters are merely convenient scapegoats whose removal might give the impression of effective action towards fish restoration while in fact having little lasting impact on increasing salmon populations.

The listed species of salmonids which the planned killing of cormorants is supposed to help were not reduced to endangered status because of cormorants. The revised regional strategy must be based on sound science, must fully employ and evaluate non-lethal measures of reducing avian predation, and must consider a full range of alternatives beyond manipulation and control of native wildlife. Most of all it needs to recognize that salmon recovery will only succeed when issues related to habitat degradation, dams, harvest, and hatcheries are adequately addressed.

We appreciate your attention to our concerns. Please notify us of further documents or decisions related to this project by mail at Skagit Audubon Society, P.O. Box 1101, Mount Vernon, WA 98273 or via email to: bctm@fidalgo.net.

Sincerely,

(For the Skagit Audubon Society Board)

Philip Wright
President, Skagit Audubon Society

Timothy Manns
Conservation Chair, Skagit Audubon Society

Spokane Tribal Natural Resources

P.O. Box 480 • Wellpinit, WA 99040 • (509) 626 - 4400 • fax 258 - 9600

August 19, 2014

Sondra Ruckwardt
U.S Army Corps of Engineers
Attn: CENWP-PM-E-14-08 / Double-crested Cormorant Draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

RE: Spokane Tribe of Indians comments on Draft Double-crested Cormorant Draft EIS (submitted via email: cormorant-eis@usace.army.mil)

Dear Ms. Ruckwardt:

comments noted

The Spokane Tribe of Indians' Department of Natural Resources ("Tribe") submits the following comments on the Double-crested Cormorant Draft EIS. For background, the Tribe's anadromous fish runs were temporarily blocked with the construction of Grand Coulee Dam, and the Tribe fully expects that the salmon will be returned to the blocked areas. However, for salmon to return to the Tribe's waters there must be healthy populations of salmon and steelhead throughout the Columbia River basin. The current avian problems within the basin threaten salmon restoration efforts, and could impact the Tribe's ability to return anadromous fish to its waters. Accordingly, the Tribe wishes to thank the Corps for beginning to address this problem.

The Tribe supports preferred alternative C: culling with integrated Non-Lethal methods including limited egg take. As you are aware, East Sand Island's current existence has been perpetuated by manmade efforts that have allowed the avian problem to develop, and alternative C begins to address the problem. Although, alternative C may not be enough, the Tribe supports it as a starting point.

The Tribe will continue to monitor the Corps' efforts and expects that the Corps and the other federal agencies involved will consult with the Tribe on this and future efforts.

If you have any questions, feel free to contact me at (509) 626-4427.

Sincerely,

BJ Kieffer

B.J. Kieffer
Director
Spokane Tribal Natural Resources Department

Cc: Rudy Peone, Chairman, Spokane Tribe Business Council

The Waterbird Society

Comments submitted on behalf of the Waterbird Society:
Public Notice Number: CENWP-PM-E-14-08
USACE Draft Environmental Impact Statement
To Reduce Double-crested Cormorant Predation of Juvenile Salmonids in the Columbia River Estuary, 19 June 2014

comments noted

I am writing this letter on behalf of The Waterbird Society, which is a member of the Ornithological Societies of North America (OSNA) and an international organization composed of professionals and students engaged in research and conservation of waterbird species. The society's primary goals include fostering science-based waterbird conservation globally and facilitating communication between professionals, policy makers and citizens regarding pertinent environmental issues affecting waterbirds.

The Waterbird Society strongly opposes the proposed management plan (Alternative C) by the US Army Corps of Engineers (USACE). Instead, the Waterbird Society recommends that the USACE pursue a nonlethal management plan (Alternative B) in an effort to mitigate predation pressure on juvenile salmonids by Double-crested Cormorants (DCCOs).

East Sand Island in the Columbia River has been designated an Important Bird Area (IBA) by BirdLife International, the National Audubon Society and the American Bird Conservancy. The island is of global significance due to its diversity of waterbirds and the fact that it supports the largest breeding population of DCCOs in North America. The island serves as breeding and roosting habitat for Caspian Terns, Brandt's Cormorants, Glaucous-winged/Western Gulls and Ring-billed Gulls. A total population of only 1,600 breeding pairs of Brandt's Cormorants exists on East Sand Island, and only 100 breeding pairs of Pelagic Cormorants nest in the Columbia River Estuary. East Sand Island also serves as a roosting habitat for a significant number of previously endangered California Brown Pelicans.

The draft EIS released by the US Army Corps of Engineers (USACE) states that these species overlap spatially and temporally throughout the area proposed for DCCO management (culling). According to the draft EIS, under the proposed management plan (Alternative C), there is a "...high potential for a substantial reduction in the size of the Brandt's Cormorant colony on East Sand Island" and a "...low to moderate potential for a substantial reduction in colony size of other species..." In addition, the breeding population of Pelagic Cormorants in the Columbia River Estuary could be reduced by as much as 20 percent as incidental take during culling. Substantial research to quantify the biological

G-21

impact that such a plan will have on these secondary species has not been done and the potential implications of incidental take on the breeding biology, metapopulation dynamics or population growth of the other species likely affected by this management plan are unknown.

Aside from these sympatric species using East Sand Island, the draft EIS proposal to cull 15,955

FEIS Section 4.4

DCCOs does not include an extensive review of ecosystem-level effects of such actions. The only ecological relationship examined in the draft EIS is that of the DCCO population and juvenile salmonid species. The removal of so many individuals would increase the likelihood of unintended consequences

G-4, FEIS Sections 4.2.5, 4.6.5

such as compensation in predation of juvenile salmonids by other marine predators. This scenario, nor any like it, was considered in the draft EIS. Moreover, removal of a large number of DCCOs that currently supplement their diet with a small percentage (15%) of junvenile salmonids does not necessarily relax predation pressure and may in fact increase loss of salmonid species. A comprehensive study modeling the responses of other piscivorous marine species to large scale removal of DCCOs is lacking.

G-8, G10 FEIS Section 4.7, App. G

The East Sand Island population of DCCOs has a much lower reliance on freshwater salmonids as part of their diet (15%) relative to colonies in the upper estuary (45%). Research into the use of dissuasion fences demonstrated that birds frequently relocated to areas predominantly in marine environments and were likely to move permanently in the event of an installation that would deter nesting. Since the marine foraging DCCOs consumed far fewer juvenile salmonids, it is unclear why predation cannot be managed by controlling nesting opportunities as described under Alternative A.

FEIS Sections 3.2.2, 4.4

The draft EIS references an analysis performed by NOAA Fisheries comparing predation of juvenile steelhead by DCCOs between a base period of 1983-2002 and a period of 2003-2009. While the analysis suggests a 3.6 percent increase in the amount of predation by DCCOs compared to the base period, no mention is made of the condition of the Western populations of cormorants during that time. Like those in Interior/Eastern North America, these populations are still recovering from heavy population losses due to overharvest and the effects of DDT since the mid-1970's. While few "base period" population estimates exist for DCCOs, current population sizes in Western North America are far below the numbers present pre-European settlement. In addition, the draft EIS suggests an ultimate goal of reducing the East Sand Island population of DCCOs to an abundance of 5,600 pairs and maintaining the population at this "sustainable" size. Under this management plan, East Sand Island would support 24 percent of the population of Western DCCOs. East Sand Island currently supports the largest known colony of DCCOs anywhere in North America. Reducing the largest and most productive colony in North America so that it supports only 24 percent of the entire population of DCCOs in Western North America will undoubtedly have far-reaching and unpredictable species-level and ecosystem impacts to the species as well as the surrounding ecosystem.

G-20

G-3, G-4 FEIS Section 4.6.5

What can be perceived as "excess" is often necessary in a balanced ecosystem to buffer against mortality driven by multiple factors. There have been no studies to support the idea that deficiencies in Western DCCO numbers following such a heavy cull at East Sand Island will be offset by increased productivity at other colonies that have not exhibited the same level of productivity. Locations that have supported substantial portions of the Western population of DCCOs (Salton Sea and the Upper Klamath Basin) have exhibited limitations as nesting habitat due to water management issues. There is no clear understanding of the capacity of this species to recover from such a population reduction, especially considering that the population is still recovering and has yet to approximate pre-European settlement numbers.

G-19, G-20

G-3, G-14, G-20

The draft EIS mentions the capacity of environmental and climatic variables to contribute to salmonid smolt mortality. Because of the considerable annual variation in these factors and the current scenarios of changing climate in the future, it is impossible to predict the long-term effects to both salmonid and DCCO populations of a cull of this magnitude. Reducing the DCCO population to a size considered to be sustainable in 1990 is not adequate preparation for the uncertain future.

comments noted

Regardless of the productivity of the East Sand Island colony, the Western North America population of DCCOs is roughly one-tenth the size of the Interior and Eastern North American populations of cormorants and has exhibited a slower growth rate than the latter populations. The last thorough survey of the Western North America DCCO population was conducted in 2009, in which a population estimate of 31,200 breeding pairs was obtained. Due to the overall small population size combined with a slow population growth-rate, the Western population of DCCOs has not been included in the public resource depredation orders (PRDO) issued by the U.S. Fish and Wildlife Service for 24 Interior and Eastern North America states. Despite this, the "preferred management plan" outlined in the draft EIS would take 15,955 DCCOs from the East Sand Island colony alone.

G-20

comments noted

The Waterbird Society strongly opposes the proposed management plan (Alternative C) by the USACE and instead supports a management plan in which nonlethal techniques are used in an effort to mitigate predation on juvenile salmonids by DCCOs (Alternative B). The proposed management plan (Alternative C) calls for the destruction of greater than 50 percent of the population of Double-crested Cormorants at East Sand Island for a potential increase in junvenile salmonid survival of only 1-4 percent and does not consider other variables likely to play an important role in the predator-prey system (climate, competitive interactions) and the ultimate recovery of salmon. The nonlethal control techniques deemed insufficient by the USACE to lessen DCCO predation were not undertaken at the appropriate scale and have therefore not been truly deployed as a control measure. Adopting nonlethal control measures at the management scale as opposed to the experimental scale is necessary before claims of failure or success of these measures can be made.

G-2, G-4

G-9 G-10, G-11

With Kindest Regards,

Susan Elbin
President
The Waterbird Society

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UCUT
UPPER COLUMBIA UNITED TRIBES

Sondra Ruckwardt
U.S Army Corps of Engineers
Attn: CENWP-PM-E-14-08 / Double-crested Cormorant Draft EIS
P.O. Box 2946
Portland, Oregon 97208-2946

August 15, 2014

Via email: cormorant-eis@usace.army.mil

Dear Ms. Ruckwardt:

comments noted

The Upper Columbia United Tribes (UCUT) is comprised of the Coeur d'Alene Tribe, the Confederated Colville Tribes, the Kalispel Tribe of Indians, the Kootenai Tribe of Idaho, and the Spokane Tribe of Indians. United, these five tribes have worked to develop regional partnerships with the other Columbia Basin tribes, Canadian First Nations, and federal, state, and local governments and stakeholders to establish, promote, and implement effective, cost-efficient, sensible, and comprehensive actions to protect, mitigate, and enhance fish, wildlife, water, and cultural resources for the benefit of all.

The UCUT support the preferred Alternative C: Culling with Integrated Non-Lethal Methods Including Limited Egg Take. The preferred alternative should provide significant, near-term reductions in the double-crested cormorant population on East Sand Island to improve juvenile salmonid survival.

However, the UCUT hereby provide notice that if implementation of Alternative C for five years does not achieve the target East Sand Island population of double-crested cormorants; or if double-crested cormorant populations above the target level do not leave the estuary or, worse, travel to inland areas in the basin where threatened and endangered populations of salmonids would make up a greater percentage of their diets; or if the current excessive predation rates to juvenile salmonid populations due to double-crested cormorant predation continue, it expects more aggressive action based on adaptive management. Thus, the U.S Army Corps of Engineers (Corps) must add to the Management Plan an explicit adaptive management option in which it will take additional actions in the near term if juvenile salmonid predation rates are not reduced commensurate with Alternative C double-crested cormorant reductions.

The UCUT have suffered the most losses due to the settlement and development of the Columbia River Basin, and have received the least mitigation for these losses. Recent success in developing mitigation for lost salmon include the construction and operation of the region's newest salmon hatchery at the base of Chief Joseph Dam, the present terminus of anadromous fish migration on the mainstem Columbia River, 545 river miles and nine dams upriver from East Sand Island. These and other efforts of the UCUT and the First Nations in Canada have resulted in promising returns on past investments to return salmon and other anadromous fish back into the upper Columbia River. Additional efforts are now underway to restore fish passage to all historic places in the upper Columbia River, including reintroduction of anadromous fish into habitat above Chief Joseph and Grand Coulee Dams.

The UCUT are concerned that these past and future investments are being wasted by the exponential growth of double-crested cormorant populations nesting on East Sand Island and other parts of the Columbia River Basin. The estimated East Sand Island population of 100 breeding pairs in 1989 has now grown to at least 15,800. With the average annual cormorant consumption of juvenile salmonids at 11 million fish over the past 15 years (with an annual peak of 20.5 million), occurring in May during the peak nesting season, and with the concentration of nesting on East Sand Island, the Corps is wise to pursue culling of double-crested cormorants, while also integrating non-lethal methods including limited egg take on the island.

Because double-crested cormorants also utilize additional habitat throughout the Columbia River Basin, and because of their exponential growth on East Sand Island, the UCUT believe that managing for a population of approximately 5,000 breeding pairs on the island as envisioned with the DEIS' Preferred Alternative C is the minimum necessary to control mortality of juvenile salmonids, particularly Upper Columbia River steelhead, and to prevent these birds from causing an exorbitant waste of money and mitigation efforts upriver. Therefore, the UCUT support adoption of Alternative C with the addition of a near-term adaptive management response option should juvenile salmonid predation rates not decrease in parallel with double-crested cormorant abundance.

The UCUT look forward to the Corps' implementation of the Management Plan and the significant benefits to the Columbia Basin's salmon and steelhead that should follow. The UCUT intends to continue providing input to the Corps and other agencies through government-to-government consultation or other processes as the management plan is implemented.

Thank you. If you have any questions, please contact me (509-954-7631; dr@ucut-nsn.org).

Sincerely,

D.R. Michel
Executive Director

Cc: Elisa Carlsen, U.S. Army Corps of Engineers (Elisa.Carlsen@usace.army.mil)

USDA

United States Department of Agriculture

Animal and Plant Health Inspection Service

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January 29, 2015

Mr. Kevin Brice
Deputy District Engineer for Programs and Project Management
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208

RE: Discussion of the potential effects of Alternative C-1in comparison to Alternative C in the FEIS.

Dear Mr. Brice:

comments noted

The United States Department of Agriculture, Animial and Plant Health Inspection Service, Wildlife Services (APHIS-WS) program has been active as a cooperating agency in reviewing, discussing, and providing professional guidance in our area of expertice in wildlife damage management techniques during the development of the Corps Double-crested Cormorant (DCCO) Management Plan. Recently the USFWS has suggested incorporating Alternative C-1as the cooperating agencies move forward with the preparation of the FEIS. The key differences in Alternative C and C-1is the proposed reduction, in C-1, of lethal take of DCCO birds and a significant increase in the nest take.

There have been discussions between the cooperating agencies during the development of C-1 but initially, APHIS-WS was concerned that the agencies had not sufficiently discussed the potential effects that we believe could occur with Alternative C-1 in comparision to C. APHIS-WS raised this concern to the ACE on November 28, 2014, and subsequent to our initial comments, the agencies reviewed the questions on a conference call December 15, 2014. Most recently, APHIS-WS was able to review the January 9th draft administrative FEIS and provide comments to the Corps. In reviewing this draft administrative FEIS, and reviewing my initial comments on the USFWS proposed Alternative C-1, I want to provide the following comments related to the comparision of potential effects that could occur during the implementation of Alternatives C and C-1. Collectively, the agencies have worked to develop alternatives and methods that would minimize potential effects as well as allowing for adaptive flexibility in management actions. Because potential effects could occur, I feel it is important to reiterate them as we move forward with the FEIS.

For the ease of describing potential effects in this letter, I am describing the effects that could occur during the first year of implementation with an assumption that similar but reduced effects could be seen in subsequent years based upon a reduction in the level of management actions. In describing effects, I am focussing on the effects that are anticipated or possible to occur when management actions make a direct incursion into the nesting colony. Direct incursions would be shooting into the colony and or walking into the colony. We are assuming that work conducted behind privacy fences, from within towers or tunnels would be the same for either alternative and are expected to be low in comparision to openly moving in or through the colony.

Comparison of the differences in causing dispersal between Alternatives C and C-1 is described in the FEIS-Executive Summary, Chapters 2 and 4. The potential effects of actions are evaluated in Chapter 4

Alternative C:
The primary design of this alternative is to implement culling of DCCO birds, up to 4 years. The original plan (i.e., Alternative C in the DEIS) to accomplish the goal of culling approximately 6,000 DCCO in the first year was a combination of on island and off island activities. We expect that the shooting of DCCO will cause a disturbance to the nesting birds which is why we included the use of supressed firearms and sub-sonic ammunition. To further reduce the potential effects we would plan for shooting to occur at night to reduce the visual disruption of the culling activity. However despite our experience with other wildlife, we don't know for certain how effective these methods will be in reducing potential effects on birds at ESI.

Following the culling event, crew members would move throughout the portion of the nesting colony where culling occurred to recover culled birds. This is expected to cause disturbance to the nesting birds but is designed to be limited to the shortest amount of time possible by limiting the duration and numbers of birds culled during one event. We anticiapte removing a minimum of 3,000 DCCO during on island culling operations, with those removals creating 6-8 incursions into the nesting area. This equates to a target of about 500 (up to 750) birds per culling session, totaling 3000 – 4000 birds culled (@500 per event) and at most 4,500 – 6,000 birds culled (@ 750 birds per event). The ideal situation is to keep the number culled per event smaller to reduce the workload and decrease the duration of the disturbance during a singular event while minimizing the number of events and incursions into the nesting colony as a whole. It was anticipated that approximately 3,000 – 4,000 birds would be culled over 6-8 events across the nesting area. (If we find that culling efforts are very effective with minimal disruption, where feasible, more birds could be culled in a single event thus reaching the goal with fewer incursions, and potentially less effects.)

Culling operation on the island would be conducted over the whole DCCO nesting area, predominately west of the most eastern boundary established by the Corps during their 2013 dissuasion efforts. Having the large area for culling operations, would help to minimize the likelihood of having to conduct culling activities in the same location more than once, thus significantly reducing the potential disturbance effects of multiple incursions into portions of the nesting colony. Other management actions by WS as well as research activities conducted by NWRC in other locations point to the need to minimize the number of incursions to prevent large dispersal and or abandonment from a nesting site.

Boat based shooting was considered and made part of the alternative because removal of DCCO off the island would not have the potential disturbance impacts that on island shooting may have. The potential lost or effected nesting success or displacement of co-nesting species such as Brandt's due to disturbance during incursions and management actions (such as other birds preying on eggs or young when the nesting birds are flushed from the nests) is difficult to quantify. Direct Non-target take of species such as Brandt's with on island removals is anticipated to be minimal, however the potential for non-target take during off island efforts could be higher because of the potential to mis-identify a cormorant species while they are in flight. However, quantitative thresholds were established for direct non-target take during off-island shooting and indirect take would be limited to the nests associated with the birds incidentally shot. Whereas indirect take of Brandt's when conducting on island management actions is hard to quantify but anticipated and could be more than minimal depending on where and how the Brandt's nest among the DCCO. Direct non-target take during on island management actions is expected to be minimal to none.

Alternative C-1:
The primary difference in this alternative is reducing the culling of DCCO birds down to approximately 3,000 birds and including the increase of approximately 6,000 nests (6,000 additional nest since the removal of 3,000 will count as 3,000 nests being removed, for a total not to exceed 9,000 nests), for the first year. As stated above in the Alt C, reaching the take of 3,000 birds would be possible with on-island removal only, since that was the minimum number estimated to be removed during on island culling. During discussion with the Corps and the USFWS in developing the draft FEIS, there was a discussion on the preference, if possible, to establish or distinguish separate areas where culling and egg oiling would occur. With approximately 14,000 nesting pairs of DCCO, 6,000 nests is a little less than half of the DCCO colony. For illustration purposes, assume that the DCCO nest distribution is equal across the whole area west of the Eastern boundary privacy fence. If management areas were established to separate culling and oiling, approximately half of the colony would be set aside for the egg/ nest oiling of 6,000 nests and the other half (6,000-8,000 nesting pairs) for culling approximately 3,000 birds (half of the culling area would need to be culled). The end result for the culling would be that the 3,000 birds to be removed (like anticipated in Alt C) would now have to be removed in about half of the area instead of the whole area. The end result of that (under the assumption that nests are equally distributed) is that culling operations would be expected (in half of the colony area) to occur in close proximity of each other with the potential to have multiple incursions into the same areas, in order to achieve the target goal. Multiple incursions could cause increased disturbances and potential displacement from the colony. Even with the additional 3 foot privacy fencing used to established different management areas, moving through those areas to retrieve birds may cause disturbances to the adjacent groups. (this is the same potential for either alternative, however increasing the repetitions among neighboring areas may have the same effect as moving through the all the area). Based on past observations by the Corps or researchers, the DCCO don't nest equally spaced across the whole area but are more prone to cluster into areas that appear to me more

preferable nesting habitat. With that in mind, it was anticipated that in areas with higher nesting density, culling operations would likely affect or disturb more birds when activities are conducted versus areas where birds are nesting in lower density. If this anticipated effect is realized during operations, we planned to spread the culling activity out over a larger area and reducing the frequency of disturbance to those areas. If we only have half of the area to implement culling, then we may not be able to reduce those effects.

When adding the oiling of eggs to this alternative, C-1, there would be an increase in the number of incursions into the colony. With oiling, we are expecting to have a minimum of 4 oiling events spread out over time every couple of weeks starting about 2 weeks into the beginning of incubation. (This helps to oil eggs that were laid ealier then the average and still catch some that were only recently laid. The two week interval then also helps to oil additional eggs in new nests from late nesters, and new eggs from renesting attempts). However 4 would be a minimum with the potential that not all eggs would be covered with only 4 oil attempts, potentially resulting is some nesting success and not achieving full coverage of all eggs in a nest. As discussed above, to accomplish the culling of 3,000 birds we expect to have approximately 6-8 culling events and incursions to recover culled birds. Adding the oiling incursions and now we are up to 10-12 incursions, at a minimum, over the whole nesting area to try to achieve the same results.

We know from prior experiences that many birds will hold on their nest or vicinity during disturbances up to a threshold for what they perceive as a threat. Some birds will flush much more quickly than other and vice versa. It is hard to predict what their holding threshold will be. WS's experience in the Great Lakes region has found that some nesting colonies will hold for very long times with a high tolerance during a disturbance, which enables a high degree of success in culling birds. Whereas, some (fewer) colonies have an extremely low tolerance, the birds leave the nest very quickly with the onset of any disturbance, resulting in very low culling efficiency. Based on the Corps' experience on ESI, we are predicting that birds will tolerate a higher level of disturbance. If this is correct, it will enable us to be more efficient at culling a larger portion of birds in a geographic area during a single session. This would help us reach the objective removal numbers.

However, if we find to the contrary, that birds will flush much sooner, then we would be less efficient in a single culling session and thus may be difficult to achieve removal numbers in only the established culling area. We would then need to decide whether to have additional culling activities into the same areas or to expand culling activities into areas where oiling has or is occurring. Either way it could result in increased incursions into the nesting area. If we moved into the oiling area and conducted culling operations, then birds culled would count as a nest removed by permit, in addition to that nest being counted as oiled, which in essence would reduce the number effectively controlled. For example, if you oiled 6,000 nests and then came into those areas and culled 500 birds to reach the target of 3,000 (2,500 from the culling area and 500 from the oiling area) we would count 500 nests being taken as a result of culling which would reduce the number of nest effectively oiled down to 5,500 (even though 6,000 were actually oiled).

APHIS-WS views Alternative C-1 as having the potential to being more complicated to manage and minimize impacts due to the potential need to implement culling and oiling in the nesting colony and because of the increased number of incursions into the colony. One way to reduce the number of incursions is to implement boat based or off island culling of DCCO. Off island removals would decrease the number of DCCO needed to be removed on island from only half of the nesting area, in order to reach the objective. Off island removal does increase the potential direct take of Brandt's or pelagic cormorants but it does reduce the number of incursions into the nesting colony which has indirect effects on Brandt's and other co-nesting species that are hard to quantify, as well as reducing the potential effects to DCCO which may cause dispersals and abandonment from ESI but that stay in the estuary. Another way to reduce potential disturbance effects in both C and C-1 is to implement some culling events on and off island after the chicks have fledged, which spreads the take over pre and post periods and reduces the effects to nesting birds.

Along with this comparision between culling with egg oiling is the duration of the event. We are not entirely certain at this point but egg oiling could take longer to oil each egg/nest systematically in the colony then what it would take to move through the colony retrieving culled birds which may not be at every nest. With the shooting proposed to occur at night, we are hoping for and anticipating that it will cause less disruption than during the day. So part of this discussion needs to be on the duration of the event, culling or oiling, as well as the percieved threat of being at each nest versus picking up and carrying a bird carcass from the nesting area. Yet, we recognize that a bird being shot will still cause some level of noise upon impact and may cause either audible or visual disturbance for neighboring birds even at nighttime. However we anticiapte that the ambient noice of the colony, water, wind, etc. will help to minimze this effect. Potentially the duration of exposure to the colony may be reduced to when the birds are collected and carried out of the colony vs. the duration of the time it would take to oil the nests in that area.

Another question about impacts of Alternative C-1 is the potential impact of DCCO relocating due to consecutive years of nest failure. Alternative C-1 is relying more on nest failure or decreased recruitment of the population and fewer birds being culled (because of the need to have more breeders should the western population suffer a significant decline). This will leave more nesting birds in the subsequent management years that may have had subsequent or repetitive nest failures, which has been found to cause site abandonment with some birds. This could become more problematic should DCCO relocate up river in the estuary instead of out of the estuary.

So there are several points of potential effects that APHIS-WS feels are important to consider in evaluating Alternative C-1. There is the possibility of more indirect effects of co-nesting species with higher number of colony incursions. There is some added feasibility concerns to create both culling and oiling areas and the complication of trying to achieve take numbers without going over or under the objective amounts. There is the potential that increased management activity could cause more delayed nesting attempts on island, which thus creates more diversity in the timing of incubating and chick hatching. This may create more public concern regarding management activities that could affect chicks. Because of these potential effects and increased complexity, additional discussion has been included in the FEIS about minimizing effects. Additionally, a disturbance threshold matrix has been added to provide monitoring feedback to help assess the level of effects that management actions are having on DCCO on ESI.

APHIS-WS understands that there are several factors involved in determining effects and making a selection of a perferred alternative, such as the concern for the potential effects Alternative C could have on the western DCCO population. Given the number of factors that need to be considered, this review process has been demanding on the agencies resources but we feel that we have produced viable alternatives that can be selected from as presented in the administrative draft FEIS.

In review, APHIS-WS believes Alternative C could have less dispesal effects on DCCO and on co-nesting species but may have more effects to the western DCCO population. Alternative C-1 does integrate adaptive strategies to minimize potential dispersal effects and effects to co-nesting species. However, implementation of those adaptive strategies could impact the overall goal of reaching the objective to reduce the DCCO population (predation effect) by 2018 if removal actions are limited or stopped in order to minimize negative effects. APHIS-WS believes that the methods in Alternative C and C-1 are feasible and the goal could be accomplished with either Alternative so long as effects remain relatively low or as anticipated. The USFWS will need to determine what alternative(s) is permitable given their statutory authority to manage bird populations.

Sincerely,

Kevin Christensen
Wildlife Biologist
Assistant State Director OR WS Program

Subject: U. S. Fish and Wildlife Service (Service) and U.S. Geological Survey (USGS) Comments on Draft Environmental Impact Statement (DEIS) for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (CENWP-PM-E)

comments noted

The U.S. Fish and Wildlife Service and U.S. Geological Survey (USGS) have reviewed the U.S. Army Corps of Engineers (Corps) Draft Environmental Impact Statement (DEIS) for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. This DEIS represents a significant effort to develop a management plan to address the effects of double-crested cormorant (DCCO) predation on juvenile salmonids in the estuary. We appreciate the Corps' commitment to fulfilling their responsibility to conserve migratory birds by avoiding and minimizing impacts to these birds and are confident that the Corps will select a management plan that balances the need for reducing salmonid consumption in the Columbia River while ensuring a healthy and sustainable population of DCCO in the western region. Additionally, the Corps should initiate consultation under section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) on the proposed action with the Service's Oregon Fish and Wildlife Office as it pertains to potential effects to the streaked-horn lark and any other ESA-listed species. Related to this issue, the Final Environmental Impact Statement (FEIS) should clarify the links between the Corps' Navigation Program and the proposed action in assessing impacts to streaked-horned larks. We offer the following comments for consideration in the development of the FEIS.

FEIS updated, BA prepared for consultation

GENERAL COMMENTS

G-2, G-8 thru G-11 App. G FEIS

In 2011-2013, USGS worked with the Corps to conduct experiments focused around DCCO predation on salmonids. During these experiments, researchers were able to successfully restrict habitat and induce temporary dispersal from East Sand Island. Based on the information provided in the DEIS, it is not clear why these management strategies were deemed inadequate. We recommend that cormorant dispersal management from East Sand Island using non-lethal habitat restriction be further analyzed and addressed in the FEIS, and that this analysis should specifically include an evaluation of utilizing social attraction techniques to attract dispersing cormorants to acceptable existing or former colony sites.

FEIS updated to clarify intent of actions

The DEIS states that in Alternatives B and C, Phase II, "no efforts would be made to maintain a minimum DCCO colony size." We recommend that the FEIS clarify this management objective by explaining that the Corps will not implement any action that ensures DCCO nesting habitat is available annually on East Sand Island.

We recommend that the Phase I management plan for Alternatives C and D be clarified in the FEIS. Specifically, the purpose of hazing during Phase 1 of Alternatives C and D should be explained because it appears that hazing would cause birds to leave the area, potentially resulting in decreased ability to target birds for lethal removal. Additionally, the FEIS should clearly explain how the designated nesting area will be set up and how lethal removal will occur. For example, the DEIS states that birds in managed units of the designated nesting area would be disturbed , but it is unclear what efforts the Corps will be implementing to ensure that

Figure 2-5 added to FEIS

disturbance would be minimized. This information is necessary in order to identify and understand any potential effects to birds not targeted for lethal removal.

Text added to FEIS Chapter 2

Under 2.2.1, No Action Alternative, the DEIS states that "additional measures would need to be identified to fill the gap in survival" and that these measures could have "potentially significant environmental and economic impacts"; however, the DEIS also indicated that these measures are unspecified at this time. We recommend that the FEIS provide additional information on how this determination was made if the measures are unknown at this time.

measures to minimize egg take clarified in FEIS

Chapter 2, Page 11 describes an impact avoidance measure of "2) ceasing hazing and habitat modification techniques within a sufficient distance of an active nest (i.e., once an egg is laid)." It is our understanding that this avoidance measure would only be implemented: (1) in the designated nesting area; (2) if egg take on East Sand Island has reached the limit of the 500 proposed in that alternative; or (3) the nest was that of a migratory bird other than a DCCO. If this is the case, it should be clearly stated in the FEIS.

Impacts to Double-crested Cormorants

added suggested language to FEIS

In the FEIS, the remainder of the western population of DCCOs outside of East Sand Island should be included in the description of the growth of the western population (Executive Summary, Page 18) in order to provide regional context for the proposed action. We suggest the following language for the FEIS: "Since 1990, the growth of the western population of DCCOs has been primarily associated with the growth of the East Sand Island colony. The sum of the breeding colony counts elsewhere in the western population, circa 2009, is similar to that observed in circa 1990. Thus, it appears that the western population of DCCOs is sustainable at approximately ca. 1990 numbers." This language should also be included in the other sections of the document where the population is referenced, including: Executive Summary, Page 21; Chapter 4, Page 14; Chapter 5, Page 1; and Appendix E-2, Page 10. Recent banding and satellite telemetry studies have demonstrated the connectivity of the East Sand Island colony with other colonies from British Columbia to the Mexican border, and from the coast to the Continental Divide. The effect of the proposed cull (~ 16,000 individuals) may exceed a quarter of the cormorant population west of the Continental Divide. Because about 40% of the breeding adults in the western population nest at the East Sand Island colony, the FEIS should quantify and address the impact of reducing that colony by two-thirds on total population size.

The DEIS proposes that an estimate of population size circa 1990 is sustainable. As written, this appears to be based on the size of the western population before the East Sand Island colony began to increase substantially during the 1990s, meaning that if the population consisted of about 20,800 breeding pairs before the advent of the East Sand Island colony, then the carrying capacity of the available nesting habitat exclusive of East Sand Island should still be at least as high as it was in 1990. Omission of the wording "The sum of the breeding colony counts elsewhere in the western population, circa 2009, is similar to that observed in circa 1990" causes great confusion on how circa 1990 population size was used. The study of the status of the western population of DCCOs, published by the USGS-led research team, was considered in the DEIS's analysis of the sustainability of the western population and needs to be highlighted here. However, this does not account for the post 2010 status and trends of major colonies in the western population. Notably, the three most significant nesting areas in the western population since the 1990 census all have uncertain but likely negative trajectories: East Sand Island (should the culling program outlined in the DEIS be implemented), Upper Klamath Basin (drought, water allocation issues), and the Salton Sea (reduced water allocation, drought). Specifically, DCCOs have not successfully bred at the Salton Sea for the last three years. The colony site is land-bridged due to low water, and this is unlikely to change in the near future. The loss of over 4,000 breeding pairs to the western population since the time of the status assessment should be included in the effects analysis of the alternatives to the western population (Chapter 4, Section 2.2 Effects to DCCOs, Alternative C, Effects to the Western Population of Double-crested Cormorants).

G-19 →

Additionally, cormorant colonies in coastal British Columbia, Washington, and southern California have been in decline for two decades. In addition, much of the initial growth in the East Sand Island colony was likely due to immigration from other colonies in western North America, especially those in British Columbia and Washington, suggesting that many of the other colonies within the range of the western population are at or near carrying capacity. The Corps funded study of the status of the western population of DCCOs, published by the USGS-led research team needs to be highlighted in the FEIS's analysis of the sustainability of the western population.

see FEIS revisions to sustainable population definition

The DEIS indicates that there is unpredictability as to the locations where cormorants would disperse to from East Sand Island. Experiments conducted by the USGS-led research team on dispersal locations and behavioral strategies found that currently active and historical colony sites are the most likely locations that dispersing cormorants would attempt to nest. These experiments showed substantial use by cormorants from East Sand Island of sites in coastal Washington and British Columbia (areas of reduced conflict with fisheries). Additionally, active colonies elsewhere in the Columbia River estuary and lower river utilize artificial structures with either limited capacity to support additional cormorant nests (e.g., navigational aids or transmission line towers) or are hazed (e.g., bridges).

G-8, FEIS Section 3.1, Table 3-2 →

Under Alternative A: No Action, the DEIS states that the East Sand Island colony and the western population of DCCOs will continue to grow. Data suggest that it is likely the East Sand Island colony and western population are currently affected by limiting factors, and are at or near carrying capacity and may be relatively stable. In addition, localized population declines at other sites in the region have been observed over the past five years, suggesting a potential limiting factor for future population growth. We recommend that this information be considered and addressed in the FEIS.

G-19, FEIS App. E changes to model parameter for carrying capacity

Currently the DEIS states that there will be no expected reduction in the western population as a result of actions proposed in Alternative B; however, there is a possibility that there will be a significant reduction. Disturbed/dissuaded birds from the Columbia River Estuary will likely not breed the first year or two after being disturbed from nesting on East Sand Island and these birds may potentially be completely lost from the western population if alternative nesting habitat is not found. The lack of suitable nesting habitat in the region could hinder the population's ability to recover from this disturbance and thus, the reduction may continue into the future for Alternative B. This possibility should analyzed and addressed in the FEIS.

G-10, FEIS updated to clarify feasibility of Alt. B to meet need

In the comparing Alternatives B and C (Executive Summary, Page 19), the DEIS states that "The reduction in predation associated with the colony target size would likely be achieved under Alternative C, whereas this is less likely under Alternative B." Based on the information provided, it appears that the reduction in predation associated with the colony target size would likely be achieved sooner under Alternative C, whereas this would potentially occur over a longer timeframe under Alternative B. This distinction should be made in the FEIS.

FEIS updated population model parameter for a reduced carrying capacity

Alternative D proposes to completely eliminate the entire DCCO colony on East Sand Island. There is the potential for a large decline in the western population if this colony is completely eliminated from nesting on East Sand Island. Excluded DCCOs may not breed again elsewhere if they do not find adequate nesting habitat. The effects of this action on the western population should be described in more detail, specifically, Chapter 4, Page 17, should recognize that there is limited suitable nesting habitat for cormorants in the region and thus, it could lead to a potential decline in the western population. Additionally, it is not clear why the effects of Alternative B and D are determined to be similar. Alternative D has the potential to have the greatest impact to the western population of DCCOs, much higher than Alternative B. We suggest removing "potentially similar" when comparing effects of Alternative D and B (Chapter 4, Page 17).

FEIS App E-1 updated per comment

The Population Model to Assess Take Levels of the Western Population of DCCOs and the DCCO Colony on East Sand Island (Appendix E-1) should be adjusted for the FEIS. This is required because sampling (a) needs to be done from an uncertainty distribution (rather than calculating with equation 3). We suggest using the distribution from Seamans et al. (2012) and adjusting the density dependence parameter (b) to match the time series. Due to the disproportional harvest among age-classes a projection model with age structure is needed. These model predictions for each management year together with monitoring data will allow an assessment of whether management actions are having the desired/predicted effects. Projected population trajectories are necessary to predict the effects of planned management actions, particularly long-term population trends.

G-9 →

Disturbances, human or otherwise, are the most often cited causes of cormorant colony failure and abandonment in the scientific literature. Experiments at East Sand Island during 2011-2013 successfully dissuaded cormorants from nesting in designated portions of the island, despite a long history of cormorant nesting in those areas. The FEIS should describe the susceptibility of cormorants to human or other disturbance, particularly during the early stages of colony formation, and include this information in the effects determination for each alternative considered.

FEIS revised Adaptive Mgmt. Framework per comment, Section 2.1.3, Ch. 5, App. E.

<u>Monitoring and Adaptive Management</u>

We support convening an Adaptive Management Team and implementing an adaptive management process. The DEIS states: "For this EIS, adaptive management is defined as evaluating the accuracy of the predicted environmental impacts, assessing the effectiveness of management actions, and modifying them as needed to ensure the purpose and need is met and levels of environmental effects predicted in Chapter 4 are not exceeded" (Chapter 2, Page 3).

The DEIS does not specify how the Adaptive Management Team would evaluate the project as it pertains to effects to the western population of DCCOs. Please add text to specify that this will be a factor the Adaptive Management Team considers when evaluating the project. The FEIS should also specify the length of time for which the Corps plans to conduct annual monitoring in priority areas.

Climate Change

Climate Projections

USFWS (1) Table J-3

Multiple references cited in the DEIS, e.g., ISAB 2007 are outdated. More recent regional climate trends and projections summaries published in the National Climate Assessment (Mote et al. 2014) are available. We recommend that the material summarizing climate trends and projections for the Region (Chapter 4, Climate Change Section, Page 65-66 etc.) be updated and reanalyzed for the FEIS. This document also summarizes Northwest region water-related changes and coastal vulnerabilities. Because there is substantial climate variation within the Northwest region (e.g., coastal areas experience less warming than interior areas) we also recommend using more specific projections by comparing two 2014-released, robust, and easily accessible statistically downscaled data sets summarized below:

(1) The Multivariate Adaptive Constructed Analogs (MACA) is a statistical downscaling method, which utilizes a training meteorological observation dataset to remove biases and match spatial patterns in the climate model outputs. MACA was used to downscale daily model outputs for 20 GCMs from CMIP5 for the historical period (1950-2005) and the future (2006-2100) for Representative Concentration Pathways (RCPs) 4.5 and 8.5 scenarios from the native resolution of the GCMs to 4 km and about 6 km (i.e. there are currently 2 MACA products available for CMIP5). The downscaling was performed for the contiguous United States and the Canadian portion of the Columbia River Basin. The MACA method has been shown to be slightly preferable to other statistical downscaling methods in regions of complex terrain due to its multivariate use of a constructed analogs approach which utilizes a historical library of observations to construct the downscaling.

The following daily climate variables are available at daily timesteps from MACA products:

- 2-m maximum/minimum temperature
- 2-m maximum/minimum relative humidity
- 10-m wind velocity
- Downwelling shortwave radiation at the surface
- 2-m specific humidity
- Accumulated precipitation

Main Website: http://maca.northwestknowledge.net/

(2) The USGS National Climate Change Viewer allows the visualization of model output at monthly timesteps of 30 GCMs from CMIP5 for the historical period (1950-2005) and projected changes in climate from the Representative Concentration Pathways (RCPs) 4.5 and 8.5 scenarios. The dataset used for these visualizations is the NASA NEX-DCP30

dataset, which is a statistical downscaling of temperature and precipitation to an 800-meter grid that covers the continental United States using the Bias Correction Statistical Downscaling method.

The visualizations are provided as averages over four climatology periods: 1950-2005, 2025-2049, 2050-2074, and 2075-2099 for the two RCP scenarios. Derived variables of snow water equivalent, runoff, soil water storage and evaporative deficit are provided utilizing a simple water-balance model based on air temperature and precipitation.

The following climate variables are available at monthly timesteps from the Viewer:

- Maximum and minimum air temperature
- Maximum and minimum precipitation

The following climate variables are expected to become available soon and should be considered if available during the formulation of the FEIS, and/or during implementation/evaluation:

- Projected changes in water balance (available soon):
    - Snow water equivalent
    - Runoff
    - Soil water storage
    - Evaporative deficit

These variables are averaged over states, counties and USGS Hydrologic Units (HUCs) and the Viewer produces comprehensive, summary reports in PDF format and CSV files for each geographic area. The Viewer and pdf files provide a number of useful tools for characterizing climate change including maps, climographs (plots of monthly averages), histograms that show the distribution or spread of the model simulations, monthly time series spanning 1950-2099, and tables that summarize changes in the quantiles (median and extremes) of the variables.

See the website for more information and access to the Viewer: http://www.usgs.gov/climate_landuse/clu_rd/nccv.asp.

<u>Reference</u>: *Mote, P., A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: Northwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX. On the Web: http://nca2014.globalchange.gov/report/regions/northwest*

Climate Change: Effects to Salmon and Other Species

USFWS (2) Table J-3

NOAA produces a very thorough analysis of climate change impacts for Pacific Northwest salmonids and associated ecosystems, and we recommend that the Corps review these findings for analysis and incorporation into the FEIS. Excerpts from the main sections of the 2014 FCRPS Supplemental Biological Opinion that address climate and climate change and recent findings based on annual literature reviews is provided here:

http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fcrps/2014_fcrps_biop_climate_change_sections.pdf.

Specific sections for consideration include:

Section 2.1.4.1 (BiOp pages 152-167), recent climate patterns, with an emphasis on those relied upon in the 2008 Biological Opinion analysis, and comparing the observations with the 2008 Biological Opinion's analytical assumptions.

Section 2.1.4.2 (BiOp pages 168-182), new information on climate change and its effects on salmon and steelhead, updating reviews in the 2008 and 2010 Biological Opinions.

Section 3.9 (BiOp pages 435-442), reasonable and prudent alternative (RPA) actions that help to implement recommendations of the ISAB (2007) to reduce the impact of climate change on listed species.

Appendix D provides a collection of NOAA's literature reviews for impacts of climate change on Columbia River salmon including a review of 2012 literature (beginning on p. D-3), 2010 literature (beginning on p. D-51), and 2011 literature (beginning on p. D-109).

These include a stronger evaluation than, and, in some cases, alternate, findings than the DEIS on such topics as the impacts of climate change on the freshwater environment (e.g., stream flow, stream temperature), ocean conditions (upwelling, ocean acidification, temperatures), marine ecosystems and fisheries, and salmonids (both freshwater and marine impacts to processes and life stages).

SPECIFIC COMMENTS

Suggested edits made in FEIS- some sections revised again in reviews with USFWS

Executive Summary, Page 18, Last line. Replace "be" with "remain".

Executive Summary, Page 19, Paragraphs 1 and 2. We suggest a change in sentence structure to "If take levels increase in subsequent years under adaptive management, in year 2 under the adjusted 2-year lethal strategy, take levels could be as high as 0.4 percent of the regional population and 10 percent of the colony on East Sand Island." And "If take levels increase in subsequent years under adaptive management, in year 2 under the adjusted 2-year lethal strategy, take levels could be as high as 0.1 percent of the regional population and 20 percent of the population in the Columbia River Estuary.

Chapter 1, Page 4. Please clarify what constitutes the 67 percent stated in the following sentence, "The coastal states and provinces account for greater than 90 percent of the western population of DCCOs, with the majority of DCCOs breeding along the Pacific Coast (67 percent; Adkins et al., in press)"

Chapter 1, Page 5, Paragraph 2, last sentence. Revise sentence to state: "50 CFR 21.41-21.54 allow for take of migratory birds through permits or other means of authorization under certain conditions to minimize depredation."

Chapter 1, Page 5 and Chapter 3, Page 16. We suggest removal of Adkins et al., in press as a reference to "areas of decline or concern for continued decline (e.g., Salton Sea, California;

Adkins et al., in press, Pacific Flyway Council 2012)". Adkins et al. did not address Salton Sea declines.

Chapter 1, Page 25. Add "No new states were included." at the end of the paragraph.

Chapter 2, Page 22, Paragraph 3, Second Sentence. Change to "The majority (approximately 70%) of DCCOs have arrived….." This prevents a contradiction with the sentence that follows it.

Chapter 2, Page 23, Paragraph 1. "When determination of active nest loss cannot be made in the field or the date that active nests are first present on East Sand Island during a given year is unknown, the date range of March 27 to July 25 would be used to report associated nest loss." Add ", assuming 1 nest associated with 1 adult" to end of sentence.

Chapter 2, Page 26, Paragraph 3. The DEIS states that "proposed take levels could be adjusted if the peak observed annual colony size during late incubation deviates from predicted annual colony size (see Appendix E-2) greater than what is expected due to natural annual variation in colony size." This statement should be clarified to state that take cannot be higher than what would be authorized in a permit.

Chapter 3, Page 16 references Figure 4-2 in Chapter 4. This figure should be located in Chapter 3 where it is first referenced. We suggest adding it between Figures 3-8 and 3-9. Change figure numbers and reference links as needed.

Chapter 3, Page 22, Coastal Oregon. Revise last sentence to read "However, only 13 DCCO nests on Three Arch Rocks and 647 nests on Bolon Island were observed in 2013." Also, the Bald Eagle disturbance is limiting coastal seabird colonies, including breeding colonies of DCCOs. This should be addressed in the FEIS.

> *Reference: Hipfner, J. M., L. K. Blight, R. W. Lowe, S. I. Wilhelm, G. J. Robertson, R. T. Barrett, T. Anker-Nilssen, and T. P. Good. 2012. Unintended consequences: How the recovery of sea eagle Haliaeetus spp. populations in the northern hemisphere is affecting seabirds. Marine Ornithology 40:39-52.*

Chapter 3, Page 29, Paragraph 1. Please change 2008 to 2009. The final delisting rule was effective in December 2009.

Chapter 4, Page 14, Paragraph 2. Please add the description of added environmental factors associated with climatic change that are now expected. These factors many not have been present or prevalent ca. 1990 – ca. 2009.

Chapter 4, Page 19, Table 4-1. Please add the range of peak attendance and associated dates. Also include the years documented by the range values presented in the table.

Chapter 5. We suggest adding more specificity in timelines, e.g. the months each activity is expected to be performed.

Chapter 5, Page 3. Please describe how hazing triggers would be adapted. Add description and analysis in earlier chapters if necessary. Change "when appropriate" to "after the breeding season" for removal of temporary habitat modification materials. Boat-based hazing is mentioned. Please describe the purpose and location of boat-based hazing.

Chapter 5, Page 4. Describe the location of the on island culling prior to active nesting to DCCOs. It is unclear whether the designated and priority nesting areas are included or not.

Chapter 5, Phase II. The expected timeline to complete the Terrain Modification should be specified. It is stated in the DEIS that habitat modification will occur during the in-water work window. State the breeding season timeline to clarify there is no overlap. In other parts of the DCCO's western population range, these dates fall within the breeding season.

Table 5-5. Modifying the terrain should be included as an action.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE 11th Avenue
Portland, Oregon 97232-4181

In Reply Refer to:
FWS/R1/MBHP

Mr. Kevin Brice
Deputy District Engineer for Programs and Project Management
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208-2946

NOV 19 2014

Dear Mr. Brice:

The U.S. Fish and Wildlife Service (Service), as a cooperating agency, has reviewed certain comment letters forwarded from the U.S. Army Corps of Engineers (Corps). The Corps is seeking our technical assistance as these comments relate to double-crested cormorants. These comment letters were received by the Corps during their public comment period for their Draft Environmental Impact Statement for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (DEIS). Substantive comments specifically addressed the effects analysis in the DEIS describing potential effects to the western population of double-crested cormorants. Commenters stated that the effects analysis was inadequate and the proposed management action will likely cause greater effects than what was described in the DEIS. In particular, commenters stated that the EIS did not properly and fully consider colony declines in areas outside of East Sand Island, current and future threats to the species, realized and potential future habitat loss in geographic areas, and levels of persecution throughout their range.

Alternative C-1 included in FEIS

Based on our review of these comments, updated information recently made available to us, and reiterating concerns the Service provided to the Corps during DEIS development, the Service is recommending a modified alternative for incorporation into the FEIS. Below we provide our rationale and outline the modified alternative.

The study of the status of the western population of double-crested cormorants, which included data up through 2010 (Adkins et al. 2014) was the primary source of data considered in the DEIS's analysis of the potential effects to the western population. However, updated data (post-2010) is now available. Notably, the three most significant nesting areas in the western population now have uncertain but likely negative trajectories: East Sand Island (should the culling program outlined in the DEIS be implemented), Upper Klamath Basin (drought, water allocation issues), and the Salton Sea (drought, reduced water allocation). Specifically, double-crested cormorants have not successfully bred at the Salton Sea for the last three years. This colony site is land-bridged due to low water, resulting in complete reproductive failure due to predation or low food availability. Based on future climate forecasts, this land-bridged scenario is likely to remain, and thus, a complete loss of this colony site in future years is anticipated. The loss of this colony (over 4,000 breeding pairs), in addition to the increasing unavailability of habitat at Klamath Basin and proposed reduction of nesting habitat on East Sand Island should be included in the effects analysis to the western population of double-crested cormorants (i.e., in Chapter 4, Section 2.2 Effects to Double-crested Cormorants, Alternative C, Effects to the Western Population of Double-crested Cormorants).

In addition, colonies in coastal British Columbia, Washington, and southern California have been in decline for two decades. Since much of the initial growth in the East Sand Island colony was likely due to immigration from other colonies in the western population, especially those in British Columbia and Washington, and suitable nesting habitat continues to be lost (due to urbanization and climate change), it is likely that many of the remaining colonies are at or near carrying capacity.

Factors, threats addressed in FEIS, Section 4.4, App. E

Another limiting factor includes increasing bald eagle disturbance to coastal seabird colonies, including breeding colonies of double-crested cormorants (see Reference: Hipfner, J. M., L. K. Blight, R. W. Lowe, S. I. Wilhelm, G. J. Robertson, R. T. Barrett, T. Anker-Nilssen, and T. P. Good. 2012. Unintended consequences: How the recovery of sea eagle *Haliaeetus* spp. populations in the northern hemisphere is affecting seabirds. Marine Ornithology 40:39-52.). All of these factors affecting the overall western population of double-crested cormorants should be addressed in the Final EIS.

App. E model parameters for carrying capacity updated per suggestion and review comments inputted into model

In considering these comments and updated information, the Service recommends updating the double-crested cormorant western population model parameters associated with biological carrying capacity (Appendix E of the DEIS). Additionally, the Service requested a peer review to be conducted on the model by U.S. Geological Survey researcher, Michael Runge, an expert in population models. Dr. Runge has provided some recommended changes to the model to provide a stronger statistical foundation.

Specific Changes to the Double-crested Cormorant Western Population Model

The analysis of the effects to the double-crested cormorant western population in the DEIS assessed estimated population trajectories based on the Preferred Alternative. The model assumed a western population carrying capacity of 62,400 breeding cormorants based on the ca. 2009 western population estimate. Based on the updated data, we now consider that to be an unrealistic 20-year population projection. The combined effect of the proposed management action on East Sand Island (Alt C), the recent losses of the double-crested cormorant colony at the Salton Sea and Klamath Basin, and other potential habitat changes caused by climate change are expected to reduce the carrying capacity of the western population. We estimate a revised 20-year population projection of 50,958 individuals. We derived this number by estimating a loss of 50% of the breeding individuals at Salton Sea (2010 estimate of 8,368) and a loss of 50% of the planned reduction of breeding individuals at East Sand Island (Reduction from 10-year average colony size to target BiOp colony size is 14,516) [62,400 – (0.5 (8,368 + 14,516)) = 50,958]. A 50% reduction was selected because we expect that there could be some growth at other breeding sites or establishment at new sites in the future. Supporting this expectation is the observation that the estimated annual sums of breeding individuals across other western colonies, not including East Sand Island, have remained stable for the last 20 years, even when accounting for losses in portions of the range. Thus a re-distribution has taken place; some locations have declined while others have increased. Also of note is that the number of active colonies (also a measure of sustainability) has increased: In about 1990, Carter et al. (1995) noted 99 active colonies in British Columbia, Washington, Oregon and California. That number increased to 160 active colonies (2008-2012) for these same states and province (The Pacific Flyway Council, 2013).

FEIS App. E-1

The Service has forwarded the peer-review comments by Michael Runge and suggests the Corps update the model and description accordingly. Specifically, please update the estimate of the density-dependent parameter (*b*) for the East Sand Island population, by finding the value of *b* that maximizes the value of R^2. This would use the entire time series available, rather than just the first and last points. This change would provide a slightly stronger statistical foundation for the estimate.

The Service also suggests updating the modeled population trajectories at East Sand Island from a midpoint value between a constant carrying capacity scenario and a 20% reduction/year carrying capacity scenario to only using the constant carrying capacity scenario for management years 1-4, while accounting for the Phase II habitat reduction in year 4 and into future years. The reduction of 20% carrying capacity annually is not necessary since the Corps is not proposing to implement hazing to reduce nesting habitat availability on East Sand Island by 20%/year in years 1-4. Therefore, this reduction should not be accounted for in the East Sand Island population model.

Egg take evaluated in FEIS, Ch. 4 and App. E

In addition, the effects analysis in the DEIS seems to have overlooked the nest take associated with hazing on Upper Estuary Islands and East Sand Island (off the main double-crested cormorant colony site), i.e., the 750 egg take. A possible solution is to include the analysis of this take with the nest take associated with the recommended modified management'strategy described below.

Recommendations

After review of the substantive comments and updated data, the Service incorporated the updated data in the population model and conducted an updated analysis of the proposed take of an estimated total of 16,000-17,000 breeding individuals (current Preferred Alternative in DEIS) from the western population to identify potential effects to the long-term population trend of the western population (dotted line in Figure 1). Based on this updated analysis, the effects of the current Preferred Alternative to the western population of double-crested cormorants are estimated to be greater than that described in the DEIS. The Service, in its cooperating status role, is recommending a possible modified management strategy for the Corps to achieve its purpose and need as stated in the DEIS. This modified strategy should address the concerns raised in the substantive comments described above as well as additional comments that addressed the potential effects of killing a high number of non-target Brandt's and pelagic cormorants when implementing the lethal take of nearly 16,000 (or more) double-crested cormorants in the DEIS Preferred Alternative.

FEIS Alternative C-1, Chapter 5 FEIS

This modified management strategy of using a fully integrated individual culling, egg oiling, with non-lethal methods is expected to meet the BiOp target East Sand Island double-crested cormorant colony size by the end of 2018. The difference from the DEIS Preferred Alternative is that this strategy includes a lesser number of culled individuals with egg-oiling as a targeted means of nest removal. This modified strategy could lessen the potential effects to the short- and long-term population trend of the western population of double-crested cormorants by decreasing the number of adults that are lethally removed and thus increasing the ability for the population to recover from future catastrophic events. This modified strategy could also reduce the numbers of Brandt's and pelagic cormorants potentially misidentified and killed associated with the culling of double-crested cormorants since culling activities would be reduced. Additionally, no additional dispersal (as compared to Alt C) of adult cormorants is expected because this modified strategy does not rely on hazing of breeding individuals on East Sand Island and dispersal resulting from egg oiling activities are likely similar to what would be expected as a result of the culling activities described for Alternative C in the DEIS. Efforts to minimize dispersal to the Upper Columbia River estuary and neighboring states addresses concerns expressed by Tribes and States.

The Service also considered more extreme egg oiling with lower individual cull scenarios, however those strategies could result in increased cormorant dispersal, or remove all productivity from East Sand Island and increase risk of complete colony collapse. These potential effects are not preferred as the Service understands that there is an interest in not increasing the number of double-crested cormorants to up-river locations where they would most likely consume more salmonid smolts and that 5,380 to 5,030 breeding pairs would still inhabit East Sand Island in the long-term.

Modified Management Strategy Description/Comparison with Current Preferred Alternative (Table 1)

Key components are:

- Individual culling (13% of the breeding individuals and associated nests years 1-4)
- Nest oiling (additional 59% nest take years 1-3) on East Sand Island
- Hazing with limited egg removal off colony on East Sand Island to prevent satellite colony establishment
- Hazing with limited egg removal on Upper Estuary Islands to prevent satellite colony establishment

Individual take could occur on East Sand Island and overwater as described currently in DEIS Alt C but at a reduced amount. Egg oiling (up to four applications to ensure new eggs have been coated) could occur via use of backpack sprayers, with marking of individual nests to facilitate monitoring. Personnel doing the work would need to have the experience necessary to document and minimize disturbance to the breeding colonies of target and non-target birds. Adaptive management triggers still need to be refined, but would be based on those already presented in the DEIS for Alt C (Chapter 5). Hazing with limited egg removal on East Sand Island would only occur if double-crested cormorants are found to be using the eastern portion of the island, not within the main colony site. Hazing with limited egg removal on Upper Estuary Islands would still occur as described in the DEIS Alt C.

Suggested Monitoring Modifications:

- Additional monitoring of number of nests oiled and location.
- Disturbance triggers would use the culling of individuals triggers as a starting point in refining an egg oiling adaptive regime.
- Implement the monitoring strategy for the western population on an annual versus every-3-year basis for the entire implementation period (i.e. 4 years).

Effects - similar to Alt C, except:

- Likely reduced take of adult Brandt's or pelagic cormorants because of reduced overwater shooting.
- May have some differing disturbance to nesting birds on colony during egg oiling operations, but would expect lower effects as compared to shooting and retrieval of individuals culled.
- Possible misidentification of Brandt's cormorant nests during egg oiling operations if birds flush before confirmation of identification of adults on nests.
- The take of 750 nests in the Upper Estuary and satellite sites off the main colony on ESI would be included in the overall nest take (i.e., egg oiling) number.

- Long-term modeled projected effects of the modified strategy to the double-crested cormorant western population are similar to Alt C except the median population size is higher by 3,083 individuals after 4 years of management (dashed line in Figure 1). The long term effects of Alt C also is predicted to remain below the ca. 1990 population level for approximately 5 years longer than the recommended modified strategy.
- The lowest of the lower 95% CI points for the modified strategy is about 2,732 higher than Alt C. Alt C drops to a potential 95% CI low of 25,834 individuals; a 58% or greater drop from the ca. 2009 Status Assessment population estimates.
- All differences noted between the scenarios are within 95% CI of each other and the ca. 1990 level.

Table 1. Comparisons of the modified strategy and DEIS Alt C Preferred Alternative (after changes were made to the model as described above; lower double-crested cormorant western population carrying capacity and constant carrying capacity on ESI).

Action	**Modified Alt C**	**Alt C – Preferred Alternative**	**Difference**
Individual take (and associated nests)*	3,358 yr 1 3,010 yr 2 2,338 yr 3 1,845 yr 4 10,551 total	5,946 yr 1 4,741 yr 2 3,759 yr 3 3,120 yr 4 17,567 total	-7,016
Nest Oiling	5,940 nests yr 1 5,326 yr 2 4,136 yr 3 0 yr 4 15,403 total	0 0 0 0 0	+15,403 nests
Egg (nest) Removal in support of hazing on East Sand Island	Yes	Yes	none
Egg Removal in support of hazing on Upper Estuary Islands	Yes	Yes	none
Phase II habitat modification on ESI	Yes	Yes	none
Overwater shooting	Reduced	Yes	Reduction in potential effects to Brant's and pelagic cormorants, concern over carcass retrieval, and concern over public/contractor boat based interactions

* All numbers presented are estimates, need confirmation model runs

Adaptive Management Plan –Similar to Alt C., follow strategy identified in Chapter 5 and Table 5-2 with the change of wording from the action being Culling On-Island to Culling/Nest Oiling on Island. The triggers developed appear to cover the modified strategy. The Service will work with the Corps on developing potential modified take levels in years 2-4. The description will be based on how the observed data for the East Sand Island and western populations will be used annually to update the population models, and the thresholds to modify lethal management numbers/techniques. This full description is needed to ensure the potential effects to the western population is fully described in the Final EIS, reducing the need for supplemental analyses in the future.

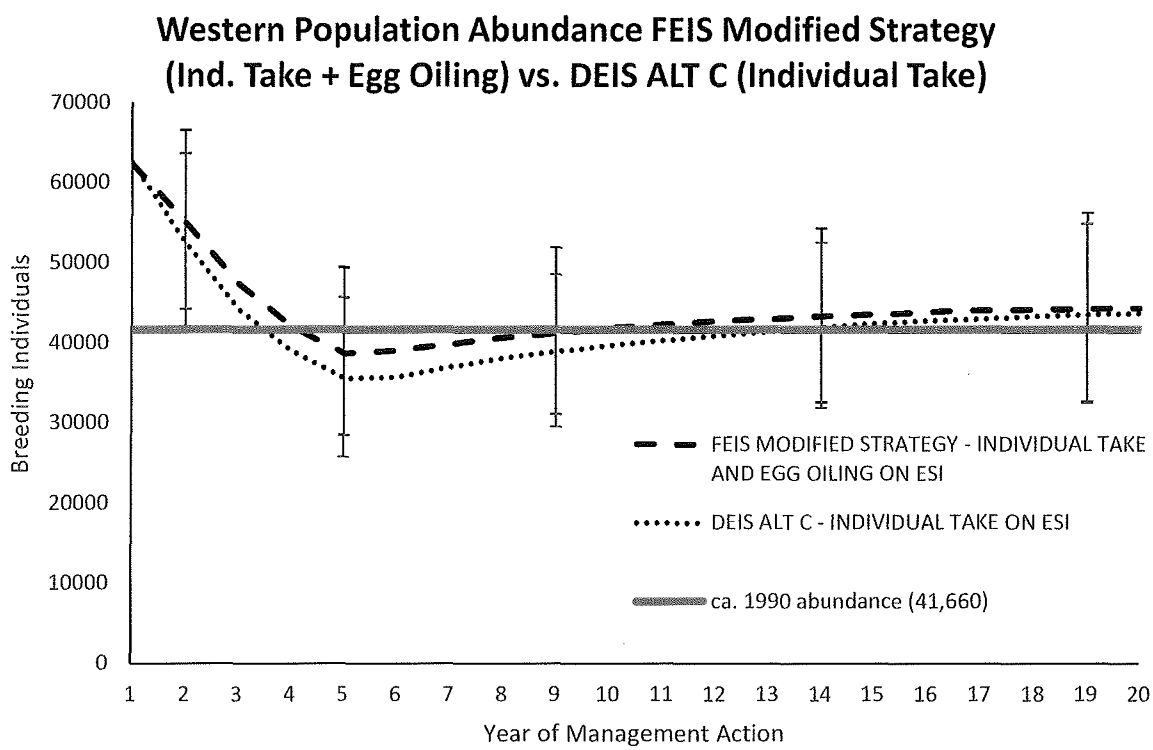

Figure 1. Double-crested cormorant western population abundance estimates through time comparing the modified strategy to DEIS Alternative C.

We will continue to work closely with the Corps on developing and incorporating the modified strategy into the FEIS. We acknowledge the hard and fast-paced collaborative work ahead to meet the Corps timelines and are up to the challenge.

Sincerely,

Deputy Regional Director

Sondra Ruckwardt June 27, 2014

U.S. Army Corps of Engineer District, Portland

Attn: CENWP-PM-E / Double-crested Cormorant draft EIS

P.O. Box 2946

Portland, OR 97208-2946

Ms. Ruckwardt,

My husband and I are residents on Puget Island in the Lower Columbia River. We view the US Army Corps recommended plan to improve Northwest Salmon runs as irresponsible and very short-sighted.

G-2, G-14

The plan to slaughter over 15,000 cormorants on East Sand Island & oil their eggs to reduce breeding success for a period of years to follow is a terrible misdirection of resources. Recent growth of this colony is a direct consequence of long-term government mismanagement in the Lower Columbia River, & it's impossible for Army Corps to guess the long-term outcome of such a drastic undertaking.

Even total elimination of the Double-Crested Cormorant cannot recover a century of Columbia River mismanagement by our State and Federal Governments.

We object to the plan based on the following reasons, and have listed a series of alternative actions to create a long-term Salmon Recovery in the Columbia River.

A. The Double-Crested Cormorant is a <u>protected species.</u>

B. The dams, hatcheries, over-fishing and dredging have taken a huge toll on the native salmon population.

G-21, G-22

C. The <u>ENDANGERED Streaked Horned Lark</u> will be nesting on East Sand Island DURING the scheduled massacre.

Alternative responsible options for long-term Native Salmon recovery:

G-2, G-3 FEIS Section 2.3

1. **Remove Dams:** ***Free-running rivers are a known solution for Native Salmon recovery, yet it is not even under consideration by the US Army Corps***. Their real interest is in protecting dams, not wildlife. US Army Corps should provide the public with a comprehensive study of the current cost of operating <u>**each existing dam**</u> in the Northwest, relative to the financial benefit that dam offers when carefully compared with every alternate energy solution possible in that specific region.

2. **Eliminate Hatcheries: Hatchery Salmon are not as resilient as Native Salmon, and though the numbers indicate recent increases, interbreeding has severely reduced the size of adults that return to spawn. Hatchery Salmon are proven to be more susceptible to disease and predation.**

a. **Better methods for raising Hatchery Salmon must be developed if Hatcheries continue to exist.** It's known that Hatchery Salmon spend more time near the top of the water than Native Salmon, making them easier prey for piscivorous birds. US Fish and Wildlife Service is not taking responsibility for this problem however. The top-feeding method currently used in hatcheries could be changed to an underwater feeding system, but instead the cheaper "solution" is to top-feed with "weighted food". The fish still leap to the top at the slightest ripple, so obviously that isn't working. Just go to any Hatchery and throw a handful of sand in the water to test this out.

2. **Eliminate Hatcheries:** (continued)

b. **Better methods for releasing Hatchery Salmon must be developed if Hatcheries continue to exist.** Transport methods currently used to release Hatchery Salmon cause a large percentage to die before they're released. (We've received reports of an "expected" 40% mortality rate from US Wildlife Biologists.) FWS repeatedly uses the same release sites at the same season, dumping a floating banquet for anything that eats Salmon. Piscivorous birds who've been conveniently provided an appropriate nesting site *(in the form of Army Corps dredge spoil islands)* right near the place this happens every year, are going to take advantage of the feast. It is not the birds who created this problem, and it's time for both Army Corps and Fish & Wildlife Service to take responsibility and change their procedures.

3. **Place a moratorium on ALL Salmon fishing including Native American Rights for a set period of years:** A simple moratorium on harvesting salmon for a few years is a better solution than the continuation of random short-term efforts. It's worth that sacrifice to renew our fisheries naturally. Fishermen and Native Americans alike should celebrate and rally for a responsible and realistic Native Salmon Recovery Plan. The fish KNOW where home is if we simply allow them to GET there. Redirect funds now spent on FWS Hatchery operations, Environmental Impact Studies, and unnatural "Wildlife Management" efforts, like murdering selected bird species, toward subsidizing Commercial Fishermen and Tribes during the Native Salmon Recovery period.

4. **Accept Dredge Spoil Responsibility:** Dredge spoil islands created by the US Army Corps of Engineers are trashing the Columbia. Leaving sand spoils undeveloped creates a natural imbalance, and appropriate post-dredge development is not being planned as part of the cost of this procedure. If the US Army Corps must create islands, they should take responsibility for planting native vegetation upon them to attract species that will be beneficial to the area.

G-21, G-22

5. **Before embarking on a massive single-species wildlife slaughter, FWS and Army Corps should perform an Environmental Impact Study on the effect the planned procedure will have on the <u>endangered</u> Streaked Horned Larks who nest on East Sand Island.** The results should be published and a comment period allowed so the people can have a say in deciding whether this plan is really the right thing to do.

Regards,

[redacted]

[redacted]

From: [redacted]
To: Cormorant EIS
Subject: [EXTERNAL] Comments on draft DCCO EIS CENWP-PM-E-14-08
Date: Monday, August 18, 2014 10:17:27 AM

The Vancouver Audubon Society offers the following comments on the draft Double-crested Cormorant (DCCO) Environmental Impact Statement, public notice CENWP-PM-E-14-08.

The favored planned action, Alternate C, and Alternatives B and D, which include lethal takes of DCCO, are neither reasonable nor prudent in the face of alternatives yet to be completely evaluated.

G-18, G-19, G-20

The EIS does not adequately consider impact on the Pacific Flyway Populations of Double-crested Cormorants. East Sand Island has accounted for about 40+/-% of the breeding pairs for the western population. Studies indicate the East Sand Island population has increased in part with the movement of DCCOs from other areas along the Pacific Flyway. What is to say that won't continue as the local population is culled? To reach the stated goal of 23,250 breeding pairs could require larger lethal takes under Alternatives B, C, and D to make up for the continued movement (influx) of birds from other sections of the Pacific Flyway. Thus there would be an even bigger negative impact on the Pacific Flyway populations. Although the data is not complete, Pacific Flyway populations are nowhere near historical levels estimated as an order of magnitude higher than current numbers.

The goal population for East Sand Island is based on the 1990 breeding pair numbers from which the local population was able to grow successfully to present day; therefore it was considered an adequate number. However, available food and habitat have changed in 24 years and it cannot be inferred that a similar population number would be sustainable in the near future. Also, since some of that increase was from immigrant DCCOs, and numbers outside the Columbia River area have decreased, it further puts doubt as to the sustainability of the local, regional and particularly Pacific flyway populations. Although DCCO predation is generally handled as a local issue, clearly the East Sand Island population is a key component of the larger Pacific Flyway populations. Culling this local population will have a severe impact on the overall health of the Pacific Flyway population.

G-21, G-24

An additional concern with the EIS plan is the acknowledgement that the shooting of Double-crested Cormorants (Alternatives C & D) could result in a 10% decrease in Brandt and Pelagic Cormorant populations in the East Sand Island areas due to misidentification during culling. Although this is the projected upper limit, at any level it is significant to the smaller populations of these birds in the area and is another reason why lethal take methods are not acceptable.

Alternatives:

We recommend instead, that the habitat on East Sand Island be altered to further decrease the breeding population locally and disperse the DCCOs in that particular area of the estuary. Taking a broader view of the issues across species, thoughtful altering of the habitat could have an additional benefit of attracting protected and endangered migrant birds which need mudflats and wetlands for feeding on marine species other than fish in this globally recognized Important Bird Area.

FEIS Section 2.3

In the Pacific Flyway Council. 2012. Pacific Flyway Plan, it is stated that alteration of fisheries management practices can reduce DCCO depredation. It is not clear in the Environmental Impact Statement that such methods as smolt release site, release timing relative to DCCO concentrations, timing relative to peak DCCO foraging (e.g. night as an alternative), dispersal of fish, or release during high water levels to decrease foraging efficiency of DCCOs have been sufficiently tried and thoroughly evaluated.

In addition, as discussed in the BioOp of 2014, Comprehensive Evaluation, Section 1, page 35, although transportation of fishery smolt has had a very good survival rate in the past, the use of this method has decreased in the last few years allowing for more in stream delivery of smolt. Though improvements in the system have closed the survival gap between transport and in-stream passage, it would appear there would be an immediate and continuous benefit to continue with transportation by truck and/or barge while less lethal methods of decreasing impact of DCCO predation are tried and evaluated.

G-16, G-4

We feel that management by culling to reduce local impact is a bad precedent. With the trending movement of Pacific Flyway birds north and changes in forage fish availability, other predators could be forced to alter their preferences and increase predation on salmonids also. Would our cheap and immediate response be to cull the eggs and shoot them too? Would a better goal be to provide for a sustainable salmonid population so it not only provides for the fishing industry, but for other species which use it as a food source too? People aren't the only fishers in the environment.

G-2

The focus of this EIS is survival of salmonids only, which admittedly is the purpose of the EIS for an endangered species. But, it does not properly consider the broader impacts on the complex ecosystem as demonstrated by the preferred Alternative C for decreasing DCCO predation. Thorough evaluation of methods for increasing successful release of salmonids, with broader consideration of impacts on other species, is critical to assure not only success for the fish, but that we do not endanger other populations of birds, mammals and fish through the effort.

Respectfully submitted for the Vancouver Audubon Society,

Susan M. Setterberg, Vice-President
Vancouver Audubon Society
P.O. Box 1966
Vancouver, WA 98668-1066
www.vancouveraudubon.org <http://www.vancouveraudubon.org/>

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Caring for
your natural resources
... now and forever

July 10, 2014

Ms. Sondra Ruckwardt,
U.S. Army Corps of Engineers, Portland District
Attn: CENWP-PM-E / Double-crested Cormorant Draft EIS
PO Box 2946
Portland, OR 97208-2946

Subject: CENWP-PM-E-14-08 Double-crested Cormorant Draft Environmental Impact Statement Comments

Dear Ms. Ruckwardt:

comments noted

Thank you for the opportunity to provide comments on the Double-crested cormorant plan to reduce predation of juvenile salmonids in the Columbia River Estuary Draft Environmental Impact Statement located in the Columbia River. The Department of Natural Resources (DNR) is steward of Washington's aquatic lands and their resources. Aquatic lands are managed for current and future citizens of the state to sustain long-term ecosystem and economic vitality, and to ensure access to the aquatic lands and the benefits derived from them. Washington DNR's management authority derives from the State's Constitution (Articles XV, XVII, XXVII), Revised Code (RCW 79.02 and 79.105) and Administrative Code (WAC 332-30). As proprietary manager of state-owned aquatic lands, DNR has been directed to manage the lands "…for the benefit of the public" in a manner that provides "…a balance of public benefits for all citizens of the state" that includes"

Encouraging direct public use and access

Fostering water-dependent uses

Ensuring environmental protection, and

Utilizing renewable resources.

In addition, generating revenue in a manner consistent with subsections 1) through 4) of this section is a public benefit (RCW 79.105.030).

PACIFIC CASCADE REGION ▮ 601 BOND RD ▮ PO BOX 280 ▮ CASTLE ROCK, WA 98611-0280
TEL (360) 577-2025 ▮ FAX (360) 274-4196 ▮ TTY (360) 902-1125 ▮ TRS 711 ▮ WWW.DNR.WA.GOV

To ensure sustainable management of state-owned aquatic lands, DNR has established environmental protection goals. These goals seek to ensure uses of state-owned land do not result in: shading that harms aquatic vegetation and fish migration; compaction, disruption, or impeding the natural movement of sediments; underwater noise that can disrupt important aquatic species when they are most vulnerable; or, release harmful contamination and waste. DNR is committed to working with applicants, in coordination with permitting agencies, to find ways to avoid impacts to aquatic habitats and species on state-owned aquatic land.

Following a thorough review of your proposal it appears that your project will not occur on state-owned aquatic lands. Therefore, no DNR authorization is required for your proposed activity and DNR has determined this project is unlikely to state-owned aquatic lands. However, as an adjacent landowner we have a vested interest in ensuring all non-targeted species are protected to the greatest extent possible if this management plan is implemented.

Again, thank you for the opportunity to comment on this important issue. If you have any questions or if I can be of assistance to you, please call me at (360) 740-6806 or email me at rick.schwartz@dnr.wa.gov.

DNR reserves the right to comment on future amendments and revisions to this proposal.

Sincerely,

Rick Schwartz

Rick Schwartz, Land Manager
Aquatic Resources Division/Rivers District

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Natural Resources Building · 1111 Washington Street SE · Olympia, WA

August 18, 2014

Sondra Ruckwardt, Project Manager
Attn: CENWP-PM-E-14-08 / Double-Crested Cormorant Draft EIS
U.S. Army Corps of Engineers, Portland District
Post Office Box 2946
Portland, Oregon 97208-2946

Dear Ms. Ruckwardt:

The Washington Department of Fish and Wildlife (WDFW) has reviewed the Draft Environmental Impact Statement for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (DEIS). As a Cooperating Agency, WDFW has participated in the development of portions of the DEIS and has provided extensive comments throughout the development process.

comments noted

As a result, WDFW understands how the approach described in preferred Alternative C will best meet the Corps' purpose and need, and we support addressing Double-crested cormorants (DCCO) take of salmonids as part of an All-H approach to salmon recovery. However, we believe that fundamentally the DEIS focuses too heavily on the metric of reduced DCCO and lacks a more comprehensive plan and associated analysis to evaluate salmonid survival, which should ultimately be the objective of this action.

WDFW(1)

We are pleased to see inclusion of our request to have the DEIS more clearly identify the scope of the project area and actions to address the possible impacts for each alternative in those areas, as well as the recognition of the need for monitoring to inform adaptive management responses. However, the details of the monitoring and adaptive management processes are insufficient in the DEIS and we note that the majority of our previously submitted comments have not been adequately addressed and therefore remain as concerns for WDFW. The primary areas that remain of concern to WDFW are as follows:

WDFW has on multiple occasions submitted our concern regarding the level of these monitoring efforts and who is responsible. Monitoring in Phase 1 of the Alternatives is limited outside of the estuary (e.g., coastal WA); however, Phase 2 and post action monitoring is inadequate and we believe does not address the potential DCCO response to management actions (especially given the most likely affected environment is the Columbia River Basin, the Washington Coast, and Salish Sea). In addition, the triggers for implementing adaptive management strategies have not been fully described and the adaptive management process is vague in terms of commitment, resources, and responsibility from the Corps and the Service to adequately fund and/or implement necessary monitoring, management, and research actions to achieve objectives. We believe monitoring and effective adaptive management strategies are essential to addressing long-term sustainability of DCCO and recovery of salmon populations.

WDFW(2)

The DEIS should assess the probability of DCCO dispersal based on appropriate data. WDFW does not agree with the Corps' conclusion that disturbed DCCO will necessarily remain in the Columbia River estuary. The non-lethal dissuasion studies conducted on East Sand Island did not restrict available nesting habitat or disturb DCCOs enough to lead to dispersal. It remains unclear how DCCOs with a drive to breed will respond to more aggressive dissuasion or lethal take methods. Hazing or culling a single colony of ground-nesting DCCOs as proposed has never been attempted; therefore, much is unknown. Understanding this situation and how to respond will require an adaptive response that will affect both Washington and Oregon, at the minimum. Thus, available data does not seem to support claims in the DEIS that dispersal of DCCOs from the Columbia River estuary is unlikely. Therefore, WDFW believes there is a reasonable likelihood that the preferred alternative will displace an unknown number of DCCOs from the Columbia River estuary, possibly into Washington.

WDFW(3)

The DEIS should adequately stress the potential conservation impacts of dispersing DCCOs on state-listed and other Species of Greatest Conservation Need. These species are of conservation concern on a state level, and could be at risk from increased mortality due to predation by DCCOs. In addition, the DEIS should adequately address the potential social and economic impacts of dispersing DCCOs in Washington.

WDFW(4)

Finally, the DEIS should reflect a cooperative, team-based effort. WDFW is very supportive of the Adaptive Management Team approach mentioned in the DEIS. However, it is unclear how this team will be effective if all team members are not able to provide input in a way that equitably distributes the decision-making response to the potential impacts from these management actions.

In support of or in addition to the major themes above, we have attached specific comments to the DEIS that we recommend be considered and addressed where appropriate before a final decision is made regarding the alternatives.

Sincerely,

Nate Pamplin
Assistant Director, Wildlife

cc: Guy Norman
Bill Tweit
Eric Gardner
Sandra Jonker

WDFW Specific Comments on the Draft Environmental Impact Statement for the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (DEIS)

August 18, 2014

Overall Document Comments:

WDFW(5)
- Under the no action alternative, the document suggests that the population of DCCO will continue to grow. But it has been stable for a number of years now.

WDFW(6)
- If the population of DCCO on East Sand is reduced by 5,380 to 5,939 pairs, what will be done to prevent the population on the estuary (as a collection of islands) from expanding in the future?

WDFW(7)
- The analysis in the Appendix that summarizes the impacts to the western population of the DCCO is not adequately summarized or considered in the document. Because DCCO appear to be highly philopatric to nesting colonies, perhaps the Corps should assemble spatio-temporal patterns in demographic rates (assuming they are available) and build a deterministic metapopulation model. This would get at the potential source-sink issue. WDFW understands that the growth of the colony has been significant, what if East Sand is an important source colony for the "western population".
    - A separate question about this modelling approach: should egg oiling and adult killing be included jointly as well as separately? Currently the preferred alternative proposes these two methods be used jointly.

WDFW(8)
- WDFW would like to see the western population of the DCCO defined from a true population definition (scientific definition not a popular definition). Defining this population is important in understanding/determining the impact of removing DCCO on the larger population of interest.

WDFW(9)
- WDFW would like to ensure that, if the DCCO are "dissuaded" and they settle on other islands on the lower Columbia (likely scenario based on previous dispersal after dissuasion), the impacts on other species like the streaked horned lark that nest on those islands are properly examined and that a mechanism is in place to respond accordingly. We note that this document does not have the most recent information on streaked horned lark nesting islands.

WDFW(10)
- The science underlying this document is not adequately referenced so it cannot be adequately evaluated.

WDFW(11)
- The assumption is not supported that if X number of cormorants are removed, there will be an equal response in survival by juvenile salmon. There are many reasons to suspect this won't be true. There are many direct and indirect effects in the system. WDFW recommends modelling the top-down and bottom-up influences on juvenile

salmon survival (e.g., Ecopath model). Because of indirect effects, the results on juvenile salmon survival could be different than the predicted linear relationship (other predators fill the void, other bottom up mortality factors become more important with an expanded juvenile salmon population).

WDFW(12)

- The DEIS should more thoroughly describe what the anticipated responses of adult salmon return rates would be if juvenile survival is increased by 3.6%? In other words, will the action result in more adult salmon? Instead, the focus is on juvenile salmon survival.

WDFW(13)

- WDFW is concerned about how uncertainty is portrayed (or not portrayed) in this document. Mean estimates are usually provided throughout and occasionally the uncertainty is presented. If it is presented, it is not defined and more often it is not presented. As a result, we don't understand the uncertainty and can't reach meaningful decisions. If, for example, the uncertainty is high in DCCO juvenile salmon predation rates, then our certainty in a population response by juvenile salmon is also highly uncertain.
    - For example: Table 4-2 from the document summarizes the potential juvenile survival benefits to selected salmon and steelhead ESUs/DPSs. In all cases, the range of potential benefits to juvenile salmon survival under the preferred alternative C ranges from 0-2% at the low end to a high of 2-9% at the high end. The expected (annual average) benefit ranges from 1-4%, again depending upon the species and unit. The executive summary focuses on annual average but does not provide the variation around these expected annual average benefits. This is the kind of uncertainty that needs to be clear to the reader up front in the executive summary so that they can make informed decisions. To evaluate the science, the reader needs to know how these estimates were derived.

Executive summary

WDFW(14)

- There seems to be a bias in how the data are presented. For example, in the introduction the authors state, "11 million juvenile salmonids being consumed on average annually and potential predation rates as high as 17 percent on particular salmonid groups within a given year". In this example and throughout the DEIS, the worst case example is often presented (17%) without the lowest estimate also being included.

WDFW(15)

- There is no variance (preferably 95% Confidence intervals) provided in the estimate of cormorant caused juvenile salmon mortality (e.g., 6.7 percent mortality).

WDFW(16)

- Why is dam mortality rate compared to cormorant mortality? It may be beneficial to include other sources of mortality.

WDFW(17)

- The caption for SS-1 does not provide enough information to interpret.

WDFW(18)
- Table ES-3: addresses species overlap. How are they overlapping (space, time)?

WDFW(19)
- Inconsistent use of the specific vs. general: auklet, gulls, falcons, and eagles vs. Caspian terns, Brandt's cormorants, pigeon guillemots, etc.

WDFW(20)
- "Streaked horned larks are the species of most concern off of East Sand Island". What does this mean? It is federally threatened under the ESA and it is state threatened in Washington.

WDFW(21)
- If the DCCO on East Sand is the largest in the "western population", is it a source for the other populations? Do we have any population modeling data to suggest any potential cascading effects associated with changing this population from a source (if it is?) to a sink?

WDFW(22)
- Alternative B: "the western population of double-crested cormorants would likely remain similar to, or decrease from, current estimates (approximately 31,200 breeding pairs) in the near term." This may not be true if the East Sand island colony is an important source for the rest of the west.

Main Document

WDFW(23)
- Throughout the document the Corps suggests that with the no action alternative, the cormorant population will continue to grow on East Sand. However, the data in figure 1-2 suggest that the population reached an asymptote around 2004, and consequently, has been stable since 2004. Has the "trend" been adequately analyzed? Similarly, and not surprisingly, the "trend" in juvenile consumption by DCCO may have also reached a peak.

WDFW(24)
- The Corps summarizes there is a bioenergetics model that estimated that the total annual smolt consumption by the East Sand Island DCCO colony (no citation provided) varied between 2.4 and 20.5 million smolts (mean = 11.0 million; Figure 1-3). Is this the variation in the mean annual estimates? Within year variation is provided in Figure 1-3 but not within year in Figure 1-4 and we don't know what measure of variation around the point estimates is being used. Therefore, the reader can't evaluate the variation around the point estimates.

WDFW(25)
- Average annual predation rate estimates derived from PIT tag recoveries at the East Sand Island: The DEIS should include a table summarizing the results, the citation, and the error associated with the estimates. Finally, if all salmon species are lumped together, how do these results compare to the bioenergetics model?

WDFW(26)
- Figures are not adequately labeled throughout the DEIS. As a result, the science cannot be evaluated. For example, in Figure 1-3, the individual bars are not labeled nor are the error bars and it is not explained how the average was determined in this figure. For some reason, we are apparently supposed to compare 2013 to other years? Why wasn't 2013 included in the "average"? Why is there no error associated with the average? There are similar concerns about nearly all of the figures.

WDFW(27)
- Factors influencing predation – are these actual factors or are these possibilities? In other words, has the causal link been made quantitatively?

WDFW(28)
- If "there was little connectivity to colonies east of the Cascade-Sierra Nevada Mountains or along the coasts of Oregon, southern California, or Mexico (Courtot et al. 2012)", then why is the "western population of DCCO defined as the breeding colonies "from British Columbia to California and east to the Continental Divide"? If the band recovery data are used, how would the "population" be defined? Is there any genetic data to inform this definition? This is an important consideration if we are concerned about the impact of reducing the East Sand colony to the larger "population" (however that is defined). If the population (as defined by genetics or banding) is a much smaller than the colonies included in the "western population", then the impact to that population by removing individuals could be even greater than portrayed in this document.

WDFW(29)
- FIGURE 1-7: The "base" and "current" periods appear arbitrary (based on the information provided). Additional explanation would be beneficial. It would be useful to look at linear or non-linear trends over time. If one is looking for a change, then there are many change detection approaches that could be applied to these data. If one were to move the "current period" two years earlier, there may be no difference (or very little) between the base and current.

WDFW(30)
- Ch 1 p.7: "Compared to the NOAA Fisheries analysis, other studies and analyses have documented much higher mortality rates from DCCO predation". Have other studies documented lower rates or does this statement reflect a complete literature review?

WDFW(31)
- Ch 3. P. 3: Figure 3-1. This table needs more description/clarification in text.

WDFW(32)
- Figure 3-2: If birds visit the colonies depicted in this image, then they might well settle there if dissuaded from East Sand. If this is the case, then the San Juan Islands and the Columbia River near Portland may be disproportionally affected.

WDFW(33)
- Ch 3. P 13: Anchovy is the primary fish consumed by DCCO on the lower Columbia River and DCCOs appear to have fairly broad diets. Based on this, what are the direct effects on other fish populations in the lower Columbia River caused by reducing DCCO numbers and, in turn, the indirect effects of the changes in those fish populations on juvenile salmon survival. Are any of the fish consumed by DCCO also juvenile salmon predators? Again, this is where a system level model would be helpful.

WDFW(34)
- Figure 3-11: We assume that this is the average number of young fledged per year (the caption doesn't say so). What are the error bars (SE, SD, CIs)? Where do the data come from?

WDFW(35)
- Figure 3-12: If these are estimates as the caption indicates, they have a variance, which should be presented.

WDFW(36)

- Ch. 3, p.32: Table 3-3 (the numbering on this table does not follow the previous table). Where do the breeding population estimates in this table come from? The lark estimate does not fit any published estimate that we are aware of (same in the text that follows). The rhinoceros auklet text below this figure is out of date. See Pearson et al. 2013. This numbers become important below when they are used to evaluate impacts of actions to other species. For example, the estimate of Brandt's cormorants is used to evaluate the impacts of the potential take to this species. Without information on where the information comes from, we cannot evaluate.

WDFW(37)

- Ch 4, p. 6: "However, overall direct or indirect adverse effects to DCCOs within the designated nesting area from actions taken under Alternative B are expected to be negligible and similar to effects during past research efforts. Productivity within the designated nesting area would likely remain similar to the average during 1997 to 2013 (i.e., 1.83 fledglings produced per breeding pair, see Figure 3-11)." If this is the case and the western population was growing with that level of output, wouldn't we expect the DCCO population along the Columbia River to grow after the initial reduction? In 10 years, we might be back in the exact same situation unless Columbia River wide hazing is done for a very long time. If not, is the Corps prepared to do similar reductions on other islands in the future? The timing of Phase II under the different alternatives is not described. Would this continue for 10 years, 20 years, indefinitely? What is the process for evaluating the effectiveness of Phase II?

WDFW(38)

- Figure 4-7: This image is illegible.

WDFW(39)

- Tables 4-2 and 4-3: This assumes a direct one-to-one relationship between a reduction in DCCO population and a reduction in juvenile salmon loss. This seems highly unlikely in the long-run given the complexity of the ecosystem. It is very important to understand how the information in this table was derived.

WDFW(40)

- Table 4-4: Uncertainty associated with this information is not presented.

Appendices

WDFW(41)

- Appendices: Many tables are presented with estimates but it is not clear how these estimates were derived.

WESTPORT CHARTERBOAT ASSOCIATION
P. O. BOX 654 • WESTPORT, WASHINGTON 98595

July 9, 2014

To: Sondra Ruckwardt
U.S. Army Corps of Engineer District, Portland
Attn: CENWP-PM-E-14-08/Double-crested Cormorant draft EIS
P.O. Box 2946
Portland, Oregon 97208 - 2946

Fr: Westport Charterboat Association
P.O. Box 654
Westport, WA 98595
Mark Cedergreen, Executive Director

Re: Support for Alternative C, Cormorant EIS

Thank you for the opportunity to comment.

Our Association is primarily dependent upon salmon production in the Columbia River system. Additionally, the impacts of not reducing the Cormorant salmon predation in the lower river affects much more of an area than just inside the Columbia River. Fisheries from southern Oregon to Alaska harvest Columbia River salmon. These fisheries are all governed to sustain natural populations of salmon in the Columbia and elsewhere. These fisheries are as legitimate as, legally entitled as, and as important as inside fisheries. Thus the impacts of bird
S-1 → predation on juvenile salmon are far reaching and don't appear to be included in the draft EIS.

comment noted → Bird predation impacts coastal community economic and social status to a very high degree. The consequences of not taking action, particularly that proposed in Alternative C, will be dire for a number fisheries and communities.

We urge you to put this plan into action as soon as possible.

Respectfully yours,

Mark Cedergreen

G-2, G-16

comments noted

Dear Sirs,

On behalf of Whidbey Audubon Society I am writing in regards to the Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Colombia River Estuary Draft EIS.

We have reviewed your proposed Alternatives, and with regret read that the Corp is considering Alternative C, which plans to kill about 16,000 Double-crested Cormorants, which is more then 25% of the entire western North American cormorant population. We understand the primary concern is the predation of juvenile salmon by the Double-crested Cormorants, however, these birds are doing what is natural, eating fish.

There are numerous and mostly HUMAN created reasons why juvenile salmon are endangered in this particular location, dams, pollution, and habitat loss to name just a few major reasons. To use Double-crested Cormorants as the reason salmon populations are in trouble is erroneous and very misleading.

Whidbey Audubon Society opposes the Corp's Alternative C which emphasizes lethal control and we strongly favor Alternative A, no action, until such time as the Corps and its partners can review and rebuild their strategy for management of avian predation on fish on a regional scale. This strategy needs to be based on sound science, fully employing and evaluating non-lethal measures of reducing avian predation, and considering a full range of alternatives beyond manipulating and controlling native wildlife.

"Culling" or killing 16,000 Double-crested Cormorants is not the answer to this problem, surely, we humans can do better than this when faced with this problem.

We request Whidbey Audubon Society be notified of any actions regarding this Management Plan.

Respectfully,

Anna Swartz
President, Whidbey Audubon Society

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"Promoting compassion, empathy and respect for all life through wildlife rehabilitation, ecological teachings and non-lethal / non-invasive conservation monitoring of wildlife and environmental health"

August 19, 2014

Attn: CENWP-PM-E-14-08

Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary
Draft Environmental Impact Statement

Submitted via e-mail: Cormorant-EIS@usace.army.mil

Sondra Ruckwardt, Project Manager
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, OR 97208

In Support of Alternative A – No Action proposal

comments noted

Wildlife Center of the North Coast (herein "WCNC") files this correspondence as a public comment with respect to the *"Draft Environmental Impact Statement – Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary"* (herein "DEIS").

WCNC strongly opposes the lethal control of piscivorous avian species on East Sand Island, at hydroelectric dam reservoirs and tailraces, within the Columbia Plateau and along the Oregon coast.

WCNC finds the DEIS is lacking in vital scientific information and does not support the preferred Alternative "C" because:

1) Bioenergetics and Annual Baseline Stomach Contents Data

G-5, G-7

The DEIS does not provide sufficient science-based information to allow independent public review, analysis and submission of meaningful comments on the bioenergetics modeling used to quantify the purported impact of DCCO predation on juvenile salmonids.

S-10

Specifically, the DEIS fails to provide the "individual" (not pooled) stomach contents data of species-specific salmonids obtained from cormorants lethally collected from 1998 through 2013. This raw data provides the basis for bioenergetics modeling of annual DCCO salmonid consumption within the Columbia River estuary which in turn directs the course of management decisions.

At the 2012 USACE scoping meeting, WCNC raised concerns over the accuracy of the computer code created for bioenergetics modeling. On December 3, 2012, WCNC submitted a FOIA request to USACE Portland Office for DCCO raw stomach data and computer coding. USACE Portland office closed our FOIA request with a "no records" response. Notwithstanding that the DCCO raw stomach data may not be required under USACE contracts, the data is used to direct the government's salmon recovery / avian management actions. This scientific data should be considered public domain and made available through the USACE FOIA process.

WCNC also requested DCCO raw stomach data at each of the 2014 Portland and Astoria open house sessions. At the 2014 Astoria open house, USACE personnel indicated that they "were working on" obtaining the baseline information. In a recent meeting with the USACE, et. al., the Audubon Society of Portland also requested the raw stomach data. Our expectation was that the raw data would be made available to interested parties within the public comment period which has not been the case.

With respect to public access under Oregon Public Records law, ORS Section 192.501 states:

> ***ORS § 192.501[1]***
> ***Public records conditionally exempt from disclosure***
>
> ***The following public records are exempt from disclosure*** *under ORS 192.410 (Definitions for ORS 192.410 to 192.505) to 192.505 (Exempt and nonexempt public record to be separated) unless the public interest requires disclosure in the particular instance: ….*
>
> *(15) Computer programs developed or purchased by or for any public body for its own use. As used in this subsection, computer program means a series of instructions or statements which permit the functioning of a computer system in a manner designed to provide storage, retrieval and manipulation of data from such computer system, and any associated documentation and source material that explain how to operate the computer program.* ***Computer program does not include:***
>
> *(a)* ***The original data, including but not limited to numbers, text, voice, graphics and images;***
>
> *(b) Analyses, compilations and other manipulated forms of the original data produced by use of the program; or*
>
> *(c) The mathematical and statistical formulas which would be used if the manipulated forms of the original data were to be produced manually."*

Based on the foregoing, we concur that the OSU bioenergetics computer program (Excel spreadsheet) is exempt from disclosure but the original data (in this case the raw stomach contents) is not considered proprietary under Oregon law.

The premise behind management of indigenous avian piscivores is their purported impact on juvenile salmonids. If the science and methodology behind the highly publicized cormorant predation calculations are flawed, then the USACE and cooperating agencies have validated the argument that the birds are merely scapegoats to deflect attention from human caused impacts. Suppressing underlying information in an effort to prohibit public scrutiny creates an atmosphere of public distrust and hints of conspiracy. The impact of the preferred Alternative "C" will have significant consequences for the local and western region DCCO population. It is presumptuous to assume that certain segments of the public will blindly accept statistics contained in the DEIS when the ability to independently review and analyze salmonid predation data is not provided.

2) Bioenergetics Computer Code

S-2 thru S-9

WCNC has received DCCO raw stomach data from Oregon Department of Fish & Wildlife **which considers that information to be public domain**. That raw stomach data was obtained from the 2012 lethal collection of cormorants in Tillamook Bay. ODFW has also committed to provide WCNC with DCCO raw stomach data from their 2013 coast-wide lethal collection. That information will be available in September/October 2014.

Using the 2012 ODFW Tillamook Bay raw stomach data, Gary Shugart, PhD, Slater Museum of Natural History at University of Puget Sound re-created the existing OSU computer code used to calculate DCCO impacts on juvenile salmonids. Gary Shugart has submitted thought provoking comments to this DEIS regarding evaluation of the bioenergetics formula. WCNC fully supports his findings and by reference herein incorporates Gary Shugart's comments into this WCNC comment letter.

3) Columbia River Estuary Salmonid Population.

G-5

The DEIS contains Appendix "D" (which is a copy of Appendix "E" of the 2014 FCRPS Supplemental Bi-OP) Appendix "D" reflects NOAA calculations of the purported 3.6% salmonid survival gap presumably caused by DCCO predation. The science supporting that calculation is lacking and provides no basis for review, analysis or meaningful comment.

Appendix "D" states:

> *"All smolt population data (1998-2012) are from annual smolt population estimate memos issued by the NOAA Northwest Fisheries Science Center (Schiewe 1998-2002, Ferguson 2003-2010, Day 2011, Zabel 2012).*
>
> *Appendix 3 lists the specific data used for this analysis for each year. The species-specific population data were derived from the estimated smolt population arriving*

at Tongue Point in the estuary. These numbers are provided in the memos for full transport and spill with transport scenarios, thus the conditions that occurred for the year in question had to be determined before the best estimate was chosen." (2014 Bi-Op)

G-3, G-5, G-7

It appears that copies of referenced memos and underlying support documents are not available to the public. Appendix "D" only contains a summary of the salmonid estuary populations. Data of DCCO diet and predation rates for 15 years of the "base period" and four years prior to the "current" period do not exist and are calculated using generalized estimates. DCCO population data in the Columbia River estuary prior to 1997 is limited. Computation of the 3.6% gap was not subject to independent peer review. Factors leading to annual variables in predation rates were not included, (i.e., river conditions, hydroelectric dam operations, spill, flow, fish water transit time, outmigration timing, salmonid body size and condition). In personal communication with fisheries statisticians at the Fish Passage Center, WCNC was informed that estimated estuary salmonid populations are computed by NOAA Fisheries without confidence intervals or detailed discussion of all of the assumptions that are contained in the annual estimates making it problematic and impossible to assess the validity of those population estimates.

Smolt consumption and smolt population are two of the three data sets used to determine the extent of purported DCCO impacts and development of management decisions.

> *"The key data sets for this analysis are the estimates of **smolt consumption**, estimates of **cormorant population** and estimates of **smolt population**."* (2014 Bi-Op)

To reiterate, it is presumptuous to assume that certain segments of the public will blindly accept statistics contained in the DEIS when the ability to independently review and analyze base scientific data is not provided. Based on the magnitude of the proposed DCCO lethal removal, the DEIS does not support the preferred Alternative "C" because the science behind the purported 3.6% gap is lacking. Salmonid estuary statistics should be validated by NOAA Fisheries with documentation that is robust and allows the public to re-create the computation process.

4. The DEIS fails to provide independent peer-reviewed science that directly attributes reduction of the DCCO estuary population with an increase in estuary salmonid survival and a resulting increase of SARs.

> "***Despite over a decade of study by scores of biologists, scientific uncertainty remains regarding the significance of avian predation on juvenile salmonids in the Columbia River estuary****. We now know that millions of smolts are consumed by Caspian terns and double-crested cormorants on an annual basis in the Columbia River estuary and that this predation constitutes a significant mortality rate: 7 – 15%, depending on species and life history type. This level of mortality is comparable or greater than the impacts of many other anthropogenic factors in the freshwater environment and is a significant proportion of the estuary/ocean mortality all anadromous salmonids endure*. ***Determining the significance of this mortality at the*** **juvenile life history stage on adult population size has remained problematic, however."** (Don Lyons et al. 2010, p. 250)

G-9, G-10, G-11, G-23

5. Although cursory feasibility studies to remove a portion of the DCCO estuary colony have been conducted, non-lethal methods have not been fully explored or tested. Prior habitat restriction and relocation studies have been shown to be feasible but a lack of resolve by USACE and cooperating agencies together with obvious impatience to quickly reduce the estuary cormorant population resulted in abandonment of additional non-lethal trials. DCCO management action should not occur until all non-lethal options have been exhausted. The RPA requiring DCCO management under the current Bi-Op should be removed, thus lifting the 2018 management goal deadline.

G-17, G-18, G-19

6. A reduction of 25% of the entire western region DCCO metapopulation is reckless and irresponsible with unknown ramifications. The negative consequences on target and non-target species on East Sand Island cannot be measured. It is safe to assume that once the shooting begins, the momentum will spiral out of control. Additional "collateral damage" to mis-identified species, mortality to eggs and chicks or full abandonment of the colony site by cormorants or other species cannot be forecast. DCCO nesting colonies outside of East Sand Island are in decline or have been abandoned. The North American western DCCO population is currently below historical levels. In addition, the future of the East Sand Island environment is in transition with intense and significant Bald Eagle predation and disturbance. Newcastle Disease affects this specific DCCO local population every-other-year and the future impact of that disease cannot be determined.

Alternative Options

The DEIS Appendix "D" memorandum of Gary Fredrick, NOAA Fisheries dated December 9, 2013 calculates the 3.6% gap and includes the following language:

S-12, G-2

> ***"While this shortfall (or gap) can be addressed with any action that improve productivity,*** *it is logical that cormorant management objectives assist in this goal."*

WCNC has significant concerns that underlying data used to measure avian impacts on salmonids is flawed and that substantial repercussions will occur to DCCO and Caspian Tern metapopulations if the current course of government management continues. The preferred Alternative "C" calls for killing up to 25% (16,000) of the western region DCCO population. This aggressive and lethal direction in DCCO management is disturbing and supports a consistent pattern of dismissal and disregard by the USACE and cooperating agencies for the well being of a wide range of avian piscivore species including DCCO and Caspian Terns.

NOAA acknowledges that the purported DCCO smolt survival gap of 3.6% ***"can be addressed through any action that improves salmon productivity".*** In support of that statement, following are a number of opportunities by which the productivity goal could be accomplished by means other than killing piscivorous avian species.

I) Spill Program

comments I-XV noted, see S-12 for response and FEIS Section 2.3

Fish Passage Center (FPC) Memorandum dated 9/6/2012

Subject: **The History of Spill and Planned Spill Programs in the Federal Columbia River Power System, 1981 to 2011**

> *"VIII. Summary: From the historic record it is evident that spill has become a more important tool in the recovery of listed stocks. Major modifications to spill over the time period addressed in this compendium include* ***expanding spill to all hydroprojects in the FCRPS; implementing a "spread the risk" transportation policy at transport collector dams by providing spill simultaneously with transport operations; providing spill in low runoff volume years, and the provision of spill during the summer months.***
>
> *Some of the recently recognized benefits of spill passage include the following:*
>
> ● ***Increasing proportion of spill provided for fish passage at hydroelectric projects has resulted in higher juvenile spring/summer Chinook, fall Chinook, sockeye and steelhead survival and faster juvenile fish travel time through the FCRPS.***
>
> ● *Increasing spill proportion provides mitigation for low flows through the hydrosystem.* ***In observations of years with similar flow and water travel time, juvenile fish survival and fish travel time are improved in years with higher average spill.***
>
> ● *Spill proportion and water travel time (i.e. flow) are correlated with smolt-to-adult return rate.* ***Increasing spill proportion and faster water travel time (i.e. higher flow) result in higher smolt-to-adult return rate.***
>
> ● *Fresh water passage conditions affect early ocean survival.* ***Spill proportion and water travel time affect ocean survival of Chinook and steelhead.***
>
> ● ***Increasing spill proportion allows a higher proportion of downstream migrants to avoid power house passage.*** *Powerhouse passage through juvenile bypass systems decreases smolt-to-adult return rates.*
>
> ● ***Direct estimates of project survival do not capture the delayed mortality effect of project passage and therefore underestimate project impact on juvenile survival and adult return.***
>
> ● ***Model simulations indicate that juvenile survival could be significantly increased and juvenile fish travel time could be decreased by increasing spill proportion in low flow periods."***

View entire articles at: http://www.fpc.org/documents/FPC_memos.html

■ **Fish Passage Center (FPC) Draft 2013 Annual Report (Spill)**

> ***"The purpose of providing a spill program is to improve the downstream passage survival of juvenile salmonid stocks by providing a route associated with reduced project passage delay and with less direct and delayed mortality relative to powerhouse***

***bypass or turbine passage**. Spill is also used to provide an alternate route for fish at transportation collector projects, allowing an increased proportion of juvenile salmonids to migrate in-river to below Bonneville Dam. Presently, **this "spread the risk" management option is employed since transportation does not provide the survival to adulthood needed for population recovery** (Tuomikoski et al., 2013) for ESA listed spring/summer Chinook, steelhead, sockeye and fall Chinook.*

*The Comparative Survival Study (CSS) has conducted analyses comparing the survival of fish that pass a hydroelectric project undetected at a transportation collection site (C0) in the Snake River versus fish that have passed through a bypass (C1). **The smolt-to-adult return rates (SARs) indicate that bypassed juvenile Chinook and steelhead appear to have a lower SAR than undetected in-river migrants that did not pass through the powerhouse juvenile bypass system,** with the magnitude of those differences varying across years (Tuomikoski et al., 2009, 2010, 2011, 2012, 2013). **The addition of the most recent data to the historic CSS time series continues to show the importance of spill and flow for in-river juvenile survival and SARs** (Haeseker et al., 2012).*

***Additionally, recent analytical results of salmon life-cycle survival modeling indicate that spillway passage affects survival throughout the life cycle. Chinook adult returns declined with multiple passages through powerhouses at dams** (Petrosky and Schaller, 2010, Schaller et al., 2014). **Analyses conducted by NOAA Fisheries in the development of the Biological Opinions showed that smolt-to-adult return rates for Chinook and steelhead were related to arrival time at Bonneville Dam, and that multiple bypass passage reduced SARs** (Scheurell and Zabel, 2007).**"** ….*

View entire articles at: http://www.fpc.org/documents/FPC_Annual_Reports.html

II) In-River Environment and Survival

Comparative Survival Study (CSS) 2013 Annual Report
CHAPTER 3 - **"EFFECTS OF THE IN-RIVER ENVIRONMENT ON JUVENILE TRAVEL TIME, INSTANTANEOUS MORTALITY RATES AND SURVIVAL"**

… "**In this chapter we continue the process of summarizing and synthesizing the results that have been obtained to date through the CSS on the responses of juvenile yearling (spring/ summer) and subyearling (fall) Chinook salmon, sockeye salmon and steelhead to conditions experienced within the hydrosystem. **These analyses evaluate the effects of management actions on fish travel times and in-river juvenile survival probabilities, while directly accounting for model uncertainty, measurement uncertainty, and environmental variation. …

"Discussion
In this analysis we provided an extensive synthesis of the patterns of variation in juvenile yearling and subyearling Chinook, steelhead and sockeye fish travel time and survival within the hydrosystem. In addition to these commonly-used metrics of fish travel time and survival, we also developed and reported estimates of instantaneous mortality rates, along with estimates of precision for those rates. We observed substantial variation in mean fish travel time, survival,

and instantaneous mortality rates both within- and across-years.

Across the species and reaches that were evaluated, some consistent patterns emerge. ***Model-averaged coefficients and relative variable importance values indicated that fish travel time is fastest when WTT is reduced (i.e., higher water velocity) and spill levels are high. These results reflect the responses to the conditions that fish experience as they migrate through the series of reservoirs and dams in the hydropower system. The effect of WTT most likely influences the amount of time required to transit the reservoirs, with faster WTT resulting in faster fish travel time through the reservoirs. Faster WTT may also influence the amount of time required to migrate through the forebay, concrete, and tailrace areas of the dams. The effect of spill percentages most likely influences the amount of time required to migrate through the forebay, concrete and tailrace areas of the dams themselves. In the case of steelhead and subyearling Chinook, we found evidence that as the number of dams with surface passage structures has increased, fish travel times have declined, but there was less evidence of this for yearling Chinook.***

There are also consistent patterns in terms of the factors that tend to influence the instantaneous mortality rates. Model-averaged coefficients and relative variable importance values indicated that the instantaneous mortality rates tend to be lowest under conditions of higher spill levels. In addition, mortality rates tend to increase over the migration season and with water temperature. Potential mechanisms for lower mortality rates with increasing spill levels include reduced forebay and tailrace predation levels as spill levels increase and increased spillway passage route proportions and reduced turbine passage route proportions with increased spill levels.

Potential mechanisms for the pattern of increasing mortality rates over the migration season and with water temperature could include declining smolt energy reserves or physiological condition over the migration season and with water temperature, increasing predation rates on smolts over the migration season and with water temperature, increases in disease susceptibility or disease-related mortality over the migration season and with water temperature, or some combination of these often interrelated mechanisms*.*

We found some evidence that the increased number of dams with surface passage structures in the spillways may be reducing mortality rates. It is interesting to note that there was an indication that **mortality rates of sockeye appear to decline with increasing water temperatures** *(Figure 3.7).*

These results indicate that improvements to fish travel time, mortality rates and survival may be possible through management actions that reduce WTT and increase spill percentages. There are only two means for reducing WTT: reducing reservoir elevations and/or increasing flow rates. Currently, only the reservoirs in the lower Snake River are maintained near their minimum operating elevations during the fish migration season. The McNary, John Day, The Dalles and Bonneville projects all operate several feet above their minimum operating elevations during the fish migration season. <u>Even without a change in flow levels, the data indicate that there is opportunity to reduce fish travel time and increase survival through this reach if these four projects were to operate at their minimum operating pools.</u>

The data also indicate that there is ***opportunity to reduce fish travel time and increase survival throughout the FCRPS through increases in spill levels up to the tailrace dissolved gas limits. Currently, none of the projects voluntarily operate up to the dissolved gas limit spill levels on a 24-hour basis.*** *If all the projects were to do so, the data indicate that fish travel times are expected to be reduced, and as a consequence survival probabilities would be expected to increase.* ***…***

The essence of adaptive management is ***implementing experimental management actions and monitoring the biological responses to*** *those management actions. The PIT-tagged fish that are released annually provide a reliable means for monitoring these types of adaptive management experiments. One recent example of an adaptive management experiment is the implementation of court-ordered summer spill at the Snake River collector projects.* ***The PIT-tag data revealed a dramatic improvement in travel time and survival for subyearling fall Chinook salmon following the implementation of court-ordered summer spill.***

Similar adaptive management experiments, ***such as reducing WTT*** *in the MCN-BON reach or dissolved gas limit spill operations on a 24-hour basis, could reveal similarly dramatic improvements for yearling and subyearling Chinook, steelhead and sockeye. We see these models as powerful tools for continued development, evaluation, and refinement of alternative hypotheses on the effects of various environmental and management factors on smolt survival probabilities and migration rates.* ***…***

When the mortality rates are standardized on a per reservoir-dam sub-reach, ***yearling Chinook mortality rates were 8%–15%, steelhead mortality rates were 11%–16%, and subyearling Chinook mortality rates were 11% per reservoir-dam subreach.*** *These estimates have important implications in terms of measuring performance of fish passage mitigation actions implemented within the hydrosystem.*

Currently, the dam performance is assessed based on survival estimates from the upstream face of a dam to a reference site in the tailrace. The survival performance standards have been set at 96% survival (equivalently, 4% mortality) for spring migrants (yearling Chinook salmon and steelhead) and 93% survival (equivalently, 7% mortality) for summer migrants (subyearling Chinook salmon). To date, most of these survival standards have been met. However, given that the per reservoir dam mortality rates have averaged 8%–16% for spring migrants and 11% for summer migrants, it appears that a substantial proportion of the overall mortality is being missed under the performance standards monitoring system."

View entire article at:
http://www.fpc.org/documents/CSS/CSS_2013_Annual_Report_rev1b.pdf

III) River Conditions

"Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook salmon and steelhead"
(Petrosky and Schaller, 2010)

Abstract:
"*Improved understanding of the relative influence of ocean and freshwater factors on survival of at-risk anadromous fish populations is critical to success of conservation and recovery efforts.* ***Abundance and smolt to adult survival rates of Snake River Chinook salmon and steelhead decreased dramatically coincident with construction of hydropower dams in the 1970s.*** *However, separating the influence of ocean and freshwater conditions is difficult because of possible confounding factors. We used long time-series of smolt to adult survival rates for Chinook salmon and steelhead to estimate first year ocean survival rates. We constructed multiple regression models that explained the survival rate patterns using environmental indices for ocean conditions and in-river conditions experienced during seaward migration.* ***Survival rates during the smolt to adult and first year ocean life stages for both species were associated with both ocean and river conditions. Best-fit, simplest models indicate that lower survival rates for Chinook salmon are associated with warmer ocean conditions, reduced upwelling in the spring, and with slower river velocity during the smolt migration or multiple passages through powerhouses at dams. Similarly, lower survival rates for steelhead are associated with warmer ocean conditions, reduced upwelling in the spring, and with slower river velocity and warmer river temperatures. Given projections for warming ocean conditions, a precautionary management approach should focus on improving in-river migration conditions by increasing water velocity, relying on increased spill, or other actions that reduce delay of smolts through the river corridor during their seaward migration."***
(End Abstract)

"***One effect of increased impoundment has been to slow the velocity of water and thus slow the outmigration of smolts to the estuary*** *(Raymond 1979, 1988; Berggren & Filardo 1993; Schaller et al. 1999, 2007).* ***Slowed outmigration may increase exposure to predation and higher temperatures during migration, increasing energetic costs, and result in poorly timed estuary entry relative to a smolt's physiological state and to the environmental conditions during early ocean residence, which affect mortality during the smolt migration and probably influence mortality in subsequent life stages*** *(Budy et al. 2002; Muir et al. 2006). …*

This study advanced the understanding of the role of river conditions during seaward migration and ocean conditions on SARs and marine survival rates of Snake River Chinook and steelhead. This advanced understanding will be valuable to inform which actions taken inland will provide the greatest benefits for these at-risk populations. The large declines in these populations following FCRPS completion was not accompanied by major survival rate decreases in the spawner to smolt stage (Petrosky et al. 2001; Wilson 2003; Yuen & Sharma 2005; Budy & Schaller 2007). ***For both species, we found evidence that SARs and marine survival rates were impacted by conditions in the migratory corridor associated with FCRPS development and operation. Results of this study considerably contribute to improved understanding of how seaward migration conditions in the FCRPS have influenced SARs during varying ocean conditions.***

Given this decrease in SARs, the NPCC (2009) emphasis on achieving SAR goals in the face of varying ocean conditions is critical for recovery. Our analysis suggests that it will be extremely difficult to achieve the NPCC goal of 2–6% SARs without modifying river conditions in the FCRPS.

Given projections for degrading ocean conditions (i.e., global warming), our analysis suggests that ***a precautionary management approach would focus on improving in river migration conditions by reducing WTT, relying on increased spill to reduce passage through powerhouse turbines and collection ⁄ bypass systems, or other actions that would increase water velocity, reduce delay at dams and substantially reduce FTT through the FCRPS."***

IV) Hydrosystem-Related Delayed-Mortality

"Assessing Freshwater and Marine Environmental Influences on Life-Stage-Specific Survival Rates of Snake River Spring–Summer Chinook Salmon and Steelhead."
(Haeseker, et al, 2012)

Abstract:
"*Pacific salmon Oncorhynchus spp. from the Snake River basin experience a wide range of environmental conditions during their freshwater, estuarine, and marine residence, which in turn influence their survival rates at each life stage. In addition,* ***researchers have found that juvenile out-migration conditions can influence subsequent survival during estuarine and marine residence, a concept known as the hydrosystem-related, delayed-mortality hypothesis.***

We also conducted correlation analyses to test the hydrosystem-related, delayed-mortality hypothesis. ***We found that the freshwater variables we examined (the percentage of river flow spilled over out-migration dams and water transit time) were important for characterizing the variation in survival rates not only during freshwater out-migration but also during estuarine and marine residence. Of the marine factors examined, we found that the Pacific Decadal Oscillation index was the most important variable for characterizing the variation in the marine and cumulative smolt-to-adult survival rates of both species.*** *In support of the hydrosystem-related, delayed-mortality hypothesis, we found that freshwater and marine survival rates were correlated, indicating that a portion of the mortality expressed after leaving the hydrosystem is related to processes affected by downstream migration conditions.* ***Our results indicate that improvements in life stage-specific and smolt-to-adult survival may be achievable across a range of marine conditions through increasing spill percentages and reducing water transit times during juvenile salmon out-migration."***
(End abstract)

"*The development and operation of the FCRPS dams and reservoirs has drastically altered freshwater migration habitat conditions,* ***which has resulted in reduced freshwater survival and delayed migration timing of juvenile Chinook salmon and steelhead*** *(Raymond 1988; Williams et al. 2001; Budy et al. 2002; Muir et al. 2006; Williams 2008).* ***For both species, measures of smolt-to-adult survival rates (SARs)***

also decreased coincident with development and operation of the FCRPS *(Raymond 1988; Schaller et al. 1999; Schaller and Petrosky 2007; Petrosky and Schaller 2010). …*

"Beginning in 2003, after these declines in abundance and smolt-to-adult survival became evident, the Northwest Power and Conservation Council (NPCC) adopted a goal of achieving SARs averaging 4% and a minimum of 2% for listed Snake River and upper Columbia River salmon and steelhead (NPCC 2003, 2009). ***The NPCC (2009) highlighted the need for identifying the effects of ocean conditions on anadromous fish survival so that this information can be used to evaluate and adjust inland actions. …***

"RESULTS
The SAR estimates for both species were well below the NPCC (2009) goal of SARs averaging 4% and a minimum of 2%. The average SAR for Chinook salmon was 0.59% and the average SAR for steelhead was 0.61%."

V) Delayed Mortality

Fish Passage Center (FPC) Memorandum dated January 19, 2011 to Tom Lorz, CRITFC
"Effects of passage through juvenile powerhouse bypass systems at main stem dams on the Snake and Columbia Rivers"

"In response to your request regarding effects of passage through main stem powerhouse bypass systems, the FPC staff reviewed available data and analyses. Our overall conclusions are listed below followed by a more detailed discussion. In addition we have attached previous analyses and reviews which address the question of effect of passage through juvenile bypass systems.

- ***Evidence from several independent analyses indicates that passage through powerhouse bypass systems results in significant delayed mortality of juvenile salmon and steelhead that reduces adult returns.*** *(FPC memorandums attached; October 6, 2010, February 3, 2010, May 21, 2009)*

- ***In addition to increasing levels of delayed mortality, passage through powerhouse bypass systems has also been shown to increase juvenile migration delay.***

- *Estimates of direct, route-specific survival do not account for delayed mortality effects that can be quantified with adult returns. Additionally, route-specific survivals do not incorporate the effects of migration delay in terms of decreased survival.* ***Therefore, route-specific estimates underestimate the cumulative effects of powerhouse passage on life-cycle survival of salmon and steelhead.***

- ***Based on these recent analyses, minimizing juvenile passage through powerhouses would reduce migration delay, reduce delayed mortality and improve adult return rates. Applying these results to project operations, increasing spill levels to dissolved gas limits would minimize juvenile passage through powerhouses and improve adult returns."***

View entire article at: http://www.fpc.org/documents/FPC_memos.html

VI) Dam Mortality

Fish Passage Center (FPC) Memorandum dated March 9, 2012 to Val Wedman, GeoSense
"Comparison of fish mortality via spillways and turbines"

> *"There is a significant body of information regarding individual experiments that address salmonid survival through turbines and spillways routes of passage at various projects. This memo does not attempt to provide you with a complete annotation of those references, but the Fish Passage Center Library houses a large number of these studies and you are welcome to use that resource.*
>
> *The most important points to note from the collective body of this research are:*
>
> ● ***The highest rate of mortality at a hydroproject is generally associated with turbine passage.***
>
> ● ***Spill is considered to be the safest route of passage at a project and is used to mitigate for turbine mortality.***
>
> ● ***The benefits of spill extend beyond the at-project improvements in survival.***
>
> *Hydroelectric Project Passage: When fish approach a hydroelectric project they can either enter the powerhouse or continue migrating downstream by passing over the spillway. Upon entering the powerhouse fish either pass through a turbine unit or are mechanically collected and bypassed downstream without passing through the turbines.* ***Reviews of studies of downstream passage for salmon at hydroelectric projects in the Columbia River basin found higher mean mortality at turbines than for spillways or bypass systems. The potential mechanisms of mortality during turbine passage may include pressure changes, cavitation, shear, turbulence, strike, or grinding*** *(Ham et al., 2005).*
>
> *Employing the use of spill for juvenile migrants has long been used as an effective management tool for improving passage survival of migrating juvenile salmon at mainstem hydroelectric projects.* ***Routing smolts through spillways at hydroelectric projects in the Columbia and Snake rivers is generally considered to be the safest passage strategy, when compared to the passage survival through bypass systems and turbine routes. Some juvenile mortality and injury is associated with all routes of dam passage, but turbines generally cause the highest direct mortality rates—generally ranging between 8 and 19 percent. Juveniles passing through project spillways, sluiceways and other surface routes generally suffer the lowest direct mortality rates, typically losses are 2% or less*** *(Ferguson et al. 2005, NOAA Technical Memoranda NMFS-NWFSC-64).*

When considering the benefits of spill passage it is important to recognize that the benefits of spill aren't completely captured in the point estimates of at-project passage survival. The benefits of spill extend from the improvement in forebay passage all the way through the tailrace of a project, and extend to the adult life stage.

A significant rate of juvenile mortality (approximately 3-5%) can occur in project forebays, just upstream of the dams *(Axel et al. 2003; Ferguson et al. 2005; Hockersmith 2007),* ***where fish can be substantially delayed (median of 15-20 hours) before passing through the dam*** *(Perry et al. 2007).* ***Hansel et al., (1999) showed that in general, yearling chinook salmon and steelhead that arrived in the forebay when no spill occurred tended to delay. …***

"Spill is an effective tool in decreasing the amount of delay experienced by fish in forebays and tailraces of dams where predator populations and predation rates are highest. …

*"****Dispersal of Predators Spill establishes a large flow net with increased velocity that disperses predators from the forebay and tailrace areas thus reducing the potential for predator/prey interactions*** *(Faler et al., 1988).* ***...***

*"****High spill volume and water velocity push water and presumably juvenile salmonids out of the immediate tailrace, and help redistribute piscivorous predators (northern pikeminnow) away from the immediate spillway tailrace, reducing potential predation opportunities*** *(Faler et al. 1988)****….***

"Spill patterns that facilitate rapid juvenile egress from the spillway stilling basin through the tailrace likely increase juvenile survival. ***Current spill patterns are developed to increase the survival of juvenile fish through tailraces, by emphasizing minimizing hydraulic cover and maintaining high water velocities near spillway shorelines.*** *To not interfere with daytime adult passage, these juvenile spill patterns are often employed during nighttime hours only (COE, 1999; NOAA 2000).*

Survival to Adult Life Stage: ***There has been a growing body of research indicating that both freshwater and marine factors are important in determining survival to adulthood of Chinook salmon and steelhead. This is particularly true in river systems where the freshwater habitat is highly influenced by anthropogenic factors*** *(Schaller and Petrosky 2007; Petrosky and Schaller 2010). Haeseker et al., 2012****, identified spill as having measureable on survival during juvenile out-migration, and on survival during the ocean-adult period for both Chinook salmon and steelhead."***

View entire article at: http://www.fpc.org/documents/FPC_memos.html

VII) Fish Passage Operations

Fish Passage Center (FPC) Memorandum dated March 25, 2014 to Ed Bowles, ODFW

"Recent data and analyses indicate that current fish passage operations can be improved and established processes do not facilitate incorporation of recent data and analyses into management decisions."

> ***"****In response to your request the Fish Passage Center staff has developed the following summary of fish passage operations that are presently implemented* ***which could be modified to benefit and improve fish passage. These modifications have been repeatedly recommended to the action agencies by the fishery managers through the process of developing the Fish Passage Operations Plan (FOP), and through the in-season technical management team process.***
>
> ***Each of the current operations is based upon data and analyses that were completed subsequent to the 2008 Biological Opinion (BiOp). The continuous implementation of each of these specific operations, without consideration of recent data and analyses, precludes full implementation of court ordered spill for fish passage and effectively creates a "death from a thousand cuts" scenario, in which small individual operations can cumulatively result in adverse fish passage conditions.***
>
> ***Apparent in this review of operations is an unrelenting effort by action agencies to reduce spill for fish passage. The refusal to consider new technical data and analyses establishes a quandary for fish passage. Although significant technical issues have been raised regarding the at-dam performance standard approach and performance standard testing, the action agencies rationalize reductions in spill for fish passage and rejection of recommendations to improve fish passage, on the basis that the performance standards are being met.***
>
> *The overall conclusions of our review are listed below followed by specific discussion of individual operations that could be modified to benefit fish passage.*
>
> ***• The "adaptive management" language of the Biological Opinions could support operations improvements based upon recent data and analyses of fish passage.***
>
> ***• The existing organizational management processes have not resulted in modifications of implementation of recommendations that are based upon recent data and analyses.***
>
> ***• Although significant technical concerns have been raised regarding operations and actions, the concerns have not been addressed and operations have not been modified.***
>
> ***• Planned spill programs are proving to be one of the most important tools in the arsenal used in the recovery of endangered species. Spill improves the downstream passage survival of juvenile salmonid stocks by providing a passage route associated with reduced project delay, and with less mortality relative to powerhouse bypass or turbine passage. These benefits translate into improved survival to adulthood*** *(Schaller and Petrosky 2007; Petrosky and Schaller 2010; Haeseker et al. 2012)****.***

***** The court-ordered spill program has been steadily reduced since its implementation in 2006.* *****

Conclusions:
The history of operations since the 2005 court order (requiring all projects to spill to the gas cap) show a steady decrease in protection for fish. Although many changes have occurred in small increments, the cumulative effect is significantly reduced spill, which may lead to higher turbine and juvenile bypass passage, increased direct mortality, and increased latent mortality.

The best available data is often not used in the decision-making process, to the detriment of improving fish passage."

View entire article at: http://www.fpc.org/documents/FPC_memos.html

VIII) Fish Operation Plan (FOP)

Fish Passage Center (FPC) Memorandum dated February 24, 2012 to ODFW
"Draft 2012 Fish Operation Plan"

"While it is true that the 2012 FOP is basically a roll-over of 2011 operations, it does not mean that the provisions included in the FOP represent the best interest of fish protection or consistent with the adaptive management elements of the 2008 FCRPS Biological Opinion or the 2010 FCRPS Supplemental Biological Opinion. *The roll-over process is not responsive to adaptive management objectives described in the introduction of the FOP. There are several items that are maintained in the FOP that continue to be included since they are considered to be a roll-over of past years' implementation.* ***Given what is presently known about spill passage and the link to adult survival, the 2012 FOP should reflect adaptive management changes considered to improve fish survival. We have provided comments and identified issues that have been previously raised regarding past FOPs and presented new data that would justify the recommendations. Our recommendations for inclusion in the 2012 FOP include using the adaptive management objectives of the FOP for improvements in fish survival, rather than rolling-over present operations." …***

View entire article at: http://www.fpc.org/documents/FPC_memos.html

IX) Density Dependent

"The density dilemma: limitations on juvenile production in threatened salmon populations"
(Walters, et al, 2013)

Abstract:
"Density-dependent processes have repeatedly been shown to have a central role in salmonid population dynamics, but are often assumed to be negligible for populations

at low abundances relative to historical records. *Density dependence has been observed in overall spring/summer Snake River Chinook salmon Oncorhynchus tshawytscha production, but it is not clear how patterns observed at the aggregate level relate to individual populations within the basin. We used a Bayesian hierarchical modelling approach to explore the degree of density dependence in juvenile production for nine Idaho populations.* ***Our results indicate that density dependence is ubiquitous, although its strength varies between populations. We also investigated the processes driving the population-level pattern and found density-dependent growth and mortality present for both common life-history strategies, but no evidence of density-dependent movement.*** *Overwinter mortality, spatial clustering of redds and limited resource availability were identified as potentially important limiting factors contributing to density dependence.* ***The ubiquity of density dependence for these threatened populations is alarming as stability at present low abundance levels suggests recovery may be difficult without major changes. We conclude that density dependence at the population level is common and must be considered in demographic analysis and management."***
(End Abstract)

"Density dependence theoretically allows populations to be resilient to stressors such as human exploitation; however, if stressors also reduce capacity, populations may become trapped in a lower productivity state *(Peterman 1987).* ***…***
The idea that there are insufficient resources due to nutrient limitation also has proponents (Achord et al. 2003). … ***In the Pacific Northwest, it is estimated that returning spawners supply only 6–7% of the historic load of marine-derived nutrients*** *(Gresh et al. 2000)* ***resulting in nutrient-limited streams*** *(Sanderson et al. 2009).* ***…***

"Two popular management techniques, population supplementation with hatchery fish and restoration of spawning habitat, will be ineffective if juvenile clustering is not addressed. … Renovation of spawning habitat is also ineffective unless adults colonise restored areas, and there is sufficient rearing habitat available. Indeed, Petrosky et al. (2001) found that the productivity rate (smolts per spawner) of the aggregated Snake River spring/summer Chinook salmon populations did not change significantly between the 1962 and 1999 brood years, indicating that the quality of currently occupied habitats has not changed greatly in the last few decades. …

"In summary, effective conservation and management of these populations will require a thorough consideration of density dependence. … Density in spawning reaches affects growth of all juveniles, which in turn affects survival of parr emigrants downstream and overwinter survival of smolt emigrants before they start their movements in spring. There are several reasons why density dependence could be occurring. Of these, habitat loss and degradation are being addressed, while further research is needed into the role of resource availability, spatial clustering and life-history trade-offs due to predation risk."

X) Juvenile Fish Condition

"Relationship between Juvenile Fish Condition and Survival to Adulthood in Steelhead"

(Evans, et al, 2014)

Abstract:
"*Understanding how individual characteristics are associated with survival is important to programs aimed at recovering fish populations of conservation concern.* ***To evaluate whether individual fish characteristics observed during the juvenile life stage were associated with the probability of returning as an adult, juvenile steelhead Oncorhynchus mykiss from two distinct population segments*** *(DPSs; Snake River and upper Columbia River)* ***were captured, photographed to determine external condition (body injuries, descaling, signs of disease, fin damage, and ectoparasites), measured, classified by rearing type (hatchery, wild), marked with a PIT tag, and released to continue out-migration to the Pacific Ocean during 2007–2010****. The PIT tags of returning adults were interrogated in fishways at hydroelectric dams on the lower Columbia River 1–3 years following release as juveniles.* ***Juvenile-to-adult survival models were investigated independently for each DPS and indicated that similar individual fish characteristics were important predictors of survival to adulthood for both steelhead populations.*** *The data analysis provided strong support for survival models that included explanatory variables for fish length, rearing type, and external condition, in addition to out-migration year and timing.* ***The probability of a juvenile surviving to adulthood was positively related to length and was higher for wild fish compared with hatchery fish. Survival was lower for juveniles with body injuries, fin damage, and external signs of disease. Models that included variables for descaling and ectoparasite infestation, however, had less support than those that incorporated measures of body injuries, fin damage, and disease. Overall, results indicated that individual fish characteristics recorded during the juvenile life stage can be used to predict adult survivorship in multiple steelhead populations."***
(End Abstract)

Results from this study also indicated that after accounting for differences in fish length, external condition, and out-migration timing, ***hatchery fish were less likely to survive to adulthood than were wild fish, especially in SR steelhead.***

The most parsimonious models predicting juvenile-to-adult survival for SR steelhead and UCR steelhead included both individual-level variables and population-level variables (year and out-migration timing). Differences in return rates by year have been attributed to differences in river conditions (temperature, flow), hydroelectric dam operational strategies (spill, juvenile fish transportation), and ocean conditions *(Sandford and Smith 2002; Scheuerell at al. 2009; Haeseker et al. 2012).*
In addition to annual differences in survival, ***results presented here also indicated that early migrating SR and UCR steelhead were significantly more likely to return as adults than were juveniles that migrated during the peak or late out-migration periods. Sandford and Smith (2002) hypothesized that early migrating juveniles may experience optimal ocean foraging conditions and reduced predation during out-migration.***

Petrosky and Schaller (2010) found ***that juvenile-to-adult survival was associated with water velocities, whereby return rates were highest for groups of fish migrating during high flow events, which often occurs during the early and peak out-migration periods.*** *Haeseker et al. (2012) found that* ***adult survival rates were associated with water***

transit times, spill patterns, and ocean conditions experienced by juvenile SR steelhead, all of which vary by year and outmigration timing.

*Despite the importance of individual-level variables in describing survivorship to adulthood****, results of this study indicated that managing for optimal fish characteristics (condition, size, and rearing type) may not by itself increase steelhead survival above target juvenile-to-adult thresholds in all years. In years when survival was very poor (e.g., 2007), juvenile-to-adult survival was below the minimum 2% goal for nearly all steelhead sampled, regardless of fish condition, size, rearing type, and outmigration timing. In years when survival was higher, however, variation in return rates was much greater, and opportunities to further increase survival above stated survival goals through management may exist. For example, management efforts to increase flows to reduce water transit times so fish reach the ocean more quickly could increase survival*** *(Scheuerell et al. 2009; Haeseker et al. 2012).* ***Efforts to reduce fish injury rates by modifying dam and dam operational strategies*** *(Johnson et al. 2000; Muir et al. 2001; Ferguson et al. 2007),* ***along with efforts to reduce disease and disease transmission*** *(Loge et al. 2005; Arkoosh et al. 2006)* ***may also increase adult returns. Finally, increasing the size and overall health of out-migrating juveniles may bolster adult return rates of steelhead and perhaps other anadromous salmonids."***

<u>XI) Hatchery Genetic Integrity</u>

"Loss of Genetic Integrity in Hatchery Steelhead Produced by Juvenile-Based Broodstock and Wild Integration: Conflicts in Production and Conservation Goals"
(Bingham, et al, 2014)

Abstract:
"We examined whether a supplementation program for steelhead Oncorhynchus mykiss in southwestern Washington ***could produce hatchery fish that contained genetic characteristics of the endemic population from which it was derived and simultaneously meet a production goal.*** *Hatchery fish were produced for three consecutive years by using broodstock comprised of endemic juveniles that were caught in the wild and raised to maturity, and then the program transitioned to an integrated broodstock comprised of wild and hatchery adults that returned to spawn. Importantly, some auxiliary conservation-based husbandry protocols were attempted (i.e., pairwise mating between males and females) but not always completed due to insufficient broodstock and conflict between production and conservation goals.* ***The hatchery met production goals in 6 of 9 years, but wild-type genetic integrity of hatchery fish was degraded every year.*** *Specifically, we analyzed 10 microsatellites and observed a* ***60% reduction*** *in the effective number of breeders in the hatchery (harmonic mean of hatchery, Nb = 45, compared with the wild, Nb = 111).* ***Hatchery fish consequently displayed reduced genetic diversity and large temporal genetic divergence compared with wild counterparts. To ensure the benefit of conservation-based husbandry, spawning protocols should be based on scientific theory and be practical within the physical and biological constraints of the system. Finally, if conservation issues are considered to be the most important issue for hatchery propagation, then production goals may need to be forfeited."***

(End Abstract)

"Recent evidence suggests that hatchery programs that incorporate wild fish into broodstock pose a lower fitness cost to adjacent wild populations than do segregated programs *(Araki et al. 2007; Hess et al. 2012);* ***however, there is less support for the use of integrated programs to maintain wild-type effective sizes and patterns of genetic diversity*** *(Verspoor 1988; Tessier et al. 1997;Wang and Ryman 2001; Christie et al. 2012; but see Eldridge and Killebrew 2008).* ***Changes to these later genetic parameters in hatchery fish could reduce the long-term viability of supplemented natural populations despite short-term fitness benefits*** *(Waples 1991; Waples and Do 1994).* ***The "Ryman–Laikre effect," whereby a few hatchery fish with high reproductive success (high fitness) provide a demographic boost to a wild population at the expense of a decrease in the inbreeding effective size*** *(Ryman and Laikre 1991),* ***has recently been shown to be a possible explanation for apparent fitness benefits at the expense of Ne and genetic diversity*** *(Christie et al. 2012).* ***New research on broodstocks that maintain both fitness and wild-type effective sizes and genetic variation would help identify hatchery culture practices that provide for the long-term viability of natural populations. …***

"*CONCLUSIONS*

Despite substantial conservation-based husbandry efforts, hatchery steelhead rapidly diverged from the wild component. Four significant management-based conclusions can be drawn.

First, juvenile-based broodstock conjoined with equal-family contribution and pairwise mating did not produce F1 hatchery offspring with wild-type genetics. In contrast, the juvenile-based broodstock itself seemed to reasonably represent the genetics of wild fish. Thus, the mating scheme did not capture the effective size and diversity of the juvenile-based broodstock population or natural reproduction.

Second, the number of wild fish used as broodstock had significant positive effects on genetic diversity and effective population sizes of hatchery fish. Prior to implementing husbandry focused on increasing wild spawners in broodstock, however, managers should weigh the possible impacts of "broodstock mining" and "Ryman–Laikre" effects.

Third, the literature review conducted in this study highlights that inconsistency in the ability of conservation-based husbandry to mitigate for genetic consequences could partially stem from the diversity of conditions, practices, and goals present in conservation-oriented supplementation programs.

We therefore recommend that critical information regarding gene flow between the hatchery and wild components, and also information on demography (e.g., number of spawners, sex ratios), be presented and considered (e.g., similar to data we show in Table 1) to allow more conclusive inferences across studies.

Finally, the AFTC hatchery management plan was designed to meet production and conservation goals with no real knowledge regarding its ability to obtain sufficient

broodstock or to implement conservation-based hatchery protocols. To ensure the benefit of conservation efforts, major logistical issues need to be seriously considered. Foremost, spawning protocols should be based on both realistic expectations for the availability of spawners and on scientific theory *(Mobrand et al. 2005; Paquet et al. 2011). Finally****, if conservation issues are determined to be the most important issue for hatchery propagation, then production goals may need to be forfeited."***

XII) Hatchery Supplementation

"Effective size of a wild salmonid population is greatly reduced by hatchery supplementation"
(Christie, et al, 2012)

Abstract:
"Many declining and commercially important populations are supplemented with captive-born individuals that are intentionally released into the wild. These supplementation programs often ***create large numbers of offspring from relatively few breeding adults, which can have substantial population-level effects. We examined the genetic effects of supplementation on a wild population of steelhead*** *(Oncorhynchus mykiss)* ***from the Hood River, Oregon, by matching 12 run-years of hatchery steelhead back to their broodstock parents. We show that the effective number of breeders producing the hatchery fish*** *(broodstock parents; Nb)* ***was quite small*** *(harmonic mean Nb¼25 fish per brood-year vs 373 for wild fish****), and was exacerbated by a high variance in broodstock reproductive success among individuals within years. The low Nb caused hatchery fish to have decreased allelic richness, increased average relatedness, more loci in linkage disequilibrium and substantial levels of genetic drift in comparison with their wild-born counterparts. We also documented a substantial Ryman–Laikre effect whereby the additional hatchery fish doubled the total number of adult fish on the spawning grounds each year, but cut the effective population size of the total population (wild and hatchery fish combined) by nearly two-thirds. We further demonstrate that the Ryman–Laikre effect is most severe in this population when (1) 410% of fish allowed onto spawning grounds are from hatcheries and (2) the hatchery fish have high reproductive success in the wild. These results emphasize the trade-offs that arise when supplementation programs attempt to balance disparate goals (increasing production while maintaining genetic diversity and fitness)."***
(End Abstract*)*

"We also documented a Ryman–Laikre effect (Table 3), in which ***the effective population size of the entire population is reduced due to the hatchery program. On taking the harmonic mean for 11 brood-years and setting the RRS equal to 1, the effective number of breeders for the entire population was 36.5% of the effective number of breeders.***

We further illustrated that <u>allowing more than one hatchery fish for every 10 returning wild fish onto the spawning grounds</u> led to a substantial reduction in the overall effective number of breeders *(Table 3). … Clearly, if the goals of supplementation are to bolster the wild population, then allowing only one hatchery fish access to the* *spawning grounds per 10 wild fish will yield little demographic benefit considering that an equivalent number of wild fish were removed from the population to be used as broodstock.* ***Allowing more hatchery fish onto the spawning grounds, however, would decrease the effective population size, which is also at odds with conservation goals….***

Although it often occurs, the practice of allowing all returning hatchery fish onto spawning grounds without the careful monitoring of important genetic parameters (for example, Nb) could have large impacts on the long-term conservation of that population *(for example, genetic variation important for future adaptation could be rapidly reduced).*

In this population, we further documented that ***the effective size of the total population decreased as the reproductive success of the returning hatchery fish increased, which is due to hatchery fish with higher reproductive success having a greater contribution to subsequent generations*** *(see Equation (3)).* ***This result is also at odds with the goals of some supplementation programs, which aim to create fish that have reproductive success equal to their wild counterparts. …***

In conclusion, we found that a contemporary supplementation program greatly reduced the effective size of a wild population. These results further illustrate that different conservation goals can be at odds with each other in a supplementation program. *For example, the small Nb of hatchery fish created in a supplementation program can have unintended genetic consequences, but bringing more wild individuals into the breeding program can also have negative consequences for the population.* ***Furthermore, adding more hatchery fish to the population may temporarily increase the census size, but can drastically decrease the effective population size. Thus, we recommend that (1) programs that release large numbers of captive-born individuals into the wild be rigorously monitored, and that (2) more consideration be given to balancing the competing goals of increasing the census size of the population (while minimizing domestication) and preserving the wild population's genetic diversity."***

XIII) 2013 Draft FCRPS Supplemental Bi-Op (now 2014 Bi-Op)

Fish Passage Center (FPC) Memorandum dated October 7, 2013 to Ed Bowles, ODFW
"Review Comments, 2013 Draft FCRPS Supplemental Biological Opinion"

"In response to your request the Fish Passage Center (FPC) staff have reviewed the hydrosystems operations portion of the NOAA 2013 Draft FCRPS Supplemental Biological Opinion (herein referred to as Draft BIOP) and the three supporting documents: ***…***

Although Skalski, et al. (2013) and Manly (2012) are presented by NOAA as the primary foundation for elements of the Draft BIOP, or at least retaining the status quo, these documents were not available for public review until September 16, 2013, after half of the public review period for the Draft BIOP had passed, although previous requests for those documents had been submitted to NOAA.

Our overall conclusion is that the hydro systems operations sections of the Draft BIOP reduces fish passage protections and does not incorporate new data, analyses, and knowledge that have been gained since the 2008 version of the Biological Opinion was completed. In this way the Draft BIOP provides less than the previous Biological Opinion in fish protection.

*The Action Agencies and NOAA have contracted with consultants, Skalski et al. 2013, Manly 2012, BioAnalysts, Inc., and Anchor QED, 2013****, for analyses intended to support the Draft BIOP, therefore maintaining, or in some cases reducing, the present status quo in fish protections in the Draft BIOP. Our review of these specific documents concludes that they do not provide a reasonable or technically sound basis for excluding new data and analyses from the Draft BIOP.***

These recent data and analyses clearly indicate ***that some of the fundamental components of the 2008 and Draft BIOP should be reconsidered, specifically the at-dam performance standards and spill for fish passage.*** *In the following we have organized our comments according to key issues regarding the Draft BIOP and our summary conclusions, followed by detailed discussion of each. We also provide specific comments on each of the above listed documents which NOAA has provided to support the Draft BIOP. We offer the following review comments for your consideration.*

Spill for Fish Passage

- ***The Draft BIOP reduces spill for fish passage, reducing the time period that spill is provided by ending spill prior to August 31, and by starting lower summer spill levels at an earlier date.***

- ***The Draft BIOP does not provide any scientific biological rationale for providing lower spill, below gas cap levels, for fall Chinook summer migrants.***

Performance Standards Evaluation and Accomplishment

- ***The Draft BIOP does not address significant serious technical concerns that have been raised over the past several years regarding the concept and approach of performance standards. NOAA has failed to address or consider recent data and analyses that raise serious issues regarding the validity of the performance standard concept and approach, specifically that route of dam passage affects survival at later life stages and adult return rates.***

- ***The present performance standard testing is likely generating estimates that are biased high and do not represent the run-at-large.***

- ***Recent data and analysis indicate that freshwater passage experience affects later life stages and adult returns, which are not considered in performance standard implementation in this Draft BIOP therefore <u>underestimating the impact of dam passage</u>. Recent data indicate that a smolt-to-adult return rate would provide a more appropriate performance standard.***

• NOAA does not offer any rationale for <u>lower performance survival standards</u> for fall Chinook compared to standards for spring/summer Chinook and steelhead.

Smolt Transportation

• The Draft BIOP increases the proportion of smolts transported by implementing an earlier date for the start of transportation.

• NOAA does not provide a biological scientific rationale for this action, but recognizes that this will provide <u>no benefit to spring Chinook</u>, which migrate earlier in the spring and will receive the majority of the impact from this action.

• Recent data and analyses indicate that overall transport SARs have improved with later transport dates and transportation of later migrating fish. Recent data and analyses indicate that powerhouse bypass passage should be avoided, indicating that increased spill at collector projects such as Lower Granite would result in higher SARs, rather than transporting earlier and increasing transportation.

• Recent data and analyses have shown that increasing transportation will increase straying and increase the negative impact of straying on other listed populations of salmon and steelhead.

Benefits of Spill for Fish Passage / Experimental Spill Management

• NOAA's rejection of consideration of Experimental Spill Management on the basis of the spring Chinook returns from the 2011 outmigration year is unfounded.

• NOAA fails to consider the high fall Chinook return from the 2011 outmigration year, which also experienced high spill and flow.

• NOAA fails to recognize, address or propose mitigation measures for hydrosystem operations under the present FCRPS configuration that took place in the 2011 outmigration year that were adverse for spring migrants.

The Draft BIOP Excludes Recent Data and Analyses and Maintains the Status Quo

• NOAA excludes recent data and analyses from consideration in the Draft BIOP on the basis of three documents: Skalski et al. 2013, Manly 2012, and BioAnalysts Incorporated and Anchor QEA 2013. **These documents do not provide valid technical justification or rationale** *for excluding consideration of recent scientific findings from development and modification of RPAs in the Draft BIOP.*

• Technical and analytical issues and methodology contained in Skalski et al. 2013, indicate that conclusions are not supportable and do not provide a valid rationale for rejecting recent data and analyses.

• *Specific comments on these documents are provided in subsequent discussion sections of this review."*

View entire article at: http://www.fpc.org/documents/FPC_memos.html

XIV) Acoustic Tags

Exhibit K, 2012 Fish Passage Center Annual Report

FROM: State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo
Nez Perce Tribe / Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife / US Fish and Wildlife Service

TO: Brad Eppard, SRWG Chairperson

SUBJECT: **Lower Columbia Survival Studies, SRWG meeting April 13, 2012**

DATE: August 17, 2012

"The purpose of this memorandum is to clearly communicate concerns regarding the acoustic tag studies being conducted by the Corps of Engineers, PNNL, and the UW to assess compliance with at-project performance standards in the NOAA Biological Opinion.

On April 13, 2012 the SRWG met to discuss concerns regarding the acoustic tag studies. The SRWG agreed that significant high grading of study fish has occurred in these studies to-date and the investigators agreed to make efforts to reduce, but not eliminate the high grading. The ***SRWG did not, however, address other significant concerns regarding these studies and the management application of the results. These concerns, expressed in verbal comments and several memorandums to the U.S. Army Corps of Engineers and the region, focus on the acoustic tag study design, study implementation, analyses and results.*** *They point out that the recent body of scientific work indicates that the* ***acoustic tag studies presently conducted do not accurately or adequately assess the impacts of hydroelectric project passage on the survival of salmon and steelhead and other species such as lamprey.***

A June 5, 2012 correspondence from Joyce Casey, Chief Environmental Branch of the Portland District COE, to the SRWG, transmitted a summary report of acoustic tag study data results, prepared by PNNL, explaining that the purpose of the summary report was to provide input data for NOAA COMPASS modeling of the FCRPS, presumably to determine the effectiveness of Biological Opinion measures. ***The outstanding unresolved technical issues identified by the fishery managers, summarized in this memorandum, raise serious concerns regarding the use of these data for COMPASS modeling and the propriety of basing certain hydrosystem management decisions on acoustic tag data.***

As in any mathematical modeling exercise, precision of the COMPASS model output is limited by the quality, accuracy and precision of the model input data. ***Technical concerns regarding the acoustic tag study design, analysis, representativeness of the data to the run-at-large, and the exclusion of consideration of documented delayed mortality associated with powerhouse***

passage, raise serious questions on the validity and advisability of using acoustic tag data results for COMPASS model inputs.

Our specific comments are:

 The limitations inherent in acoustic tagging studies are significant and affect the applicability of results to the run-at-large population.

 The salmon managers are very concerned with the large discrepancy between the expected tagging selection bias and the actual reported bias. Carlson (2010) indicated that researchers expected to reject "less than ***1%*** *of the fish over the sampling season" based on the proposed condition criteria. Data presented in the 2010 performance standards reports indicate, however, that researchers actually rejected* ***12.5%*** *of fish collected due to size or condition.* ***These high levels of tagging selection bias based on fish length and physical condition will result in higher survival estimates than would occur if tagging were truly representative of the target population. The managers do not believe the study results with this large a bias can be applied to the run-at-large.***

 The acoustic tag data base should be made public and available for review. Transparency and rigorous peer review of data used and the data selection process are essential for effective regional collaboration and evaluation.

 If acoustic tag study results are biased high, then the Biological Opinion performance standards are not being met. *The recently released interim report by Ploskey, et al., June 2012, "Route-Specific Passage Proportions and Survival Rates for Fish Passing through John Day Dam, The Dalles Dam, and Bonneville Dam in 2010 and 2011", cites in Table 3.1, three 2011 estimates of survival exceeding 100 %. This suggests that some study assumptions and or requirements were not met at the identified sites for the Virtual Paired Release (VPR) study design. Several reviewers have raised concerns regarding the specific acoustic tag study design being implemented at lower Columbia River projects, and that* ***the current design may be generating at- dam survival estimates that are biased high.*** *Participants at the April SRWG meeting offered that* ***the current study design is potentially seriously flawed, further raising doubt regarding the management application of study results. Also at this meeting, it was stated that acoustic tag data appear to generate reach survival estimates that are biased high relative to PIT-tag data on the run-at-large.***

 Concerns remain regarding the implementation of the lower Columbia River studies. The selection of study fish based on size and physical condition raises issues whether the results from these acoustic tag studies can be applied to the run-at-large. In addition, fish handling and the actual tag implantation surgery raise concerns regarding fish behavior and whether results can be applied to the run-at-large. These issues raise further questions regarding confidence and management applicability of study results.

 In addition to all of the limitations and concerns associated with the present measurement of performance standards, a growing body of scientific evidence indicates that at-project survival estimates generated by these acoustic tag studies do not reflect the actual impact of hydroelectric project passage on juvenile salmon and steelhead survival. *The existence of apparent and significant delayed mortality associated with powerhouse passage is emerging* *from several different analyses. A growing body of scientific information indicates that powerhouse passage has extended impacts on juvenile salmon and steelhead, their first year ocean survival and adult return (Haeseker et al. 2012, Petrosky and Schaller 2010, Tuomikoski et al. 2010, FPC Memos May 21, 2009; Feb 3, 2010; Oct 6, 2010; Jan 19, 2011).* ***The present at-dam survival estimates do not incorporate or address the delayed mortality impact of dam passage. Therefore, they underestimate actual impacts of powerhouse passage, and are thus inadequate to provide a basis for determining specific project operations for fish passage.***

In summary, it is our expectation that given the importance of the performance standards testing, that the COE will seek regional agreement (consensus) on how the studies are conducted and the applicability of the results.

View entire article at:
http://www.fpc.org/documents/CSS/CSS_2012_Annual_Report_rev1b.pdf

XV) Independent Scientific Review Panel

"Summary of ISRP Reviews of Steelhead and Spring and Fall Chinook Salmon Programs of the Lower Snake River Compensation Plan"
June 18, 2014

> *"Major unforeseen factors have impacted the LSRCP since it was authorized in 1976.* ***First, smolt-to-adult survival rates (SAS) for natural Chinook and steelhead populations have been less than originally projected,*** *leading to listing Snake River spring and fall Chinook as threatened under the Endangered Species Act in 1992. Steelhead were listed as threatened in 1997.*
>
> ***The need to reduce harvest rates in mainstem Columbia River fisheries, to protect natural-origin fish, caused a higher proportion of the annual hatchery runs to return to the project area than projected at the time the program was authorized.***

Supplementation:

> *All three LSRCP hatchery programs have implemented supplementation programs in an* ***effort to increase the abundance of natural origin fish or in some cases to prevent the extinction of endemic populations.***
>
> *Even though increasing harvest opportunities were prioritized in the LSRCP's* ***steelhead*** *program,* ***supplementation efforts are occurring in a few locations to increase the abundance of natural-origin steelhead.***
>
> ***Spring Chinook supplementation programs have increased the total abundance of spawners in their rivers (hatchery plus wild) but have not produced an increase in natural-origin adults.***
>
> ***Fall Chinook supplementation has likely contributed to the recent increases in natural-origin fish abundance in the Snake River Basin, but the productivity of the natural-***

spawning population remains very low. Supplementation remains a controversial strategy.

The effects of supplementation on adult abundance and productivity of natural populations are also being investigated. Results of these studies have been mixed.

Density Dependence:

Clear evidence for density dependence has been observed in supplemented populations, especially in spring Chinook, and this ecological response may inhibit desired increases in abundance and productivity.

For example, reduced growth and survival of juvenile spring Chinook salmon in response to increasing population density has been documented in a number of Snake River watersheds. Total abundance of natural origin fall Chinook salmon has increased in recent years in association with increasing numbers of natural spawning by hatchery fish (~73% of spawners are hatchery fish but R/S values have typically been less than 1 ***suggesting that the capacity to support large numbers of spawners has been exceeded.*** *These recent findings of density-dependence provide impetus for integration and coordination of the LSRCP with other hatchery programs, habitat restoration efforts, harvest management, and ESA recovery efforts.*

At this time, however, no plans are in place to regulate the proportion of hatchery fall Chinook on natural spawning grounds. Given the recent upsurge in Snake River fall Chinook abundance, it would be prudent to incorporate planning of this type into the fall Chinook Recovery Plan that is currently under development. Furthermore, harvest of surplus hatchery fish would help achieve the mitigation goals.

Straying:

*New research is examining the spawning distribution of hatchery and natural -origin fish in streams****; some hatchery fish formed spawning aggregations adjacent to release locations. Straying of hatchery fish was evaluated annually, and it varied by year and species. In a few cases, straying percentages for project steelhead to out-of-basin watersheds exceeded 20%. After this degree of straying was identified, the LSRCP implemented a number of strategies, including the use of endemic broodstocks and the wide-scale use of acclimation ponds, which reduced the incidence of straying.***

However, transport of juveniles in barges around the dams remains a key factor contributing to the straying of steelhead. Potential interactions between juvenile hatchery and wild fish were considered and some protocols have been implemented to minimize disease transmission and the possible occurrence of competitive and predaceous interactions.

Factors responsible for straying included the disruption of imprinting on natal waters caused by handling stresses at hatcheries or in barges and trucks if juveniles were artificially transported downstream. Additionally, warm water temperatures experienced by returning adults forced some fish to seek cold-water refugia in streams located below the project area. In some cases, these fish would resume their up stream migrations after water temperatures had cooled, but many stayed and apparently

spawned in their new watersheds. In one instance, cooperators found that a substantial number of Snake River steelhead from the LSRCP hatcheries strayed.

Age at Maturation and Spawning Ground Distribution:

Some demographic, ecological, and genetic impacts to hatchery and naturally produced fish attributable to the LSRCP hatchery programs have been detected. ***An increase in the proportion of early maturing males (three-year-olds) and a corresponding reduction in the proportion of late maturing fish (age five and older) were observed in hatchery spring Chinook.***

Potential demographic, ecological, and genetic impacts of the hatchery programs were assessed. *Age data were collected over time on hatchery and natural populations of spring Chinook, and no identifiable trend toward an increasing number of younger fish was detected in either group.* ***This result suggests that changes in age observed in hatchery populations were mainly caused by environmental conditions the fish experienced during artificial culture. Nevertheless, naturally spawning hatchery fish influence the age structure of natural populations because they currently represent a high proportion of natural spawners.***

Smolt-to-Adult Survival (SAS)**:**

Smolt-to-adult survival objectives were established for spring Chinook and steelhead. They ranged from 3.25% to 4.35% for the eight spring Chinook hatcheries. These survival objectives have never been met. *Instead, with a few exceptions, SAS RCP spring Chinook were less than 1% in most years. No SAS goals were established for the fall Chinook hatcheries.*

The SAS goals for the 12 steelhead hatcheries vary from 1.5% to 2.6%. Over the past decade these hatcheries reached their SAS objectives about 38% of the time.

Smolt-to-Adult Return (SAR):

SAR goals were established for all LSRCP hatcheries. The fall Chinook program, for instance has a SAR goal of 0.2% which has been dependably reached. A SAR value of 0.87% was put in place for spring Chinook, and the project's hatcheries have met this goal about 20% of the time.

G-2,

SUMMARY:

WCNC strongly urges the USACE and cooperating agencies to select Alternative A – "NO ACTION".

The foregoing documentation is a small sampling of information available to the public. The papers contain a variety of opportunities for improvement in salmonid survival, SAR and productivity, none of which call for shooting tens of thousands of indigenous avian piscivores. The problems for salmon and the outcomes of USACE avian management actions extend far beyond the Columbia River system. A review of the direction of managing avian predation and the incorporation of a holistic ecosystem level approach should now be considered.

Another consideration is the adaptive management clause associated with avian management plans that appears to be either ignored or that lags behind in implementation. Actions against DCCO under Alternative “C” could go very wrong, very quickly. As an example, beginning in 2008, alternate island habitat constructed for displaced East Sand Island CATE was made available. Over the years, it has become apparent that many of those artificial islands have not met criteria for quality CATE nesting. Those deficiencies have yet to be addressed and it appears that the required 2:1 habitat ratio called for in the CATE management plan has been abandoned. Displaced Columbia River estuary and now Columbia Plateau terns are left to search for appropriate habitat on their own at locations from which they will not be hazed.

Myopic CATE management and proposed DCCO management each have instantaneous and incremental negative outcomes for the target species. Those outcomes will be more difficult to correct than they were to put into motion.

Thank you for considering our comments and suggestions.

Sharnelle A. Fee, Director

References:

Fish Passage Center
http://www.fpc.org/documents/FPC_memos.html
http://www.fpc.org/documents/FPC_Annual_Reports.html

Comparative Survival Study Annual Report
http://www.fpc.org/documents/CSS/CSS_2013_Annual_Report_rev1b.pdf

C. E. Petrosky, H. A. Schaller (2010)
Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook salmon and steelhead
Ecology of Freshwater Fish 2010: 19: 520–536

Haeseker, S.L., McCann, J.A., Tuomikoski, J and Chockley, B (2012)
Assessing Freshwater and Marine Environmental Influences on Life-Stage-Specific Survival Rates of Snake River Spring–Summer Chinook Salmon and Steelhead.
Transactions of the American Fisheries Society, 141:1, 121-138

Walters, A. W., Copeland, T. and Venditti, D. A. (2013)
The density dilemma: limitations on juvenile production in threatened salmon populations
Ecology of Freshwater Fish, 22: 508–519.

Evans, A.F., Hostetter, N.J. and Collis, K., Roby, D.D. and Loge, F.J. (2014)
Relationship between Juvenile Fish Condition and Survival to Adulthood in Steelhead
Transactions of the American Fisheries Society 143:899–909, 2014

Bingham, D.M., Kennedy, B.M., Hanson, K.C. and Smith, C.T. (2014)
Loss of Genetic Integrity in Hatchery Steelhead Produced by Juvenile-Based Broodstock and Wild Integration: Conflicts in Production and Conservation Goals
North American Journal of Fisheries Management, 34:3, 609-620

Christie, M.R., Marine, M.L., French, R.A., Waples, R.S. and Blouin, M.S. (2012)
Effective size of a wild salmonid population is greatly reduced by hatchery supplementation
Heredity 109, 254–260

Independent Scientific Review Panel (June 18, 2014)
Summary of ISRP Reviews of Steelhead and Spring and Fall Chinook Salmon Programs of the Lower Snake River Compensation Plan
ISRP Summary Review of the LSRCP 2011-2014, ISRP 2014-6

Willapa Hills Audubon Society

August 4, 2014

Willapa Hills Audubon
PO Box 399
Longview, WA 98632

Sondra Ruckwordt
US Army Corps of Engineers
Portland, OR

Attn: CENNP-PM-E-14-08/DBL Crested Cormorant Draft EIS

Ms Ruckwordt and Corps:

comments noted

Our Chapter of the Audubon family, Willapa Hills, encompasses the region along the Columbia River, from Longview to Long Beach, Washington, and that part of Columbia County, including Rainier, OR. Our membership includes sportsmen and fishermen and we have frequently advocated on behalf of wild salmon recovery. So, we are uniquely qualified to comment on the proposal to control the burgeoning population of Double-crested Cormorants (DCCO) on East Sand Island in the lower estuary.

We understand and appreciate that predation can be a factor in the survival of wild salmon. In protecting endangered species we have supported some use of lethal means in reducing predation in a targeted manner (i.e. Snowy Plover (Corvids), Spotted Owl (Barred Owl)). Additionally, we recognize that a regimen of hazing and harassment alone may only disperse nesting and do little to eliminate predation overall, and also disrupt other nesting species of no concern.

G-2, G-16

However, our main focus must be the DCCO. After reviewing the draft EIS and available information regarding DCCO and from other interest groups and agencies, we are not convinced that your preferred alternative "C" is appropriate to the situation or that the killing of up to 16,000 DCCO is consistent with an appreciation for the situation in the lower Columbia estuary (LCE). We believe the proposed killing of DCCO is reflexive and excludes other factors in salmonid decline; and that the proposal fails to honor the historic presence of the DCCO in the ecobiology of the LCE. The use of lethal means to control predation on such a scale deserves a more thorough review of the facts.

Therefore, we support Alternative "A"—no action—at this time, and until such time as a more comprehensive plan of action is adopted. We urge the Corps to proceed in researching, promoting and adopting a plan that uses the best science to address the issue of dredge spoil dumping, the effects of the dams on predation success, and the loss of habitat on salmonid decline. In the meantime we can support a continued effort to stem the growth of the DCCO colony by limiting their access to preferred habitat.

Our Reasoning:

G-23, G-5

First, the use of lethal means in the preservation of an endangered species must mean that all other options have been exhausted, and that survival of the species is most immediately connected to predation, as in the case of the Snowy Plover along the Washington coast. This is

G-2, G-3, G-4,

not the case with DCCO predation of salmonids. It is also the case that, generally, DCCO numbers are well below historical records, and declining. The view of science is that reducing predation alone is no solution to promoting endangered salmon: DCCO and bird predation in general is a minor factor when compared with habitat loss, pollution, and dam operation, among other factors. Also, according to your own statistics, the predation rates are highly variable, as are the survival rates of the salmonids in total.

G-2, G-21, G-22

Willapa Hills Audubon (WHAS) also questions whether enough attention has been paid to the method and practice of dredge spoil disposal in the LCE, and in the operation of the dams. Dredge spoil dispersal in the estuary and adjoining lands is still in question, outside of a few beneficial instances such as beach replenishment. Credible anecdotal evidence exists of spoils being layered atop existing streaked horned lark nests, for instance. The idea of dumping of spoils well offshore should be reconsidered, with emphasis on replenishment of the beaches north and south of the river's mouth. There is also some scientific and anecdotal evidence to suggest that the loss of the Spring freshets on the Columbia, which helped flush and hide smolts from predators, has resulted in much greater mortality.

WHAS believes these are authentic concerns that have not been addressed by the Corps and that there remain options to the killing of the East Sand Island DCCO.

Thank you for your time,
Sincerely,

George Exum, President
For the Board of Directors
Willapa Hills Audubon