ENVIRONMENTAL ASSESSMENT
(Final)

MANAGING DAMAGE AND THREATS OF DAMAGE CAUSED BY DOUBLE-CRESTED CORMORANTS IN THE STATE OF MISSISSIPPI

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ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

In cooperation with:

TENNESSEE VALLEY AUTHORITY

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ACRONYMS

APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
BBS	Breeding Bird Survey
CBC	Christmas Bird Count
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FY	Federal Fiscal Year
MBTA	Migratory Bird Treaty Act
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
NEPA	National Environmental Policy Act
NWRC	National Wildlife Research Center
TVA	Tennessee Valley Authority
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WS	Wildlife Services

CHAPTER 1: NEED FOR ACTION AND SCOPE OF ANALYSIS

1.1 INTRODUCTION

Wildlife is an important public resource greatly valued by people. In general, people regard wildlife as providing economic, recreational, emotional, and esthetic benefits. Knowing that wildlife exists in the natural environment provides a positive benefit to many people. However, the behavior of animals may result in damage to agricultural resources, natural resources, property, and threaten human safety. Therefore, wildlife can have either positive or negative values depending on the perspectives and circumstances of individual people.

Wildlife damage management is the alleviation of damage or other problems caused by or related to the behavior of wildlife and can be an integral component of wildlife management (Berryman 1991, Reidinger and Miller 2013, The Wildlife Society 2015) and the North American Model of Wildlife Conservation (Geist 2006, Organ et al. 2010). Resolving damage caused by wildlife requires consideration of both sociological and biological carrying capacities. The wildlife acceptance capacity, or cultural carrying capacity, is the limit of human tolerance for wildlife or the maximum number of a given species that can coexist compatibly with local human populations. Biological carrying capacity is the land or habitat's ability to support healthy populations of wildlife without degradation to the species' health or their environment during an extended period of time (Decker and Purdy 1988).

Those phenomena are especially important because they define the sensitivity of a person or community to a wildlife species. For any given damage situation, there are varying thresholds of tolerance exhibited by those people directly and indirectly affected by the species and any associated damage. This damage threshold determines the wildlife acceptance capacity. While the biological carrying capacity of the habitat may support higher populations of wildlife, in many cases the wildlife acceptance capacity is lower or already met. Once the wildlife acceptance capacity is met or exceeded, people begin to implement population or damage management to alleviate damage or address threats to human health and safety. Therefore, the wildlife acceptance capacity helps define the range of wildlife population levels and associated damages acceptable to individuals or groups (Decker and Brown 2001).

Animals have no intent to do harm. They utilize habitats (*e.g.*, feed, shelter, reproduce) where they can find a niche. If their activities result in lost value of resources or threaten human safety, people often characterize this as damage. When damage exceeds or threatens to exceed an economic threshold and/or pose a threat to human safety, people often seek assistance. The threshold triggering a person to seek assistance with alleviating damage or threats of damage is often unique to the individual person requesting assistance and many factors (*e.g.*, economic, social, esthetics) can influence when people seek assistance. Therefore, the threshold of damage that triggers a person to seek assistance is often unique to the individual person. What one individual person considers damage, another person may not consider as damage. However, the use of the term "*damage*" is consistently used to describe situations where the individual person has determined the losses associated with an animal or animals is actual damage requiring assistance (*i.e.*, has reached an individual threshold). Many people define the term "*damage*" as economic losses to resources or threats to human safety; however, "*damage*" could also occur from a loss in the esthetic value of property and other situations where the behavior of wildlife was no longer tolerable to an individual person. The threat of damage or loss of resources is often sufficient for people to initiate individual actions and the need for damage management could occur from specific threats to resources.

1.2 PURPOSE OF THIS DOCUMENT

When people experience damage caused by wildlife or when wildlife threatens to cause damage, people may seek assistance from other entities. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program is the lead federal agency responsible for managing conflicts between people and wildlife (USDA 2013)(see WS Directive 1.201)[1]. The primary statutory authority for the WS program is the Act of March 2, 1931 (46 Stat. 1468; 7 USC 8351-8352) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 8353). WS' directives define program objectives and guide WS' activities when managing wildlife damage (see WS Directive 1.201, WS Directive 1.205, WS Directive 1.210). Therefore, people experiencing damage or threats of damage associated with wildlife could seek assistance from WS. The WS program has offices in Mississippi that provide assistance with managing damage caused by wildlife when people request such assistance.

In Mississippi, WS has and continues to receive requests for assistance to reduce and prevent damage associated with double-crested cormorants (*Phalacrocorax auritus*), including requests for assistance to manage damage and threats of damage on properties owned or managed by the Tennessee Valley Authority (TVA)[2]. Requests for assistance that WS receives in Mississippi are primarily associated with double-crested cormorants feeding on commercially raised fish at aquaculture facilities in the state. WS also occasionally receives requests for assistance associated with the damage that double-crested cormorants can cause to property and natural resources. In addition, double-crested cormorants can pose risks to human health and safety, primarily associated with aircraft strikes involving double-crested cormorants. Section 1.4 discusses the need for action associated with requests for assistance that WS receives associated with double-crested cormorants.

The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental planning into federal agency actions and decision-making processes (Public Law 9-190, 42 USC 4321 et seq.). Therefore, if WS provided assistance by conducting activities to manage damage caused by double-crested cormorants, those activities would be a federal action requiring compliance with the NEPA. The NEPA requires federal agencies to have available and fully consider detailed information regarding environmental effects of federal actions and to make information regarding environmental effects available to interested persons and agencies.

1.2.1 Complying with the NEPA

As part of the decision-making process associated with the NEPA, WS follows the Council on Environmental Quality (CEQ) regulations implementing the NEPA (40 CFR 1500 et seq.) along with the implementing procedures of the USDA (7 CFR 1b) and the APHIS (7 CFR 372). The NEPA sets forth the requirement that federal agencies evaluate their actions in terms of their potential to significantly affect the quality of the human environment to avoid or, where possible, to mitigate and minimize adverse impacts, making informed decisions, and including agencies and the public in their planning to support informed decision-making.

To comply with the NEPA and CEQ regulations, WS, in cooperation with the TVA, is preparing this Environmental Assessment (EA) to evaluate alternative approaches of achieving the objectives of WS and to determine whether the potential environmental effects caused by the alternative approaches might be significant, requiring the preparation of an Environmental Impact Statement (EIS). As described by the

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[1]At the time of preparation, WS' directives occurred at the following web address: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_WS_Program_Directives.

[2]See Section 1.4.7 for the role and authorities of the TVA

CEQ (2007), the intent of an EA is to provide brief but sufficient evidence and analysis to determine whether to prepare an EIS, aid in complying with the NEPA when an EIS is not necessary, and to facilitate preparation of an EIS when one is necessary. The CEQ (2007) further states, "*The EA process concludes with either a Finding of No Significant Impact…or a determination to proceed to preparation of an EIS*".

1.2.2 Using this EA to Inform Decisions

Although WS only provides assistance when requested, WS is required to comply with the NEPA before making final decisions about actions that could have environmental effects. Similarly, the TVA is also required to comply with the NEPA before making decisions about actions that occur on properties they own and/or manage. WS and the TVA will use the analyses in this EA to help inform agency decision-makers, including a decision on whether the alternative approaches of meeting the need for action requires the preparation of an EIS or the EA process concludes with a Finding of No Significant Impact.

Another major purpose of the NEPA is to include other agencies and the public during the planning process to support informed decision-making. Prior to making and publishing the decision[3] to conclude this EA process, WS and the TVA will make this EA available to the public, agencies, tribes, and other interested or affected entities for review and comment. Making the EA available to the public, agencies, tribes, and other interested or affected entities during the planning process will assist with understanding applicable issues and reasonable alternative means to meeting the need for action (see Section 1.4) and to ensure that the analyses are complete for informed decision-making.

Public outreach notification methods for this EA will include posting a notice on the national WS program webpage and on the www.regulations.gov webpage. In addition, WS will send out direct mailings to local known stakeholders and an electronic notification to stakeholders registered through the APHIS Stakeholder Registry. WS will also publish a notice in the legal section of the *Clarion Ledger* newspaper. WS will provide for a minimum of a 30-day comment period for the public and interested parties to review the EA and provide their comments. WS will inform the public of the decision using the same venues.

WS and the TVA will coordinate the preparation of this EA with consulting partner agencies and tribes to facilitate planning, efficient use of agency and tribal expertise, and to promote interagency and tribal coordination, which includes the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). WS and the TVA have asked each consulting agency to review the draft EA and provide input and direction to WS and the TVA to ensure proposed activities would comply with applicable federal and state regulations and policies, federal land management plans, Memorandum of Understandings, and cooperative agreements.

1.2.3 The Geographical Scope of this EA

WS and the TVA have decided that one EA analyzing potential effects of implementing the alternatives approaches of meeting the need for action for the entire State of Mississippi provides a more comprehensive and less redundant analysis than multiple EAs covering smaller regions. This approach also provides a broader scope for the effective analysis of potential cumulative impacts and for using data and reports from state and federal wildlife management agencies, which are typically on a statewide basis.

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[3] As discussed in Section 1.2.1 and Section 1.3.1, the EA process concludes with either a Finding of No Significant Impact or the publication of a Notice of Intent to prepare an EIS.

Double-crested cormorants can occur statewide and throughout the year in Mississippi. Double-crested cormorants are dynamic and mobile; therefore, damage and threats of damage caused by double-crested cormorants can occur wherever double-crested cormorants occur in the state. Although double-crested cormorants occur throughout the year in Mississippi, they are more abundant during the winter and migration periods as they arrive from their northern breeding areas. The fall migration period for double-crested cormorants generally occurs from August through early November with the peak occurring from late August through mid-October (Dorr et al. 2014). The spring migration period generally occurs from late March through the end of May with the peak occurring from mid-April through early March (Dorr et al. 2014).

Responding to requests for assistance falls within the category of actions in which the exact timing or location of individual requests for assistance can be difficult to predict. Although WS could predict some of the possible locations or types of situations and sites where some requests for assistance could occur, the program cannot predict the specific locations or times at which affected resource owners would determine that damage had become intolerable and they request assistance from WS. Therefore, WS must be ready to provide assistance on short notice anywhere in Mississippi when receiving a request for assistance. Therefore, the geographic scope of the actions and analyses in this EA is statewide and this EA analyzes actions that could occur on federal, state, county, city, and private lands, when requested, including properties that the TVA owns and/or manages.

The analyses in this EA would apply to any actions that WS may conduct to alleviate damage caused by double-crested cormorants in any locale and at any time within Mississippi when WS receives a request for such assistance from the appropriate landowner or land manager. The standard WS Decision Model (see WS Directive 2.201; Slate et al. 1992) would be the site-specific procedure for individual actions conducted by WS in the state (see Chapter 2 for a description of the WS Decision Model and its application). The WS Decision Model is an analytical thought process used by WS' personnel for evaluating and responding to requests for assistance. If WS and the TVA determine that the analyses in this EA do not warrant the preparation of an EIS, the decisions made by WS' personnel using the model would be consistent with the alternative approach that WS selects to meet the need for action. In addition, decisions made using the model would be in accordance with WS' directives as well as relevant laws and regulations.

As discussed previously, the landowner or land manager would determine when assistance from WS was appropriate. Therefore, WS would only conduct activities after receiving a request from the appropriate landowner or land manager. In addition, WS would only conduct activities after the appropriate landowner or manager signed a work initiation document allowing WS to conduct activities on the property they own or manage. Therefore, this EA meets the intent of the NEPA with regard to site-specific analysis, informed decision-making, and providing the necessary timely assistance to those people requesting assistance from WS.

1.2.4 Period for which this EA is Valid

If WS and the TVA determine that the analyses in this EA indicate that an EIS is not warranted, this EA remains valid until WS and/or the TVA determine that new or additional needs for action, changed conditions, new issues, and/or new alternatives having different environmental impacts need to be analyzed to keep the information and analyses current. At that time, this analysis and document would be reviewed and, if appropriate, supplemented if the changes would have "*environmental relevance*" (40 CFR 1502.9(c)), or a new EA prepared pursuant to the NEPA.

If WS provides assistance with managing damage caused by double-crested cormorants, WS would monitor activities conducted by its personnel to ensure those activities and their impacts remain consistent with the activities and impacts analyzed in this EA and selected as part of the decision. Monitoring activities would ensure that program effects occurred within the limits of evaluated/anticipated activities. Monitoring involves review of the EA for all of the issues evaluated in Chapter 3 to ensure that the activities and associated impacts have not changed substantially over time.

1.2.5 Relationship of This Document to Other Environmental Documents

Additional environmental documents relate to activities that WS could conduct to manage damage or threats of damage associated with double-crested cormorants in the state. Environmental documents also relate to activities that could occur on properties owned and/or managed by the TVA. The relationship of those documents to this EA occurs below for each of those documents.

WS' Canada Goose Damage Management Environmental Assessment

WS, in cooperation with the TVA, prepared an EA to evaluate potential impacts to the human environment from the implementation of a management program to address damage to agricultural resources, natural resources, property, and to reduce threats to human safety caused by Canada geese in Mississippi. The EA evaluated the need for WS' activities and the relative effectiveness of three alternatives to meet that proposed need, while accounting for the potential environmental effects of those activities (USDA 2015*a*). The EA also evaluated activities to manage damage caused by Canada geese on properties owned and/or managed by the TVA. After consideration of the analysis contained in the EA and review of public comments, WS issued a Decision and Finding of No Significant Impact for the EA on January 11, 2016. The Decision and Finding of No Significant Impact selected the proposed action alternative, which implemented an integrated damage management program using multiple methods to address the need to manage Canada goose damage.

WS' Double-crested Cormorant Damage Management Environmental Assessment

WS previously developed an EA that analyzed the need for action to manage damage associated with double-crested cormorants. That EA identified the issues associated with managing damage associated with double-crested cormorants in the state and analyzed alternative approaches to meet the specific need identified in the EA while addressing the identified issues. Changes in the need for action and the affected environment have prompted WS to initiate this new analysis to address damage management activities in the state. This new EA will address more recently identified changes and will assess the potential environmental effects of program alternatives. Because this EA will re-evaluate activities conducted under the previous EA, the outcome of the Decision issued based on the analyses in this EA will supersede the previous EA that addressed managing damage caused by double-crested cormorants.

WS' Bird Damage Management Environmental Assessment

WS, in cooperation with the TVA, prepared an EA to evaluate potential impacts to the human environment from the implementation of a management program to address damage to agricultural resources, natural resources, property, and to reduce threats to human safety caused by several additional bird species in Mississippi. The EA evaluated the need for WS' activities and the relative effectiveness of three alternatives to meet that proposed need, while accounting for the potential environmental effects of those activities. The EA also evaluated activities to manage damage caused by birds on properties owned and/or managed by the TVA. After consideration of the analysis contained in the EA and review of public comments, WS issued a Decision and Finding of No Significant Impact for the EA selecting an alternative that implemented an integrated damage management program using multiple methods to address the need to manage bird damage.

Southeast United States Waterbird Conservation Plan

The United States Fish and Wildlife Service (USFWS) and their partners developed a regional waterbird conservation plan for the southeastern region of the United States to assist with the recovery of high priority waterbird species (Hunter et al. 2006). The plan addresses waterbirds from eastern Texas and Oklahoma, through Florida, and northward into eastern North Carolina and Virginia, which includes 10 Bird Conservation Regions and 2 pelagic Bird Conservation Regions (Hunter et al. 2006). The plan addresses several overarching conservation goals including the recovery of high priority species, maintaining healthy populations of waterbirds, restoring and protecting essential habitats, and developing science-based approaches to resolving human interactions with waterbirds (Hunter et al 2006). Information in the plan on waterbirds and their habitats provide a regional perspective for local conservation action.

Atlantic and Mississippi Flyways Double-crested Cormorant Management Plan

The Atlantic Flyway Council and the Mississippi Flyway Council developed a joint management plan that "…*provides the basic principles and strategies to help guide management of* [double-crested cormorants] *in the Atlantic and Mississippi Flyways* (Atlantic Flyway Council and Mississippi Flyway Council 2010). The main goal of the Atlantic and Mississippi Flyways Double-crested Cormorant Management Plan is to minimize "…*negative ecological impacts to habitats, other species, or personal property and other socioeconomic interests*" associated with double-crested cormorants while maintaining "…*the double-crested cormorant as a natural part of the waterbird biodiversity of the Atlantic and Mississippi Flyway…*" (Atlantic Flyway Council and Mississippi Flyway Council 2010).

USFWS Double-crested Cormorant Management Environmental Assessment

The USFWS completed an EA for issuing depredation permits to manage damage caused by double-crested cormorants. The EA evaluated the reasonably foreseeable environmental impacts of making decisions on depredation permit applications to take double-crested cormorants in accordance with 50 CFR 21.41 (USFWS 2017).

TVA Natural Resource Plan

TVA has developed an extensive plan to strategically evaluate both renewable and nonrenewable resources and fulfill the responsibilities associated with good stewardship of TVA lands and resources. The Natural Resource Plan is designed to integrate the objectives of six resource areas (biological, cultural, recreation, water, public engagement and reservoir lands planning); provide optimum public use benefit; and balance competing and sometimes conflicting resource uses (TVA 2011*a*).

TVA Environment Impact Statement Assessing the Natural Resource Plan

TVA has also prepared an EIS to assess the impacts of the Natural Resource Plan and its reasonable alternatives on the environment. It specifically describes the stewardship programs that are ongoing and the programs the TVA is evaluating for future implementation as part of the Natural Resource Plan; and assesses the potential environmental impacts associated with implementing the various alternatives (TVA 2011*b*).

Mississippi State Wildlife Action Plan

The primary goal of the Mississippi State Wildlife Action Plan is "…*to provide a guide to effective and efficient long-term conservation of Mississippi's biological diversity*" (Mississippi Museum of Natural

Science 2015). By state statue, the MDWFP is the state agency responsible for conserving, developing, and protecting Mississippi's natural resources and providing outdoor recreational opportunities (Mississippi Museum of Natural Science 2015).

1.3 PREPARATION OF AN EA INSTEAD OF AN EIS

One comment that WS often receives during the public involvement process associated with the development of an EA is that WS should have prepared an EIS instead of an EA or that proposed activities require the development of an EIS. As discussed in Section 1.2, the primary purpose for developing an EA is to determine if the alternative approaches developed to meet the need for action could potentially have significant individual and/or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS (see 40 CFR 1501.4, 40 CFR 1508.9(a)(3)). WS and the TVA prepared this EA so that WS and the TVA can make an informed decision on whether or not an EIS would be necessary if WS implemented the alternative approaches to meeting the need for action.

WS and the TVA are preparing this EA to facilitate planning, promote interagency coordination, streamline program management, clearly communicate to the public the analysis of individual and cumulative impacts of proposed activities, and evaluate and determine if there would be any potentially significant or cumulative effects from the alternative approaches developed to meet the need for action. The analyses contained in this EA are based on information derived from WS' Management Information System, available documents (see Appendix A), interagency consultations, and public involvement.

If WS and the TVA makes a determination that implementation of a selected alternative approach would have a significant impact on the quality of the human environment based on this EA, WS would publish a Notice of Intent to prepare an EIS. This EA would be the foundation for developing that EIS in accordance with the NEPA implementing regulations of the CEQ (40 CFR 1508.9(a)(3)).

1.3.1 How WS and the TVA will Evaluate Significant Impacts

The process for determining if a project or program may have significant impacts is based on the CEQ regulations at 40 CFR 1508.27. Chapter 3 evaluates the direct, indirect, and cumulative impacts associated with the alternative approaches of meeting the need for action. The need for action involves the requests for assistance that WS receives to manage damage to aquaculture, natural resources, and property caused by double-crested cormorants in Mississippi. In addition, WS receives requests for assistance to reduce risks to human health and safety associated with double-crested cormorants in the state. A similar need for action arises from damage and threats of damage occurring on properties owned and/or managed by the TVA.

Most of the factors included in 40 CFR 1508.27(b) include the phrase "*the degree to which*" a particular type of resource might be adversely affected, not a determination of no adverse impact at all. Therefore, WS and the TVA evaluate the impacts to resources and documents the predicted effects in this EA. WS and the TVA will use those effect analyses to determine if the levels of impact are indeed "*significant*" impacts for which a Finding on No Significant Impact would not be appropriate; thus, requiring the need to prepare an EIS. If WS and the TVA determines that the levels of impacts are not significant, WS and the TVA will document the rationale for not preparing an EIS in a publicly available Decision and Finding of No Significant Impact in accordance with guidance from the CEQ. WS and the TVA will review the impacts evaluated in Chapter 3 of this EA in two ways: the severity or magnitude of the impact on a resource and the context of the impact. For example, WS and the TVA may consider the context of activities when the resource is rare, vulnerable, not resilient, or readily changed long-term with even a short-term stressor.

The factors identified in 40 CFR §1508.27 are not checklists, nor do they identify thresholds of impacts, but they are factors for consideration by the agency while making the decision regarding whether to prepare a Finding of No Significant Impact or preparing an EIS. WS and the TVA will determine how to consider those factors in its decision on whether to prepare a Finding of No Significant Impact or an EIS. WS and the TVA will determine the *degree* to which a factor applies or does not apply to the impacts documented in the EA. An outline of how WS and the TVA will use this EA, and the criteria at 40 CFR §1508.27, to make the decision regarding whether a Finding of No Significant Impact or an EIS is appropriate occurs below (see Section 1.3.2 through Section 1.3.6).

1.3.2 Controversy Regarding Effects

The factor at 40 CFR 1508.27(b)(4) is described as "*the degree to which the effects on the quality of the human environment are likely to be highly controversial*." The failure of any particular organization or person to agree with every act of a federal agency does not create controversy regarding effects. Dissenting or oppositional public opinion, rather than concerns expressed by agencies with jurisdiction by law or expertise and/or substantial doubts raised about an agency's methodology and data, is not enough to make an action "*controversial*". This EA evaluates peer-reviewed and other appropriate published literature, reports, and data from agencies with jurisdiction by law to conduct the impact analyses and evaluate the potential for significant impacts. This EA also includes and evaluates differing professional opinions and recommendations expressed in publications where they exist and that are applicable to the informed decision-making of WS and the TVA.

1.3.3 Unique or Unknown Risks

Another concern commonly expressed in comments involves the potential for unknown or unavailable information (40 CFR 1502.22) to potentially result in uncertain, unique, or unknown risks (40 CFR 1508.27(b)(5)), especially related to population numbers and trends and the extent and causes of mortality of wildlife species. Throughout the analyses in this EA, WS and the TVA use the best available data and information. For example, the EA uses data from the USFWS, which has jurisdiction by law to manage migratory bird populations in the United States. In addition, WS and the TVA will use the scientific literature to make informed decisions.

Population and mortality data for many native wildlife species are typically non-existent from any source, in or outside of Mississippi. WS and the TVA recognize that estimating wildlife populations over large areas can be extremely difficult, labor intensive, and expensive. Instead, the USFWS and the MDWFP may choose to monitor population health using other factors, such as indices of abundance and/or trend data to evaluate the status of populations that do not have direct population data. This EA uses the best available information from wildlife management agencies, including the USFWS and the MDWFP, when available, and peer-reviewed literature to assess potential impacts to double-crested cormorants.

If population estimates are available, then the analyses will use the lowest density or number estimates for wildlife species populations (where high and low population estimates are provided in the text) to arrive at the most conservative impact analysis. Coordination with the USFWS and/or the MDWFP and providing the opportunity for agency review of and involvement in this EA ensure that analyses are as robust as possible. The analyses in this EA provide information to determine if the cumulative mortality from all sources, including mortality that could occur by WS or mortality on property owned and/or managed by the TVA, would adversely affect double-crested cormorant populations, and non-target wildlife species.

1.3.4 Threatened or Endangered Species, Unique Geographic Areas, Cultural Resources, and Compliance with Environmental Laws

This EA also provides analyses and documentation related to threatened and endangered species, areas with special designations, such as wilderness areas, cultural and historic resources, and compliance with other environmental laws, including state laws. This will be used to address the significance criteria at 40 CFR 1508.27(b)(3), CFR 1508.27(b)(8), CFR 1508.27(b)(9), and CFR 1508.27(b)(10).

Evaluation of those issues occurs in the following sections of this EA:

- Impacts to threatened and endangered species occurs in Section 3.2.2
- Impacts to unique geographic areas occurs in Section 2.1.2
- Impacts to cultural and historic resources occurs in Section 2.1.2
- Compliance with other environmental laws occurs in Sections 1.4.8

1.3.5 Cumulatively Significant Impacts

Another common comment involves the criterion for the analysis of "*cumulatively significant impacts*" (40 CFR 1508.27(b)(7)), which this EA considers in various ways. Cumulative impacts, as defined by the CEQ (40 CFR 1508.7), are impacts to the environment that result 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. Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time. Cumulative impacts could potentially occur from either damage management activities over time by WS or from the aggregate effects of those activities combined with the activities of other agencies and private entities. Many of the issues identified in Section 2.1.1 and evaluated in detail in Section 3.2 are inherently cumulative impact analyses. For example:

- Impacts to the double-crested cormorant population would evaluate known sources of mortality, only one of which could be removal by WS
- Impacts to wildlife species listed as threatened or endangered pursuant to the Endangered Species Act (ESA), as these species' populations are already cumulatively impacted by many sources of mortality, loss of habitat, climate change, and other stressors, causing them to be listed

The underlying intent for preparing an EA is to determine if a proposed action might have a significant impact on the human environment. The EA development process is issue driven, meaning issues that were raised during the interdisciplinary process and through public involvement that were substantive, would be used to drive the analysis and determine the significance of the environmental impacts of the alternatives. Therefore, the level of site specificity must be appropriate to the issues. The issues raised during the scoping process of this EA drove the analysis. As discussed previously, one EA analyzing impacts for the entire state would provide a more comprehensive and less redundant analysis that allows for a better cumulative impact analysis. If WS and the TVA determined through the EA that the alternative approaches developed to meet the need for action could result in a significant impact on the quality of the human environment, then an EIS would be prepared.

1.3.6 Public and Employee Health and Safety

The concern regarding public health and safety (significance criterion at 40 CFR 1508.27(b)(2)) is evaluated in several analyses in Chapter 3 if this EA. For example:

- The deposition of lead into the environment from ammunition used in firearms occurs in Section 2.1.2
- The risk of injury to the public from methods available to alleviate double-crested cormorant damage occurs in Section 3.2.3
- The risk of injury to WS' employees occurs in Section 3.2.3

1.4 NEED FOR ACTION

As discussed in Section 1.2, when people seek assistance with managing damage associated with double-crested cormorants, they may seek assistance from the WS program. Therefore, the need for action to manage damage and threats associated with double-crested cormorants in Mississippi arises from requests for assistance[4] that WS could receive to reduce and prevent damage from occurring. The double-crested cormorant is a large fish-eating, colonial waterbird widely distributed across North America (Dorr et al. 2014). In general, double-crested cormorant populations have increased in North America, including the southeastern United States, in the last 30 years (Jackson and Jackson 1995, Dorr et al. 2014). In Mississippi, double-crested cormorants occur throughout the year but are more abundant during the winter migration periods (Barras 2004, Dorr et al. 2014). Double-crested cormorants can cause damage to aquaculture, natural resources, property, and pose threats to human safety. Most requests for assistance that WS receives are associated with double-crested cormorants feeding on commercially raised fish at aquaculture facilities in the state.

1.4.1 Need to Manage Damage caused by Double-crested Cormorants at TVA Properties and Facilities

Damage and threats of damage occurring at facilities and properties owned or managed by the TVA associated with double-crested cormorants primarily occurs from accumulations of fecal dropping in areas where double-crested cormorants roost, loaf, and/or nest. Accumulations of fecal droppings along with the nesting behavior of double-crested cormorants can cause habitat degradation in those areas where double-crested cormorants roost, loaf, and/or nest. Section 1.4.5 provides further discussion on habitat degradation that can occur from roosting, loafing, and/or nesting double-crested cormorants, which could occur on properties owned and/or managed by the TVA.

In addition to habitat degradation, accumulations of fecal droppings from double-crested cormorants can cause economic damage to buildings, equipment, and facilities resulting in constant cleaning. The droppings can also occur in work areas, which can be esthetically displeasing to employees. Section 1.4.4 provides further discussion on damage to property that can occur from roosting, loafing, and/or nesting double-crested cormorants, which could occur to property owned and/or managed by the TVA.

1.4.2 Need to Address Double-crested Cormorant Damage to Aquaculture

The National Agricultural Statistics Service (2014) defines aquaculture as the farming of aquatic organisms that involves some form of intervention in the rearing process, such as seeding, stocking, feeding, and protection from predators. The National Agricultural Statistics Service (2014) further defines aquatic organisms as baitfish, crustaceans, food fish, mollusks, ornamental fish, sport/game fish, and other aquaculture products. The principal aquatic organisms that people farm in the United States are catfish, trout, salmon, tilapia, hybrid striped bass, mollusks, shrimp, crayfish, baitfish, and ornamental tropical fish (National Agricultural Statistics Service 2014).

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[4]WS would only conduct activities to manage damage caused by double-crested cormorants after receiving a request for assistance. Before initiating activities, WS and the cooperating entity must sign a Memorandum of Understanding, work initiation document, or another comparable document that lists all the methods the property owner or manager would allow WS to use on property they own and/or manage.

Reed et al. (2003) stated, "*The local impacts of* [fish-eating] *birds at aquaculture ponds and hatcheries are well known and have been the subject of numerous studies…*", which includes the double-crested cormorant. Aquaculture producers often identify double-crested cormorants as the most serious depredator of farm-raised aquaculture species (Stickley and Andrews 1989, Price and Nickum 1995, Dorr et al. 2012, Craig et al. 2016). Traditionally, most double-crested cormorants breeding inland and along the Great Lakes region of North America migrated south after the breeding season to winter along the coastal areas of the United States and Mexico (Dorr et al. 2014). However, as aquaculture production increased in the southern United States, an increasing number of double-crested cormorants began wintering inland near aquaculture facilities (Glahn et al. 2000, King et al. 2010, Dorr et al. 2012, Dorr et al. 2014). The number of double-crested cormorants often increases rapidly wherever prey is readily accessible, such as stocking release sites and aquaculture ponds (Wires et al. 2001, Dorr et al. 2012, Dorr et al. 2014). Double-crested cormorants are adept at seeking out the most favorable foraging and roosting sites. For example, within two weeks of stocking two ponds in Florida with fingerling catfish, 12 double-crested cormorants were feeding in the ponds and roosting on nearby poles (Schramm et al. 1984). In another example, a pond stocked with 75,000 catfish in August 1980 had attracted 13 double-crested cormorants by September 1980 and those double-crested cormorants continued to feed at the pond throughout the fall and winter, and in spring 1981, they nested in a nearby cypress dome. By November 1981, about fifty double-crested cormorants were feeding at the pond (Schramm et al. 1984). The response of double-crested cormorants to the presence of aquaculture ponds may be a contributing factor to the increase in the wintering population of double-crested cormorants in the fish producing regions of the southern United States (Jackson and Jackson 1995, Glahn et al. 1999, Reinhold and Sloan 1999).

Damage to aquaculture resources occurs primarily from the economic losses associated with double-crested cormorants consuming fish and other commercially raised aquatic organisms. Damage can also result from the death of fish and other aquatic wildlife from injuries associated with predation as well as the threat of disease transmission from one impoundment to another or from one aquaculture facility to other facilities as double-crested cormorants move between sites.

The frequency of occurrence of double-crested cormorants at a given aquaculture facility can be a function of many interacting factors. Those factors may include the size of the regional and local double-crested cormorant population, the number, size, and distribution of ponds, and the size distribution, density, health, and species composition of fish populations in the ponds. Additional factors may include the number, size, and distribution of natural wetlands in the immediate area, the size distribution, density, health, and species composition of natural fish populations in the surrounding landscape, the number, size, and distribution of suitable roosting habitat, and the variety, intensity and distribution of local damage abatement activities. As a result, double-crested cormorants rarely distribute evenly over a given region, but rather tend to be highly clumped or localized. Damage abatement activities can shift bird activities from one area to another; thereby, not eliminating predation but only reducing damage at one site while increasing damage at another (Aderman and Hill 1995, Mott et al. 1998, Reinhold and Sloan 1999, Tobin et al. 2002, Taylor and Strickland 2008). Thus, some aquaculture producers in a region suffer little or no economic damage from double-crested cormorants, while others experience exceptionally high losses.

Price and Nickum (1995) concluded that the aquaculture industry has small profit margins so that even a small percentage reduction in the farm gate value due to predation is an economic issue. The magnitude of economic impacts that double-crested cormorants have on the aquaculture industry can vary dependent upon many different variables, including the value of the fish stock, number of depredating birds present, and the time of year the predation is taking place.

Much of the research on the potential economic impacts to the aquaculture industry associated with double-crested cormorants has focused on the production of farm-raised catfish in the southeastern United States, primarily on catfish production in Mississippi. The Mississippi Delta and the Yazoo River Basin regions of Mississippi support some of the largest concentration of acres devoted to aquaculture production in North America (Dorr et al. 2007, Dorr et al. 2012). The Mississippi Delta and the Yazoo River Basin also support large concentrations of resident, wintering, and migrating fish-eating birds, including the double-crested cormorant. Aquaculture production in Mississippi ranked second nationally with the value of sales totaling over $185 million in 2012 (National Agricultural Statistics Service 2017). Mississippi produces over 55% of the farm-raised channel catfish in the United States, which ranks first in the nation (Mississippi Farm Bureau 2016). The principal species propagated at aquaculture facilities in Mississippi is channel catfish, but people farm other freshwater aquatic species in the state, including hybrid striped bass, tilapia, crawfish, baitfish, and turtles (Mississippi State University Extension Service 2017). In 2013, there were 224 aquaculture farms in Mississippi with nearly 47,500 acres of freshwater ponds used for aquaculture production. The value of aquaculture products sold in 2013 was nearly $204 million (National Agricultural Statistics Service 2014).

In the Mississippi Delta catfish industry, the majority of catfish fingerling loss from double-crested cormorants (about 64 to 67%) occurred in February and March, when large numbers of wintering double-crested cormorants are present in the state (Glahn and Brugger 1995). In Mississippi, double-crested cormorants occur throughout the year but are more abundant during the winter and migration periods as they arrive from their northern breeding areas. The wintering population of double-crested cormorants can feed heavily on fish raised for human consumption (*e.g*., catfish), and on fish commercially raised for bait and other purposes (Glahn and Stickley 1995, Glahn and King 2004, Dorr et al. 2012). Double-crested cormorants can affect the aquaculture industry in Mississippi by reducing yields from direct predation at commercial facilities that grow aquatic organisms, such as catfish and baitfish.

In the Mississippi Delta, King et al. (1995) found that double-crested cormorants flew an average of 16 kilometers (10 miles) from their night roosts to feeding sites. King et al. (1995) found that each double-crested cormorant spent about 18% of daylight hours feeding with 88% of their foraging occurring at ponds with commercial catfish and 12% occurring near roost sites. The average double-crested cormorant foraged for 60 minutes each day, but spent just 20 minutes underwater in actual pursuit of fish (King et al. 1995). The feeding rates of double-crested cormorants may be dependent on the size and abundance of the available fish and the metabolic demands of the double-crested cormorants, which is likely variable.

Actively feeding double-crested cormorants in commercial catfish ponds capture an average of five fish per double-crested cormorant per hour (Stickley et al. 1992), but can vary from zero to 28 fish (Stickley et al. 1992). Partly because of this variability, the rate of five fish per double-crested cormorant per hour reported by Stickley et al. (1992) is highly skewed with the median only being two fish per double-crested cormorant per hour, and the mean was equal to or exceeded at only three of the 14 ponds in the study. Stickley et al. (1992) did not find a statistically significant relationship between the mean number of double-crested cormorants present on ponds and the number of catfish consumed, but ponds with 40 or more double-crested cormorants generally had a feeding rate of one or fewer fish per double-crested cormorant per hour. Similarly, double-crested cormorant feeding rates were not related to the density of fingerling catfish, density of all catfish (all size classes combined), or mean length of fish. However, Werner and Dorr (2006) found that fish stocking density could influence the foraging behavior of double-crested cormorants. When given a choice of ponds stocked with relatively high and low densities of fish in a pen trial, double-crested cormorants allocated more time and effort in ponds with higher fish densities. In addition, double-crested cormorants captured more fish in ponds with higher fish densities (Werner and Dorr 2006).

Double-crested cormorants eat a wide variety of fish; thus, there is a great deal of variation in prey composition, both geographically and seasonally. Most of the research on the diet composition of double-crested cormorants at aquaculture facilities has occurred near catfish farms in the southeastern United States. Among double-crested cormorants collected at winter roosting sites, the average proportion of commercial catfish in the winter diet of double-crested cormorants near aquaculture facilities can range from 50% to 55% by number. The proportion of commercial catfish can vary seasonally from less than 30% in October and November to more than 80% in February, March, and April (*e.g.*, see Bivings et al. 1989, Glahn et al. 1995, Glahn and Brugger 1995, Glahn et al. 1999).

Double-crested cormorants are capable of taking catfish up to 42 centimeters (16 inches) in length (Campo et al. 1993). However, the majority of catfish caught by double-crested cormorants at commercial facilities are in the range of 7 to 20 centimeters (3 to 8 inches), with most averaging about 10 to 15 centimeters (4 to 6 inches) (Schramm et al. 1984, Stickley et al. 1992, Glahn et al. 1995). This range of prey size is similar in size to prey eaten by double-crested cormorants in natural freshwater habitats. In natural freshwater habitats, double-crested cormorant prey on fish ranging from six to 21 centimeters (2 to 8 inches), with a median value of about 12 centimeters (5 inches) (Hirsch 1986, Hobson et al. 1989, Campo et al. 1993, Glahn et al. 1998).

Based on monthly double-crested cormorant populations in 1997-1998 and 1998-1999, Glahn et al. (2000) predicted that, on an annual basis, double-crested cormorant predation losses could result in the removal of up to 48 million catfish valued at $5 million in the Mississippi Delta. Glahn et al. (1999) stated that as much as 75% of the diet of double-crested cormorants in certain roosting areas of the Mississippi Delta consisted of catfish and according to bioenergetic models, double-crested cormorants can exploit as much as 940 metric tons of catfish per winter. In the Yazoo River Basin of Mississippi, Dorr et al. (2012) found that double-crested cormorants consumed 1,775.3 metric tons of catfish during the winter of 2000-2001 valued at $12 million and 1,346.6 metric tons during the winter of 2003-2004 valued at nearly $6 million.

Controlled experiments by Glahn et al. (2002) examined output parameters at harvest with and without double-crested cormorant predation. Using sampling weights of fish inventoried from captive double-crested cormorant trials, Glahn et al. (2002) calculated a 19.6% biomass production loss from double-crested cormorant predation. At the scale of a commercial catfish pond, the 20% loss in production would correspond to a loss of 6,800 kg valued at $10,500 or almost 5 times the value of the fingerlings lost. Using this ratio, catfish production losses to Mississippi Delta catfish farmers may currently approach $25 million or 8.6% of all catfish sales in Mississippi per year (Glahn et al. 2002). Furthermore, Glahn et al. (2002) examined the economic effects of double-crested cormorant predation on net returns in an enterprise budget for an average 130-hectare catfish farm using data collected from captive double-crested cormorant trials and standard budgeting techniques. Enterprise budgets resulted in a 111% loss of profits based upon a 20% production loss observed at harvest from simulating 30 double-crested cormorants feeding at a 6-hectare catfish pond for 100 days. However, Dorr and Engle (2015) found that an increase in the growth of individual catfish associated with lower catfish densities in production ponds with high predation rates, in part, could mitigate declines in catfish production associated with double-crested cormorant predation.

Also of concern to aquaculture facilities is the transmission of diseases by double-crested cormorants between impoundments and from facility to facility. Given the confinement of aquatic organisms inside impoundments at aquaculture facilities and the high densities of those organisms in those impoundments, the introduction of a disease could result in substantial economic losses. Although actual transmission of diseases through transport by double-crested cormorants is difficult to document, birds have been documented as having the capability of spreading diseases through fecal droppings and possibly through other mechanical means such as on feathers, feet, and regurgitation. Birds can be a possible source of transmission of Spring Viraemia of Carp, Viral Hemorrhagic Septicaemia, and Infectious Pancreatic Necrosis in Europe, which are fish viruses capable of causing the death of fish, reducing growth rates, and making fish unmarketable (European Inland Fisheries Advisory Commission 1989). Birds may also be capable of passing bacterial pathogens through fecal droppings and on their feet (Price and Nickum 1995). Taylor (1992) found the bacterial pathogen for the fish disease Enteric Septicemia of Catfish within the intestines and rectal areas of double-crested cormorants collected from aquaculture facilities in Mississippi. However, because Enteric Septicemia of Catfish is endemic in the region, Taylor (1992) did not consider birds as a primary vector of the disease.

A highly virulent strain of *Aeromonas hydrophila* bacteria caused the loss of more than 3 million pounds of market-sized catfish at aquaculture facilities in western Alabama from June through October in 2009 (Pridgeon and Klesius 2011). Cunningham et al. (2018) found that double-crested cormorants could shed a highly virulent strain of *Aeromonas hydrophila* bacteria in their feces when fed catfish infected with the bacteria, which demonstrated that double-crested cormorants could transfer the bacteria from an aquaculture pond with infected fish to ponds with uninfected fish. Birds can also pose as primary hosts to several cestodes, nematods, trematodes, and other parasites that can infect fish. In the Mississippi River Delta region of Mississippi, O'Hear et al. (2014) found up to five species of trematodes in the gastrointestinal tract of double-crested cormorants that may be capable of infecting a variety of freshwater fish species. Birds can act as intermediate hosts of parasites that can infect fish after completing a portion of their life cycle in crustaceans or mollusks (Price and Nickum 1995).

Although documentation that double-crested cormorant can pose as vectors of pathogens known to infect fish, the rate of transmission is currently unknown and is likely very low. Fish-eating birds often target fish that are diseased and less likely to escape predation at aquaculture facilities (Price and Nickum 1995, Glahn et al. 2002). Because double-crested cormorants have the ability to move from one impoundment or facility to another, the threat of disease transmission is a concern given the potential economic loss that could occur from extensive mortality of fish or other cultivated aquatic organisms if a disease outbreak occurred.

1.4.3 Need to Reduce Risks that Double-crested Cormorants Pose to Human Safety

Threats to human health and safety associated with double-crested cormorants in Mississippi are primarily associated with aircraft striking double-crested cormorants at or near air facilities, including military airfields. Although there have been no reports of aircraft strikes involving double-crested cormorants in Mississippi from 1990 through early 2019, double-crested cormorants can and do pose aircraft strike risks at air facilities and military airfields in the state. When aircraft strike double-crested cormorants, structural damage can occur to the aircraft and, in some circumstances, could cause a catastrophic failure of the aircraft leading to crashes, especially when an aircraft ingests double-crested cormorants into an engine or engines.

Although rare, aircraft strikes involving wildlife, including double-crested cormorants, can lead to human injuries and human fatalities. From 1990 through 2017, Dolbeer and Begier (2019) reported four aircraft strikes involving double-crested cormorants caused injuries to five people in the United States. It is more common for wildlife-aircraft strikes to result in expensive repairs, flight delays, or aborted aircraft movements than injury or loss of human life.

A high percentage of bird strikes occur during peak migration periods, but dangerous situations can develop during any season. Species of birds that occur in flocks or flight lines entering or exiting a roost at or near airports or when present in flocks foraging on airport property can result in aircraft strikes involving several individuals of a bird species, which can increase damage and increase the risks of catastrophic failure of the aircraft. Aircraft are most vulnerable to bird strikes while at low altitudes, generally related to landing and taking off. Dolbeer et al. (2013) found that 72% of commercial aircraft strikes and 74% of general aviation aircraft strikes occurred at less than 500 feet above ground level, which is why management of the area immediately surrounding taxiways, runways, and runway approaches is important.

When ranking the 66 most hazardous bird groups or species to aircraft in the United States from 1990 to 2009, DeVault et al. (2011) concluded that double-crested cormorants were the sixth most hazardous bird group or bird species to aircraft. DeVault et al. (2011) based those hazard estimates on the number of strikes involving a bird group or species, the amount of damage strikes involving those bird groups or species caused to aircraft, the effect on the flight after the strike, and the average body mass of a bird species or birds in a group. Pfeiffer et al. (2018) ranked double-crested cormorants as the ninth most hazardous species group to military aircraft in the United States out of 108 species groups assessed.

In addition to threats associated with aircraft striking double-crested cormorants at or near air facilities and military airfields, other threats to human health and safety are primarily associated with contamination of water supplies and human exposure to large accumulations of fecal droppings in areas where double-crested cormorants roost or nest. During a survey conducted by Wires et al. (2001), respondents in seven states and one Canadian province expressed concerns about the presence of double-crested cormorants and the possible effects to public health due to water quality and disease transmission.

Fecal droppings from roosting or nesting birds can contain pathogens (*e.g.*, coliform bacteria, streptococcus bacteria, salmonella) and contaminants (*e.g.*, toxic chemicals, nutrients), which can result in poor water quality depending on the number of birds, the amount of excrement, and the size of the water body. Fecal accumulations from other waterbirds, such as gulls (*Larus* spp.), Canada geese (*Branta canadensis*), and great cormorants (*Phalacrocorax carbo*), that occur at high concentrations over or near water bodies can influence water quality (*e.g.*, see Hussong et al. 1979, Benton et al. 1983, Klett et al. 1998, Alderisio and DeLuca 1999, Lévesque et al. 2000, Kirschner et al. 2004, Meerburg et al. 2011, Klimaszyk and Rzymski 2013, Klimaszyk et al. 2015, Han et al. 2017). Fecal contamination of water can also accelerate the process of eutrophication (*e.g.*, see Nakamura et al. 2010, Klimaszyk and Rzymski 2013). However, linking the elevated presence of pathogens and contaminants in water to a single source can be difficult because those inputs could originate from many other sources (*e.g.*, water runoff, landfills, leaking pipes) or may be the accumulated result associated with multiple inputs. Although anecdotal evidence may exist linking concentrations of double-crested cormorants to specific water quality concerns (*e.g.*, see Wires et al. 2001), very little research has occurred that directly links double-crested cormorants to specific instances of poor water quality, including concerns involving public water supplies.

Lafferty et al. (2016) did not find evidence that double-crested cormorants nesting on islands within an Alabama lake were having a direct effect on water quality. However, Lafferty et al. (2016) stated, "*cormorants may have indirect effects due to interactions among nutrient flow, aquatic plant growth and slight differences in pH associated with cormorant colonies*." In addition, Lafferty et al. (2016) noted that nesting densities on islands within an Alabama lake (97.1 cormorants per square hectare) were much lower than nesting densities that may occur in areas further north (*e.g.*, more than 500 cormorants per square hectare).

1.4.4 Need to Reduce Double-crested Cormorant Damage Occurring to Property

Damage to property associated with double-crested cormorants is primarily associated with aircraft striking double-crested cormorants at or near air facilities and military airfields. Collisions between aircraft and wildlife, including double-crested cormorants, are a concern because wildlife strikes threaten passenger safety, result in lost revenue, require costly repairs to aircraft (Linnell et al. 1996, Robinson 1996, Dolbeer and Begier 2019), and can erode public confidence in the air transportation industry as a whole (Conover et al. 1995). From 1990 through 2017, the Federal Aviation Administration received 153 reports of aircraft strikes involving double-crested cormorants in the United States (Dolbeer and Begier 2019). Of those 153 reports, 53 strikes reported that damage to the aircraft occurred and 40 of the total aircraft strike involving double-crested cormorants had a negative effect on the flight (*e.g*., emergency landing). In addition, 25 of those reported 153 aircraft strikes involved the aircraft strike multiple double-crested cormorants. In total, those 153 aircraft strikes resulted in 3,307 hours of aircraft downtime for repairs and inspections and caused over $6.3 million in damages to aircraft.

Wildlife strikes result in millions of dollars in direct and indirect damages annually. Direct costs include damage to aircraft, aircraft downtime, and medical expenses of injured personnel and passengers. Indirect costs can include lost revenue from the flight, cost of housing delayed passengers, rescheduling aircraft, and flight cancellations. Current damage and injury data related to aircraft striking wildlife may be an underestimate of total damage because reporting a strike is voluntary. Therefore, the number of actual bird strikes is likely to be much greater than that reported. An estimated 80% of civil bird strikes may go unreported (Linnell et al. 1999, Wright and Dolbeer 2005). Between 2004 and 2008, Dolbeer (2009) estimated the Federal Aviation Administration received reports on only 39% of the actual aircraft strikes; therefore, 61% of aircraft strikes went unreported. In addition, not all reports on aircraft strikes provide notation as to whether or not there was damage and some strike reports to the Federal Aviation Administration that indicate there was an adverse impact on the aircraft from the strike do not include a monetary estimate of the damage caused. Additionally, most reports indicating damage to aircraft report direct damages and do not include indirect damage, such as lost revenue, cost of putting passengers in hotels, rescheduling aircraft and flight cancellations.

In addition to damage that could occur from aircraft striking double-crested cormorants, double-crested cormorants can cause damage to many other types of property, primarily from accumulation of fecal droppings under areas where congregations of double-crested cormorants nest and roost. Double-crested cormorants can nest and roost on artificial structures, such as power transmission line towers and bridges (Dorr et al. 2014). Corrosion caused by fecal uric acid from nesting or roosting congregations of double-crested cormorants can damage metal surfaces. In addition, accumulations of fecal droppings can be esthetically displeasing to property owners along with the unpleasant smell associated with fecal accumulations.

1.4.5 Need to Reduce Damage to Natural Resources Associated with Double-crested Cormorants

Double-crested cormorants often nest in colonies and exhibit gregarious behavior. Both characteristics often lead to accumulations of fecal droppings in areas where they nest and roost, which can have a negative impact on vegetation because fecal droppings can contribute to excessive amounts of ammonium nitrogen, phosphorous, and metals in the soil. Changes in the soil from fecal droppings can affect the composition of plant species, which often leads to a reduction in the number of species and an opportunity for non-native species to establish (Boutin et al. 2011, Craig et al. 2012). In addition, double-crested cormorants often strip leaves for nesting material and the weight of nests can break branches, which often leads to the death of the tree (Lemmon et al. 1994, Boutin et al. 2011, Koh et al. 2012, McGrath and Murphy 2012, Ayers et al. 2015, Lafferty et al. 2016).

In some cases, the habitat degradation on islands can be so severe that the roosting and nesting activities of double-crested cormorants completely eliminates all woody vegetation, which can leave those islands completely denuded of vegetation (Cuthbert et al. 2002). For example, double-crested cormorants began nesting relatively recently on islands at Lake Guntersville in Alabama. The number of double-crested cormorants nesting at Lake Guntersville has led to concerns about the potential impacts double-crested cormorants are having on vegetation, soil quality, and water quality in the area where they nest (Barras 2004). Barras (2004) stated, "…*the effects of so many* [double-crested cormorants] *building nests and* *depositing tons of feces can be catastrophic to sensitive vegetation and other birds using the same habitats*" and "*…are presently experiencing this type of loss of natural resources on Lake Guntersville*." Double-crested cormorants often nest on islands to avoid predators (Dorr et al. 2014), which is where double-crested cormorants are primarily nesting on Lake Guntersville. Barras (2004) further stated, "*In addition to the loss of habitat when trees and vegetation are killed from large amounts of fecal matter, the island is more susceptible to erosion. Some of the islands impacted by cormorant rookeries and roosts have begun to lose shoreline to erosion and dead trees have fallen into the water creating navigational hazards*." Similar concerns regarding habitat degradation on islands associated with double-crested cormorant roosts and nesting colonies could occur in Mississippi.

Additionally, degradation of vegetation due to the presence of double-crested cormorants can reduce nesting habitat for other birds (Jarvie et al. 1997, Shieldcastle and Martin 1999) and habitat used by wildlife, including threatened or endangered species (Korfanty et al. 1999). In tree-nesting colonies, high concentrations of nesting double-crested cormorants can compete with other bird species, such as great blue herons, great egrets, snowy egrets, and black-crowned night-herons, for limited nesting space (Weseloh and Ewins 1994, Weseloh and Collier 1995, Wires et al. 2001). Additionally, double-crested cormorant droppings into nests situated in lower trees can cause nest abandonment (Moore et al. 1995). Double-crested cormorant eggs can occur in other species' nests suggesting that some level of species displacement can occur (Somers et al. 2011). This often leads to displacement of other native bird species and a decrease of species diversity on islands that host high concentrations of double-crested cormorants. In some cases, the establishment of colonial waterbird nesting colonies on islands has led to the complete denuding of vegetation within three to 10 years of areas being occupied (Lewis 1929, Lemmon et al. 1994, Weseloh and Ewins 1994, Bédard et al. 1995, Weseloh and Collier 1995, Weseloh et al. 1995, Korfanty et al. 1999, Hebert et al. 2005). Although loss of vegetation can have an adverse effect on many species, some colonial waterbirds, such as pelicans and terns, prefer sparsely vegetated substrates for nesting.

1.4.6 Need to Protect Double-crested Cormorants from Oil Spills and Other Hazards

WS could also receive requests for assistance with recovering double-crested cormorants from areas affected by oil spills or other chemical spills. In addition, WS could receive requests to conduct activities to exclude, haze, and/or disperse double-crested cormorants from areas where oil or other toxic spills have occurred to prevent double-crested cormorants from contacting those chemicals. Exposure to oil, both chronic and acute, such as that from an oil spill, can adversely affect bird species (Szaro 1977, Flickinger 1981, Rocke 1999). Petroleum in all of its forms can affect birds through external oiling of feathers (which causes loss of buoyancy and waterproofing properties), ingestion, oiling of eggs, and habitat alteration (Rocke 1999). Death of individual birds often occurs from exposure or drowning, or sometimes indirectly from disease, malnutrition, and predation that results from ingesting oil.

1.4.7 Roles and Authorities of Other State and Federal Agencies

If WS provides assistance to meet the need for action, several state and federal agencies would have roles and authorities that would relate to WS conducting activities. Below are brief discussions of the roles and authorities of other state and federal agencies, as those authorities relate to conducting wildlife damage management.

Tennessee Valley Authority

The TVA is a federal corporation created by an Act of Congress in May 18, 1933 [48 Stat. 58-59, 16 USC Sec. 831, as amended]. The TVA provides electricity for business customers and local public power companies serving 10 million people, businesses, and industries and manages 293,000 acres of public land and 11,000 miles of reservoir shoreline in the 7-state Tennessee Valley region (Tennessee, Alabama, Mississippi, Kentucky, Georgia, North Carolina, and Virginia – an area of 80,000 square miles). The electricity generating assets of the TVA includes 29 hydroelectric dams, six coal-fired power plants, three nuclear plants, 18 natural gas-fired power facilities, and a pump-storage plant as well as solar, wind, and other renewable energy production sites that can produce about 34,000 megawatts of electricity, delivered over 16,000 miles of high-voltage power lines. The TVA also provides flood control, navigation, land management, and recreation for the Tennessee River system and works with local utilities and state and local governments to promote economic development across the region. The TVA often requests assistance from WS to provide assistance with managing wildlife damage on its land and at its facilities.

United States Fish and Wildlife Service Authority

The USFWS is the primary federal agency responsible for conserving, protecting, and enhancing the nation's fish and wildlife resources and their habitats. The USFWS shares this responsibility with other federal, state, tribal, and local entities. However, the USFWS has specific responsibilities for the protection of threatened and endangered species under the ESA, migratory birds, inter-jurisdictional fish, and certain marine mammals, as well as for lands and waters that the USFWS administers for the management and protection of those resources, such as the National Wildlife Refuge System.

Mississippi Department of Wildlife, Fisheries, and Parks

The MDWFP authority in wildlife management is given within the Mississippi Code Annotated Section 49-4-1 et seq., the official regulations of the Commission of Wildlife, Fisheries, and Parks and applicable state laws. The mission of the MDWFP is to conserve, manage, develop, and protect the natural resources and wildlife in the state.

1.4.8 State and Federal Regulations That Would Apply to WS' Activities

In addition to the NEPA, several statutes and executive orders would be relevant to activities that WS could conduct when providing assistance. This section discusses several laws and executive orders that are highly relevant to the WS program when providing assistance. All management actions conducted and/or recommended by WS would comply with appropriate federal, state, and local laws in accordance with WS Directive 2.210.

Endangered Species Act

Under the ESA, all federal agencies will seek to conserve threatened and endangered species and will utilize their authorities in furtherance of the purposes of the ESA (Section 2(c)). Evaluation of the alternatives in regards to the ESA will occur in Section 3.2.2 of this EA.

National Historic Preservation Act

The National Historic Preservation Act and its implementing regulations (see 36 CFR 800) require federal agencies to initiate the Section 106 process if an agency determines that the agency's actions are undertakings as defined in Section 800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects on historic properties. If the undertaking is a type of activity that does not have the potential to cause effects on historic properties, assuming such historic properties were present, the agency official has no further obligations under Section 106.

Migratory Bird Treaty Act of 1918 (16 USC 703-711; 40 Stat. 755), as amended

The Migratory Bird Treaty Act (MBTA) makes it unlawful to pursue, hunt, take, capture, kill, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or their parts, nests, or eggs (16 USC 703-711). A list of bird species protected under the MBTA occurs at 50 CFR 10.13. The MBTA also provides the USFWS regulatory authority to protect families of migratory birds. The law prohibits any "*take*" of migratory bird species by any entities, except as authorized by the USFWS. Under permitting guidelines in the MBTA, the USFWS may issue depredation permits to requesters experiencing damage caused by bird species protected under the MBTA. In addition, the USFWS may establish orders for migratory birds that allow people to take birds species without the need for a depredation permit when those species cause damage (*e.g*., depredation orders). Information regarding migratory bird permits and orders occurs in 50 CFR 13 and 50 CFR 21, respectively.

Responsibilities of Federal Agencies to Protect Migratory Birds - Executive Order 13186

Executive Order 13186 requires each federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations, to develop and implement a Memorandum of Understanding with the USFWS that shall promote the conservation of migratory bird populations. The APHIS has developed a Memorandum of Understanding with the USFWS as required by this Executive Order and WS would abide by the Memorandum of Understanding signed by the APHIS and the USFWS.

Environmental Justice in Minority and Low Income Populations - Executive Order 12898

Executive Order 12898 promotes the fair treatment of people of all races, income levels, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice is the pursuit of equal justice and protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. Executive Order 12898 requires federal agencies to make environmental justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income persons or populations. This EA will evaluate activities addressed in the alternative approaches for their potential impacts on the human environment and compliance with Executive Order 12898.

Protection of Children from Environmental Health and Safety Risks - Executive Order 13045

Children may suffer disproportionately for many reasons from environmental health and safety risks, including the development of their physical and mental status. Federal agencies must make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. In addition, federal agencies must ensure agency policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

1.4.9 Areas Where WS' Activities could occur

As discussed in Section 1.4.2, most requests for assistance that WS receives involving double-crested cormorants are associated with damage occurring to aquaculture. Aquaculture producers often identify double-crested cormorants as the most serious depredator of farm-raised aquaculture species (Stickley and Andrews 1989, Price and Nickum 1995, Dorr et al. 2012, Craig et al. 2016). In 2013, there were 224 aquaculture farms in Mississippi with nearly 47,500 acres of freshwater ponds used for aquaculture production. The Mississippi Delta and the Yazoo River Basin regions of northwest Mississippi support some of the largest concentration of acres devoted to aquaculture production in North America (Dorr et al. 2007, Dorr et al. 2012). In general, aquaculture producers build ponds by constructing levees over clay-rich soils that they fill with fresh water. The ponds are generally rectangular and average 10 to 20 acres each with a water depth of four to six feet.

Double-crested cormorants are adept at seeking out the most favorable foraging and roosting sites. The number of double-crested cormorants often increases rapidly wherever prey is readily accessible (Dorr et al. 2012). As a result, double-crested cormorants rarely distribute evenly over a given region, but are often highly clumped or localized. Thus, some aquaculture producers in an area suffer little or no economic damage from double-crested cormorants, while others experience exceptionally high losses. In addition to feeding habitats, double-crested cormorants need suitable places for daytime resting or loafing and nighttime roosts. When double-crested cormorants are not feeding, they spend time perching on exposed sites near aquatic habitats, such as rocks, sandbars, pilings, shipwrecks, high-tension wires, and trees often near feeding areas.

Nighttime roosts are often more remote and often are used by larger numbers of double-crested cormorants (Dorr et al. 2014). Many double-crested cormorants wintering near aquaculture facilities in the southeastern United States roost in trees associated with permanently flooded forested wetlands. Forested wetlands that double-crested cormorants often use include flooded areas of bald cypress (*Taxodium distichum*) or mixes of bald cypress and tupelo gum (*Nyssa aquatica*) (Aderman and Hill 1995, Glahn et al. 1996, King 1996, Dorr et al. 2004, King et al. 1995, Dorr et al. 2012). In general, congregations of double-crested cormorants begin arriving at roosts late in the afternoon/early evening and stay overnight at the locations. Double-crested cormorants disperse from those nighttime roosts in the morning to feed in surrounding areas, including nearby aquaculture facilities, before moving back to the roosts during the late afternoon/early evening. Conducting a coordinated effort to disperse double-crested cormorants from winter roosts near aquaculture facilities can be effective (Mott et al. 1998, Reinhold and Sloan 1999, Glahn et al. 2000). As double-crested cormorants arrived at a location to roost for the night, Mott et al. (1998) found that coordinated harassment could reduce the number of double-crested cormorants observed at aquaculture facilities near the roosts.

In the Mississippi Delta and the Yazoo River Basin regions of northwest Mississippi, the intent of harassing double-crested cormorants as they arrive at roost locations is to disperse those double-crested cormorants toward roost locations closer to the Mississippi River. Glahn et al. (1995) found that commercially raised fish from aquaculture facilities comprised a much lower percentage of the diet of double-crested cormorants roosting closer to the Mississippi River, likely due to the higher availability of natural forage from the oxbow lakes along the Mississippi River. Glahn et al. (2000) found that a higher percentage of double-crested cormorants used roosts along the Mississippi River following the implementation of dispersal activities at roost locations further from the river. In general, activities to disperse double-crested cormorants from roost locations would occur during a two-hour period before sunset and would target double-crested cormorants in a roost and flying towards a roost. To be effective, coordinated harassment efforts should occur to ensure that dispersal of double-crested cormorants occurs nearly simultaneously to prevent double-crested cormorants from merely moving between roosts near aquaculture facilities. In addition, the design and orientation of the coordinated efforts should be to disperse double-crested cormorants toward roost locations away from other aquaculture facilities. Conducting uncoordinated nighttime roost dispersal or conducting nighttime roost dispersal activities at a small number of roosts may be ineffective at reducing the number of double-crested cormorants using aquaculture facilities near those nighttime roost locations (Taylor and Strickland 2008).

Therefore, depending on the alternative approach that WS implements (see Section 2.2.2), WS could conduct activities and/or recommend activities that occur at aquaculture facilities, fish hatcheries, and at roost locations that are primarily associated with permanently flooded forested wetlands such as lakes, ponds, rivers, swamps, and bayous.

WS could also conduct activities to manage damage and threats of damage occurring in areas owned or managed by the TVA. The TVA owns and manages over 293,000 acres in the Tennessee River system. All of those lands support TVA's goals of power generation and transmission, flood control, and economic development of the Tennessee River Valley. Therefore, WS could conduct activities in areas associated with power-generating equipment, power transmission structures, dams, locks, and other facilities. In addition, the TVA operates public recreation areas throughout the Tennessee Valley region, including campgrounds, day-use areas, and boat launching ramps. The TVA owns five combustion turbine sites in Mississippi and two solar facilities. The TVA also owns or maintains electrical power substations and switching stations in Mississippi along with the associated transmission lines and rights-of-way easements. Part of the Pickwick Reservoir is located in northeastern Mississippi, which includes 90 miles of public shoreline. In addition, the TVA manages more than 1,700 acres of public land in Mississippi. Therefore, areas where WS may conduct activities could include islands and other natural areas along lakes, rivers, and waterways.

Depending on the alternative approach that WS implements, activities could also occur in those areas and in those situations described in Section 1.4.3 through Section 1.4.6, which may include island habitats, boat marinas, bridges, airports, military facilities, and private property. Therefore, the geographic scope of the actions and analyses in this EA is statewide and this EA analyzes actions that could occur on federal, state, county, city, and private lands, when requested.

CHAPTER 2: ISSUES AND ALTERNATIVES

The WS program in Mississippi has identified a need for action based on requests for assistance that WS receives to manage damage caused by double-crested cormorants in the state (see Section 1.4). The TVA has identified a need to manage damage or threats of damage caused by double-crested cormorants on property they own or manage in the state (see Section 1.4.1). WS and the TVA have identified several issues associated with the activities that WS could implement to meet that need for action. Issues are concerns regarding potential effects that might occur from proposed activities. Federal agencies must consider such issues during the decision-making process required by the NEPA. Section 2.1 of this EA discusses the issues that WS and the TVA identified, which could occur from the implementation of alternative approaches to meet the need for action. Section 2.1.1 discusses issues carried forward for further analysis in Chapter 3. Section 2.1.2 discusses additional issues that WS and the TVA identified; however, the EA does not analyze those issues further in Chapter 3 for the reasons provided in Section 2.1.2.

WS and the TVA developed four alternative approaches to meet the need for action that Section 1.4 of this EA identifies and to address the identified issues discussed in Section 2.1. Section 2.2.2 discusses the four alternative approaches that WS could implement to meet the need for action. Section 2.2.3 discusses alternatives considered but not analyzed in detail and provides the rationale for not considering those alternative approaches in detail within this EA. In addition, WS' directives would provide guidance to WS' personnel conducting official activities (see WS Directive 1.101).

2.1 ISSUES ASSOCIATED WITH MEETING THE NEED FOR ACTION

Chapter 3 analyzes several issues in detail for their potential direct and indirect impacts on the human environment. WS and the TVA identified those issues based on experience, previous EAs developed by WS, and public comments on those EAs. Chapter 3 discusses the issues, as those issues relate to the possible implementation of the alternative approaches to meeting the need for action discussed in Section 1.4. WS and the TVA evaluated, in detail, the following issues.

2.1.1 Issues Analyzed Further in Chapter 3

This section describes the issues that WS and the TVA identified during the scoping process for this EA. Section 3.2 analyzes the environmental consequences of each alternative in comparison to determine the extent of actual or potential impacts on the issues.

Issue 1 - Effects on the Double-crested Cormorant Population

A common issue when addressing damage caused by wildlife is the potential impacts of management actions on the populations of target species. Methods available to alleviate damage or threats of damage associated with double-crested cormorants are either non-lethal or lethal methods. Non-lethal methods available can exclude, disperse, or otherwise make an area unattractive to double-crested cormorants causing damage, which can reduce the presence of those double-crested cormorants at the site and potentially the immediate area around the site where people use those non-lethal methods. Lethal methods could also be available to remove a double-crested cormorant or those double-crested cormorants responsible for causing damage or posing threats to human safety. Therefore, if WS' personnel used lethal methods, the removal of a double-crested cormorant or double-crested cormorants could result in local population reductions in the area where damage or threats were occurring. The number of double-crested cormorants that WS could remove from the population using lethal methods under the alternatives would be dependent on the number of requests for assistance received, the number of individual double-crested cormorants involved with the associated damage or threat, and the efficacy of methods employed.

The basis for the analysis to determine the magnitude of impacts on the double-crested cormorant population from the use of lethal methods would be a measure of the number of individuals lethally removed in relation to the abundance of double-crested cormorants. Magnitude may be determined either quantitatively or qualitatively. Quantitative determinations may rely on population estimates, allowable removal levels, and actual removal data. Qualitative determinations may rely on population trend data, when available. The WS program in Mississippi would monitor the annual take of double-crested cormorants by comparing the number of double-crested cormorants lethally removed with overall populations or trends. WS' personnel would only use lethal methods at the request of a cooperator seeking assistance and only after the USFWS authorized the take of double-crested cormorants pursuant to the MBTA, when required.

Any activities conducted by WS under the alternatives addressed would occur along with other natural processes and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, and human-induced alterations of wildlife habitat. Section 3.2.1 analyzes the effects on the double-crested cormorant population from implementation of the alternative approaches. Information on the double-crested cormorant population and population trend data can be available from several sources, including the Breeding Bird Survey (BBS), the Christmas Bird Count (CBC), and available literature. Further information on those sources of information occurs below.

BREEDING BIRD SURVEY

People can monitor bird populations by using trend data derived from bird observations collected during the BBS. Under established guidelines, observers count birds at established survey points along roadways for a set duration along a pre-determined route. Routes are 24.5 miles long with the observer stopping every 0.5 miles along the route to conduct the survey. The observer records the number of birds observed and heard within 0.25 miles of each of the survey points during a 3-minute sampling period at each point. A survey along the route occurs once per year. Surveys first occurred in 1966 and occur in June, which is generally the period of time when those birds present at a location are likely breeding in the immediate area. The BBS occurs annually in the United States, across a large geographical area, under standardized survey guidelines. The BBS is a large-scale inventory of North American birds coordinated by the United States Geological Survey, Patuxent Wildlife Research Center (Sauer et al. 2017). The BBS is a combined set of over 3,700 roadside survey routes primarily covering the continental United States and southern Canada. The primary objective of the BBS has been to generate an estimate of population change for all breeding birds. Populations of birds tend to fluctuate, especially locally, because of variable local habitat and climatic conditions. Trends can be determined using different population equations and statistically tested to determine if a trend is statistically significant. Hierarchical model analysis is the basis for the current population trends derived from BBS data (Link and Sauer 2002, Sauer and Link 2011) and are dependent upon a variety of assumptions (Link and Sauer 1998).

CHRISTMAS BIRD COUNT

Numerous volunteers conduct the CBC annually in December and early January under the guidance of the National Audubon Society. The CBC reflects the number of birds frequenting a location during the winter months. Survey data consists of the number of birds observed within a 15-mile diameter circle around a central point (177 mi^2). The CBC data does not provide a population estimate, but the data can be an indicator of trends in a population over time. Researchers have found that population trends reflected in CBC data tend to correlate well with those from censuses taken by more stringent means (National Audubon Society 2010).

POTENTIAL TAKE LIMIT MODEL DEVELOPED BY THE USFWS

The USFWS has developed a Potential Take Limit model to estimate the potential impacts of allowing the take of double-crested cormorants to manage damage on the double-crested cormorant population. The Potential Take Limit model developed by the USFWS is a biologically based model that allows the USFWS to integrate scientific and policy elements into the decision-making process of allowing the take of double-crested cormorants to manage damage and to manage the double-crested cormorant population. For a detailed discussion of the Potential Take Limit model and its application, please see Appendix 1 in the EA developed by the USFWS for issuing depredation permits to manage damage caused by double-crested cormorants (USFWS 2017).

Issue 2 - Effects on the Populations of Non-target Wildlife Species, Including Threatened and Endangered Species

The potential for effects on non-target species and threatened or endangered species arises from the use of non-lethal and lethal methods identified in the alternatives. The use of non-lethal and lethal methods has the potential to inadvertently disperse, capture, or kill non-target wildlife. Appendix B describes the methods available for use under the alternative approaches.

The ESA states that all federal agencies *"...shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act"* [Sec. 7(a)(1)]. The USFWS and the National Marine Fisheries Service are responsible for managing and regulating take of species that are listed as threatened or endangered under the ESA (see 50 CFR 17). WS conducts consultations pursuant to Section 7 of the ESA to ensure compliance with the ESA and to ensure that *"any action authorized, funded or carried out by such an agency...is not likely to jeopardize the continued existence of any endangered or threatened species…Each agency shall use the best scientific and commercial data* *available"* [Sec. 7(a)(2)]. As part of the scoping process for this EA, WS consulted with the USFWS pursuant to Section 7 of the ESA during the development of this EA, which Section 3.2.2 discusses in further detail.

Issue 3 - Effects of Damage Management Methods on Human Health and Safety

An additional issue often raised is the potential risks to human health and safety associated with employing methods to manage damage caused by double-crested cormorants. WS' employees would use and recommend only those methods that were legally available, selective for target species, and were effective at resolving the damage associated with double-crested cormorants. Still, some concerns exist regarding the safety of methods despite their legality, selectivity, and effectiveness. As a result, this EA will analyze the potential for proposed methods to pose a risk to members of the public and employees of WS. Section 3.2.3 further evaluates the risks to human safety as this issue relates to the alternative approaches.

Issue 4 - Humaneness and Animal Welfare Concerns of Methods

Several non-lethal and lethal methods would be available to alleviate damage associated with double-crested cormorants. The use of non-lethal and lethal methods has the potential to exclude, disperse, capture, or kill double-crested cormorants. Section 3.2.4 will discuss concerns regarding the humaneness of available methods and animal welfare concerns.

Issue 5 - Effects on Waterfowl Hunting from Activities to Disperse Double-crested Cormorant Roosts

The presence of high numbers of wintering double-crested cormorants in the state generally coincides with the presence of high numbers of waterfowl in the state. Waterfowl hunting is an outdoor activity that people pursue and enjoy during the fall and winter months in Mississippi. Waterfowl can use a variety of aquatic habitats in Mississippi during the fall and winter, such as bayous, streams, lakes, flooded fields, flooded timber, and waterfowl impoundments, which can also be habitats that double-crested cormorants use during the fall and winter. Thus, people often hunt waterfowl in those same areas where double-crested cormorants roost at night. The presence of high numbers of wintering double-crested cormorants in the state overlaps the hunting season for waterfowl in the state. Because waterfowl and double-crested cormorants use similar habitats, WS could also disperse waterfowl from areas if waterfowl were present in the same area while attempting to disperse double-crested cormorants from a roost location. If WS' personnel unintentionally dispersed waterfowl during activities to disperse double-crested cormorants, those waterfowl may not be present in those areas when people attempt to hunt waterfowl.

2.1.2 Issues Considered But Not Analyzed Further in Chapter 3 for the Reasons Provided

WS and the TVA identified additional issues during the scoping process of this EA. WS and the TVA considered those additional issues but a detailed analysis does not occur in Chapter 3. Discussion of those additional issues and the reasons for not analyzing those issues in detail occur below.

Effects of Activities on Soils, Water, and Air Quality

The implementation of those alternative approaches discussed in Section 2.2.2 by WS would meet the requirements of applicable federal laws, regulations, and Executive Orders for the protection of the environment, including the Clean Air Act. The actions described in Section 2.2.2 do not involve major ground disturbance, construction, or habitat alteration. Activities that WS could conduct during implementation of those alternative approaches discussed in Section 2.2.2 would not cause changes in the flow, quantity, or storage of water resources. The use and storage of methods by WS' personnel would also follow WS' directives, including WS Directive 2.210, WS Directive 2.430, WS Directive 2.465, WS Directive 2.601, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.625, and WS Directive 2.627.

Most methods available for use to manage damage caused by double-crested cormorants are mechanical methods. Mechanical methods would not cause contaminants to enter water bodies or result in bioaccumulation. For example, firearms are mechanical methods that WS could use to remove a target double-crested cormorant lethally and to reinforce the noise associated with non-lethal methods, such as pyrotechnics. Firearms would not enter bodies of water and would be securely stored off-site after each use; therefore, the firearm itself would not contaminate water or result in the bioaccumulation of chemicals or other hazardous materials. Depredation permits issued by the USFWS require the use of non-toxic shot when using shotguns to target birds listed on the permit. Therefore, when conducting activities pursuant to a depredation permit issued by the USFWS and when using shotguns, WS' personnel would only use non-toxic shot. Occasionally, WS' personnel could use lead ammunition in rifles or air rifles.

Questions have arisen about the deposition of lead into the environment from ammunition used in firearms to remove double-crested cormorants lethally. As described in Appendix B, the lethal removal of double-crested cormorants with firearms by WS to alleviate damage or threats could occur using a shotgun or rifle, including an air rifle. In an ecological risk assessment of lead shot exposure in non-waterfowl birds, ingestion of lead shot was identified as the concern rather than just contact with lead shot or lead leaching from shot in the environment (Kendall et al. 1996). As part of the standard conditions of depredation permits issued pursuant to the MBTA for the lethal take of birds under 50 CFR 21.41, the Migratory Bird Permit Program within the USFWS has implemented the requirement that people receiving depredation permits must use non-toxic shot as defined under 50 CFR 20.21(j). In addition, it appears the USFWS may be moving toward incorporating the requirements of using non-toxic ammunition in firearms to take migratory birds in most cases. For example, the depredation order for blackbirds was recently amended to include the requirement that entities use non-toxic ammunition when using firearms to take depredating blackbirds, except when using an air rifle or an air pistol (see 50 CFR 21.43(d)).

The take of double-crested cormorants by WS in the state would occur primarily from the use of shotguns. WS would only use non-toxic shot as defined in 50 CFR 20.21(j) when using shotguns. However, WS' personnel could use rifles and air rifles to disperse or remove double-crested cormorants in some situations when WS' personnel determine their use to be safe. To reduce risks to human safety and property damage from bullets passing through double-crested cormorants, the use of rifles and air rifles would be applied in such a way (*e.g.*, caliber, bullet weight, distance) to reduce the likelihood of the bullet passing through double-crested cormorants. WS' personnel would retrieve the carcasses of double-crested cormorants to the extent possible and would dispose of the carcasses in accordance with WS Directive 2.515. With risks of lead exposure occurring primarily from ingestion of bullet fragments and lead shot, the retrieval and proper disposal of double-crested cormorant carcasses would greatly reduce the risk of scavengers ingesting lead contained within the carcass.

However, deposition of lead into soil could occur if, during the use of a rifle or air rifle, the projectile passed through a double-crested cormorant, if misses occurred, or if WS' personnel were not able to retrieve the carcass. Laidlaw et al. (2005) reported that, because of the low mobility of lead in soil, all of the lead that accumulates on the surface layer of the soil generally stays within the top 20 cm (about 8 inches). In addition, concerns occur that lead from bullets deposited in soil from shooting activities could lead to contamination of ground water or surface water. Stansley et al. (1992) studied lead levels in water that had high concentrations of lead shot accumulation because of intensive target shooting at several shooting ranges. Lead did not appear to "*transport*" readily in surface water when soils were neutral or slightly alkaline in pH (*i.e*., not acidic), but lead did transport more readily under slightly acidic conditions. Although Stansley et al. (1992) detected elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at a shooting range, the study did not find higher lead levels in a lake into which the stream drained, except for one sample collected near a parking lot. Stansley et al. (1992) believed the lead contamination near the parking lot was due to runoff from the lot, and not from the shooting range areas. The study also indicated that even when lead shot was highly accumulated in areas with permanent water bodies present, the lead did not necessarily cause elevated lead levels in water further downstream. Muscle samples from two species of fish collected in water bodies with high lead shot accumulations had lead levels that were well below the accepted threshold standard of safety for human consumption (Stansley et al. 1992).

Craig et al. (1999) reported that lead levels in water draining away from a shooting range with high accumulations of lead bullets in the soil around the impact areas were far below the "*action level*" of 15 parts per billion as defined by the United States Environmental Protection Agency (*i.e*., requiring action to treat the water to remove lead). The study found that the dissolution (*i.e*., capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments, which reduces the transport of lead across the landscape and naturally serves to reduce the potential for ground or surface water contamination (Craig et al. 1999). Those studies suggest that, given the very low amount of lead deposited and the concentrations that would occur from WS' activities to reduce double-crested cormorant damage using rifles, as well as most other forms of hunting in general, lead contamination from such sources would be minimal to nonexistent.

Because the take of double-crested cormorants could occur by other entities when authorized by the USFWS, WS' assistance with removing double-crested cormorants would not be additive to the environmental status quo. WS' assistance would not be additive to the environmental status quo because those double-crested cormorants removed by WS using firearms could be lethally removed by the entities experiencing damage using the same method in the absence of WS' involvement. WS' involvement in activities may result in lower amounts of lead being deposited into the environment due to efforts by WS to ensure projectiles do not pass through, but are contained within the double-crested cormorant carcass, which would limit the amount of lead potentially deposited into soil from projectiles passing through the carcass. The proficiency training received by WS' employees in firearm use and accuracy increases the likelihood that WS' personnel lethally remove double-crested cormorants humanely in situations that ensure accuracy and that misses occur infrequently, which would further reduce the potential for WS' activities to deposit lead in the soil.

In addition, WS' involvement in activities would ensure WS' personnel made efforts to retrieve double-crested cormorant carcasses lethally removed using firearms to prevent the ingestion of lead in carcasses by scavengers. WS' involvement would also ensure carcasses were disposed of properly to limit the availability of lead. Based on current information, the risks associated with lead bullets that WS' activities could deposit into the environment due to misses, the bullet passing through the carcass, or from double-crested cormorant carcasses that may be irretrievable would be below any level that would pose any risk from exposure or significant contamination. WS would not use lead ammunition at a magnitude that activities would deposit a large amount of spent bullets in such a limited area that would result in large accumulations of lead in the soil. As stated previously, when using shotguns, only non-toxic shot would be used by WS pursuant to 50 CFR 20.21(j). Additionally, WS may utilize non-toxic ammunition in rifles and air rifles as the technology improves and ammunition becomes more effective and available. WS would use non-toxic ammunition as required by the standard conditions of depredation permits issued for double-crested cormorants and/or any future depredation orders established for double-crested cormorants.

In addition, there is a concern about the use of aircraft during surveillance and monitoring activities for double-crested cormorants. The use of a fixed-winged aircraft or helicopter for surveillance and monitoring activities, like any other flying, may result in an accident. WS would primarily use aircraft to conduct roost counts in the state. WS' pilots and crewmembers receive training and have experience to recognize the circumstances that lead to accidents. The national WS Aviation Program has a strong emphasis on safety, including funding for training, the establishment of a WS Flight Training Center, and annual recurring training for all pilots. In addition, WS has developed a comprehensive Aviation Operations and Safety Manual that provides guidance to WS' personnel when conducting aerial operations. However, accidents may still occur. Nationwide, the WS program has been using aircraft during aerial operations for many years. During this time, no incidents of major ground fires associated with WS' aircraft accidents have occurred; thus, the risk of catastrophic ground fires caused by an aircraft accident is exceedingly low.

Aviation fuel is extremely volatile and it will normally evaporate within a few hours or less to the point that even detecting its odor is difficult. The fuel capacity for aircraft used by WS varies. For fixed-winged aircraft, a 52-gallon capacity would generally be the maximum, while 91 gallons would generally be the maximum fuel capacity for helicopters. In some cases, little or none of the fuel would spill if an accident occurs. Thus, there should be little environmental hazard from unignited fuel spills.

With the size of aircraft used by WS, the quantities of oil (*e.g.*, 6 to 8 quarts maximum for reciprocating (piston) engines and 3 to 5 quarts for turbine engines) capable of spilling in any accident would be small with minimal chance of causing environmental damage. Aircraft used by WS would be single engine models, so the greatest amount of oil that could spill in one accident would be about eight quarts.

Petroleum products degrade through volatilization and bacterial action, particularly when exposed to oxygen (United States Environmental Protection Agency 2000). Thus, small quantity oil spills on surface soils can biodegrade readily. Even in subsurface contamination situations involving underground storage facilities that generally involve larger quantities than would ever be involved in a small aircraft accident, the United States Environmental Protection Agency guidelines provide for *"natural attenuation"* or volatilization and biodegradation in some situations to mitigate environmental hazards (United States Environmental Protection Agency 2000). Thus, even where the owner of the aircraft did not clean up oil spills in small aircraft accidents, the oil does not persist in the environment or persists in such small quantities that no adverse effects would likely occur. In addition, WS' accidents generally would occur in remote areas away from human habitation and drinking water supplies. Thus, the risk to drinking water appears to be exceedingly low to nonexistent.

For those reasons, the risk of ground fires or fuel/oil pollution from aviation accidents would be low. In addition, based on the history and experience of the program in aircraft accidents, it appears the risk of environmental damage from such accidents is exceedingly low.

Currently, the two principal types of fuel used in aviation today are aviation gasoline (commonly referred to as avgas) and jet fuel. According to the Federal Aviation Administration, aviation gasoline is the only transportation fuel that still contains a lead additive (Federal Aviation Administration 2018). Jet fuel does not contain a lead additive. The helicopters that WS could use to conduct monitoring and surveillance activities would use jet fuel, which does not contain lead. However, the airplanes that WS could use would use aviation gasoline, which does contain a lead additive. The Federal Aviation Administration (2018) stated, "[Aviation gasoline] *emissions have become the largest contributor to the relatively low levels of lead emissions produced in* [the United States]."

In consultation with the Federal Aviation Administration, the United States Environmental Protection Agency has the authority to regulate aircraft emissions under the Clean Air Act, including lead emissions from the use of aviation gasoline. When the United States Environmental Protection Agency sets standards for aircraft emissions, the Clean Air Act specifies that the United States Environmental Protection Agency and the Federal Aviation Administration must consider the time needed to develop required technology, consider cost, and must not adversely affect aircraft safety or noise (Federal Aviation Administration 2018).

In 2006, an environmental advocacy organization petitioned the United States Environmental Protection Agency to find that lead emissions from airplanes using aviation gasoline containing lead additives contribute to lead air pollution that may endanger public health or welfare. The same environmental advocacy organization petitioned the United States Environmental Protection Agency again in 2014 and urged the United States Environmental Protection Agency to make an endangerment finding regarding lead emissions from aviation gasoline. Despite the petitions, the United States Environmental Protection Agency continues to indicate a need for more data and findings to make a judgment on whether lead emissions from aviation gasoline are a danger to public health. Pursuant to Section 231 of the Clean Air Act, the United States Environmental Protection Agency is currently conducting proceedings regarding whether lead emissions from piston-engine general aviation aircraft that use aviation gasoline cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. In addition, the Federal Aviation Administration is supporting research of alternative fuels to replace aviation gasoline that contain lead additives. The Federal Aviation Administration anticipates issuing final test reports on alternative fuels to replace aviation gasoline that contain lead additives by mid-2020 (Federal Aviation Administration 2018). The Federal Aviation Administration is committed to developing an alternative fuel or fuels for use in airplanes and the United States Environmental Protection Agency continues to proceed with investigations regarding whether lead emissions from airplanes using aviation gasoline cause or contribute to air pollution that may endanger the public. When the United States Environmental Protection Agency and the Federal Aviation Administration approve the general use of an alternative fuel or fuels and the fuel or fuels become readily available for use, WS would use the alternative fuel or fuels.

In conclusion, the WS program in Mississippi and the TVA do not expect that implementing any of the alternative approaches discussed in Section 2.2.2 would significantly change the environmental status quo with respect to soils, geology, minerals, water quality, water quantity, floodplains, wetlands, other aquatic resources, air quality, prime and unique farmlands, timber, and range. WS has received no reports or documented any effects associated with soil, water, or air quality from previous activities associated with managing damage caused by double-crested cormorants in the state that WS conducted. Therefore, the EA will not analyze those elements further.

Greenhouse Gas Emissions by the WS Program

Under the alternative approaches intended to meet the need for action discussed in Section 2.2.2, the WS program in Mississippi could potentially produce criteria pollutants (*i.e.*, pollutants for which maximum allowable emission levels and concentrations are enforced by state agencies). Those activities could include working in the office, travel from office to field locations, travel at field locations (vehicles or all-terrain vehicles), and from other work-related travel (*e.g.*, attending meetings). During evaluations of the national program to manage feral swine (*Sus scrofa*), the WS program reviewed greenhouse gas emissions for the entire national WS program (see pages 266 and 267 in USDA 2015*b*). The analysis estimated effects of vehicle, aircraft, office, and all-terrain vehicle use by WS for federal fiscal year (FY) 2013 and included the potential new vehicle purchases that could be associated with a national program to manage damaged caused by feral swine. The review concluded that the range of Carbon Dioxide Equivalents (includes CO_2, NO_x CO, and SO_x) for the entire national WS program would be below the reference point of 25,000 metric tons per year recommended by CEQ for actions requiring detailed review of impacts on greenhouse gas emissions. The activities that WS could conduct under the alternative approaches discussed in Section 2.2.2 would have negligible cumulative effects on atmospheric conditions, including the global climate.

Potential Irreversible and Irretrievable Commitments of Resources

Other than relatively minor uses of fuels for vehicles/aircraft, electricity for office operations, carbon dioxide for euthanasia, and some components associated with ammunition (*e.g.*, black powder, shot) and pyrotechnics (*e.g.*, black powder, cardboard), no irreversible or irretrievable commitments of resources result from the WS program.

Impacts on Cultural, Archaeological, Historic, and Tribal Resources and Unique Characteristics of Geographic Areas

A number of different types of federal and state lands occur within the analysis area, such as national wildlife refuges, national forests, and wildlife management areas. WS recognizes that some persons interested in those areas may feel that any activities that could occur in those areas would adversely affect the esthetic value and natural qualities of the area. Similarly, WS' activities could occur within areas with cultural, archaeological, historic, and/or tribal resources. The WS program in Mississippi would only provide direct operational assistance if WS implements Alternative 1 or Alternative 2 (see Section 2.2.2). WS would provide no assistance with managing damage caused by double-crested cormorants if WS implements Alternative 4 and WS would only provide technical assistance if WS implements Alternative 3.

If WS implements Alternative 1 or Alternative 2, the methods that WS could employ would not cause major ground disturbance and would not cause any physical destruction or damage to property. In addition, the methods available would not cause any alterations of property, wildlife habitat, or landscapes, and would not involve the sale, lease, or transfer of ownership of any property. WS would only conduct activities at a location after the property owner and/or manager signed a Memorandum of Understanding, work initiation document, work plan, or a similar document allowing WS to conduct activities on their property. The Memorandum of Understanding, work initiation document, work plan, and/or similar document would identify the methods the property owner and/or manager would allow WS to use on their property or properties. Therefore, the property owner and/or manager would be aware of the activities and the methods that WS could use on their properties.

Similarly, the WS program in Mississippi would only conduct activities on tribal lands at the request of the Tribe and only after signing appropriate authorizing documents. Therefore, the Tribe would determine what activities they would allow and when WS' assistance was required. Because Tribal officials would be responsible for requesting assistance and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would likely occur. WS would also adhere to the Native American Graves Protection and Repatriation Act. If WS' personnel located Native American cultural items while conducting activities on federal or tribal lands, WS would notify the land manager and would discontinue work at the site until authorized by the managing entity.

On rare occasions, WS could conduct activities in close proximity to cultural, archaeological, historic, and/or tribal sites to alleviate damage caused by double-crested cormorants. Conducting activities in close proximity to cultural, archaeological, historic, and/or tribal site for the purposes of alleviating damage caused by double-crested cormorants could introduce audible and visual effects on the use and enjoyment of those sites. WS use of auditory deterrents (*e.g.*, pyrotechnics, propane cannons), exclusion methods (*e.g.*, overhead wires, netting), and visual frightening methods (*e.g.*, mylar type, effigies) would have the potential to introduce visual and auditory effects to historic properties if WS used those methods on properties adjacent to cultural, archaeological, historic, and/or tribal sites. A built-in minimization factor is that audible methods, such as pyrotechnics and firearms, would only have temporary effects on the audible nature of a site. WS could end the use of those methods at any time to restore the audible qualities of such sites to their original condition with no further effects. In addition, WS could use those audible methods during times when activities at an adjacent cultural, archaeological, historic, and/or tribal site were minimal. For example, WS could conduct activities in the early morning or late in the evening.

For double-crested cormorants, WS could use and/or recommend the use of overhead wires and netting in limited situations. The use of exclusion methods is often impractical in many situations where double-crested cormorants cause damage because of the need to exclude them from a large area. For example, aquaculture ponds average 10 to 20 acres in size; therefore, covering the entire pond with netting or overhead wires would be impractical. In addition, the use of exclusion methods could prevent access to the pond to feed, stock, and harvest aquatic organisms. Exclusion methods are more practical for use in small areas (*e.g.*, retention ponds) (Curtis et al. 1996, Dorr et al. 2016). In most cases, the entity experiencing damage would be responsible for installing and maintaining exclusion methods.

The visual deterrents that WS could use to haze and disperse double-crested cormorants include effigies, mylar tape, lasers, and lights. Lasers and lights would occur in low light conditions, such as late evening or at night, to disperse double-crested cormorants. As with audio deterrents, WS could end the use of visual deterrents at any time to restore the visual qualities of such sites to their original condition with no further effects. In addition, WS could use visual deterrents during times when activities at an adjacent cultural, archaeological, historic, and/or tribal site were minimal, such as late in the evening.

Therefore, if WS implemented Alternative 1 or Alternative 2, the methods generally would not have the potential to affect the unique characteristics of geographic areas or any cultural, archeological, historic, and tribal resources. If WS implements Alternative 1 or Alternative 2 and WS planned an individual activity with the potential to affect those resources, WS and/or the entity requesting assistance would conduct the site-specific consultation required by Section 106 of the National Historic Preservation Act, as necessary. WS would abide by federal and state laws, regulations, work plans, Memorandum of Understanding, and policies to minimize any effects and would abide by any restrictions imposed by the entity requesting assistance or from the consultation process.

Impacts of Dispersing a Winter Double-crested Cormorants Roost on Nearby Aquaculture Facilities

Another issue often raised is that the dispersal of double-crested cormorants from a roost location to alleviate damage or conflicts at one site could result in new damage or conflicts at a new roost site. When dispersing double-crested cormorants from winter roosts, WS' personnel would generally use pyrotechnics, lights, lasers, boats, vehicles, and propane cannons. WS' personnel would coordinate harassment efforts at roosts to ensure that dispersal of double-crested cormorants occurs nearly simultaneously to prevent double-crested cormorants from merely moving between roosts near aquaculture facilities. In addition, WS' personnel would design and orient the coordinated efforts to disperse double-crested cormorants toward roost locations away from other aquaculture facilities. Therefore, WS and the TVA did not consider this issue further.

2.2 DESCRIPTION OF THE ALTERNATIVES

Section 2.2 discusses those alternative approaches that WS and the TVA identified during the initial scoping process for this EA. WS and the TVA developed the alternative approaches based on the need for action. The need for action identified by WS is associated with requests for assistance that WS receives to manage damage and threats of damage caused by double-crested cormorants in Mississippi (see Section 1.4). The TVA has identified a need to manage damage or threats of damage caused by double-crested cormorants on property they own or manage in the state (see Section 1.4.1). WS and the TVA also developed the alternative approaches to address those issues identified in Section 2.1.

Section 2.2.1 addresses actions that would be common to all of the alternatives. Section 2.2.2 discusses those alternative approaches WS and the TVA considered in detail within Chapter 3 of this EA. Chapter 3 analyzes the environmental consequences of each alternative as that alternative relates to the identified issues. Section 2.2.3 discusses additional alternative approaches that WS and the TVA identified but this EA will not analyze those alternative approaches in detail within Chapter 3 for the reasons provided in the description of each alternative.

2.2.1 Actions Common to all of the Alternatives

The following subsections discuss those actions WS and the TVA identified that would continue to occur if WS implemented any of the alternative approaches identified in Section 2.2.2.

WS' Co-managerial Approach to Making Decisions

Those entities experiencing damage associated with double-crested cormorants could conduct activities on their own, they could contact a private business for assistance, they could seek assistance from another governmental agency, they could seek assistance from WS, if available, or they could take no action. However, in all cases, the person and/or entity experiencing damage or threats of damage would determine the appropriate involvement of other people and/or entities and to what degree those people or other entities were involved in the decision-making process.

If a person and/or entity requested assistance from WS and WS was able to provide assistance, the WS program in Mississippi would follow the "*co-managerial approach*" to alleviate damage or threats of damage as described by Decker and Chase (1997). Within this management model, WS could provide technical assistance regarding the biology and ecology of double-crested cormorants and effective, practical, and reasonable methods available to a local decision-maker(s) to reduce damage or threats. Generally, a decision-maker seeking assistance would be part of a community, municipality, business, governmental agency, and/or a private property owner.

Under a community based decision-making process, WS would provide information, demonstration, and discussion on all available methods to the appropriate representatives of the community for which services were requested to ensure a community-based decision was made. By involving decision-makers in the process, WS could present damage management recommendations to the appropriate decision-maker(s) to allow decisions on damage management to involve those individuals that the decision maker(s) represents. As addressed in this EA, WS would provide technical assistance to the appropriate decision-maker(s) to allow the decision-maker(s) to present information on damage management activities to those persons represented by the decision-maker(s), including demonstrations and presentations by WS at public meetings to allow for involvement of the community. Requests for assistance to manage damage caused by double-crested cormorants often originate from the decision-maker(s) based on community feedback or from concerns about damage or threats to human safety. As representatives, the decision-maker(s) would be able to provide the information to local interests either through technical assistance provided by WS or through demonstrations and presentations by WS on activities to manage damage. This process would allow WS to recommend and implement activities based on local input.

The decision-maker for the local community would be officials or representatives of the communities that residents of a community have elected to represent them. The elected officials or representatives would be people who oversee the interests and business of the local community. This person or persons would represent the local community's interest and make decisions for the local community or bring information back to a higher authority or the community for discussion and decision-making. In the case of private property owners, the decision-maker would be the individual that owns or manages the affected property. The decision-maker for local, state, or federal property would be the official responsible for or authorized to manage the public land to meet interests, goals, and legal mandates for the property. If WS implemented Alternative 4, WS would not provide any assistance with managing the damage the double-crested cormorants can cause in the state; therefore, the co-managerial approach would not be applicable.

Availability of Methods to Manage Damage Caused by Double-crested Cormorants

Appendix B discusses several methods available to alleviate damage or threats of damage associated with double-crested cormorants. All of the methods discussed in Appendix B would be available to any entity for use when managing damage or threats of damage caused by double-crested cormorants. Therefore, despite the level of involvement by the WS program in Mississippi, those methods discussed in Appendix B would be available to other entities to manage damage or threats of damage associated with double-crested cormorants, including the public, private businesses, tribal entities, and other state or federal agencies.

Effectiveness of Methods to Address Damage and Threats of Damage

Defining the effectiveness of any damage management activities often occurs in terms of losses or risks potentially reduced or prevented. Effectiveness can be dependent upon how accurately practitioners diagnose the problem, the species responsible for the damage, and how people implement actions to correct or mitigate risks or damages. To determine that effectiveness, WS must be able to complete management actions expeditiously to minimize harm to non-target animals and the environment, while at the same time, using methods as humanely as possible. Efficacy is based on the types of methods employed, the application of the method, restrictions on the use of the method(s), the skill of people using the method and, for WS' personnel, the guidance provided by WS' directives and policies.

WS is considering several methods (see Appendix B) that WS' personnel could incorporate into alternative approaches (see Section 2.2.2) to meet the need for action. If WS provides assistance and depending on the alternative approach selected to meet the need for action (see Section 2.2.2), WS could consider the use of an individual method or consider the use of several methods in combination to address damage and threats of damage. When WS provides assistance, WS' personnel would use the WS Decision Model (see Directive 2.201) to identify methods (see WS Directive 2.101) appropriate to reducing damage and reducing the threat of damage. In general, when providing assistance, WS' personnel would consider an adaptive approach that would integrate a combination of methods to resolve damage and reduce threats of damage (see WS Directive 2.105). If WS provides assistance, WS' personnel would evaluate the request for assistance and would consider the effectiveness of the methods available for that request based on how effective a method or methods were during previous requests for assistance and/or how effective methods were when used by those entities experiencing damage or threats of damage. When using methods, WS' personnel would continue to evaluate method effectiveness during the use of those methods. Therefore, WS' personnel would consider method effectiveness as part of the decision making-process during their use of the WS Decision Model for each damage management request based on continual evaluation of methods and results.

In meeting the need for action, the objective would be to reduce damage, risks, and conflicts with double-crested cormorants as requested and not to reduce/eliminate the double-crested cormorant population. If WS excludes, removes, and/or disperses double-crested cormorants from an area where they were causing damage or posing a threat of damage, those double-crested cormorants would no longer be present at that location to cause damage or pose a threat. The removal and/or dispersal of double-crested cormorants could be short-term because new individuals may immigrate to an area, especially during the migration periods. Therefore, the return of double-crested cormorants to an area after removal and/or dispersal activities does not mean individual management actions or methods were unsuccessful, but that periodic management may be necessary.

Similar to the effectiveness of methods to reduce damage or reduce threats of damage is the cost effectiveness of methods. The cost of methods and/or the cost of implementing methods may sometimes be a secondary consideration because of overriding environmental, legal, human health and safety, humaneness, animal welfare, or other concerns. Therefore, the cost effectiveness of methods and/or a cost benefit analysis is not essential to making a reasoned choice among the alternative approaches that WS and the TVA are considering. In addition, the CEQ does not require a formal, monetized cost benefit analysis to comply with the NEPA.

Research Related to Damage and Threats of Damage Caused by Double-crested Cormorants

Under any of the alternatives, the national WS program would continue to research and develop methods to address double-crested cormorant damage through the National Wildlife Research Center (NWRC). The NWRC functions as the research unit of WS by providing scientific information and by developing methods to address damage caused by animals. Research biologists with the NWRC work closely with WS' personnel, wildlife managers, researchers, and others to develop and evaluate methods and techniques. For example, one research area that is a focus of the NWRC is the damage occurring to aquaculture associated with fishing-eating bird species, including double-crested cormorants. In addition, the NWRC conducts research to understand the life history of double-crested cormorants, such as migration routes and feeding habits.

Authorization of Migratory Bird Take by the USFWS

As noted in Section 1.4.8, the MBTA makes it unlawful to pursue, hunt, take, capture, kill, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or their parts, nests, or eggs (16 USC 703-711). Double-crested cormorants are a migratory bird protected by the MBTA (see 50 CFR 10.13). Pursuant to 50 CFR 21.41, "*…a depredation permit is required before any person may take, possess, or transport migratory birds for depredation control purposes. No permit is required merely to scare or herd depredating migratory birds other than endangered or threatened species or bald or golden eagles*". Therefore, prior to the use of lethal methods to alleviate damage or threats of damage, any entity, including WS, must apply for and receive a depredation permit from the USFWS. In general, the dispersal (*i.e.*, scaring) of double-crested cormorants from an area using non-lethal methods would not require an entity to apply for and receive a depredation permit. A depredation permit is also not required to destroy inactive nests (*i.e.*, nests without eggs or nestlings). Under the permitting application process for a depredation permit, the USFWS requires applicants to describe prior non-lethal damage management techniques that they have used. The USFWS can also authorize the take of migratory birds by establishing depredation orders, control orders, and other permitting process.

Influence of Global Climate Change on the Double-crested Cormorant Population

The State of the Climate in 2012 report indicates that every year has been warmer than the long-term average since 1976 (Blunden and Arndt 2013). Impacts of this change will vary throughout the United States, but some areas could experience air and water temperature increases, alterations in precipitation, and increased severe weather events. Temperature and precipitation often influence the distribution and abundance of a plant or animal species. According to the United States Environmental Protection Agency (2016), as temperatures continue to increase, the ranges of many species will likely expand into northern latitudes and higher altitudes. Species adapted to cold climates may struggle to adjust to changing climate conditions (*e.g*., less snowfall, range expansions of other species). Sheikh et al. (2007) stated, "*Wildlife species can be affected by several climatic variables such as increasing temperatures, changes in precipitation, and extreme weather events*". Sheikh et al. (2007) further stated that changes in climate could benefit some species of wildlife.

The impact of climate change on wildlife and their habitats is of increasing concern to land managers, biologists, and members of the public. Climate change may alter the frequency and severity of habitat-altering events, such as wildfires, weather extremes, such as drought, presence of invasive species, and wildlife diseases. WS recognizes that climate change is an ongoing concern and may result in changes in species range and abundance. Climate change may also affect other factors, such as agricultural practices and the timing of water freeze up, which can influence the timing and movement pattern of bird migrations. Over time, climate change would likely lead to changes in the scope and nature of human-wildlife conflicts in the state. Because these types of changes are an ongoing process, WS has developed adaptive management strategies that allow WS and other agencies to monitor for and adjust to impacts of ongoing changes in the affected environment.

If the WS program selected an alternative approach to meeting the need for action that allows the program in Mississippi to provide assistance (see Section 2.2.2), WS would monitor activities, in context of the issues analyzed in detail, to determine if the need for action and the associated impacts remain within the parameters established and analyzed in this EA. If WS implemented Alternative 1, activities would not exceed the levels authorized by the USFWS and/or the MDWFP. In addition, WS would submit annual reports to the USFWS and/or the MDWFP so the USFWS and/or the MDWFP had the opportunity to evaluate WS' activities and the cumulative take occurring for double-crested cormorants. The mission of the USFWS is "…*working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people*" (USFWS 2018). The mission of the MDWFP is to "…*conserve and enhance Mississippi's wildlife, fisheries, and parks, provide quality outdoor recreation, and engage the public in natural resource conservation*" (MDWFP 2018).

Therefore, coordinating activities between WS with the USFWS and/or the MDWFP would ensure the USFWS and/or the MDWFP have the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the state. As part of those coordinated activities, WS would submit annual activity reports to the USFWS and/or the MDWFP to aid with the ongoing monitoring efforts. If WS determines that a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts warrant a new or additional analysis, WS would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS can evaluate and adjust activities as changes occur over time.

WS' monitoring would also include reviewing the list of species the USFWS and the National Marine Fisheries Service considers as threatened or endangered within the state pursuant to the ESA. As appropriate, WS would consult with the USFWS and/or the National Marine Fisheries Service pursuant to Section 7 of the ESA to ensure the activities conducted by WS would not jeopardize the continued existence of threatened or endangered species or result in adverse modification to areas designated as critical habitat for a species within the state. Through the review of species listed as threatened or endangered and the consultation process with the USFWS and/or the National Marine Fisheries Service, the WS program in Mississippi can evaluate and adjust activities conducted to meet the need for action. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review and consultation process. Should this monitoring and analysis determine it to be necessary, WS could adjust activities to assure that its actions do not significantly contribute to changes in the environmental status quo that occur because of climate change.

2.2.2 Alternatives Carried Forward for Further Analysis in Chapter 3

As discussed in Section 1.2 and Section 1.4, people experiencing damage or threats of damage associated with wildlife often seek assistance from other entities to alleviate that damage or to prevent damage from occurring. The WS program is the lead federal agency responsible for managing conflicts between people and wildlife (see Section 1.2); therefore, people could request assistance from WS, including the TVA. WS and the TVA identified four alternative approaches to meeting the need for action that also address the issues identified in Section 2.1. Section 2.2.2 describes those alternative approaches identified by WS and the TVA and provides a description of how WS would implement those approaches.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

If WS implements Alternative 1, the WS program in Mississippi would be available to provide assistance when people experience damage or threats of damage associated with double-crested cormorants and, consequently, request assistance from WS. When responding to a request for assistance, WS' personnel would use the WS Decision Model (Slate et al. 1992; see WS Directive 2.201) to formulate a management strategy to address each request for assistance.

The general thought process and procedures of the WS Decision Model would include the following steps.

1. **Receive Request for Assistance:** WS would only provide assistance after receiving a request for such assistance. WS would not respond to public bid notices.
2. **Assess Problem:** First, WS would make a determination as to whether the assistance request was within the authority of WS. If an assistance request were within the authority of WS, WS' employees would gather and analyze damage information to determine applicable factors, such as what species was responsible for the damage, the type of damage, the extent of damage, and the magnitude of damage. Other factors that WS' employees could gather and analyze would include the current economic loss or current threat (*e.g.*, threat to human safety), the potential for future losses or damage, the local history of damage, and what management methods, if any, were used to reduce past damage and the results of those actions.
3. **Evaluate Management Methods:** Once a problem assessment was completed, a WS' employee would conduct an evaluation of available management methods (see Appendix B). The employee would evaluate available methods in the context of their legal and administrative availability and their acceptability based on biological, environmental, humaneness, social, and cultural factors.
4. **Formulate Management Strategy:** A WS' employee would formulate a management strategy using those methods that the employee determines to be practical for use. The WS employee would also consider factors essential to formulating each management strategy, such as available expertise, legal constraints on available methods, human safety, humaneness, non-target animal risks, costs, and effectiveness.
5. **Provide Assistance:** After formulating a management strategy, a WS employee could provide technical assistance and/or direct operational assistance to the requester (see WS Directive 2.101). All management actions conducted and/or recommended by WS would comply with appropriate federal, state, and local laws in accordance with WS Directive 2.210.
6. **Monitor and Evaluate Results of Management Actions:** When providing direct operational assistance, it is necessary to monitor the results of the management strategy. Monitoring would be important for determining whether further assistance was required or whether the management strategy resolved the request for assistance. Through monitoring, a WS' employee would continually evaluate the management strategy to determine whether additional techniques or modification of the strategy was necessary.

7. **End of Project:** When providing technical assistance, a project would normally end after a WS' employee provided recommendations or advice to the requester. A direct operational assistance project would normally end when WS' personnel stop or reduce the damage or threat to an acceptable level to the requester or to the extent possible. Some damage situations may require continuing or intermittent assistance from WS' personnel and may have no well-defined termination point.

Therefore, if WS implements Alternative 1, WS could respond to requests for assistance by: 1) taking no action, if warranted, 2) providing only technical assistance to property owners or managers on actions they could take to reduce damage caused by double-crested cormorants, or 3) providing technical assistance and direct operational assistance to a property owner or manager experiencing damage. WS would provide technical assistance to those entities requesting assistance as described for Alternative 3. Direct operational damage management assistance would include damage management activities that WS' personnel would conduct directly or supervise. WS' employees may initiate operational damage management assistance when technical assistance alone could not effectively alleviate the damage or the threat of damage and when WS and the entity requesting assistance have signed a Memorandum of Understanding, work initiation document, or another comparable document. Funding for WS' activities could occur from state and/or federal appropriations and/or from cooperative service agreements with an entity requesting WS' assistance. WS' activities to manage damage associated with double-crested cormorants in Mississippi would comply with WS Directive 2.301.

Appendix B discusses those methods that WS' employees would consider when evaluating management methods to alleviate damage or threats of damage associated with double-crested cormorants. Non-lethal methods from Section I in Appendix B that WS could use and/or recommend include exclusion methods (*e.g.*, surface coverings, netting, overhead wires), auditory deterrents (*e.g.*, propane cannons, pyrotechnics, electronic distress calls), visual deterrents (*e.g.*, scarecrows, lasers, lights), nest destruction, and live-capture methods (*e.g.*, modified foothold traps, nets). In addition, WS could recommend changes in cultural practices, such as changes in flight patterns at an air facility or changes to an aquaculture facility design, location of fish stock, fish stocking rates, or fish feeding methods. Lethal methods would include the use of a firearm, euthanasia after live-capture using carbon dioxide, and egg destruction (*i.e.*, puncturing, breaking, oiling, or shaking an egg). Section II in Appendix B describes those lethal methods that would be available to manage damage and threats of damage associated with double-crested cormorants. The initial investigation would define the nature, history, and extent of the problem; species responsible for the damage; and methods available to alleviate the problem. When evaluating management methods and formulating a management strategy, WS' personnel would give preference to non-lethal methods when they determine those methods to be practical and effective (see WS Directive 2.101).

WS would only use lethal methods, including egg destruction, after the USFWS authorized the take of double-crested cormorants and would only use those methods authorized by the USFWS. For example, the USFWS may authorize the take of double-crested cormorant through the issuance of a depredation permit or by establishing a depredation order. Similarly, the use of methods that capture double-crested cormorants alive would also require authorization from the USFWS; therefore, WS would only use live-capture methods after the USFWS had authorized the capture of double-crested cormorants.

In general, the most effective approach to resolving damage would be to integrate the use of several methods simultaneously or sequentially while continuing to evaluate the effectiveness of the method or methods. Alternative 1 would be an adaptive approach to managing damage that would integrate the use of the most practical and effective methods as determined by a site-specific evaluation for each request after applying the WS Decision Model. The philosophy behind an adaptive approach would be to integrate the best combination of methods in a cost-effective[5] manner while minimizing the potentially harmful effects on people, target and non-target species, and the environment. Therefore, WS' personnel would not necessarily use every method from Appendix B to address every request for assistance but would use the WS' Decision Model to determine the most appropriate approach to address each request for assistance, which could include using additional methods from Appendix B if initial efforts were unsuccessful at reducing damage or threats of damage adequately.

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

Under this alternative, WS would implement an adaptive integrated methods approach as described under Alternative 1, including the use of the WS' Decision Model; however, WS would only consider non-lethal methods when formulating approaches to resolve damage associated with double-crested cormorants. WS could provide technical assistance and/or direct operational assistance similar to Alternative 1. WS would provide technical assistance to those entities requesting assistance as described for Alternative 3. The only methods that WS could recommend and/or use would be non-lethal methods. Non-lethal methods that WS could use and/or recommend include exclusion methods (*e.g.*, surface coverings, netting, overhead wires), auditory deterrents (*e.g.*, propane cannons, pyrotechnics, electronic distress calls), visual deterrents (*e.g.*, scarecrows, lasers, lights), nest destruction, and live-capture methods (*e.g.*, modified foothold traps, nets). In addition, WS could recommend changes in cultural practices, such as changes in flight patterns at an air facility or changes to an aquaculture facility design, location of fish stock, fish stocking rates, or fish feeding methods. WS could also continue to use aircraft to conduct surveillance and monitoring of the double-crested cormorant population in the state. Section I of Appendix B describes those non-lethal methods in more detail. WS would continue to provide technical assistance and coordinate the efforts of aquaculture producers and other entities to disperse double-crested cormorants from winter roost locations near aquaculture facilities, which would include the use of non-lethal dispersal methods by WS' personnel to haze double-crested cormorants from roost locations.

WS would refer requests for information regarding lethal methods to the USFWS, the MDWFP, and/or private entities. Although WS would not recommend or use lethal methods under this alternative, other entities, including private entities, could continue to use those lethal methods discussed in Section II of Appendix B to resolve damage or threats when the USFWS authorizes those activities, such as through the issuance of a depredation permit or the establishment of a depredation order.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

If WS implements Alternative 3, WS would continue to use the WS' Decision Model to respond to requests for assistance; however, WS would only provide those cooperators requesting assistance with technical assistance. Technical assistance would provide those cooperators experiencing damage or threats of damage associated with double-crested cormorants with information, demonstrations, and recommendations on available and appropriate methods available. The implementation of methods and techniques to alleviate or prevent damage would be the responsibility of the requester with no direct involvement by WS. In some cases, WS may provide supplies or materials that were of limited availability for use by private entities (*e.g.*, loaning of propane cannons). Similar to Alternative 1 and Alternative 2, a key component of assistance provided by WS would be providing information to the

[5]The cost of management may sometimes be secondary because of overriding environmental, legal, human health and safety, humaneness, animal welfare, or other concerns.

requester about double-crested cormorants and how to manage damage associated with double-crested cormorants.

Education would be an important component of technical assistance because wildlife damage management is about finding balance and coexistence between the needs of people and needs of wildlife. This is extremely challenging as nature has no balance, but rather is in continual flux. When responding to a request for assistance, WS would provide those entities with information regarding the use of appropriate methods. WS would provide property owners or managers requesting assistance with information regarding the use of effective and practical techniques and methods. In addition to the routine dissemination of recommendations and information to individuals or organizations experiencing damage, WS could provide lectures, courses, and demonstrations to agricultural producers, homeowners, state and county agents, colleges and universities, and other interested groups. WS frequently cooperates with other entities in education and public information efforts. Additionally, WS' personnel may present technical papers at professional meetings and conferences so that other wildlife professionals and the public receive updates on recent developments in damage management technology, programs, laws and regulations, and agency policies.

Technical assistance would include collecting information, such as the number of double-crested cormorants involved, the extent of the damage, and previous methods that the cooperator had used to alleviate the problem. WS' personnel would then provide information on appropriate methods that the cooperator could consider to alleviate the damage themselves. Types of technical assistance projects may include a site visit to the affected property, written communication, telephone conversations, or presentations to groups such as homeowner associations or civic leagues.

Generally, WS' personnel would describe several management strategies to the requester for short and long-term solutions to managing damage based on the level of risk, need, and the practicality of their application. WS' personnel would recommend and loan only those methods legally available for use by the appropriate individual. Those methods described in Appendix B would be available to those people experiencing damage or threats associated with double-crested cormorants in the state. WS would continue to provide technical assistance and coordinate the efforts of aquaculture producers and other entities to disperse double-crested cormorants from winter roost locations near aquaculture facilities.

Those entities seeking assistance with reducing damage could seek direct operational assistance from other governmental agencies, private entities, or conduct activities on their own. In situations where non-lethal methods were ineffective or impractical, WS could advise the property owner or manager of appropriate lethal methods to supplement non-lethal methods. In order for the property owner or manager to use lethal methods, they would be required to have authorization from the USFWS to take double-crested cormorants, such as applying for a depredation permit.

When conducting technical assistance, WS' personnel could assist people experiencing damage caused by double-crested cormorants with the process for applying for their own depredation permit from the USFWS. In accordance with WS Directive 2.301, WS' personnel will assist people seeking assistance with applying for a depredation permit from the USFWS by completing a USFWS Migratory Bird Permit Application or Review form (WS Form 37). The USFWS Migratory Bird Permit Application or Review form provides the USFWS with the basic information required as part of the application process for a depredation permit, which includes information on the extent of the damages or risks, the number of double-crested cormorants involved, and recommended methods to alleviate damage (see 50 CFR 21.41 for required information). Following review by the USFWS of a complete application for a depredation permit from a property owner or manager and the USFWS Migratory Bird Permit Application or Review form, the USFWS could issue a depredation permit authorizing the lethal take of a specified number of double-crested cormorants.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

This alternative would preclude any activities by WS to alleviate damage or threats of damage associated with double-crested cormorants. WS would refer all requests for assistance associated with double-crested cormorants to the USFWS, to the MDWFP and/or to private entities. This alternative would not prevent other federal, state, local agencies, and/or private entities from conducting damage management activities directed at alleviating damage and threats associated with double-crested cormorants in the state. Therefore, under this alternative, entities seeking assistance with addressing damage caused by double-crested cormorants could contact WS but WS would immediately refer the requester to other entities. The requester could then contact those entities for information and assistance, could take actions to alleviate damage without contacting any entity, or could take no further action. Those methods listed in Appendix B would be available for use by other agencies and private entities to manage damage and threats associated with double-crested cormorants.

2.2.3 Alternatives Considered But Not Analyzed Further In Chapter 3 for the Reasons Provided

In addition to those alternatives discussed in Section 2.2.2, WS and the TVA identified several additional alternative approaches to meeting the need for action. However, those alternatives will not receive detailed analysis in Chapter 3 for the reasons provided for each alternative. Those alternatives considered but not analyzed in detail include the following.

Implementation of Alternative 1 but WS must use all of the Non-lethal Methods Identified in Appendix B before using Lethal Methods

Implementation of this alternative would be an adaptive integrated methods approach similar to Alternative 1. However, this alternative would require that WS use all of the non-lethal methods or techniques described in Appendix B to all requests for assistance to reduce damage and threats to safety associated with double-crested cormorants in the state. If the use of every non-lethal method described in Appendix B failed to alleviate the damage situation or reduce threats to human safety at each damage situation, WS' personnel would use lethal methods to alleviate the damage or threat occurring. WS' personnel would have to use all of the non-lethal methods regardless of severity or intensity of the damage or threat. This alternative would not prevent the use of lethal methods by other entities to alleviate damage or threats of damage.

WS and the TVA did not carry this alternative forward for further analysis in Chapter 3 because people experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting WS. For example, Stickley and Andrews (1989) conducted a survey of catfish farms in Mississippi during 1988 to determine the methods and costs associated with dispersing fish-eating birds from ponds where the farms were raising catfish. Of the 281 catfish farms that replied to the survey, 87% of the farmers felt the economic losses associated with fish-eating birds, which included double-crested cormorants, was sufficient to warrant harassing fish-eating birds from the ponds (Stickley and Andrews 1989). Stickley and Andrews (1989) found that catfish farms in Mississippi spent an average of 2.6 hours per day harassing waterbirds from aquaculture ponds. Of those aquaculture facilities that used propane cannons, 9% indicated their use was "*very effective*", 51% indicated they were "*somewhat effective*" and 40% indicated they were "*not effective*" (Stickley and Andrews 1989). Similarly, of the aquaculture facilities using pyrotechnics, 24% considered their use to be "*very effective*", 57% considered them to be "*somewhat effective*" and 19% determined the use of pyrotechnics was "*not effective*" (Stickley and Andrews 1989). In 1988, aquaculture producers in Mississippi reported spending an average of $7,400 per farmer, or a total of more than $2.1 million, to haze birds from their ponds (Stickley and Andrews

1989). In addition, the USFWS requires the use of non-lethal methods prior to authorizing the take of birds, including double-crested cormorants.

If WS implemented this alternative, WS would be required to implement non-lethal methods the entity requesting assistance had already used or would have to establish criteria to measure the efforts of the requesting entity to determine if the requesting entity applied non-lethal methods appropriately. For example, Price and Nickum (1995) concluded that the aquaculture industry has small profit margins so that even a small percentage reduction in the farm gate value due to predation is an economic issue. Therefore, continuing to use methods already proven ineffective at alleviating the damage could prolong the amount of time damage occurs, which could increase the economic losses. Because many people that request assistance use non-lethal methods but continue to experience damage or threats of damage and because there is no standard that exists for the use of non-lethal methods, WS and the TVA did not carry this alternative forward for further analysis in Chapter 3. In addition, implementation of Alternative 1 would be similar to a non-lethal before lethal alternative because WS' personnel would consider the use of non-lethal methods before considering the use of lethal methods (see WS Directive 2.101). Adding a non-lethal before lethal alternative and the associated analysis would not add additional information to the analyses in this EA.

WS would implement Alternative 1 but would only Use Lethal Methods

This alternative would be similar to Alternative 1 but WS would use only those methods that lethally remove double-crested cormorants. Under WS Directive 2.101, WS must consider the use of non-lethal methods before lethal methods. The USFWS also requires the use of non-lethal methods prior to authorizing the take of birds, including double-crested cormorants. In addition, conducting a coordinated effort to disperse double-crested cormorants from winter roosts near aquaculture facilities can be effective (Mott et al. 1998, Reinhold and Sloan 1999, Glahn et al. 2000). Therefore, WS and the TVA did not consider this alternative in detail.

WS would develop a Program that Compensates People for Damage

This alternative would require WS to establish a system to reimburse persons impacted by double-crested cormorant damage. Under such an alternative, WS would continue to provide technical assistance to those persons seeking assistance with managing damage. In addition, WS would conduct site visits to verify damage. Compensation would require large expenditures of money and labor to investigate and validate damage claims and to determine and administer appropriate compensation. Compensation would most likely be below full market value. Compensation for damages would give little incentive to resource owners to limit damage through improved cultural or other practices and management strategies and would not be practical for reducing threats to human health and safety. For the above listed reasons, WS and the TVA did not carry this alternative forward for further analysis in Chapter 3.

WS would implement Alternative 1 but would establish a Loss Threshold before Allowing Lethal Methods

There is also a concern that damage caused by animals should be a cost of doing business and/or that there should be a threshold of damage before allowing the use of lethal methods to manage damage. In some cases, cooperators will tolerate some damage and economic loss until the damage reaches a threshold where the damage becomes an economic burden. The appropriate level of allowed tolerance or threshold before employing lethal methods would differ among cooperators and damage situations. In some cases, any loss in value of a resource caused by double-crested cormorants could be financially burdensome to some people. In addition, establishing a threshold would be difficult or inappropriate to apply to human health and safety situations. For example, aircraft striking double-crested cormorants could lead to property damage and could threaten passenger safety if a catastrophic failure of the aircraft occurred because of the strike. Therefore, addressing the threats of aircraft strikes prior to an actual strike occurring would be appropriate. For those reasons, WS and the TVA did not carry this alternative forward for further analysis in Chapter 3.

WS would require Cooperators Completely Fund Activities (no taxpayer money)

This alternative would be similar to Alternative 1 or Alternative 2 except WS would require the entity requesting assistance to pay for any activities conducted by WS. Therefore, no activities conducted by WS would occur through federal appropriations or state funding (*i.e.*, no taxpayer money). Funding for WS' activities could occur from federal appropriations, through state funding, and/or through money received from the entity requesting assistance. In those cases where WS receives federal and/or state funding to conduct activities, federal, state, and/or local officials have made the decision to provide funding for damage management activities and have allocated funds for such activities. Additionally, damage management activities are an appropriate sphere of activity for government programs because managing wildlife is a government responsibility. Treves and Naughton-Treves (2005) and the International Association of Fish and Wildlife Agencies (2005) discuss the need for wildlife damage management and that an accountable government agency is best suited to take the lead in such activities because it increases the tolerance for wildlife by those people being impacted by their damage and has the least impacts on wildlife overall. Therefore, WS and the TVA did not carry this alternative forward for further analysis in Chapter 3.

WS would implement Alternative 1 but would require Cooperators Fund the use of Lethal Methods

This alternative would be identical to Alternative 1 except WS would require people requesting assistance to pay for all the costs associated with using lethal methods to resolve their request for assistance. If WS used lethal methods to alleviate or prevent damage, the person requesting assistance would be responsible for paying for the costs associated with those activities. WS could then use existing federal and/or state funding to pay for the costs associated with using non-lethal methods to manage double-crested cormorant damage. WS did not carry this alternative forward for further analysis because the environmental consequences associated with the use of this method would be identical to Alternative 1.

WS would refer requests for assistance to Private Nuisance Wildlife Control Agents

People experiencing damage or threats of damage associated with double-crested cormorants could contact private wildlife control agents and/or other private entities to reduce damage when they deem appropriate. In addition, WS could refer persons requesting assistance to private wildlife control agents and/or other private entities if WS implemented Alternative 1, Alternative 2, Alternative 3, or Alternative 4. WS Directive 3.101 provides guidance on establishing cooperative projects and interfacing with private businesses. WS only responds after receiving a request for assistance. If WS implemented Alternative 1, Alternative 2, or Alternative 3, WS would inform requesters that other service providers, including private entities, might be available to provide assistance. Therefore, WS and the TVA did not carry this alternative forward for further analysis.

CHAPTER 3: ENVIRONMENTAL EFFECTS

Chapter 3 provides information needed for making informed decisions by comparing the environmental consequences of the four alternatives. Section 3.1 provides further discussion on how WS and the TVA will evaluate significance as it relates to the NEPA. To determine if the real or potential effects are greater, lesser, or the same as the environmental baseline, Section 3.2 compares the environmental consequences associated with each of the four alternatives. A discussion occurs on the cumulative and unavoidable impacts, including direct and indirect effects, in relation to the issues for each of the alternatives. Impacts caused by implementation of an alternative approach and occur at the same time and place are direct effects. In contrast, impacts caused by implementing an alternative approach that occur later in time or further removed in distance, and are still reasonably foreseeable, are indirect effects. The analyses discuss the cumulative effects in relationship to each of the alternatives analyzed, with emphasis on potential cumulative effects from similar activities, and include summary analyses of potential cumulative impacts to target and non-target species, including threatened or endangered species, threats to human health and safety, and the humaneness of methods.

3.1 EVALUATION OF SIGNIFICANCE

Section 3.2 evaluates the direct, indirect, and cumulative impacts associated with implementation of the four alternatives under each of the issues. The NEPA describe the elements that determine whether an impact is "*significant*". Significance is dependent upon the context and intensity of the action. When reviewing the context and intensity of the four alternatives, WS and the TVA considered the magnitude of the impact, the duration/frequency of the action, the likelihood of the impact, the geographic extent, the legal status, and conforming to statutes, regulations, and policies.

3.1.1 Magnitude of the Impact

The basis for determining the magnitude of an impact is the size, number, or relative amount of the impact (intensity). For example, the analysis that occurs in Section 3.2 measures the number of double-crested cormorants that WS could lethally remove annually in relation to the abundance of double-crested cormorants to determine the magnitude of impact to the double-crested cormorant population from the lethal removal of those double-crested cormorants. Magnitude may be determined either quantitatively or qualitatively. Determinations based on population estimates, allowable take levels, and actual take data would be quantitative. Determinations based on population trends and harvest trend data would be qualitative.

3.1.2 Duration and Frequency of the Action

The duration and frequency of the impact relates to factors, such as, is the impact temporary, seasonal, or ongoing throughout the year (intensity). The duration and frequency of activities associated with the alternatives would be highly variable. Abiotic and biotic factors affecting double-crested cormorant behavior would affect the duration and frequency of activities conducted by WS if WS implemented Alternative 1, Alternative 2, or Alternative 3. Although activities may involve programs of long duration, the frequency of individual activities within the program may be highly variable depending upon spatial, temporal, and biotic factors affecting the behavior of double-crested cormorants that are causing damage. For instance, most requests for assistance are associated with double-crested cormorants that nest further north but spend the winter in Mississippi before they migrate back northward in the spring to nest. Therefore, most activities that could occur if WS implemented Alternative 1, Alternative 2, or Alternative 3 would occur in the fall, winter, and early spring when the number of double-crested cormorants present in the state increases. Projects involving damage management activities at individual sites are generally of short duration but may happen frequently at different sites.

3.1.3 Likelihood of the Impact

This factor can relate to the likelihood that there would be a need for a particular damage management action, and to the likelihood that an impact may occur because of a damage management action. For example, most requests to alleviate damage caused by double-crested cormorants in Mississippi are associated with aquaculture facilities; therefore, the likelihood that WS could address double-crested cormorants to reduce the number of double-crested cormorants feeding at aquaculture facilities may be relatively high. WS receives very few requests for assistance involving accumulations of fecal droppings causing damage to property in Mississippi; therefore, the need to address double-crested cormorants to alleviate property damage caused by fecal accumulations may be much lower.

3.1.4 Geographic Extent

If WS implemented Alternative 1, Alternative 2, or Alternative 3, WS would continue to provide assistance in areas of Mississippi where people request assistance and, when applicable, agreements for activities are in place. Because most requests for assistance are associated with double-crested cormorants feeding at aquaculture facilities, most activities would occur in rural areas of the state where aquaculture production occurs. Mississippi encompasses about 46,923 square miles of land area (United States Census Bureau 2010), which equates to approximately 30 million acres. However, agreements to conduct activities to manage damage associated with double-crested cormorants comprise a small portion of the land area in the state and not all properties where people request assistance may need assistance with double-crested cormorants in any given year. From FY 2013 through FY 2017, WS conducted activities associated with double-crested cormorants on 0.4% of the total land area of the state annually.

3.1.5 Legal Status

The legal status of an affected resource would be a contextual consideration. Legal status may range from protected by federal law or state law to no protection. In addition to the NEPA, several state and federal regulations would be relevant to activities that WS could conduct when providing assistance (see Section 1.4.8). For example, the MBTA protects double-crested cormorants from take. In another example, federal law protects species of wildlife and plants listed as threatened or endangered pursuant to the ESA.

3.1.6 Complying with Statutes, Regulations, and Policies

Statues, regulations, and policies provide contextual information in the analysis. Compliance with applicable statutes, regulations, and policies can also serve as mitigation to ensure that certain types of adverse effects on the environment do not occur.

3.2 ENVIRONMENTAL CONSEQUENCES BY ISSUE ANALYZED IN DETAIL

WS and the TVA developed alternative approaches (see Section 2.2.2) to meet the need for action identified in Section 1.4 and to address the issues identified in Section 2.1. This section analyzes the environmental consequences of each alternative approach in comparison to determine the extent of actual or potential impacts on each of the issues. Therefore, Alternative 1 serves as the baseline for the analysis and the comparison of expected impacts among the alternative approaches. The analysis also takes into consideration mandates, directives, and the procedures of WS, the TVA, the USFWS, and the MDWFP.

3.2.1 Issue 1 - Effects on the Double-crested Cormorant Population

Maintaining viable populations of native species is a concern of the public and of biologists within state, tribal, and federal wildlife and land management agencies, including WS. If WS implemented Alternative 1, Alternative 2, or Alternative 3, the WS program in Mississippi could conduct and/or recommend that others conduct activities that could disperse, exclude, capture, or lethally remove double-crested cormorants depending on the alternative approach WS selected and implemented. Appendix B identifies and discusses the methods that WS could consider when formulating strategies to resolve damage caused by double-crested cormorants in Mississippi when someone requests such assistance. If WS implemented Alternative 4, WS would not conduct any activities in Mississippi involving double-crested cormorants. This section evaluates the magnitude of cumulative effects on the double-crested cormorant population that could occur if WS implemented one of the four alternative approaches.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

Implementation of Alternative 1 would allow WS' personnel to consider the widest range of methods available when formulating strategies to resolve requests for assistance associated with double-crested cormorants. WS' personnel would use the WS Decision Model (see WS Directive 2.201) to identify the most appropriate damage management strategies and their impacts. If WS implemented Alternative 1, WS' personnel could choose to use any of the methods discussed in Appendix B when using the WS Decision Model to formulate strategies. WS' personnel would employ those methods described in Appendix B in an adaptive approach that would integrate methods to reduce damage and threats of damage associated with double-crested cormorants in the state. When practical and effective, WS' personnel would give preference to non-lethal methods pursuant to WS Directive 2.101.

A common concern is whether damage management actions would adversely affect the double-crested cormorant population, especially when WS and other entities use lethal methods. If WS implemented Alternative 1, the potential effects on the double-crested cormorant population associated with WS' use of non-lethal methods would be similar to those potential effects discussed for Alternative 2 because the same non-lethal methods would be available for use by WS' personnel. To limit redundancy, a discussion on the potential effects associated with the use of non-lethal methods does not occur for Alternative 1 because those potential effects would be similar to those discussed for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1. In general, the use of non-lethal methods to disperse, exclude, or capture double-crested cormorants from areas where they are causing damage or posing a threat of damage would have minimal effects on the overall population of double-crested cormorants because those methods generally do not harm double-crested cormorants (see discussion for Alternative 2).

Therefore, the evaluation of potential effects on the double-crested cormorant population for Alternative 1 will primarily focus on WS' use of lethal methods because WS' personnel could use lethal methods to remove an individual double-crested cormorant or a group of double-crested cormorants to alleviate damage. WS would only target an individual double-crested cormorant or a group of double-crested cormorants identified as causing damage or posing a threat to human safety. Therefore, if WS implemented Alternative 1, WS could lethally remove double-crested cormorants, which could potentially have direct, indirect, and cumulative effects on the double-crested cormorant population. However, WS would only take double-crested cormorants when authorized by the USFWS and only at authorized levels.

DOUBLE-CRESTED CORMORANT POPULATION DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS

Double-crested cormorants are large fish-eating colonial waterbirds widely distributed across North America (Dorr et al. 2014). The diet of a double-crested cormorant consists almost entirely of fish but they will also eat other aquatic animals (Dorr et al. 2014). Therefore, double-crested cormorants generally occur in areas near bodies of water, such as coastal areas, rivers, ponds, lakes, estuaries, and artificial water impoundments (Dorr et al. 2014). Similarly, double-crested cormorants nest near bodies of water with nests generally occurring on the ground on rocky or sandy islands, but they also will nest in trees close to or that survive in water. Double-crested cormorants will also nest on bridges, docks, power line transmission towers, and other structures near water (Dorr et al. 2014). Double-crested cormorants are highly social birds that not only nest together but also feed, travel, and roost in flocks that can exceed 1,000 birds (Dorr et al. 2014).

Since the late 1970s, the double-crested cormorant population has increased in many regions of North America (Wires et al 2001). Jackson and Jackson (1995) and Wires et al. (2001) suggested that the current double-crested cormorant resurgence might be, at least in part, a population recovery following years of reproductive suppression from organochlorine contaminants and unregulated take prior to protection under the MBTA. Between the late 1970s and early 1990s, the double-crested cormorant population expanded to an estimated 372,000 nesting pairs (Tyson et al. 1999, Wires et al. 2001). Tyson et al. (1999) found that the double-crested cormorant population increased about 2.6% annually during the early 1990s. The greatest increase was in the Interior region, which was the result of a 22% annual increase in the number of double-crested cormorants in Ontario and those states in the United States bordering the Great Lakes (Tyson et al. 1999). From the early 1970s to the early 1990s, the Atlantic breeding population of double-crested cormorants increased from about 25,000 pairs to 96,000 pairs (Hatch 1995). Since 1966, the number of double-crested cormorants observed in all areas surveyed during the BBS has shown an increasing trend estimated at 3.76% annually with a 8.48% annual increase occurring from 2005 through 2015 (Sauer et al. 2017). Breeding populations of double-crested cormorants in the southeastern United States are also showing increasing trends, with the total nesting population for this region estimated to be between 10,600 (Hunter et al. 2006) and over 13,604 nesting pairs (Tyson et al. 1999).

The recent increase in the double-crested cormorant population in North America and the subsequent range expansion of double-crested cormorants has been well documented along with concerns of the negative impacts associated with the expanding population (*e.g*., see Taylor and Dorr 2003, Hunter et al. 2006, Atlantic Flyway Council and Mississippi Flyway Council 2010). The Southeast United States Regional Waterbird Conservation Plan ranks double-crested cormorants in the "*population control*" action level, which includes those species' populations that are increasing to a level where damages to economic ventures or adverse effects to populations of other species are occurring (Hunter et al. 2006). One of the objectives in the Southeast United States Regional Waterbird Conservation Plan is to maintain no more than 15,000 pairs of double-crested cormorants in the Southeast United States Region (Hunter et al. 2006). Double-crested cormorants are considered a species that "*...may impact either native species or economic interests in portions of the Southeastern U.S. Region for which no increase and potentially population decreases may be recommended*" (Hunter et al. 2006).

Based on 2012 data, Wetlands International (2019) estimated the continental population of double-crested cormorants to be between 1,078,280 and 1,160,590 double-crested cormorants. In Northeast and Central North America, Wetlands International (2019) estimated the population of double-crested cormorants to be between 947,000 and 1,020,000 double-crested cormorants. The USFWS recently estimated the double-crested cormorant population in the central and eastern United States and Canada to be 731,880 to 752,516 double-crested cormorants (see Table 4-1 and Table A-1 in USFWS (2017)).

Double-crested cormorants occur throughout the year in Mississippi but they are more common and more widely distributed during the fall, winter, and spring months when the winter migrating population is present (Atlantic Flyway Council and Mississippi Flyway Council 2010, Dorr et al. 2014). The fall migration period for double-crested cormorants generally occurs from August through early November with the peak occurring from late August through mid-October (Dorr et al. 2014). The spring migration period generally occurs from late March through the end of May with the peak occurring from mid-April through early March (Dorr et al. 2014).

Since 1966, the number of double-crested cormorants observed in areas of the state surveyed during the CBC has shown a general increasing trend (see Figure 4.1; National Audubon Society 2010). Periodically, WS has conducted mid-winter double-crested cormorant roost counts in the areas of Mississippi associated with the production of aquaculture. As part of those surveys conducted in

Mississippi, WS also conducts the survey in eastern Arkansas and eastern Louisiana at locations that double-crested cormorants roost at night and then fly to aquaculture facilities in Mississippi to feed. During the 2018 survey, WS and others conducted surveys at 78 possible roost locations in the Delta Region of Mississippi and 13 possible roost locations in eastern Mississippi. In addition, surveys occurred at potential roost locations in southeastern Arkansas and in eastern Louisiana. Observers counted nearly 41,000 double-crested cormorants at roost locations during the 2018 survey, which was lower than the 51,575 double-crested cormorants identified at roosts in 2017 and the 44,4998 double-crested cormorants counted in 2013 (D. Lunsford, WS, unpublished data).

The mid-winter survey conducted periodically by WS only represents the number of double-crested cormorants present at specific roost locations during a relatively short period (*i.e.*, at the time the survey was conducted). Therefore, WS uses the survey information as an index for monitoring wintering double-crested cormorant trends in specific areas over time. The survey is not a complete census of wintering double-crested cormorants in the state. The actual number of double-crested cormorants that winter in Mississippi and migrate through Mississippi is unknown and like all bird species, the actual number of double-crested cormorants present in the state fluctuates throughout the year and varies from year to year.

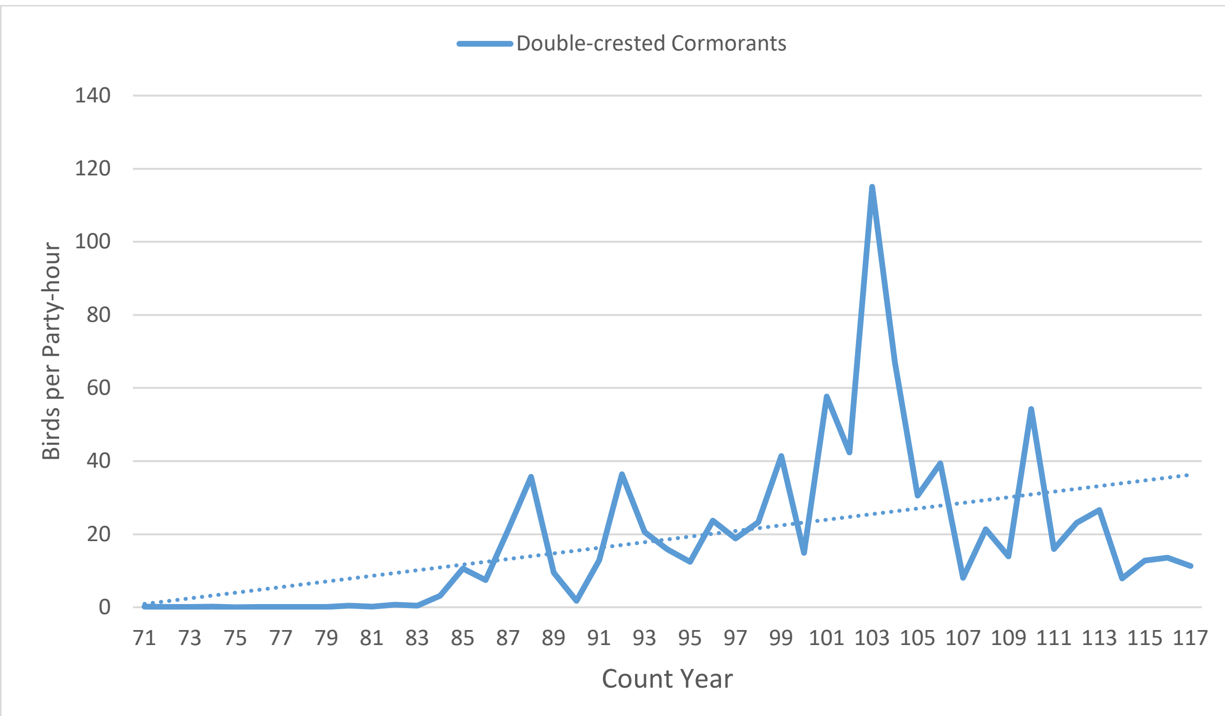

Figure 4.1 – Number of double-crested cormorants observed per party-hour in areas of Mississippi surveyed during the CBC, 1966-2016 (adapted from National Audubon Society 2010).

The number of double-crested cormorants present in Mississippi during the nesting season is also likely increasing. Since 1966, the number of double-crested cormorants observed in areas of the state surveyed during the BBS has increased 45.36% with a 46.33% annual increase occurring from 2005 through 2015 (Sauer et al. 2017). However, Sauer et al. (2017) indicate the survey trend data for double-crested cormorants in Mississippi have important deficiencies and indicate users of the information should use caution when interpreting the results. Those deficiencies in the BBS data for the breeding population of double-crested cormorants in Mississippi may include a very low abundance of double-crested cormorants on routes, a very small sample size, and/or the results are very imprecise.

In Mississippi, several factors likely contribute to the deficiencies in the BBS data for double-crested cormorants indicated by Sauer et al. (2017). The survey criteria for the BBS are likely not conducive to surveying for double-crested cormorants because surveys occur along predetermined roadside routes and double-crested cormorant use bodies of water to forage, loaf, roost, and nest (*e.g*., reservoirs). In addition, the number of double-crested cormorants present in Mississippi during June when people conduct the BBS is small. The number of double-crested cormorants that nest in Mississippi likely ranges from 200 to 500 breeding pairs (Hunter et al. 2006, Atlantic Flyway Council and Mississippi Flyway Council 2010), which equates to 400 to 1,000 breeding adults and does not include non-breeding double-crested cormorants that are also present in the state during the breeding season. Although the number of double-crested cormorants nesting within the state is likely increasing, the rate of increase may be much lower than indicated by the data from the BBS.

Because WS could receive requests for assistance throughout the year in Mississippi, the direct, indirect, and cumulative effects on the double-crested cormorant population associated with implementing Alternative 1 could involve the double-crested cormorants nesting in the state and those double-crested cormorants that nest in the northern United States and Canada but spend the winter in Mississippi.

Direct effects on the double-crested cormorant population associated with implementing Alternative 1

As identified in Section 1.4, most requests for assistance that WS receives are associated with damage occurring to aquaculture caused by double-crested cormorants that nest in the northern United States and southern Canada but migrate into Mississippi during the fall and winter and then depart in the spring to return to their nesting areas. As noted previously, the nesting population of double-crested cormorants in the state likely ranges from 400 to 1,000 breeding adults. In contrast, WS has periodically counted 40,000 to 50,000 double-crested cormorants in the aquaculture production areas of Mississippi during mid-winter roost counts conducted from 2011 through 2018.

If WS implements Alternative 1, WS' personnel would use the WS Decision Model to formulate strategies using an adaptive approach that could integrate the use of several methods to alleviate damage and threats of damage. Those methods that WS' personnel could consider for use to alleviate damage would disperse, exclude, capture, or lethally remove double-crested cormorants. As discussed in Section 1.4.7 and Section 1.4.8, the USFWS is responsible for managing and protecting bird species that are listed as migratory under the MBTA (see 50 CFR 10.13), including double-crested cormorants. The MBTA prohibits the take[6], possession, or transport of migratory birds. However, the USFWS can issue depredation permits that allow people and entities to take, possess, and/or transport migratory birds to manage the damage those birds cause (see 50 CFR 21.41), including damage caused by double-crested cormorants. In addition, the USFWS can authorize the take of birds, including double-crested cormorants, pursuant to additional permits and orders (see 50 CFR 21). In general, the use of non-lethal methods to disperse birds, including double-crested cormorants, does not require a depredation permit from the USFWS because dispersing birds using non-lethal methods does not meet the definition of take. Pursuant to 50 CFR 21.41(a), "[n]*o permit is required merely to scare or herd depredating migratory birds other than endangered or threatened species or bald or golden eagles*". Thus, the non-lethal harassment of double-crested cormorants to alleviate damage or threats of damage does not require a depredation permit to conduct those activities.

Pursuant to WS Directive 2.101, WS' personnel would give preference to non-lethal methods when they determine those methods to be practical and effective. If WS implemented Alternative 1, WS' use of non-lethal methods would be similar to WS' use of non-lethal methods if WS implemented Alternative 2.

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[6]The MBTA prohibits the take of a migratory bird or its nest or eggs. Regulations of the USFWS define "*take*" to mean "*pursue, hunt, shoot, wound, kill, trap, capture, or collect*". See 50 CFR 10.12.

If WS implemented Alternative 1, the direct effects on the double-crested cormorant population associated with WS' use of non-lethal methods would be identical to those direct effects discussed if WS implemented Alternative 2. To limit redundancy, a discussion on the potential direct effects associated with the use of non-lethal methods does not occur for Alternative 1 because those potential effects would be similar to those discussed for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1. If WS implements Alternative 1, WS could also live-capture double-crested cormorants using nets and/or modified padded foothold traps and then fit the double-crested cormorants with devices to track their movements (*e.g.*, radio transmitters). To limit redundancy, discussion on the potential direct effects associated with the use of tracking devices occurs for Alternative 2 but those potential effects from the use of tracking devices could possibly occur if WS' implemented Alternative 1. Similarly, discussion on the potential direct effects associated with the use of aircraft to monitor and track double-crested cormorants occurs for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1.

Because WS is the primary federal agency responsible for managing damage caused by animals, including migratory birds, the WS program in Mississippi anticipates the need to take migratory birds annually to alleviate damage and threats of damage. Therefore, the WS program in Mississippi has applied for and received a depredation permit from the USFWS pursuant to 50 CFR 21.41. The depredation permit issued to the WS program in Mississippi by the USFWS authorizes WS' personnel (and designated subpermittees) to take several species of birds in Mississippi, including double-crested cormorants. During the development of this EA, the depredation permit issued by the USFWS to the WS program in Mississippi authorized WS (including designated subpermittees) to take 700 double-crested cormorants per permit year in the state to alleviate damage and threats of damage.

As discussed previously, the take of double-crested cormorants by WS occurs primarily during the fall and winter when the number of double-crested cormorants present in the state is higher than the nesting season. From FY 2013 through FY 2016, over 71% of the double-crested cormorants taken by WS in Mississippi occurred from September through March, which is generally the period of time when double-crested cormorants that nest further north are present within the state. If all take of double-crested cormorants by WS in Mississippi occurred from September through March, the take of 700 double-crested cormorants would represent 1.7% of the nearly 41,000 double-crested cormorants surveyed in the aquaculture producing areas of western and eastern Mississippi, eastern Arkansas, and eastern Louisiana during the 2018 mid-winter roost survey. In 2011, 2013, 2017, and 2018, WS and others counted an average of 44,600 double-crested cormorants per year in western and eastern Mississippi, eastern Arkansas, and eastern Louisiana during the mid-winter roost survey. The take of 700 double-crested cormorants by WS would represent 1.6% of the average number of double-crested cormorants counted per year during the mid-winter roost survey conducted in 2011, 2013, 2017, and 2018.

WS may also receive requests for assistance associated with double-crested cormorants during the breeding season. Requests for assistance that WS receives when double-crested cormorants present in the state are likely nesting within the state are primarily associated with airports and military bases where those double-crested cormorants pose a strike risk to aircraft. However, WS could receive requests for assistance at aquaculture facilities when double-crested cormorants from nesting colonies feed at nearby aquaculture facilities. WS could also receive requests for assistance to address nesting double-crested cormorants that cause damage or pose a threat to natural resources and property, such as nesting double-crested cormorants creating conditions that result in the loss of vegetation on islands or double-crested cormorants competing for nesting locations with other higher priority bird species.

From FY 2013 through FY 2016, the WS program in Mississippi has lethally removed an average of 92 double-crested cormorants from April through August, which would generally coincide with the period of time when double-crested cormorants present in the state could be nesting within the state. However, non-breeding double-crested cormorants are also likely present in the state during the nesting season. The number of non-breeding double-crested cormorants present in the state during the breeding season is unknown. Despite an average annual take of 92 double-crested cormorants by WS from FY 2013 through FY 2016, the breeding population in the state is generally continuing to increase based on trend data from the BBS. If WS implemented Alternative 1, WS anticipates the annual take of double-crested cormorants during the breeding season would be similar to previous years. In the double-crested cormorant management plan for the Atlantic and Mississippi Flyways, the breeding population goal for Mississippi was stated to be no breeding pairs because of the economic impacts double-crested cormorants have on the aquaculture industry and because, historically, only sporadic nesting of double-crested cormorants occurred in Mississippi (Atlantic Flyway Council and Mississippi Flyway Council 2010). The increasing presence of aquaculture facilities in Mississippi may have reduced the tendency for some double-crested cormorants to migrate because of the abundant food source provided by those facilities (King et al. 2010).

Indirect effects associated with implementing Alternative 1

In addition to direct and cumulative effects on the population of double-crested cormorants, a concern would be the indirect effects that could occur to the double-crested cormorant population from the implementation of Alternative 1. As discussed previously, impacts that occur later in time or further removed in distance from an activity would be indirect effects. If WS implements Alternative 1, lethal and non-lethal methods would be available for WS' personnel to use to manage the damage that double-crested cormorants cause. WS' personnel would use the WS Decision Model to determine the most appropriate methods using information that WS' employees gather and analyze for each request for assistance.

If WS implemented Alternative 1, WS' use of non-lethal methods would be similar to WS' use of non-lethal methods if WS implemented Alternative 2. If WS implemented Alternative 1, the indirect effects on the double-crested cormorant population associated with WS' use of non-lethal methods would be identical to those indirect effects discussed if WS implemented Alternative 2. To limit redundancy, a discussion on the potential indirect effects associated with the use of non-lethal methods does not occur for Alternative 1 because those potential effects would be similar to those indirect effects discussed for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1. If WS implements Alternative 1, WS could lethally remove double-crested cormorants to alleviate damage in the state. The removal of double-crested cormorants could indirectly affect beneficial ecosystem services that double-crested cormorants provide by reducing the double-crested cormorant population.

Ecosystems are communities of living organisms on, and interacting with, a particular landscape. Ecosystems are dynamic and are frequently recovering from periodic disturbances. The frequency and severity of each disturbance determines the way it affects ecosystem function and the ecological services they provide. Animal populations vary from year to year, approaching ecological carrying capacity during resource-rich periods and declining from a lack of resources, overstocking, disease outbreaks, or other mortality sources. Ecosystem services are the suite of benefits that ecosystems provide to humanity (Cardinale et al. 2012). Those services include supporting services, which are processes necessary for the production of all other ecosystem services (*e.g.*, nutrient cycling, photosynthesis, and soil formation)(de Groot et al. 2002) and provisioning services that involve the production of renewable resources (*e.g.*, food, wood, fresh water) (Cardinale et al. 2012). In addition, those services include regulating services, which are those that lessen environmental change (*e.g.*, climate regulation, pest/disease control) (Cardinale et al. 2012) and cultural services representing human values and enjoyment (*e.g.*, landscape esthetics, cultural heritage, outdoor recreation, and spiritual significance) (Daniel et al. 2012). The double-crested cormorant is a native bird species in the United States that provides many beneficial ecosystem services. The potential for indirect effects to occur from the implementation of Alternative 1 occurs below.

- *Creation of habitat by nesting double-crested cormorants that benefit other nesting birds*

Double-crested cormorants are a colonial nester, which means they often nest together at a single nesting location. Nesting colonies may have as many as 10,000 double-crested cormorants nesting together (Barras 2004). As discussed in Section 1.4.5, the colonial nesting and roosting behavior of double-crested cormorants can often lead to accumulations of fecal droppings in areas where they nest and roost. The accumulations of fecal droppings can have a negative impact on vegetation because fecal droppings can contribute to excessive amounts of ammonium nitrogen, phosphorous, and metals in the soil. Changes in the soil from fecal droppings can affect the composition of plant species, which often leads to a reduction in the number of species and an opportunity for non-native species to establish (Boutin et al. 2011, Craig et al. 2012). In some cases, the habitat degradation can be so severe that the roosting and nesting activities of double-crested cormorants can leave some areas completely denuded of vegetation. Double-crested cormorants may begin nesting in trees on an island and, as the trees and underlying vegetation die over time, double-crested cormorants will often begin gradually nesting on the ground after the trees die and are no longer suitable for nesting.

The loss of vegetation from the accumulations of fecal droppings can be detrimental to those species that rely on that vegetation for nesting. However, is some cases, the loss or reduction of vegetation associated with accumulations of fecal droppings from roosting or nesting double-crested cormorants can be beneficial to ground nesting colonial waterbird species. Double-crested cormorants often nest in close association with other ground and tree nesting waterbird species. While eliminating vegetation can be detrimental to other bird species that nest in those trees and the underlying vegetation, colonial nesting waterbirds that nest solely on the ground, such as terns, gulls, and pelicans, can benefit from the elimination of vegetation.

A concern would be that a double-crested cormorant population decline caused by the lethal take of double-crested cormorants to alleviate damage would result in fewer nesting double-crested cormorants, which could mean less habitat created for other ground-nesting bird species to use. Although double-crested cormorants nest in Mississippi, very few ground-nesting bird species that often co-nest with double-crested cormorants also nest in the state and those waterbird species that do nest on the ground in the state, such as the least tern (*Sternula antillarum*) and the laughing gull (*Leucophaeus atricilla*), are not associated with nesting colonies of double-crested cormorants in the state. In Mississippi, least terns nest on sandbars associated with the Mississippi River and along the coastal areas of the state (Thompson et al. 1997, Jackson and Jackson 1985). Laughing gulls may nest on islands along the coastal areas of Mississippi (Burger 2015).

Damage management activities that could possibly involve the use of lethal methods to reduce damage generally occur in the fall and winter when double-crested cormorants that nest further north are present within the state. The double-crested cormorants that migrate to Mississippi from their northern nesting locations would primarily be a part of the Mississippi/Central Flyway subpopulation of double-crested cormorants. The Mississippi/Central Flyway subpopulation of double-crested cormorants nest in the Great Lakes and the north-central plains and migrate along the Mississippi Flyway and/or the Central Flyway corridor to their wintering areas, including those double-crested cormorants that winter in Mississippi (Dolbeer 1991, Scherr et al. 2010, Guillaumet et al. 2011, Chastant et al. 2014). Therefore, those double-crested cormorants present in the state when most activities occur likely originate from breeding populations across a wide geographical area and any lethal removal would not represent a large portion of the double-crested cormorant breeding population in any one specific area.

The indirect and cumulative take of double-crested cormorants would occur within the Potential Take Limit model developed by the USFWS. The Potential Take Limit model predicts the maximum allowable annual take that corresponds with a biologically sustainable level of annual take. The take of double-crested cormorants by WS would occur as allowed by the USFWS. The USFWS concluded an evaluation of allowed cumulative take levels for double-crested cormorants in the central and eastern United States. Based on that evaluation, the USFWS determined the allowed cumulative take levels authorized in the central and eastern United States, including allowed cumulative take in Mississippi, would maintain the current double-crested cormorant population (see Section 5.4 in USFWS (2017), Table 5-2 in USFWS (2017), and Appendix 1 in USFWS (2017)).

➢ *Benefits to native fish from double-crested cormorants preying on non-native and diseased fish*

As discussed in Section 1.4.2, double-crested cormorants are opportunistic feeders that typically prey on fish within a specific size range and they often aggregate in areas with concentrations of prey (Schramm et al. 1984, Dorr et al. 2014). Double-crested cormorants are native predators of many fish species, but generally prey on slow moving or schooling fish species. Double-crested cormorants prey on more than 250 species of fish (Dorr et al. 2014). Double-crested cormorants prey on many fish species that are not native to the areas where those fish species occur, such as alewife (*Alosa pseudoharengus*), round goby (*Apollonia melanostomus*), and white perch (*Morone americana*) in the Great Lakes.

In their study area of southern Lake Michigan, Madura and Jones (2016) found that alewife, round goby, and white perch, which are not native fish species in Lake Michigan, made up over 90% of the diet of double-crested cormorants by biomass and over 80% of their diet by number depending on the time of year. DeBruyne et al. (2012) found that alewife became a larger percentage of the double-crested cormorant diet once the alewife population began increasing in Lake Champlain. Those fish species that are not native to the areas where they occur, such as alewife and round goby, can often have negative effects on more desirable fish species. For example, Brandt et al. (1987) concluded that alewife predation on yellow perch (*Perca flavescens*) larvae could reduce yellow perch recruitment in Lake Ontario. Because double-crested cormorants primarily focus on slow moving fish, they may also consume stressed, diseased, or injured fish (Collis et al. 2002). Therefore, double-crested cormorants could provide some benefit to native or more desirable fish species by feeding predominantly on undesirable, non-native fish species.

Research on the diets of double-crested cormorants in areas where they spend their winters, such as Mississippi, is limited except near aquaculture facilities (Dorr et al. 2014). Glahn et al. (1998) found the diets of double-crested cormorants that were feeding within Lake Beulah along the Mississippi River in Mississippi and Lake Eufaula on the border of Alabama and Georgia consisted primarily of shad (*Dorosoma* spp.) and sunfishes (*Lepomis* spp.) but also included channel catfish, which was likely from nearby aquaculture facilities. Glahn et al. (1998) concluded that double-crested cormorants appeared to prey on those fish species most available in Lake Beulah and Lake Eufaula.

Similar to the other potential indirect effects associated with the use of lethal methods, a concern would be that a double-crested cormorant population decline caused by the lethal take of double-crested cormorants to alleviate damage would result in fewer double-crested cormorants, which could mean fewer double-crested cormorants to feed on diseased and non-native fish species. Double-crested cormorants are a natural component of the ecosystem and are a native fish predator. As discussed previously, those double-crested cormorants present in the state when most activities occur to alleviate damage likely originate from breeding populations across a wide geographical area and any lethal removal would not represent a large portion of the double-crested cormorant breeding population in any one specific area. The USFWS concluded an evaluation of allowed cumulative take levels for double-crested cormorants in the central and eastern United States and determined the allowed cumulative take levels authorized in the central and eastern United States, including allowed cumulative take in Mississippi, would maintain the current double-crested cormorant population.

- *Activities would shift fish predation to other fish-eating bird species*

Another potential indirect effect associated with activities to manage the damage that double-crested cormorants cause would be shifting predation on fish, primarily at aquaculture facilities, from double-crested cormorants to other fish-eating bird species, such as pelicans, herons, and egrets. Several fish-eating bird species occur at aquaculture facilities, including aquaculture facilities in Mississippi (Littauer et al. 1997, Wywialowski 1999, Belant et al. 2000, Glahn and King 2004). However, those species often exhibit differing foraging behavior.

For example, American white pelicans and double-crested cormorants use distinctly different techniques when foraging for fish (Knopf and Kennedy 1981). Double-crested cormorants dive up to 10 meters underwater to prey on fish (Dorr et al. 2014) while American white pelicans prey on fish near the surface of the water (Knopf and Evans 2004). Great blue herons forage on aquatic organisms near the edges of aquatic habitats by wading in the water near the shore. Vennesland and Butler (2011) indicated that great blue herons might catch fish chased toward the shore by double-crested cormorants. Ainley et al. (1981) found pelagic cormorants, Brandt's cormorants, and double-crested cormorants foraged in the same areas at the same time using the same technique; however, those three species of cormorants used different microhabitats as defined by prey behavior and the prey species consumed differed between double-crested cormorants and the other two cormorant species.

Although double-crested cormorants and other fish-eating waterbirds often occur together in similar habitat, there is no evidence that double-crested cormorants limit the ability of other fish-eating bird species to feed on fish at aquaculture facilities or other aquatic habitats. Therefore, the removal or dispersal of double-crested cormorants from those areas is not likely to result in an increase in other fish-eating bird species using those areas because of the absence of double-crested cormorants. Fish-eating bird species often have differing feeding behavior to diminish competition with other fish-eating birds, such as foraging on different sizes of fish, at different distances from nest locations, or by having non-overlapping breeding seasons (Cody 1973, Knopf and Kennedy 1981). Therefore, the presence or absence of double-crested cormorants at those facilities would not likely influence the presence or absence of other fish-eating birds at those facilities.

- *Effects on the public's esthetic enjoyment of double-crested cormorants*

Public opinion about the best ways to reduce conflicts between people and animals is highly variable, making the implementation and conduct of damage management programs extremely complex. Some people express concerns that proposed activities could interfere with their enjoyment of recreational activities and their esthetic enjoyment of double-crested cormorants. Another concern is WS' activities would result in the loss of esthetic benefits of double-crested cormorants to the public.

People generally regard animals as providing economic, recreational, and esthetic benefits, and the mere knowledge that animals exists is a positive benefit to many people (Decker and Goff 1987). Esthetics is the philosophy dealing with the nature of beauty, or the appreciation of beauty. Therefore, esthetics is truly subjective in nature, dependent on what an observer regards as beautiful. The human attraction to animals likely started when people began domesticating animals. The public today share a similar bond with animals and/or wildlife in general and in modern societies, a large percentage of households have indoor or outdoor pets. However, some people may consider individual wild animals as "*pets*" or exhibit affection toward those animals, especially people who enjoy viewing animals. Therefore, the public reaction can be variable and mixed to animal damage management because there are numerous philosophical, esthetic, and personal attitudes, values, and opinions about the best ways to manage conflicts/problems between people and animals.

Animal populations provide a wide range of social and economic benefits (Decker and Goff 1987). Those include direct benefits related to consumptive and non-consumptive uses, indirect benefits derived from vicarious wildlife related experiences, and the personal enjoyment of knowing animals exists and contributes to the stability of natural ecosystems (Bishop 1987). Direct benefits are derived from a personal relationship with animals and may take the form of direct consumptive use (*e.g.,* using parts of or the entire animal) or non-consumptive use (*e.g.*, viewing the animal in nature or in a zoo, photographing) (Decker and Goff 1987).

Indirect benefits or indirect exercised values arise without the user being in direct contact with the animal and originate from experiences, such as looking at photographs and films of animals, reading about animals, or benefiting from activities or contributions of animals (*e.g*., their use in research) (Decker and Goff 1987). Indirect benefits come in two forms: bequest and pure existence (Decker and Goff 1987). Bequest is providing for future generations and pure existence is merely knowledge that the animals exist (Decker and Goff 1987). Double-crested cormorants may provide similar benefits to people that enjoy viewing double-crested cormorants and knowing they are part of natural ecosystems.

In 2011, the USFWS and the United States Department of Commerce (2011) found nearly 1.4 million people participated in wildlife-associated recreation in Mississippi, including people that participated in hunting, fishing, and wildlife watching. In total, people spent over $2.6 billion on wildlife recreation in Mississippi during 2011 (USFWS and the United States Department of Commerce 2011).

In the wild, few animals in the United States have life spans approaching that of people. Mortality is high among wildlife populations and specific individuals among a species may experience death early in life. Mortality in wildlife populations is a natural occurrence and people who form affectionate bonds with animals experience loss of those animals over time in most instances. A number of professionals in the field of psychology have studied human behavior in response to attachment to pet animals (Gerwolls and Labott 1994, Marks et al. 1994, Zasloff 1996, Ross and Baron-Sorensen 1998, Archer 1999, Meyers 2000). Similar observations are probably applicable to close bonds that could exist between people and wild animals. As observed by researchers in human behavior, normal human responses to loss of loved ones proceed through phases of shock or emotional numbness, sense of loss, grief, acceptance of the loss or what cannot be changed, healing, and acceptance and rebuilding which leads to resumption of normal lives (Lefrancois 1999). Those people who lose companion animals, or animals for which they may have developed a bond and affection, can proceed through the same phases as with the loss of human companions (Gerwolls and Labott 1994, Boyce 1998, Meyers 2000). However, they usually establish a bond with other individual animals after such losses. Although they may lose the sense of enjoyment and meaning from the association with those animals that die or are no longer accessible, they usually find a similar meaningfulness by establishing an association with new individual animals or through other relational activities (Weisman 1991). Through this process of coping with the loss and establishing new affectionate bonds, people may avoid compounding emotional effects resulting from such losses (Lefrancois 1999).

WS only conducts activities on properties where the landowner or property manager signs a Memorandum of Understanding, work plan, work initiation document, or a similar document allowing WS' personnel to conduct activities and personnel would only target those double-crested cormorants identified as causing damage or posing a threat of damage. In addition, other double-crested cormorants would likely continue to be present in the affected area and people would tend to establish new bonds with those remaining double-crested cormorants. In addition, human behavior processes usually result in individuals ultimately returning to normalcy after experiencing the loss of association with a wild animal that an entity removed from a specific location.

Even in the absence of any involvement by WS, other entities could conduct activities to alleviate damage or threats of damage. In addition, activities that could occur by WS would occur on a relatively limited portion of the total area in Mississippi. As discussed previously, the effects on the double-crested cormorant population from damage management activities would be relatively low if WS implemented Alternative 1, and opportunities to view, hear, or see evidence of double-crested cormorants would still be available over the majority of land area of the state. Implementation of Alternative 1 would not limit recreational opportunities within the state and would not reduce the ability of people to enjoy the esthetic value of double-crested cormorants within the state.

Cumulative effects on the double-crested cormorant population from implementing Alternative 1

Many natural processes and human generated changes would be occurring simultaneously during the implementation of Alternative 1 that could cumulatively affect the double-crested cormorant population. Those natural processes and human generated changes could include:

- Natural mortality of double-crested cormorants
- Human-induced mortality through aircraft strikes and illegal take
- Human-induced mortality of double-crested cormorants through damage management activities
- Human and naturally induced alterations of wildlife habitat
- Annual and perennial cycles in population densities

All those factors can play a role in the dynamics of the double-crested cormorant population. As discussed in Section 1.4.7 and Section 1.4.8, the USFWS is responsible for managing migratory bird species in the United States pursuant to the MBTA (16 USC 703-712). The MBTA is the implementing legislation for four international conventions that protect migratory birds. The MBTA prohibits the take of migratory birds unless authorized (16 USC 703). The MBTA allows the USFWS to authorize the take of migratory birds when the take is compatible with the terms of the four international conventions (16 USC 704(a)).

Because of the cumulative activities associated with managing damage caused by double-crested cormorants, the USFWS has developed a Potential Take Limit model to evaluate the cumulative annual take of double-crested cormorants in the central and eastern United States (see Appendix 1 in USFWS (2017) for a description of the model). The Potential Take Limit model developed by the USFWS estimates the maximum allowable cumulative take of double-crested cormorants in three subpopulations found in the central and eastern United States and Canada. The USFWS distinguished those three subpopulations primarily on the migratory corridors those double-crested cormorants use as they move between areas where they nest and areas where they spend the winter.

The USFWS designated those three subpopulations of double-crested cormorants that occur in the central and eastern United States and Canada as the Atlantic Flyway subpopulation, the Mississippi/Central Flyway subpopulation, and the Florida subpopulation. The Florida subpopulation is generally non-migratory and occurs in southern Florida. The Atlantic Flyway subpopulation nests primarily along Lake Ontario, the St. Lawrence River, the northeastern United States, and corresponding areas in Canada. The Atlantic Flyway subpopulation generally follows the Atlantic Flyway migratory path during the spring and fall. The Mississippi/Central Flyway subpopulation nests in the central and western portion of the Great Lakes and the north-central plains and generally migrates along the Mississippi Flyway and/or the Central Flyway corridor. The double-crested cormorants that occur in Mississippi would primarily be a part of the Mississippi/Central Flyway subpopulation (Dolbeer 1991, Scherr et al. 2010, Guillaumet et al. 2011, Chastant et al. 2014).

The lower limit of the Potential Take Limit model developed by the USFWS estimated an allowable take of 74,396 double-crested cormorants per year in the central and eastern United States would maintain the current double-crested cormorant population (see Section 5.2 in USFWS (2017) and Appendix 1 in USFWS (2017)), which would include the cumulative take of double-crested cormorants in Mississippi. However, the USFWS will limit allowable take in the central and eastern United States to 51,571 double-crested cormorants per year based on the cumulative take of double-crested cormorants reported by all entities issued depredation permits from 2010 through 2015, which is below the lower limit of allowable take predicted by the Potential Take Limit model. Even if the USFWS transitioned to allowing cumulative take of up to 74,396 double-crested cormorants in the central and eastern United States, the Potential Take Limit model developed by the USFWS predicts the cumulative take of double-crested cormorants would maintain the current population level.

The Potential Take Limit model developed by the USFWS estimates the maximum allowable take of double-crested cormorants; however, the maximum allowable take is not a prescribed take level for double-crested cormorants. The Potential Take Limit model predicts the maximum allowable annual take that corresponds with a biologically sustainable level of annual take. The take of double-crested cormorants by WS would occur as allowed by the USFWS. The USFWS determined the allowed cumulative take levels authorized in the central and eastern United States, including allowed cumulative take in Mississippi, would maintain the current double-crested cormorant population (see Section 5.4 in USFWS (2017), Table 5-2 in USFWS (2017), and Appendix 1 in USFWS (2017)).

With management authority over bird populations, the USFWS could adjust take levels, including the take by WS, to achieve population objectives for double-crested cormorants. Consultation and reporting of take by WS would ensure the USFWS had the opportunity to consider the activities conducted by WS. As stated previously, WS would not use or recommend those lethal methods available as population management tools over broad areas. WS would use and recommend lethal methods to reduce the number of double-crested cormorants present at a location where damage was occurring by targeting those double-crested cormorants causing damage or posing threats; therefore, the intent of using lethal methods would be to manage those double-crested cormorants causing damage and not to manage the entire double-crested cormorant population. The annual take of double-crested cormorants by WS would not exceed the levels authorized by the USFWS. WS would submit annual reports to the USFWS listing the number of double-crested cormorants lethally removed so the USFWS had the opportunity to evaluate WS' activities and the cumulative take occurring for double-crested cormorants. In addition, WS would monitor activities to ensure those activities remained within the impact parameters analyzed in this EA.

If WS implements Alternative 1, the activities conducted by WS to manage damage caused by double-crested cormorants in Mississippi would be within the scope and management objectives of the Southeast United States Waterbird Conservation Plan (Hunter et al. 2006) and the Atlantic and Mississippi Flyways Double-crested Cormorant Management Plan (Atlantic Flyway Council and Mississippi Flyway Council 2010).

- *Concerns That Killing Double-Crested Cormorants Represents "Irreparable Harm"*

Public comments have often raised a concern that the killing of any wildlife causes irreparable harm. In meeting the need for action, the objective would be to reduce damage, risks, and conflicts with double-crested cormorants as requested and not to reduce/eliminate the double-crested cormorant population. WS would only target an individual double-crested cormorant or a group of double-crested cormorants identified as causing damage or posing a threat to human safety. Although the WS program may lethally remove individual or multiple double-crested cormorants in a specific area to alleviate damage or the threat of damage, the lethal removal of individual or multiple double-crested cormorants in a localized area would not represent irreparable harm to the continued existence of the species. Double-crested cormorant populations experience mortality from a variety of causes, including damage management activities.

Magnitude is a measure of the number of animals killed in relation to their abundance. As discussed previously, the cumulative effects of known activities would not reach a magnitude that adverse effects would occur to the double-crested cormorant population. Despite previous activities to manage damage caused by double-crested cormorants, including the lethal removal of double-crested cormorants, trend data continues to indicate that the breeding population of double-crested cormorants is generally increasing across all routes surveyed during the BBS, including the number of double-crested cormorants nesting in Mississippi (Sauer et al. 2017). Across all areas of the United States surveyed during the CBC, the number of double-crested cormorants observed has shown a general increasing trend since 1966 with a general stable trend since the early 1990s (National Audubon Society 2010). The International Union for Conservation of Nature and Natural Resources ranks the double-crested cormorant as a species of "*least concern*" (BirdLife International 2018*a*). The International Union for Conservation of Nature and Natural Resources assigned the ranking based on the "*species…extremely large range…*", "*the population trend appears to be increasing*", and "*…the population size is extremely large…*" (BirdLife International 2018*a*). In the North American Waterbird Conservation Plan, Kushlan et al. (2002) ranked the double-crested cormorant as a species "*not currently at risk*".

The USFWS developed a Potential Take Limit model to ensure the authorized cumulative take of double-crested cormorants in the central and eastern United States would maintain double-crested cormorant populations. If the USFWS continues to use the Potential Take Limit model and continues to authorize cumulative take within the allowable take limits predicted by the model, the cumulative take of double-crested cormorants should maintain current population levels. For a detailed discussion of the Potential Take Limit model and its application, please see Appendix 1 in the EA developed by the USFWS for issuing depredation permits to manage damage caused by double-crested cormorants (USFWS 2017). In addition, the activities that WS could conduct to manage damage caused by double-crested cormorants in Mississippi would be within the scope and management objectives of the Southeast United States Waterbird Conservation Plan (Hunter et al. 2006) and the Atlantic and Mississippi Flyways Double-crested Cormorant Management Plan (Atlantic Flyway Council and Mississippi Flyway Council 2010).

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

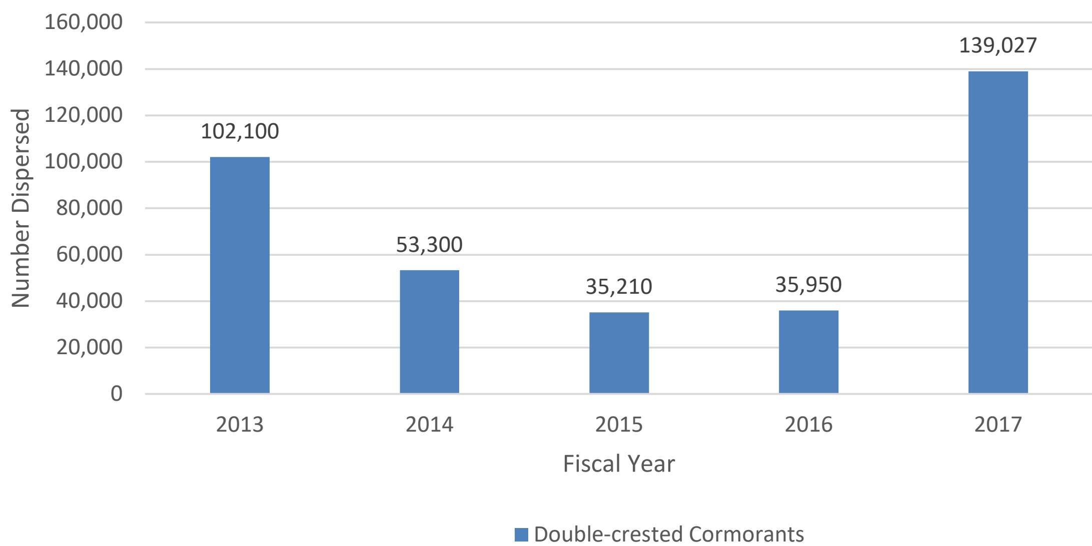
If WS implements Alternative 2, WS would only use non-lethal methods to resolve damage or threats of damage associated with double-crested cormorants in Mississippi. No intentional lethal removal of double-crested cormorants would occur by WS. Non-lethal methods generally disperse, exclude, or live-capture double-crested cormorants. Methods intended to scare double-crested cormorants from areas where they are causing damage or posing a threat of damage are generally visual or acoustic deterrents, such as lights, lasers, boats, vehicles, drones, pyrotechnics, or propane cannons. Exclusion methods would prevent double-crested cormorants from accessing a resource and could disperse those birds to other areas where resources are unprotected. Exclusion methods could include overhead wires or netting. WS could also live-capture double-crested cormorants as part of research projects using live-capture techniques, such as large fish-landing nets (see King et al. 1994, King et al. 2000) and padded foothold traps (see King et al. 2000, Guillaumet et al. 2011). WS could continue to use aircraft to monitor and track double-crested cormorants in Mississippi.

Direct effects on the double-crested cormorant population associated with implementing Alternative 2

As shown in Figure 4.2, WS has used non-lethal methods to disperse double-crested cormorants. For example, WS could conduct activities to disperse double-crested cormorants from winter roosts.

Dispersing double-crested cormorants from winter roosts near aquaculture facilities can be effective (Mott et al. 1998, Reinhold and Sloan 1999, Glahn et al. 2000). As double-crested cormorants arrived at a location to roost for the night, Mott et al. (1998) found that harassment could reduce the number of double-crested cormorants observed at aquaculture facilities near the roosts. In the Mississippi Delta region, the intent of harassing double-crested cormorants as they arrive at roost locations is to disperse those double-crested cormorants toward roost locations closer to the Mississippi River. Glahn et al. (1995) found that commercially raised fish from aquaculture facilities comprised a much lower percentage of the diet of double-crested cormorants roosting closer to the Mississippi River, likely due to the higher availability of natural forage from the oxbow lakes along the Mississippi River. Mott et al. (1998) found that a higher percentage of double-crested cormorants used roosts along the Mississippi River following the implementation of dispersal activities at roost locations further from the river.

Figure 4.2 - Number of double-crested cormorants dispersed by WS in Mississippi, FY 2013 - FY 2017



When dispersing double-crested cormorants from winter roosts, WS' personnel would generally direct the use of pyrotechnics, lights, lasers, boats, vehicles, and other noise making devices (*e.g.*, propane cannons) at double-crested cormorants in a roost and flying towards a roost during a two-hour period before sunset. WS' personnel would coordinate harassment efforts at roosts to ensure that dispersal of double-crested cormorants occurs nearly simultaneously to prevent double-crested cormorants from merely moving between roosts near aquaculture facilities. In addition, WS' personnel would design and orient the coordinated efforts to disperse double-crested cormorants toward roost locations away from other aquaculture facilities.

The intent associated with the use of auditory and visual deterrents is to elicit a flight response by scaring double-crested cormorants from an area where damage is occurring or where damage could occur. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of double-crested cormorants or the ability of a double-crested cormorant to survive, especially if the exposure to the stressor is chronic. If stress occurs to double-crested cormorants from the scaring associated with harassment, the negative effects associated with causing a flight response could be exacerbated by other deleterious stressors already occurring (*e.g.*, disease). The stress from harassment could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs. When using methods to live-capture double-crested cormorants, injuries or death could occur during the process of capturing a double-crested cormorant (King et al. 1994, King et al. 2000). Constantly monitoring and addressing captured double-crested cormorants immediately after capture can reduce the likelihood of injuries and death. In addition, making appropriate modification to live-capture methods can reduce injuries (King et al. 2000).

However, the use of non-lethal methods to capture, disperse, or exclude double-crested cormorants would generally have minimal effects on the overall population of double-crested cormorants because those methods would not harm individual double-crested cormorants. WS' personnel would not employ non-lethal methods over large geographical areas or apply those methods at such an intensity that double-crested cormorants would be unable to access essential resources (*e.g*., food sources, habitat) for extended durations. Similarly, the use of aircraft by WS to monitor and/or track double-crested cormorants would not occur at such frequency or at an intensity level that would adversely affect double-crested cormorant populations. Aircraft used by WS would spend a very small amount of time at any location during surveys and/or tracking double-crested cormorants.

WS could also live-capture a limited number of double-crested cormorants using nets and/or modified padded foothold traps and then fit the double-crested cormorants with external tracking devices, such as radio transmitters or Global Positioning System transmitters, to track their movements. In addition, WS could live-capture double-crested cormorants to place leg bands or other identifying markers (*e.g*., patagial tags) for identification purposes. Live-capturing and fitting double-crested cormorants and/or applying other identifying markers would only occur after WS or another entity received the appropriate permits from the USFWS and the United States Geological Survey to attach those tracking devices and/or markers on double-crested cormorants.

When using transmitters, WS would follow established procedures for using those devices (*e.g*., see King et al. 2000, Guilaumet et al. 2011). When using leg bands, WS would use those band sizes indicated in the North American Bird Banding Manual developed by the United States Geological Survey. Because the intent of using transmitters and other identifying markers is to monitor natural movement patterns and to identify individual double-crested cormorants, researchers have designed those methods to allow for natural movements and limit adverse effects on the bird species. Fair et al. (2010) stated "[w]*hen appropriate* [leg] *band sizes are used, the occurrence and rate of adverse effects on the subjects is ordinarily very low*". The effects on individual double-crested cormorants associated with attaching transmitters likely vary on the type of transmitter used and how an entity attaches the transmitter to a double-crested cormorant (King et al. 2000). For example, transmitters and their harness may cause weight loss, excessive feather wear, feather loss, abrasions, reduced reproduction, and result in entanglement; however, using appropriately size transmitters and properly fitting harnesses can minimize effects (King et al. 2000, Fair et al. 2010). In addition, transmitters and batteries have generally become smaller as advances in technology occur, which may further minimize any effects associated with the weight of the transmitter and the battery.

The WS program in Mississippi anticipates using transmitters and banding double-crested cormorants on a very limited basis because of the time and cost required to live-capture double-crested cormorants and the costs associated with using transmitters. In addition, when used, WS anticipates using those methods on a limited number of double-crested cormorants.

Indirect effects associated with implementing Alternative 2

As discussed previously, the use of non-lethal methods by WS in Mississippi to exclude, capture, or haze double-crested cormorants would have no effect on the double-crested cormorant population. WS would not employ non-lethal methods over large geographical areas at such intensity levels that resources (*e.g*., food sources, habitat) would be unavailable for extended durations or over a wide geographical scope.

Therefore, indirect effects that relate to the double-crested cormorant population would not occur by WS from implementation of Alternative 2.

Implementation of Alternative 2 by WS would not prevent the USFWS from continuing to issue depredation permits for the take of double-crested cormorants in Mississippi. WS anticipates the lethal take of double-crested cormorants would continue to occur by other entities if WS implements Alternative 2 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1. Therefore, WS anticipates the indirect effects associated with implementing Alternative 2 would be similar to those indirect effects discussed for Alternative 1 because the lethal take of double-crested cormorants in the state would continue to occur by other entities.

Cumulative effects on the double-crested cormorant population from implementing Alternative 2

WS does not anticipate any cumulative effects to occur associated with WS' use of non-lethal methods even when considered with the use of non-lethal by other entities. Although non-lethal methods likely elicit a flight response, the cumulative use of non-lethal methods by all entities is not likely to rise to a level that would have any effect on the double-crested cormorant population.

Although implementation of this alternative would limit WS to using only non-lethal methods, entities other than WS could continue to use lethal methods when authorized by the USFWS. The USFWS could continue to authorize other entities to use lethal methods when non-lethal methods become less effective at excluding and/or dispersing double-crested cormorants. The continued use of many non-lethal methods can often lead to the habituation of double-crested cormorants to those methods (*i.e.*, showing no response or limited movements), which can decrease the effectiveness of those methods (Mott and Boyd 1995, Mott et al. 1998, Seamans and Gosser 2016).

Based on annual reports received by the USFWS from 2004 through 2015, all entities in Mississippi lethally removed an average of 8,732 double-crested cormorants per year to alleviate damage to aquaculture resources (see Table 4-3 in USFWS (2017)), which includes the take of double-crested cormorants by WS. The average annual take of 8,732 double-crested cormorants in Mississippi to alleviate or prevent damage to aquaculture resources does not include double-crested cormorants lethally removed in the state for other purposes, such as at airports or to protect natural resources. From 2004 through 2015, the annual take of double-crested cormorants to alleviate damage to aquaculture resources in Mississippi has ranged from a low of 3,910 double-crested cormorants lethally removed in 2012 to 18,111 double-crested cormorants lethally removed in 2006.

The annual take of double-crested cormorants by WS in Mississippi has been a small percentage of the cumulative annual take of double-crested cormorants. For example, from 2013 through 2016, the WS program in Mississippi lethally removed an average of 321 double-crested cormorants per year to alleviate damage or threats of damage, which compares to an average annual take of 10,887 double-crested cormorants in Mississippi from 2013 through 2015 by all entities to alleviate damage or threats of damage to just aquaculture resources. The annual take of double-crested cormorants would represent less than 3% of the annual take of double-crested cormorants by all entities in the state to alleviate damage to just aquaculture resources. Therefore, WS anticipates the lethal take of double-crested cormorants to continue to occur by other entities if WS implements Alternative 2. In addition, WS anticipates the cumulative effects to be similar to those discussed for Alternative 1 because the lethal take of double-crested cormorants in the state has primarily occurred by entities other than WS.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

Under a technical assistance only alternative, WS would recommend an integrated methods approach similar to Alternative 1 and Alternative 2; however, WS would not provide direct operational assistance under this alternative. Using information that a requester provides or from a site visit by an employee, WS' personnel would recommend methods and techniques based on their use of the WS Decision Model. In some instances, information provided to the requester by WS could result in tolerance/acceptance of the situation. In other instances, WS would discuss and recommend damage management options.

Direct effects on the double-crested cormorant population associated with implementing Alternative 3

When discussing damage management options with the person requesting assistance, WS' personnel could recommend and demonstrate for use both non-lethal and lethal methods legally available for use to alleviate damage. Those persons receiving technical assistance from WS could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from other entities, or take no further action. Therefore, if WS implements Alternative 3, WS would have no direct effect on the double-crested cormorant population because WS would not conduct direct operational assistance.

WS anticipates the lethal take of double-crested cormorants would continue to occur by other entities if WS implements Alternative 3 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1 or Alternative 2. Therefore, WS anticipates the direct effects associated with implementing Alternative 3 would be similar to those direct effects discussed for Alternative 1 because the lethal take of double-crested cormorants in the state would continue to occur by other entities. As discussed for Alternative 1, the lethal take of double-crested cormorants to alleviate damage in Mississippi occurs primarily by entities other than WS.

Indirect effects associated with implementing Alternative 3

Indirect effects that relate to the double-crested cormorant population would not occur by WS from implementation of Alternative 3. Similar to the other alternatives, implementation of Alternative 3 by WS would not prevent the USFWS from continuing to authorize the take of double-crested cormorants in Mississippi. WS anticipates the lethal take of double-crested cormorants would continue to occur by other entities if WS implements Alternative 3 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1 or Alternative 2. Therefore, WS anticipates the indirect effects associated with implementing Alternative 3 would be similar to those indirect effects discussed for Alternative 1 because the lethal take of double-crested cormorants in the state would continue to occur by other entities. As discussed for Alternative 1, the lethal take of double-crested cormorants to alleviate damage in Mississippi occurs primarily by entities other than WS.

Cumulative effects on the double-crested cormorant population from implementing Alternative 3

Despite WS not providing direct operational assistance to resolve damage and threats associated with double-crested cormorants, those people experiencing damage caused by double-crested cormorants could continue to alleviate damage by employing those methods legally available or by seeking assistance from other entities. The USFWS could continue to authorize the take of double-crested cormorants. Appendix B discusses the methods available for use when managing damage and threats associated with double-crested cormorants. Similar to Alternative 1 and Alternative 2, those methods described in Appendix B would be available to those persons experiencing damage or threats associated with double-crested cormorants in the state.

The cumulative effects associated with the use of non-lethal methods would be similar to those identified and discussed for Alternative 1 and Alternative 2. Although implementation of Alternative 3 would limit WS to providing only technical assistance, entities other than WS could continue to take double-crested cormorants when authorized by the USFWS. If WS implements Alternative 3, the cumulative effects on the double-crested cormorant population associated with the take of double-crested cormorants would likely be similar to Alternative 1 and Alternative 2 because people could continue to take double-crested cormorants when allowed by the USFWS and the majority of take that has occurred previously in Mississippi occurred by entities other than WS.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

If WS implements Alternative 4, WS would have no direct involvement with any aspect of addressing damage caused by double-crested cormorants and would provide no technical assistance. When contacted about double-crested cormorant damage or the threat of double-crested cormorant damage, WS would refer those people to other entities, such as the USFWS, MDWFP, and/or private entities.

Direct effects on the double-crested cormorant population associated with implementing Alternative 4

Similar to Alternative 3, if WS implemented Alternative 4, WS would have no direct effect on the double-crested cormorant population because no take of double-crested cormorants would occur by WS. WS anticipates the lethal take of double-crested cormorants would continue to occur by other entities if WS implements Alternative 4 and would likely occur at levels similar to the take that would occur if WS implemented the other alternative approaches. Therefore, WS anticipates the direct effects associated with implementing Alternative 4 would be similar to those direct effects discussed for Alternative 1 because the lethal take of double-crested cormorants in the state would continue to occur by other entities. As discussed for Alternative 1, the lethal take of double-crested cormorants to alleviate damage in Mississippi occurs primarily by entities other than WS.

Indirect effects associated with implementing Alternative 4

Similar to Alternative 3, indirect effects that relate to the double-crested cormorant population would not occur by WS from implementation of Alternative 4. Like the other alternatives, implementation of Alternative 4 by WS would not prevent the USFWS from continuing to authorize the take of double-crested cormorants in Mississippi. WS anticipates the lethal take of double-crested cormorants would continue to occur by other entities if WS implements Alternative 4 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1, Alternative 2, or Alternative 3. Therefore, WS anticipates the indirect effects associated with implementing Alternative 4 would be similar to those indirect effects discussed for Alternative 1 because the lethal take of double-crested cormorants in the state would continue to occur by other entities and the majority of double-crested cormorant take that has occurred previously in Mississippi, occurred by entities other than WS.

Cumulative effects on the double-crested cormorant population from implementing Alternative 4

Despite WS not providing any assistance to resolve damage and threats associated with double-crested cormorants, those people experiencing damage caused by double-crested cormorants could continue to alleviate damage by employing those methods legally available or by seeking assistance from other entities. The USFWS could continue to authorize the take of double-crested cormorants. Appendix B discusses the methods available for use when managing damage and threats associated with double-crested cormorants. Similar to the other alternatives, those methods described in Appendix B would be available to those persons experiencing damage or threats associated with double-crested cormorants in the state.

The cumulative effects associated with the use of non-lethal methods would be similar to those identified and discussed for Alternative 1 and Alternative 2. Although WS would not provide any assistance with managing damage associated with double-crested cormorants in Mississippi, entities other than WS could continue to take double-crested cormorants when authorized by the USFWS. If WS implements Alternative 4, the cumulative effects on the double-crested cormorant population associated with the take of double-crested cormorants would likely be similar to the other alternatives because people could continue to take double-crested cormorants when allowed by the USFWS and the majority of take that has occurred previously in Mississippi occurred by entities other than WS.

3.2.2 Issue 2 - Effects on the populations of Non-target Wildlife Species, Including Threatened and Endangered Species

As discussed previously, a concern would be the potential impacts to non-target species, including threatened and endangered species, from the use of methods to resolve damage caused by double-crested cormorants. When using methods, WS could unintentionally live-capture, disperse, or kill non-target animals. Discussion on the potential direct, indirect, and cumulative effects of the alternatives on the populations of non-target animal species, including threatened and endangered species, occurs below for each of the alternatives identified in Section 2.2.2.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

Using the WS Decision Model, WS' personnel would formulate a management strategy, which would include the method or methods the employee determines to be practical for use to alleviate damage or reduce risks caused by double-crested cormorants. When determining the appropriate method or methods, WS' personnel would consider risks to non-target animals from the use of a method or methods. Despite WS' efforts to reduce risks to non-target animals, the use of a method or methods could exclude, disperse, capture, or kill non-target animals unintentionally.

If WS implements Alternative 1, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance. When providing direct operational assistance, WS' employees could use lethal and/or non-lethal methods in an integrated methods approach to reduce damage and alleviate risks of damage associated with double-crested cormorants. Personnel of WS would use a decision making process for evaluating and responding to requests for assistance detailed in the WS Decision Model (see WS Directive 2.201). As part of that decision making process, employees of WS would consider the methods available and their potential to disperse, capture, or kill non-target animals based on the use pattern of the method. Personnel with WS would have experience with managing animal damage and would receive training in the use of methods, which would allow WS' employees to use the WS Decision Model to select the most appropriate methods to address damage caused by double-crested cormorants and to reduce the risks to non-target animals. Despite efforts by WS to minimize risks to non-target animals, the potential for WS to live-capture, exclude, disperse, or lethally remove non-target animals exists when applying both non-lethal and lethal methods to manage damage or reduce threats to safety.

The risks to non-target animals associated with WS providing technical assistance during the implementation of Alternative 1 would be similar to those risks to non-target animals discussed for Alternative 3. Therefore, to reduce redundancy, the effects associated with WS providing technical assistance that would occur if WS implements Alternative 1 occur in the discussion for Alternative 3.

Similarly, the risks to non-target animals from the use of non-lethal methods during the implementation of Alternative 1 would be similar to those risks to non-target animals discussed for Alternative 2. To reduce redundancy, the risks to non-target animals from the use of non-lethal methods if WS implements Alternative 1 occur in the discussion for Alternative 2. A discussion of the risks to non-target animals and the potential effects on the populations of non-target animals if WS implements Alternative 1 occurs below.

DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS ON NON-TARGET POPULATIONS

In regards to risk to non-target animals, the primary risk would be associated with lethal methods because the use of lethal methods would likely result in the death of a non-target animal. Lethal methods that WS' employees could use would include the use of a firearm, euthanasia after live-capture using carbon dioxide, and egg destruction (*i.e.*, puncturing, breaking, oiling, or shaking an egg). When using firearms, WS' personnel would retrieve the carcasses of double-crested cormorants to the extent possible and would dispose of the carcasses in accordance with WS Directive 2.515. After live capturing and euthanizing a double-crested cormorant, WS' personnel would also dispose of the carcass pursuant to WS Directive 2.515.

If WS implemented Alternative 1, WS would monitor activities to ensure potential impacts to non-target species continue to occur within the scope analyzed in this EA. Through those monitoring activities, the WS program in Mississippi can evaluate and adjust activities conducted to meet the need for action. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review and monitoring of implemented activities.

Direct effects on non-target animal populations associated with implementing Alternative 1

As discussed previously, if WS implements Alternative 1, WS could provide technical assistance and/or direct operational assistance, when requested, and could recommend and/or use non-lethal and lethal methods to address double-crested cormorants causing damage or posing a threat of damage. The potential effects on non-target animal populations associated with WS providing technical assistance would be similar to the potential effects discussed for Alternative 3. Similarly, the potential effects on non-target animal populations associated with the use of non-lethal methods would be similar to those potential effects discussed for Alternative 2. The primary risks to non-target animals would be associated with lethal methods. Lethal methods that WS' employees could use would include the use of euthanasia using carbon dioxide after live-capture, egg destruction (*i.e.*, puncturing, breaking, oiling, or shaking an egg), and the use of a firearm.

WS could euthanize double-crested cormorants using carbon dioxide after capturing a double-crested cormorant alive. Because WS' employees would identify a double-crested cormorant prior to administering carbon dioxide, unintentional take of non-target animals would not occur. Similarly, WS' employees would identify the eggs of double-crested cormorants prior to destroying eggs; therefore, the unintentional take of eggs associated with other bird species would not occur.

Of those lethal methods that WS could use, of primary concern would be the use of firearms. As appropriate, WS' personnel would use suppressed firearms to minimize the noise produced when firing. The use of firearms would essentially be selective for double-crested cormorants because WS' personnel would identify an animal prior to application. However, there is potential for misidentification of other bird species, especially bird species with a similar appearance to a double-crested cormorant. The only two bird species with a similar appearance to the double-crested cormorant that could occur in Mississippi are the neotropic cormorant (*Phalacrocorax brasilianus*) and the anhinga (*Anhinga anhinga*). Both the neotropic cormorant and the anhinga are fish-eating bird species that occur in aquatic habitats and have similar appearances to double-crested cormorants. Those species often intermix with double-crested cormorants. The misidentification of a neotropic cormorant and/or an anhinga as a double-crested cormorant can occur especially when those species mix with double-crested cormorants in flight and low-light conditions that WS is likely to encounter when addressing winter roosts of double-crested cormorants.

During FY 2007, WS unintentionally killed one neotropic cormorant in Mississippi with a firearm while conducting activities associated with double-crested cormorants. In addition, personnel with the NWRC unintentionally killed one neotropic cormorant in Mississippi with a firearm during FY 2008 (Hanson et al. 2010). WS unintentionally killed two neotropic cormorants with a firearm in FY 2018. The WS program in Mississippi has not lethally removed any other non-target animals during activities to manage the damage or threats of damage associated with double-crested cormorants. No take of threatened or endangered species has occurred by WS during activities to manage damage caused by double-crested cormorants and activities have had no effect on any critical habitat designated for threatened or endangered species in the state.

Neotropic cormorants are similar in appearance to double-crested cormorants and the two species are sometimes confused, especially juveniles and immature individuals of the two species (Turcotte and Watts 1999, Telfair II and Morrison 2005). Neotropic cormorants can occur in flocks of double-crested cormorants, especially during the winter migration period (Telfair II and Morrison 2005, Hanson et al. 2010). During flight and low light conditions, distinguishing between the two species can be difficult.

Neotropic cormorants occur throughout the year in South America, Central America, Mexico, and the West Indies. In the United States, breeding colonies of neotropic cormorants occur in southern Arizona, New Mexico, north-central Texas, southwest Louisiana, southwest Arkansas, and southeastern Oklahoma (Telfair II and Morrison 2005). The population of neotropic cormorants appears to be increasing in the United States (Telfair and Morrison 2005, National Audubon Society 2010, BirdLife International 2018*b*). Telfair II and Morrison (2005) indicated that neotropic cormorants are "…*widespread spring through winter wanderers in some areas*." Neotropic cormorants can be present in Mississippi, but occurrences are rare (Turcotte and Watts 1999, Telfair II and Morrison 2005). However, their presence in Mississippi may be increasing (Hanson et al. 2010). Information on the number of neotropic cormorants occurring in Mississippi is not available, including trend data from the BBS and the CBC. BirdLife International (2018*b*) estimated the population to be 2 million neotropic cormorants across their entire range, which includes South America, Central America, and those neotropic cormorants occurring in the United States.

A neotropic cormorant identified on February 28, 2003 in northwest Humphreys County was only the third published sighting of a neotropic cormorant for the State of Mississippi and was the first published record of a sighting away from the coastal area of Mississippi (Turcotte and Watts 1999, Knight and Knight 2006). The first record of a neotropic cormorant in the State of Mississippi was a juvenile identified along the coast of the Gulf of Mexico in Jackson County during August 1979. The second record was also a juvenile neotropic cormorant observed at the same location in December 1980 (Turcotte and Watts 1999, Knight and Knight 2006). From 2003 through 2008, Hanson et al. (2010) documented 22 individual neotropic cormorants in the Mississippi Delta region during 20 separate sightings, which included sightings at breeding colonies of other colonial waterbirds and at commercial aquaculture facilities. If each of those 22 neotropic cormorants were unique individuals, then Hanson et al. (2010) observed an average of four neotropic cormorants per year in Mississippi. Hanson et al. (2010) speculated their observations of an adult neotropic cormorant attending to a nest in Yazoo County during May and June 2008 was the first nesting record of neotropic cormorants in Mississippi.

Although unintentional take of neotropic cormorants has occurred by WS and the NWRC in Mississippi, take has occurred infrequently and involved only a few individual neotropic cormorants. In total, WS and the NWRC have lethally removed four neotropic cormorants unintentionally over the past 12 years and unintentional lethally removal only occurred during three of those 12 years. Therefore, the unintentional take of neotropic cormorants by WS has not occurred at a magnitude that would likely adversely affect the neotropic cormorant population. WS reported the take of all neotropic cormorants to the USFWS.

➢ *Disturbance of non-target animals from implementation of Alternative 1*

If WS implements Alternative 1, WS' personnel could use a wide range of non-lethal and lethal methods to alleviate damage caused by double-crested cormorants in the state (see Appendix B). Many of those methods produce auditory and/or visual stimuli. The intent associated with the use of auditory and visual deterrents is to elicit a flight response by scaring double-crested cormorants from an area where damage is occurring or where damage could occur. Those methods that elicit a fright response from double-crested cormorants are also likely to elicit a similar response from non-target animals. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal or the ability of a non-target animal to survive, especially if the exposure to the stressor is chronic. In addition, the presence of WS' personnel conducting activities at a location could elicit a fright response from a non-target animal. For example, if WS' personnel were conducting activities within a nesting colony of double-crested cormorants, the presence of WS' personnel and the activities those personnel conduct could result in the disturbance of other nesting colonial waterbirds when they nest in the same locations as double-crested cormorants.

The use of non-lethal methods would be similar to WS' use of non-lethal methods if WS implemented Alternative 2. If WS implemented Alternative 1, the direct effects on non-target animals associated with WS' use of non-lethal methods would be identical to those direct effects discussed if WS implemented Alternative 2. To limit redundancy, a discussion on the potential direct effects associated with the use of non-lethal methods does not occur for Alternative 1 because those potential effects would be similar to those direct effects discussed for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1.

WS could also use firearms if WS implements Alternative 1. Although WS could use firearms to take double-crested cormorants, the noise produced when using a firearm can also elicit a fright response in double-crested cormorants and non-target animals. Some non-lethal methods mimic the noise produced by a firearm, such as propane cannons, and the noise produced by non-lethal methods (*e.g.*, pyrotechnics) would likely cause a similar flight response to the noise produced by a firearm. Therefore, if WS implements Alternative 1, the use of a firearm by WS' personnel would elicit a similar flight response to the response from using other non-lethal methods that use noise as a negative stimulus. To limit redundancy, a discussion on the potential direct effects associated with the noise produced when using a firearm does not occur for Alternative 1 because those potential effects would be similar to those effects discussed for Alternative 2 but those potential effects could possibly occur if WS' implemented Alternative 1.

Another common concern would be the direct effects of WS' personnel conducting activities within a colony of nesting double-crested cormorants, which could disturb other co-nesting colonial waterbirds. Activities within a nesting colony of double-crested cormorants would primarily be associated with requests for assistance with discouraging double-crested cormorants from nesting at a location to prevent or limit the loss of vegetation from accumulations of fecal droppings and the nesting behavior of double-crested cormorants (see Section 1.4.5). If other colonial waterbirds are also nesting at the location or nearby, WS' personnel could disturb those waterbirds while conducting activities within the nesting colony of double-crested cormorants or as personnel approach a nesting colony of double-crested cormorants. Jackson and Jackson (1995) noted that most nesting colonies of double-crested cormorants in Arkansas, west Tennessee, Louisiana, and Mississippi were associated with "*various heron species*". At two nesting locations in Mississippi, Reinhold et al. (1998) found nesting double-crested cormorants interspersed within a nesting colony of anhingas, great blue herons, and great egrets.

If adults of co-nesting species are startled from their nest for too long or at the wrong time of day, there is the potential for increased mortality rates of eggs and chicks. However, in most instances, co-nesting birds may temporarily leave the immediate vicinity of scaring, but usually return after conclusion of the action. Moore et al. (2005) evaluated the impact on co-nesting great blue herons and great egrets on Lake Ontario from activities to remove double-crested cormorants. For both great blue herons and great egrets, there was no impact on the proportion of time that great blue herons and great egrets spent attending nests between control and treatment sites for the interval prior to the removal of double-crested cormorants, the intervals between double-crested cormorant removal efforts, and the period after double-crested cormorant removal was completed. However, nest attendance by great blue herons and great egrets declined for both species during double-crested cormorant removal periods (35±20 min). Great blue herons disturbed during the removal of double-crested cormorants returned to the nest in 11 to 14 minutes (longest unattended=50±30 min) and all egrets returned to nests before the removal of double-crested cormorants had ended (longest unattended=6±4 min). In addition, there was no difference in the nest success of great blue herons or great egrets between treated and untreated sites.

A study of common tern response to activities and research disturbance conducted on an island within Lake Oneida in New York, found that the greatest levels of disturbance in the common tern colony were from human activities within the colony (Mattison 2006). Disturbance of common terns included researchers monitoring common tern reproduction, the banding of birds within the colony, and from activities to install Mylar tape on one side of the island to deter double-crested cormorants from nesting at the location. However, the Mylar tape itself did not appear to be particularly alarming to the common terns. Noise disturbance from other locations on the lake including that from the use of pyrotechnics was less disruptive than visits to the colony, and birds appeared to acclimate to the use of the devices quickly and some pyrotechnics appeared to be less disruptive to terns than other types of pyrotechnics. Terns did not leave nests when using pyrotechnics that produce a loud bang after firing when using those pyrotechnics within observable distance of the colony. The common terns did lift off nests in three of the seven instances when using pyrotechnics that produce a whistling noise after firing when using those types of pyrotechnics from similar distances of the common tern colony.

At nesting colonies that support a high number of co-nesting gulls, predation by gulls has become an increasing concern when conducting activities associated with double-crested cormorants at those colonies. Human activities including research, population surveys, and activities to disperse or remove double-crested cormorant that cause adult birds to leave their nests create opportunities for gulls to prey on eggs and chicks of other gulls and co-nesting species (Kury and Gochfeld 1975, Ellison and Cleary 1978, DesGranges and Reed 1981, Duerr et al. 2007). Modeling by Wyman et al. (2018) found that colony growth of herring gulls and ring-billed gulls responded positively to double-crested cormorant abundance and to activities to manage double-crested cormorants. In Mississippi, laughing gulls are the only gull species known to nest within the state with nesting colonies only occurring along the coastal areas of the state (Turcotte and Watts 1999). Nesting double-crested cormorants in Mississippi have only been associated with anhingas, great blue herons, and great egrets (Jackson and Jackson 1995, Reinhold et al. 1998).

In the Great Lakes, Wyman et al. (2018) found that colony growth of great blue herons co-nesting with double-crested cormorants showed little response to double-crested cormorant abundance and activities to manage co-nesting double-crested cormorants. However, Wyman et al. (2018) found the growth of black-crowned night-heron colonies responded negatively to both increasing double-crested cormorants co-nesting at a location and from activities associated with managing double-crested cormorants at a location. Black-crowned night-herons do nest in Mississippi (Hothem et al. 2010).

If WS implements Alternative 1, WS would consider potential effects to other colonial waterbirds when conducting activities to manage a colony of nesting double-crested cormorants. WS could implement measures to minimize disturbance to other co-nesting species, such as conducting activities at night to reduce the likelihood that co-nesting species would move off nests. For example, Duerr et al. (2007) found that gulls did not prey on double-crested cormorant eggs when egg oiling occurred at night. WS could also minimize the number of site visits to limit disturbance or conduct activities to manage double-crested cormorants at a nesting colony later in the nesting season when other species have eggs and nestlings and are less likely to leave their young. In addition, WS could maintain sufficient distance from other co-nesting waterbirds to prevent or reduce incidences of adults flushing from nests or use suppressed firearms to minimize noise disturbance.

- *Analysis of Risks to Threatened and Endangered Species*

WS would make special efforts to avoid jeopardizing threatened or endangered species through biological evaluations of potential effects and the establishment of special restrictions or minimization measures through consultation with the USFWS and/or the National Marine Fisheries Service. The ESA states that all federal agencies *"...shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act"* [Sec. 7(a)(1)]. WS conducts consultations with the USFWS and/or the National Marine Fisheries Services pursuant to Section 7 of the ESA to ensure compliance. The WS program also conducts consultations to ensure that *"any action authorized, funded or carried out by such an agency...is not likely to jeopardize the continued existence of any endangered or threatened species…Each agency shall use the best scientific and commercial data available"* [Sec. 7(a)(2)].

Because double-crested cormorants may occur statewide in Mississippi throughout the year and WS could conduct activities to manage damage caused by double-crested cormorants when an entity requests such assistance, WS could conduct activities to manage damage in areas where threatened or endangered species occur. However, no take of threatened or endangered species by WS has occurred previously in the state during the implementation of activities and the use of methods to manage the damage that double-crested cormorants cause. During the development of this EA, WS reviewed the current list of species designated as threatened or endangered in Mississippi as determined by the USFWS and the National Marine Fisheries Service. WS conducted a review of potential impacts of implementing Alternative 1 on each of those species listed in Table 3.1. The evaluation took into consideration the direct and indirect effects of implementing Alternative 1 to alleviate damage caused by double-crested cormorants. WS reviewed the status, critical habitats designations, and current known locations of those species identified in Table 3.1. As part of the review process, WS prepared and submitted a biological evaluation to the USFWS as part of the consultation process pursuant to Section 7 of the ESA.

Based on the use pattern of the methods and the locations where WS could implement damage management activities, the implementation of Alternative 1 would have no effect on those threatened or endangered species in Mississippi under the jurisdiction of the National Marine Fisheries Service, including any designated critical habitat. In addition, WS has made a no effect determination for several species currently listed in the state based on those methods currently available and based on current life history information for those species (see Table 3.1). For several species listed within the state, WS has determined that the proposed activities "*may affect*" those species but those effects would be solely beneficial, insignificant, or discountable, which would warrant a "*not likely to adversely affect*" determination. Based on those determinations, WS initiated informal consultation with the USFWS for those species that a "*may affect, not likely to adversely affect*" determination was made (see Table 3.1).

The USFWS concurred with WS' determination that activities conducted pursuant to the proposed action would not likely adversely affect those species (S. Ricks, USFWS, pers. comm. 2018).

Wood storks occur seasonally in Mississippi during the non-breeding season, which is generally from June through December. Foraging sites associated with wood storks include freshwater marshes, swales, ponds, hardwood and cypress swamps, tidal creeks and pools, and artificial wetlands (*e.g.*, stock ponds; shallow, seasonally flooded roadside or agricultural ditches; and impoundments). Wood storks could use aquatic habitats in areas where double-crested cormorant occur, especially areas where double-crested cormorants roost. To ensure activities would not likely adversely affect the status of wood storks in the state, WS would conduct activities more than 1,000 feet from active wood stork roost sites and more than 750 feet from feeding wood storks in Mississippi.

Table 3.1 – Federal list of threatened or endangered species in Mississippi

Common Name	Scientific Name	Status†	Determination‡
Animals			
Invertebrates			
Alabama Heelsplitter	*Potamilus inflatus*	T	MANLAA
Black Clubshell	*Pleurobema curtum*	E	NE
Ovate Clubshell	*Pleurobema perovatum*	E	MANLAA
Oyster Mussel	*Epioblasma capsaeformis*	E	NE
Southern Clubshell	*Pleurobema decisum*	E	MANLAA
Cumberlandian Combshell	*Epioblasma brevidens*	E	NE
Southern Combshell	*Epioblasma penita*	E	MANLAA
Fat Pocketbook	*Potamilus capax*	E	MANLAA
Rabbitsfoot	*Quadrula cylindrica cylindrica*	T	MANLAA
Alabama Moccasinshell	*Medionidus acutissimus*	T	MANLAA
Orangenacre Mucket	*Lampsilis perovalis*	T	MANLAA
Sheepnose Mussel	*Plethobasus cyphyus*	E	MANLAA
Snuffbox Mussel	*Epioblasma triquetra*	E	NE
Heavy Pigtoe	*Pleurobema taitianum*	E	NE
Slabside Pearlymussel	*Pleuronaia dolabelloides*	E	NE
Mitchell's Satyr Butterfly	*Neonympha mitchellii mitchellii*	E	NE
Reptiles			
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	NE
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	NE
Leatherback Sea Turtle	*Dermochelys coriacea*	E	NE
Loggerhead Sea Turtle	*Caretta caretta*	T	NE
Gopher Tortoise	*Gopherus polyphemus*	T	NE
Ringed Map Turtle	*Graptemys oculifera*	T	MANLAA
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	T	MANLAA
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	E	MANLAA
Black Pine Snake	*Pituophis melanoleucus lodingi*	T	NE
Amphibian			
Dusky Gopher Frog	*Rana sevosa*	E	NE
Fish			
Atlantic Sturgeon	*Acipenser oxyrinchus desotoi*	T	NE
Pallid Sturgeon	*Scaphirhynchus albus*	E	NE
Pearl Darter	*Percina aurora*	T	MANLAA

Snail Darter	*Percina tanasi*	T	NE
Bayou Darter	*Etheostoma rubrum*	T	NE
Mammals			
West Indian Manatee	*Trichechus manatus*	T	NE
Gray Bat	*Myotis grisescens*	E	NE
Indiana Bat	*Myotis sodalist*	E	NE
Northern Long-eared Bat	*Myotis septentrionalis*	T	MANLAA
Birds			
Piping Plover	*Charadrius melodus*	T	MANLAA
Least Tern	*Sterna antillarum*	E	MANLAA
Red-cockaded Woodpecker	*Picoides borealis*	E	NE
Mississippi Sandhill Crane	*Grus canadensis pulla*	E	MANLAA
Wood Stork	*Mycteria americana*	T	MANLAA
Red Knot	*Calidris canutus rufa*	T	NE
Plants			
Price's Potato-bean	*Apios priceana*	T	NE
Louisiana Quillwort	*Isoetes louisianensis*	E	NE
Pondberry	*Lindera melissifolia*	E	NE
White Fringeless Orchid	*Platanthera integrilabia*	T	NE

†T=Threatened; E=Endangered

‡NE=No effect; MANLAA=May affect, not likely to adversely affect

The USFWS has also designated critical habitat in Mississippi for some of the species listed as threatened or endangered. Table 3.2 provides a list of those species with critical habitat designated in Mississippi along with WS' effects determination. WS' based the effects determinations on a review of the activities that WS could conduct if WS implemented Alternative 1. The USFWS concurred with WS' effects determination for critical habitats designated in Mississippi (S. Ricks, USFWS pers. comm. 2018). WS would continue to review the species listed as threatened or endangered by the USFWS and the National Marine Fisheries Service and would continue to consult with the USFWS and/or the National Marine Fisheries Service, as appropriate.

Table 3.2 – Critical habitats designated in Mississippi

Common Name	Scientific Name	Status†	Determination‡
Animals			
Invertebrates			
Alabama Moccasinshell	*Medionidus acutissimus*	CH	NE
Cumberlandian Combshell	*Epioblasma brevidens*	CH	NE
Orangenacre Mucket	*Lampsilis perovalis*	CH	NE
Ovate Clubshell	*Pleurobema perovatum*	CH	NE
Oyster Mussel	*Epioblasma capsaeformis*	CH	NE
Rabbitsfoot	*Quadrula cylindrica cylindrica*	CH	NE
Slabside Pearlymussel	*Pleuronaia dolabelloides*	CH	NE
Southern Clubshell	*Pleurobema decisum*	CH	NE
Fish			
Atlantic Sturgeon	*Acipenser oxyrinchus desotoi*	CH	NE
Amphibian			
Dusky Gopher Frog	*Rana sevosa*	CH	NE
Reptile			

Common Name	Scientific Name	Status†	Determination‡
Loggerhead Sea Turtle	*Caretta caretta*	CH	NE
Bird			
Mississippi Sandhill Crane	*Grus canadensis pulla*	CH	NE
Piping Plover	*Charadrius melodus*	CH	NE

Appendix C shows those species designated by the MDWFP as threatened or endangered within the state. The WS program in Mississippi has also reviewed the list of species the MDWFP has designated as threatened or endangered. Based on the review of species listed in the state, WS has determined that the proposed activities would have no effect on those species currently listed as threatened or endangered by the MDWFP. WS would continue to review the species listed as threatened or endangered by the MDWFP. As appropriate, the WS program would consult with the MDWFP when WS determines activities may affect a threatened or endangered species designated by the MDWFP.

Indirect effects on non-target animal populations associated with implementing Alternative 1

The WS program in Mississippi does not anticipate any indirect effects on non-target animal populations if the WS program implemented Alternative 1. Personnel of WS use a decision making process for evaluating and responding to requests for assistance detailed in the WS Decision Model (see WS Directive 2.201), which Slate et al. (1992) describes in more detail. As part of that decision making process, employees of WS would consider the methods available and their potential to disperse or kill non-target animals based on the use pattern of the method. The WS program does not attempt to eradicate any species of native wildlife in the state. WS operates in accordance with applicable federal and state laws and regulations enacted to ensure species viability. WS' personnel have experience and receive training in wildlife identification, which allows them to identify individual species and to identify damage or recognize damage threats associated with animals, including double-crested cormorants. WS' employees also have knowledge in the use patterns of methods available to resolve animal damage, which allows them to select the most appropriate method(s) to address animal damage and minimize impacts on non-target species.

In addition, WS operates on a small percentage of the land area in Mississippi and would only target double-crested cormorants identified as causing damage or posing a threat of damage. Between FY 2013 and FY 2017, WS conducted activities associated with double-crested cormorants on 0.4% of the total land area of the state annually. Therefore, if WS implements Alternative 1, the activities would not have any indirect effects on the populations of non-target animals in the state.

Cumulative effects on non-target animal populations associated with implementing Alternative 1

As discussed previously, the unintentional lethal removal of non-target animals has not occurred by WS during activities targeting double-crested cormorants except for the unintentional removal of one neotropic cormorant during FY 2007 and two neotropic cormorants during FY 2018. In addition, personnel with the NWRC lethally removed one neotropic cormorant during FY 2008 in Mississippi. Neotropic cormorants and anhingas have a similar appearance to double-crested cormorants. In addition, neotropic cormorants and anhingas utilize the same habitats as double-crested cormorants and they can intermix with double-crested cormorants. Therefore, there is potential for misidentification of neotropic cormorants and anhingas to occur. An analysis of the cumulative effects on the populations of neotropic cormorants and anhingas associated with implementing Alternative 1 occurs below for each species.

➢ *Neotropic Cormorant Population Impact Analysis*

Despite the similarity in appearance, WS anticipates the likelihood of unintentionally removing a neotropic cormorant to be low because neotropic cormorants infrequently occur in the state, especially inland from the coast. Despite opportunistic and targeted surveys of known and suspected colonial waterbird roosts, breeding colonies, and aquaculture facilities in the Mississippi Delta region of Mississippi from late February through August, Hanson et al. (2010) only observed an average of four neotropic cormorants per year in the Mississippi Delta region from 2003 through 2008.

However, if the occurrence of neotropic cormorants in Mississippi continues to increase, the likelihood of WS' personnel encountering a neotropic cormorant during the implementation of Alternative 1 would also likely increase. In addition, the WS program in Mississippi may occasionally lethally remove neotropic cormorants intentionally to alleviate damage or threats of damage. For example, if neotropic cormorants pose a risk to aircraft at an airport or military facility, WS could intentionally target neotropic cormorants to reduce risks of an aircraft striking a neotropic cormorant. WS anticipates the unintentional take of neotropic cormorants to continue to occur infrequently with the intentional and unintentional take of neotropic cormorants not exceeding five neotropic cormorants per year. Therefore, cumulatively, WS would not take more than five neotropic cormorants per year across all activities. A separate EA will address the intentional take of neotropic cormorants in Mississippi by WS. This EA discusses those activities to ensure a cumulative analysis occurs.

Although unintentional take of neotropic cormorants has occurred by WS and the NWRC in Mississippi, take has occurred infrequently and involved only a few individual neotropic cormorants. Similarly, WS anticipates the need to take neotropic cormorants intentionally to occur infrequently. From FY 2013 through FY 2017, no intentional take of neotropic cormorants occurred by WS in Mississippi. Therefore, the cumulative take of five neotropic cormorants annually is unlikely, and the actual take of five neotropic cormorants in any given year is likely to occur infrequently. The neotropic cormorant population appears to be increasing, including an increasing trend in the United States (Telfair and Morrison 2005, National Audubon Society 2010, BirdLife International 2018*b*). Their occurrence in Mississippi also appears to be increasing (Hanson et al. 2010). The International Union for Conservation of Nature and Natural Resources ranks the neotropic cormorant as a species of "*least concern*" (BirdLife International 2018*b*). The International Union for Conservation of Nature and Natural Resources assigned the ranking based on the "*species…extremely large range…*", "*the population trend appears to be increasing*", and "*…the population size is extremely large…*" (BirdLife International 2018*b*). Across the entire range of the neotropic cormorant, BirdLife International (2018*b*) estimated the population to be 2 million neotropic cormorants. Hunter et al. (2006) estimated the breeding population of neotropic cormorants in the southeastern United States to be 8,000 breeding pairs, which equates to 16,000 breeding adults and does not include non-breeding neotropic cormorants.

The lethal removal of up to five neotropic cormorants by the WS program in Mississippi would represent 0.03% of the estimated 16,000 breeding adult neotropic cormorants in the southeastern United States. Therefore, the take of up to five neotropic cormorants by WS would not occur at a frequency and/or intensity that would likely adversely affect the neotropic cormorant population in the southeastern United States. WS would continue to report all take of neotropic cormorants to the USFWS; therefore, the USFWS would have the opportunity to consider any take by WS when establishing population objectives for this species.

➢ *Anhinga Population Impact Analysis*

The distribution of the anhinga is similar to the distribution of the neotropic cormorant but anhingas appear to be more widespread in the southern United States. Anhingas occur throughout the year in South

America, Central America, and the Caribbean Islands. In the United States, anhingas occur throughout the year along the coastal areas of the Gulf of Mexico from Texas to Florida and northward along the coast of the Atlantic Ocean from Florida to southern South Carolina. Breeding colonies of anhingas also occur further inland as far north as Oklahoma and Tennessee and further north along the coast of the Atlantic Ocean to southern North Carolina (Frederick and Siegel-Causey 2000). Anhingas nest in southern Mississippi and locally along the Mississippi River with anhingas being present throughout the year along the coastal areas of the state (Frederick and Siegel-Causey 2000). Turcotte and Watts (1999) indicated anhingas are a "*locally common, breeding summer resident*" in the state and a "*rare winter resident*". In Mississippi, most anhingas have left the state by the end of October as they migrate to their wintering areas and return to the state to nest during March and April (Turcotte and Watts 1999).

Most activities associated with double-crested cormorants in the state occur during those winter months when most anhingas have left the state. However, anhingas can occasional occur in mixed-species flocks with double-crested cormorants at roosts (Frederick and Siegel-Causey 2000). Frederick and Siegel-Causey (2000) stated, "*Cormorants (Phalacrocorax spp.) are somewhat similar in structure, plumage, and behavior, but Anhingas are readily distinguished by much longer neck; longer, more pointed bill (lacking the distinct terminal hook found in cormorants); and longer tail*". Although the general appearance of anhingas is similar to double-crested cormorants, the unintentional take of anhingas has not occurred previously by WS in Mississippi. WS anticipates the likelihood of removing an anhinga unintentionally to be extremely low. Therefore, WS anticipates the unintentional take of anhinga to occur infrequently. If WS implements Alternative 1, WS anticipates the unintentional take of anhingas would not exceed two anhingas per year. Therefore, the cumulative take of two anhingas annually by WS is unlikely, and the actual take of two anhingas in any given year is likely to occur infrequently.

Across all routes surveyed during the BBS, the number of anhingas observed has increased 1.71% annually from 1966 through 2015 and 5.68% annually from 2005 through 2015 (Sauer et al. 2017). In Mississippi, the number of anhingas observed along routes in the state during the BBS has increased 8.76% annually from 1966 through 2015 with a 19.82% annual increase occurring from 2005 through 2015 (Sauer et al. 2017). Similarly, the number of anhingas observed in areas of the state surveyed during the CBC has shown a general increasing trend since 1966 (National Audubon Society 2010). Hunter et al. (2006) considered the general population of anhingas in the southeastern United States to be stable. Hunter et al. (2006) recommended maintaining 10,000 to 50,000 breeding pairs of anhingas in the southeastern United States.

Information on the number of anhingas occurring in Mississippi is not available. Hunter et al. (2006) estimated the breeding population of anhingas in the southeastern United States to be 10,000 pairs or 20,000 breeding adults, which would not include non-breeding anhingas that are also present in the population. In the Mississippi Alluvial Valley[7], Hunter et al. (2006) estimated the breeding population of anhingas to be 1,100 pairs, which equates to 2,200 breeding adults. An estimate of the anhinga population across their range is currently not available, but the overall population appears to be decreasing despite the increasing trends occurring in North America (BirdLife International 2016). However, the International Union for Conservation of Nature and Natural Resources ranks the anhinga as a species of "*least concern*" (BirdLife International 2016). The International Union for Conservation of Nature and Natural Resources assigned the ranking based on the "*species…extremely large range*…" and "*the decline is not believed to be sufficiently rapid*" (BirdLife International 2016).

[7]The Mississippi Alluvial Valley region includes the floodplain of the Mississippi River that extends from southern Missouri and western Kentucky southward into Arkansas, Tennessee, Louisiana, and Mississippi. The Mississippi Delta region is part of the Mississippi Alluvial Valley.

The lethal removal of up to two anhingas annually by the WS program in Mississippi would represent 0.1% of the estimated 2,200 breeding adults in the Mississippi Alluvial Valley. Therefore, the take of up to two anhingas annually by WS would not occur at a frequency and/or intensity that would likely adversely affect the anhinga population in the Mississippi Alluvial Valley. WS would report any take of anhingas to the USFWS; therefore, the USFWS would have the opportunity to consider any take by WS when establishing population objectives for this species.

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

Implementation of this alternative would require the WS program to only recommend and use non-lethal methods to manage and prevent damage associated with double-crested cormorants. WS would provide technical assistance and direct operational assistance by recommending and/or using only non-lethal methods. Using the WS Decision Model, WS' personnel would consider the potential effects to non-target animals from the potential use of non-lethal methods.

DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS ON NON-TARGET POPULATIONS

If WS implemented Alternative 2, of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal, or the ability of a non-target animal to survive, especially if the exposure to the stressor were chronic. The stress caused during the use of non-lethal methods could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs.

As shown in Figure 4.2, the WS program in Mississippi has used non-lethal methods to disperse double-crested cormorants previously. From FY 2013 through FY 2017, WS has dispersed an average of 73,117 double-crested cormorants per year to alleviate damage or threats of damage, primarily to disperse double-crested cormorants from night roosts near aquaculture facilities. The number of double-crested cormorants hazed per year in Mississippi by WS has ranged from 35,210 to 139,027 double-crested cormorants. WS' personnel primarily dispersed double-crested cormorants using pyrotechnics and the noise associated with discharging a firearm along with the presence and noise associated with the use boats or other vehicles.

Direct effects on non-target animal populations associated with implementing Alternative 2

Non-lethal methods have the potential to cause adverse effects to non-target animals primarily through live-capture, exclusion, and dispersal. Live-capture methods (*e.g.*, padded foothold traps, nets) would restrain double-crested cormorants once captured. When using padded foothold traps, trap placement in areas where double-crested cormorants were active, such as at a double-crested cormorant nest, would minimize the capture of non-target animals. When using live-capture methods, WS' personnel would be present on site to monitor and address double-crested cormorants live-captured; therefore, WS' personnel could release any non-target animals captured unharmed or could prevent non-target from being captured. Any exclusionary device erected to prevent access by double-crested cormorants also potentially excludes species that were not the primary reason for erecting the exclusion; therefore, exclusion methods potentially could adversely affect non-target species if the area excluded was large enough. However, WS and other entities would not use exclusion methods over such a large geographical areas or apply those methods at such intensity that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations. Similarly, WS and other entities would not use those methods over such a wide geographical scope that long-term adverse effects would occur to a species' population.

Non-lethal methods that use auditory and visual stimuli to reduce or prevent damage elicit fright responses in animals. The use of auditory and visual dispersal methods to reduce damage or threats caused by double-crested cormorants would also likely disperse non-target animals in the immediate area the methods were employed. Therefore, non-target animals may disperse permanently from an area while employing non-lethal dispersal techniques. However, like target species, the potential impacts on non-target species would likely be temporary with target and non-target species often returning after the cessation of dispersal methods. In addition, for effects to occur from the use of auditory and visual stimuli a non-target animal would have to see or be within hearing distance at the time a WS' personnel used an auditory or visual stimuli method and the resulting noise or visual stimuli would have to elicit a negative response. Similarly, when using a boat or another vehicle, a non-target animal would have to be present as the boat or vehicle passed and the presence of the boat or vehicle would have to elicit a negative response.

➢ *Potential effects of implementing Alternative 2 on eagles and wood storks*

Bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), and wood storks use similar habitats as double-crested cormorants and those bird species may be present in areas where double-crested cormorants occur, especially near double-crested cormorant roosting areas and near aquaculture facilities. As discussed previously, the USFWS lists wood storks as a threatened species pursuant to the ESA. WS consulted with the USFWS pursuant to Section 7 of the ESA, which included the use of those non-lethal methods that WS could use if WS implemented Alternative 2. To ensure activities would not likely adversely affect the status of wood storks in the state, WS would conduct activities more than 1,000 feet from active wood stork roost sites and more than 750 feet from feeding wood storks in Mississippi similar to Alternative 1.

The Bald and Golden Eagle Protection Act and the MBTA protect the bald eagle and the golden eagle from a variety of harmful actions and impacts. Under the Bald and Golden Eagle Protection Act (16 USC 668-668c), the take of bald eagles and golden eagles is prohibited without a permit from the USFWS. Under the Bald and Golden Eagle Protection Act, the definition of "*take*" includes actions that may "*disturb*" eagles. Disturb has been defined under 50 CFR 22.3 as those actions that cause, or are likely to cause, injury to an eagle, a decrease in productivity, or nest abandonment by substantially interfering with their normal breeding, feeding, or sheltering behavior.

The USFWS developed national bald eagle management guidelines to advise people of when and under what circumstances the protective provisions of the Bald and Golden Eagle Protection Act may apply to their activities (see USFWS 2007). A variety of human activities can potentially interfere with bald eagles and golden eagles, affecting their ability to forage, nest, roost, breed, or raise young. The USFWS developed the bald eagle management guidelines to help people minimize such impacts to eagles, particularly where they may constitute "*disturbance*".

In Mississippi, bald eagles may occur statewide throughout the year (Buehler 2000). In the southeastern United States, bald eagles may build nests from September through February and egg laying, incubation, hatching, and young rearing may occur from early October through the end of April. Fledging young may be present at or near nests from late January through the end of May (USFWS 2007). The breeding range of golden eagles occurs mainly in western North America from Alaska to central Mexico with small numbers breeding in northeastern Canada and isolated breeding pairs occurring in the eastern United States (Kochert et al. 2002). The winter range of golden eagles is similar to their breeding range, but golden eagles also occur locally throughout the eastern United States, including Mississippi, during the migration and winter (Kochert et al. 2002). Kochert et al. (2002) indicated that golden eagles are "*scarce*" in Mississippi during the non-breeding season. Turcotte and Watts (1999) described golden eagles as "*occasional winter visitors*" in Mississippi.

WS would only conduct limited activities near active eagle nests and Important Eagle Use Areas[8] in accordance with the National Bald Eagle Management Guidelines (USFWS 2007). The categories from the guidelines that would encompass most of these activities are Category D (off-road vehicle use), Category E (motorized watercraft use), Category F (non-motorized recreation and human entry), and Category H (blasting and other loud, intermittent noises). Those categories generally call for a buffer of 330 to 660 feet around active nests for Category D, Category E, and Category F activities, and a half mile buffer for Category H activities. Although similar guidelines do not exist for golden eagles, WS would apply those guidelines when encountering golden eagles. In addition, golden eagles do not nest in Mississippi but may be present during the migration periods and during the winter. WS does not expect non-lethal hazing activities to agitate or bother a bald eagle or golden eagle to a degree that causes, or is likely to cause, a decrease in its productivity or cause nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. WS based this determination on its adherence to the national bald eagle management guidelines (see USFWS 2007).

➢ *Potential effects of aerial overflights on non-target species*

An issue that has arisen is the potential for low-level flights to disturb wildlife, including threatened and endangered species. Aerial operations could be an important method for surveying, monitoring, and tracking double-crested cormorants in Mississippi. Aircraft play an important role in the management of various wildlife species for many agencies. Resource management agencies rely on low flying aircraft to monitor the status of many animal populations, including large mammals (Lancia et al. 2000), birds of prey (Fuller and Mosher 1987), waterfowl (Bellrose 1976), and colonial waterbirds (Speich 1986). Low-level flights also occur when entities use aircraft to track animal movements by radio telemetry (Gilmer et al. 1981, Samuel and Fuller 1996).

A number of studies have looked at responses of various wildlife species to aircraft overflights. The National Park Service (1995) reviewed the effects of aircraft overflights on wildlife and suggested that adverse effects could occur to certain species. Some species will frequently or at least occasionally show an adverse response to even minor overflights. In general though, it appears that the more serious potential adverse effects occur when overflights are chronic (*i.e*., they occur daily or more often over long periods). Chronic exposures generally involve areas near commercial airports and military flight training facilities. Aerial operations conducted by WS rarely occur in the same areas on a daily basis, and aircraft used by WS actually spend little time flying over those particular areas.

The effects on wildlife from military-type aircraft have been studied extensively (Air National Guard 1997), and were found to have no expected adverse effects on wildlife. Examples of species or species groups that people have studied with regard to the issue of aircraft-generated disturbance are as follows:

WATERBIRDS AND WATERFOWL: Low-level overflights of two to three minutes in duration by a fixed-wing airplane and a helicopter produced no "*drastic*" disturbance of tree-nesting colonial waterbirds, and, in 90% of the observations, the individual birds either showed no reaction or merely looked up (Kushlan 1979). Belanger and Bedard (1989, 1990) observed responses of greater snow geese (*Chen caerulescens atlantica*) to human disturbance on a sanctuary area and estimated the energetic cost of such disturbance. Belanger and Bedard (1989, 1990) observed that disturbance rates exceeding two per hour reduced goose use of the sanctuary by 50% the following day. They also observed that about 40% of the disturbances caused interruptions in feeding that would require an estimated 32% increase in

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[8]Pursuant to 50 CFR 22.3, the definition of an Important Eagle-use Area is "…*an eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles*."

nighttime feeding to compensate for the energy lost. They concluded that managers should strictly regulate overflights of sanctuary areas to avoid adverse effects. Conomy et al. (1998) quantified behavioral responses of wintering American black ducks (*Anas rubripes*), American wigeon (*Mareca americana*), gadwall (*M. strepera*), and American green-winged teal (*A. crecca carolinensis*) exposed to low-level military aircraft and found that only a small percentage (2%) of the birds reacted to the disturbance. They concluded that such disturbance was not adversely affecting the daily activities of the species. Thus, there is little to no potential for any adverse effects on waterbirds and waterfowl.

RAPTORS: The Air National Guard analyzed and summarized the effects of overflight studies conducted by numerous federal and state government agencies and private organizations (Air National Guard 1997). Those studies determined that military aircraft noise initially startled raptors, but negative responses were brief and did not have an observed effect on productivity (see Ellis 1981, Fraser et al. 1985, Lamp 1989, United States Forest Service 1992 as cited in Air National Guard 1997). A study conducted on the impacts of overflights to bald eagles suggested that the eagles were not sensitive to this type of disturbance (Fraser et al. 1985). During the study, observations were made of more than 850 overflights of active eagle nests. Only two eagles rose out of either their incubation or brooding postures. This study also showed that perched adults were flushed only 10% of the time during aircraft overflights. Evidence also suggested that golden eagles were not highly sensitive to noise or other aircraft disturbances (Ellis 1981, Holthuijzen et al. 1990). Finally, one other study found that eagles were particularly resistant to disturbances flushing them from their nests (see Awbrey and Bowles 1990 as cited in Air National Guard 1997). Therefore, there is considerable evidence that overflights during aerial operations would not adversely affect eagles.

Mexican spotted owls (*Strix occidentalis lucida*) (Delaney et al. 1999) did not flush when chain saws and helicopters were greater than 110 yards away; however, owls flushed to these disturbances at closer distances and were more prone to flush from chain saws than helicopters. Owls returned to their pre-disturbance behavior 10 to 15 minutes following the event and researchers observed no differences in nest or nestling success (Delaney et al. 1999), which indicates that aircraft flights did not result in adverse effects on owl reproduction or survival.

Andersen et al. (1989) conducted low-level helicopter overflights directly at 35 red-tailed hawk (*Buteo jamaicensis*) nests and concluded their observations supported the hypothesis that red-tailed hawks habituate to low level flights during the nesting period because results showed similar nesting success between hawks subjected to overflights and those that were not. White and Thurow (1985) did not evaluate the effects of aircraft overflights, but found that ferruginous hawks (*B. regalis*) were sensitive to certain types of ground-based human disturbance to the point that reproductive success may be adversely affected. However, military jets that flew low over the study area during training exercises did not appear to bother the hawks, nor did the hawks become alarmed when the researchers flew within 100 feet in a small fixed-wing aircraft (White and Thurow 1985). White and Sherrod (1973) suggested that disturbance of raptors by aerial surveys with helicopters may be less than that caused by approaching nests on foot. Ellis (1981) reported that five species of hawks, two falcons (*Falco* spp.), and golden eagles were "*incredibly tolerant*" of overflights by military fighter jets, and observed that, although birds frequently exhibited alarm, negative responses were brief and the overflights never limited productivity.

Grubb et al. (2010) evaluated golden eagle response to civilian and military (Apache AH-64) helicopter flights in northern Utah. Study results indicated that golden eagles exposed to flights ranging from 100 to 800 meters along, towards, and from behind occupied cliff nests did not adversely affect eagle courtship, nesting, and fledglings, indicating that no special management restrictions were required in the study location.

The above studies indicate raptors were relatively unaffected by aircraft overflights, including those by military aircraft that produce much higher noise levels. Therefore, aerial operations would have little or no potential to affect raptors adversely.

PASSERINES: Reproductive losses have been reported in one study of small territorial passerines ("*perching*" birds that included sparrows, blackbirds) after exposure to low altitude overflights (see Manci et al. 1988 as cited in Air National Guard 1997), but natural mortality rates of both adults and young are high and variable for most species. The research review indicated passerine birds cannot be driven any great distance from a favored food source by a non-specific disturbance, such as military aircraft noise, which indicated quieter noise would have even less effect. Passerines avoid intermittent or unpredictable sources of disturbance more than predictable ones, but return rapidly to feed or roost once the disturbance ceases (Gladwin et al. 1988, United States Forest Service 1992). Those studies and reviews indicated there is little or no potential for aerial operations to cause adverse effects on passerine bird species.

DOMESTIC ANIMALS AND SMALL MAMMALS: A number of studies with laboratory animals (*e.g*., rodents [Borg 1979]) and domestic animals (*e.g*., sheep [Ames and Arehart 1972]) have demonstrated that they can habituate to noise. Long-term lab studies of small mammals exposed intermittently to high levels of noise demonstrate no changes in longevity. The physiological "*fight or flight*" response, while marked, does not appear to have any long-term health consequences on small mammals (Air National Guard 1997). Small mammals habituate, although with difficulty, to sound levels greater than 100 dbA (United States Forest Service 1992).

Information on the effects of aerial overflights demonstrates the relative tolerance most wildlife species have of overflights, even those that involve noise at high decibels, such as from military aircraft. In general, the greatest potential for impacts to occur exists when overflights are frequent, such as hourly and over many days that could represent "*chronic*" exposure. Chronic exposure situations generally involve areas near commercial airports and military flight training facilities. Even then, many wildlife species often habituate to overflights, which would naturally minimize any potential adverse effects where such flights occur on a regular basis. Therefore, aircraft used by WS should have far less potential to cause any disturbance to wildlife than military aircraft because the military aircraft produce much louder noise and would be flown over certain training areas many more times per year, and yet were found to have no expected adverse effects on wildlife (Air National Guard 1997).

WS would only conduct aerial activities on a very small percentage of the land area of the state, which indicates that WS would not even expose most wildlife to aerial overflights. Further lessening the potential for any adverse effects would be that such flights occur infrequently throughout the year.

Indirect effects on non-target animal populations associated with implementing Alternative 2

In general, the use of non-lethal methods to disperse, exclude, or capture double-crested cormorants from areas would have no effect on the populations of non-target animals because those methods generally would not occur with such frequency and would not occur at an intensity level that would cause adverse effects. Therefore, WS does not anticipate indirect effects to occur to any non-target species.

Cumulative effects on non-target animal populations associated with implementing Alternative 2

Based on the use pattern of methods and the activities that WS could conduct to manage damage or threats of damage caused by double-crested cormorants, WS does not anticipate cumulative effects to occur to any non-target species. Activities conducted by WS would not occur with such frequency and would not occur at an intensity level that would cause cumulative adverse effects. WS has received no reports or documented any cumulative effects associated with the use of non-lethal methods from previous activities associated with managing damage caused by double-crested cormorants in the state that WS conducted.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

If WS implements Alternative 3, the WS program in Mississippi would only provide technical assistance to those entities that request assistance from WS. Those persons requesting assistance could employ methods that WS' personnel recommend or could use equipment that WS' personnel loan to them. Using the WS Decision Model, WS' personnel would make recommendations based on information provided by the person requesting assistance or through site visits. Recommendations would include methods or techniques to minimize impacts on non-target animals associated with the methods that WS' personnel recommend or loan. Methods recommended could include non-lethal and lethal methods as deemed appropriate by the WS Decision Model and as permitted by laws and regulations.

DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS ON NON-TARGET POPULATIONS

If WS implements Alternative 3, direct, indirect, and cumulative effects on non-target animals could potentially occur from people that conduct activities based on the technical assistance provided by WS. In addition, those methods discussed in Appendix B would be available for use by those entities requesting assistance.

Direct effects on non-target animal populations associated with implementing Alternative 3

Under a technical assistance alternative, WS would have no direct impact on non-target species, including threatened or endangered species. The potential direct impacts to non-target animals from other entities conducting activities to alleviate damage would be variable and based on several factors. If people employed methods as recommended by WS, the potential impacts to non-target animals would likely be similar to Alternative 1. If people provided technical assistance did not use the recommended methods and techniques correctly or people used methods that WS did not recommend, the potential impacts on non-target species, including threatened or endangered species, would likely be higher when compared to Alternative 1.

The potential impacts of harassment and exclusion methods on non-target species would be similar to those described for Alternative 2. Harassment and exclusion methods would be easily obtainable and simple to employ. Because identification of targets would occur when employing shooting as a method, the potential impacts to non-target species would likely be low under this alternative. However, the knowledge and experience of the person could influence their ability to distinguish between double-crested cormorants and similar bird species correctly.

People experiencing damage from double-crested cormorants may implement methods and techniques based on the recommendations of WS. The knowledge and skill of those persons implementing recommended methods would determine the potential for impacts to occur. If those persons experiencing damage do not implement methods or techniques correctly, the potential impacts from providing only technical assistance could be greater than Alternative 1. The incorrect implementation of methods or techniques recommended by WS could lead to an increase in non-target animal removal when compared to the non-target animal removal that could occur by WS under Alternative 1.

If WS provided technical assistance to people but those people did not implement any of the recommended actions and conducted no further action, the potential to remove non-target animals would be lower when compared to Alternative 1. If those persons requesting assistance implemented recommended methods appropriately and as instructed or demonstrated, the potential impacts to non-target animals would be similar to Alternative 1. If WS made recommendations on the use of methods to alleviate damage but people did not implement those methods as recommended by WS or if people used those methods recommended by WS inappropriately, the potential for lethal removal of non-target animals would likely increase under a technical assistance only alternative. Therefore, the potential impacts to non-target animals, including threatened or endangered species, would be variable under a technical assistance only alternative. It is possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal killing of double-crested cormorants, which could lead to unknown effects on local non-target species populations, including some threatened or endangered species.

The ability to reduce negative effects caused by double-crested cormorants to wildlife species and their habitats, including threatened or endangered species, would be variable under this alternative. The skills and abilities of the person implementing damage management actions would determine the risks to non-target animals.

Indirect effects on non-target animal populations associated with implementing Alternative 3

Similar to Alternative 1 and Alternative 2, WS' personnel would continue to use the WS Decision Model to recommend methods appropriate to each request for assistance using information gathered during site visits and information provided by the entity requesting assistance. WS could recommend the use of any of the methods discussed in Appendix B when formulating a management strategy using the WS Decision Model. Therefore, if those entities receiving technical assistance from WS implement those methods to manage damage or threats of damage caused by double-crested cormorants, the indirect effects associated with implementing Alternative 3 would likely be similar to those indirect effects discussed for Alternative 1 and Alternative 2.

Cumulative effects on non-target animal populations associated with implementing Alternative 3

As discussed previously, if those entities receiving technical assistance from WS implement methods that WS' personnel recommend, the cumulative effects associated with implementing Alternative 3 would likely be similar to those cumulative effects discussed for Alternative 1 and Alternative 2. If WS made recommendations on the use of methods to alleviate damage but people did not implement those methods as recommended by WS or if people used those methods recommended by WS inappropriately, the potential for lethal removal of non-target animals would likely increase under a technical assistance only alternative. Therefore, the potential cumulative effects to non-target animals, including threatened or endangered species, could be higher than implementation of Alternative 1.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

If WS implements Alternative 4, the WS program would not provide any assistance with managing damage caused by double-crested cormorants in Mississippi. WS would refer all requests for assistance to the USFWS, the MDWFP, and/or private entities.

DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS ON NON-TARGET POPULATIONS

People could continue to conduct activities to alleviate damage or threats of damage caused by double-crested cormorants in the state. Therefore, direct, indirect, and cumulative effects on non-target animals could potentially occur from people that conduct activities. Those methods discussed in Appendix B would continue to be available for use by those entities experiencing damage or threats of damage caused by double-crested cormorants in the state.

Direct effects on non-target animal populations associated with implementing Alternative 4

Under this alternative, WS would not provide any assistance with managing damage caused by double-crested cormorants in the state. Therefore, no direct impacts to non-target animals or threatened and endangered species would occur by WS under this alternative. Risks to non-target animals and threatened and endangered species would continue to occur from those people who implement damage management activities on their own or through recommendations by other federal, state, and private entities. Although some risks could occur from those people that use methods in the absence of any involvement by WS, those risks would likely be low, and would be similar to those risks under the other alternatives.

The ability to reduce damage and threats of damage caused by double-crested cormorants would be variable based upon the skills and abilities of the person implementing damage management actions under this alternative. The risks to non-target animals and threatened and endangered species would be similar across the alternatives because those methods described in Appendix B would be available to use by people if WS implements this alternative. If people apply those methods available as intended, risks to non-target animals would be minimal to non-existent. If people apply those methods available incorrectly or apply those methods without knowledge of animal behavior, risks to non-target animals would be higher if WS implements this alternative. If frustration from the lack of available assistance causes those persons experiencing double-crested cormorant damage to take illegal action (Wires et al. 2001), risks to non-target animals could be higher if WS implements this alternative. Risks to non-target animals could be higher if WS implements this alternative because those entities would likely have no regard for potential impacts of their actions on non-target animals, such as disturbing non-target birds that nest in the same locations as double-crested cormorants.

Indirect effects on non-target animal populations associated with implementing Alternative 4

Entities other than WS would likely continue to conduct activities to alleviate damage or threats of damage caused by double-crested cormorants in the state despite the lack of assistance provided by WS. Those methods described in Appendix B would continue to be available for people to use when managing damage caused by double-crested cormorants. Therefore, if other entities continue to manage damage or threats of damage caused by double-crested cormorants, the indirect effects associated with implementing Alternative 4 would likely be similar to those indirect effects discussed for the other alternatives.

Cumulative effects on non-target animal populations associated with implementing Alternative 4

If those entities experiencing damage or threats of damage associated with double-crested cormorants conduct activities, the cumulative effects associated with implementing Alternative 4 would likely be similar to those cumulative effects that could occur if WS implemented one of the other alternatives.

3.2.3 Issue 3 - Effects of Damage Management Methods on Human Health and Safety

A common concern is the potential adverse effects methods available could have on human health and safety. An evaluation of the threats to human health and safety associated with methods available under the alternatives occurs below for each of the four alternatives carried forward for further analysis.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

If WS implements Alternative 1, WS' personnel would assess the damage or threat occurring, would evaluate the management methods available, and would formulate a management strategy to alleviate damage or reduce the risk of damage. A WS' employee would formulate a management strategy by selecting from those methods described in Appendix B that the employee determines to be practical for use. After formulating a management strategy, WS' personnel would provide technical assistance and/or direct operational assistance to the requester. When evaluating management methods and formulating a management strategy for each request for assistance, WS' employees would consider risks to human health and safety associated with methods.

WS' employees who conduct activities to alleviate double-crested cormorant damage would be knowledgeable in the use of methods, the wildlife species responsible for causing damage or threats, and WS' directives. WS' personnel would incorporate that knowledge into the decision-making process inherent with the WS' Decision Model, which they would apply when addressing threats and damage caused by double-crested cormorants. For example, WS' personnel would consider the location where activities could occur. Risks to human safety from the use of methods would likely be greater in highly populated urban areas in comparison to rural areas that are less densely populated. If WS' personnel conducted activities on rural private property, where the property owner or manager could control and monitor access to the property, the risks to human safety from the use of methods would likely be lower. If damage management activities occurred at or near public use areas, then risks of the public encountering damage management methods and the corresponding risk to human safety would increase. In general, WS' personnel would conduct activities when human activity was minimal (*e.g.*, early mornings, at night) or in areas where human activity was minimal (*e.g.*, in areas closed to the public).

WS' personnel receive training in the safe use of methods and would follow the safety and health guidelines required by WS' directives (*e.g.*, see WS Directive 2.601, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.625, WS Directive 2.627, WS Directive 2.630, WS Directive 2.635, WS Directive 2.640). For example, WS' employees would adhere to safety requirements and use appropriate personal protective equipment pursuant to WS Directive 2.601. In addition, WS' personnel would also follow WS Directive 2.635 that establishes guidelines and standard training requirement for health, safety, and personal protection from zoonotic diseases. When responding to oil spills and other hazardous materials operations, WS' personnel would follow WS Directive 2.640. When using watercraft, WS' employees would follow the guidelines in WS Directive 2.630. In addition, the WS use of methods would comply with applicable federal, state, and local laws and regulations (see WS Directive 2.210).

Before providing direct operational assistance, WS and the entity requesting assistance would sign a Memorandum of Understanding, work initiation document, or a similar document that would indicate the methods the cooperating entity agrees to allow WS to use on the property they own or property they manage. Thus, the cooperating entity would be aware of the methods that WS could use on property they own or manage, which would help identify any risks to human safety associated with the use of those methods. WS' personnel would also make the cooperator requesting assistance aware of threats to human safety associated with the use of methods.

Besides direct operational assistance, WS could also recommend methods to people when providing technical assistance. As described previously, technical assistance would consist of WS' personnel providing recommendations on methods the requester could use themselves to resolve damage or threats of damage without any direct involvement by WS. Technical assistance could also consist of occasionally providing methods to a requester that might have limited availability, such as propane cannons. If people receiving technical assistance use methods according to recommendations and as demonstrated by WS, the potential risks to human safety would be similar to those risks if WS' personnel were using those methods. If people use methods without guidance from WS or apply those methods inappropriately, the risks to human safety could increase. The extent of the increased risk would be unknown and variable. However, methods inherently pose minimal risks to human safety given the design and the extent of the use of those methods. If WS implements Alternative 1, risks to human health and safety associated with WS' personnel providing technical assistance would be identical to those risks discussed if WS implemented Alternative 3. A discussion of threats to human health and safety for the methods discussed in Appendix B occurs below.

- *Changes in cultural practices and exclusion methods*

Based on their use profile for alleviating damage associated with wildlife, WS considers risks to human safety associated with changes in cultural practices and exclusion methods to be low. The use of surface coverings, overhead lines/wires, and netting to exclude double-crested cormorants would not pose risks to human health and safety. Changes in cultural practices would involve altering aircraft flight patterns or modifying the designs of aquaculture facilities to reduce the threat of double-crested cormorant damage. Altering cultural practices would not pose a threat to human health and safety.

- *Auditory deterrents*

Auditory deterrents that WS could use and/or recommend would include alarm/distress calls, pyrotechnics, and propane cannons. Risks to human health and safety would primarily occur from the noise produced by those methods, such as hearing loss from repeated and/or prolonged exposure to the noise produced by those methods. Other risks could include fire risks and bodily harm associated with the use of pyrotechnics and propane cannons. Although hazards to human safety from the use of auditory deterrents do occur, those methods are generally safe when used by trained individuals who have experience in their use. For example, although some risk of fire and bodily harm exists from the use of pyrotechnics, when used appropriately and in consideration of those risks, WS' personnel can use those methods with a high degree of safety. WS' employees would adhere to safety requirements and use appropriate personal protective equipment pursuant to WS Directive 2.601. WS' personnel who use pyrotechnics would follow the guidelines for using pyrotechnics in accordance with WS Directive 2.627.

- *Visual deterrents*

Visual deterrents that WS' personnel could use and/or recommend would include mylar tape, effigies, lasers, and lights. Lasers and lights would pose minimal risks to the public because application occurs directly to target species by trained personnel, which limits the exposure of the public to misuse of the method. Similarly, the use of mylar tape and effigies would not pose risks to human safety.

- *Live-capture methods*

Live-capture methods that would be available for WS' personnel to use and/or recommend would include bow nets, hand nets, cannon nets, and modified foothold traps. Live-capture methods are typically set in situations where human activity would be minimal to ensure public safety. Modified padded foothold traps rarely cause serious injury because they require a double-crested cormorant to trigger the trap. Therefore, human safety concerns associated with modified padded foothold traps used to capture double-crested cormorants require direct contact to cause bodily harm. If left undisturbed, risks to human safety would be minimal. In addition, WS' personnel would be on site during the use of modified padded foothold traps and would monitor the traps. Other live-capture devices, such as cannon nets, pose minor safety hazards to the public because activation of the device occurs by trained personnel that are present on site and personnel would only activate the method after they observe double-crested cormorants in the capture area of the net. Although some fire and explosive hazards exist with cannon nets during ignition and storage of the explosive charges, safety precautions associated with the use of the method, when adhered to, pose minimal risks to human safety and primarily occur to the handler. WS would not use cannon nets in areas where public activity was high, which further reduces the risks to the public. WS would use nets in areas with restricted public access whenever possible to reduce risks to human safety. WS' personnel employing hand nets would also be present at the site during application to ensure the safety of the public.

- *Nest destruction*

WS could use nest destruction to discourage double-crested cormorants from nesting in areas by removing nesting material. Removal of nesting material by WS' personnel would occur by hand or hand tools. Double-crested cormorants build nests on the ground or in trees using sticks, vegetation, and similar debris. The removal of nesting material by WS' personnel would not pose risks to the public and would pose a very low risk to WS' employees. Minor injuries could occur to WS' employees related to bending to remove nesting material on the ground or from falling debris from removing nests in trees.

- *Aircraft*

WS could also use fixed-winged aircraft and/or helicopters to monitor and survey double-crested cormorants in the state. For example, WS could use fixed-winged aircraft to locate double-crested cormorant roosts and count the number of double-crested cormorants using a roost location. WS' use of aircraft would primarily occur in the fall and winter when a large number of double-crested cormorants are present in the state. WS could also use unmanned aircraft to survey and locate double-crested cormorants. A concern when using aircraft would be the potential risks to human safety associated with aircraft accidents, which would include risks to the pilot, crewmembers, and the public.

The use of aircraft by WS would be quite different from general aviation use. The environment in which WS would conduct aerial operations would be inherently a higher risk environment than that for general aviation. Low-level flights introduce hazards, such as power lines and trees, and the safety margin for error during maneuvers is higher when comparing the safety margins associated with high-level flights. WS has established an Aviation Training and Operations Center to support aerial activities and WS recognizes that an aggressive overall safety and training program is the best way to prevent accidents.

While the goal of the aviation program is to have no accidents, accidents may still occur. All WS' personnel associated with aerial operations would follow the policies and directives set forth in WS Directive 2.620, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137. Because of the remote locations in which the WS program conducts aerial operations, the risk to the public from aviation operations or accidents would be minimal. The WS program aircraft-use policy helps ensure the program uses aircraft in a safe and environmentally sound manner in accordance with federal and state laws.

- *Firearms*

Certain safety issues do arise related to misusing firearms and the potential human hazards associated with the use of firearms to reduce damage and threats of damage. All WS' personnel who use firearms would follow the guidelines in WS Directive 2.615. To help ensure safe use and awareness, WS' employees who use firearms to conduct official duties receive training from an approved firearm safety-training course and to remain certified for firearm use, WS' employees must attend a re-certification safety-training course in accordance with WS Directive 2.615. WS' employees who carry and use firearms as a condition of employment are subject to the Lautenberg Domestic Confiscation Law and are required to inform their supervisor if they can no longer comply with the Lautenberg Domestic Confiscation Law (see WS Directive 2.615). WS would work closely with cooperators requesting assistance to ensure that WS' personnel consider all safety issues before deeming the use of firearms to be appropriate. Whether a person contacted WS or consulted with WS, the use of firearms to alleviate double-crested cormorant damage would be available if WS implements any of the alternatives unless otherwise prohibited by the USFWS. Because the use of firearms to alleviate double-crested cormorant damage would be available under any of the alternatives and the use of firearms by those persons experiencing double-crested cormorant damage could occur whether they contacted or consulted WS, the risks to human safety from the use of firearms would be similar among all the alternatives.

If WS' personnel use firearms to remove double-crested cormorants lethally, WS would retrieve the carcasses to the extent possible. WS' personnel would dispose of the carcasses retrieved in accordance with WS Directive 2.515 and would comply with requirements in depredation orders, control orders, depredation permits, and/or authorizations issued by the USFWS for activities associated with double-crested cormorants.

- *Egg destruction*

Egg destruction would involve puncturing, breaking, shaking, or oiling an egg. Risks to human health and safety associated with egg destruction would be minimal. Egg oiling involves the use of corn oil to coat the eggs in the nest of double-crested cormorants, which renders the egg unviable. WS' personnel generally apply the corn oil by hand (rubbing oil over eggs), dipping eggs in corn oil, or spraying corn oil from a pump-type (non-aerosol) container. WS' personnel use commercially available, food-grade corn oil when oiling eggs. Egg oiling is generally a method used to treat the eggs of bird species that nest on the ground, such as double-crested cormorants. WS' personnel coat each egg with a light to moderate amount of corn oil. WS only uses food-grade corn oil that people use every day when preparing food and uses a small amount of corn oil to treat each egg; therefore, risks to human safety associated with the use of corn oil to coat eggs would be extremely low.

- *Euthanasia*

After WS live-captured a double-crested cormorant, WS could euthanize the double-crested cormorant by placing the double-crested cormorant into a sealed chamber and releasing compressed carbon dioxide inside the chamber. The American Veterinary Medical Association (AVMA) considers carbon dioxide to be an acceptable form of euthanasia for birds (AVMA 2013). As with many methods, risks to human health and safety primarily occur to the applicator. The carbon dioxide released into the sealed chamber would diffuse into the atmosphere once WS' personnel opened the chamber to dispose of the double-crested cormorant. The use of carbon dioxide for euthanasia would occur in ventilated areas where exposure of the applicator or the public to large concentrations of carbon dioxide from the release of carbon dioxide would not occur. Based on the use patterns from the use of carbon dioxide in sealed chamber to euthanize animals, the risks to human safety is extremely low. WS would dispose of carcasses euthanized using carbon dioxide in accordance with WS Directive 2.515 and would comply with requirements in depredation orders, control orders, depredation permits, and/or authorizations issued by the USFWS for activities associated with double-crested cormorants.

SAFETY OF METHODS AVAILABLE

Overall, risks to human safety from activities and methods would be similar to the other alternatives because the same methods would be available. If people misuse or apply those methods inappropriately, any of the methods available to alleviate double-crested cormorant damage could threaten human safety.

However, when used appropriately, methods available to alleviate damage would pose minimal risks to human health and safety. No adverse effects to human safety occurred from WS' use of methods to alleviate double-crested cormorant damage in the state from FY 2013 through FY 2017. The risks to human safety from the use of non-lethal and lethal methods, when used appropriately and by trained personnel, would be low. Based on the use patterns of methods available to address damage caused by double-crested cormorants, this alternative would comply with Executive Order 12898 and Executive Order 13045.

EFFECTS OF NOT EMPLOYING METHODS TO REDUCE THREATS TO HUMAN SAFETY

Section 1.4.3 discusses the need to resolve threats to human safety associated with the double-crested cormorants. Threats to human safety associated with double-crested cormorants are primarily associated with the risks of aircraft striking double-crested cormorants at airports in the state. Double-crested cormorants have the potential to cause severe damage to aircraft and can threaten the safety of flight crews and passengers. Limiting the methods available to alleviate aircraft strike risks could lead to higher risks to the safety of flight crews and passengers.

Other risks to human safety can include the threats of disease transmission between double-crested cormorants and people associated with their gregarious nesting and roosting behavior. If WS implements Alternative 1, those methods identified in Appendix B would be available for WS' personnel to use when formulating a management strategy using the WS Decision Model. WS' personnel would not necessarily use every method from Appendix B to address every request for assistance but would use the WS' Decision Model to determine the most appropriate approach to address each request for assistance, which could include using additional methods from Appendix B if initial efforts did not adequately reduce threats to human safety.

Restricting methods or limiting the availability of methods could lead to incidents where risks to human safety increase because the only available methods may not be effective enough to reduce risks to human safety adequately. In addition, implementation of Alternative 1 would provide another way for people to resolve threats to human safety because the WS program in Mississippi would be available to provide direct operational assistance and/or technical assistance. People experiencing threats to human safety could conduct activities themselves to alleviate threats, they could seek assistance from private businesses/entities, they could seek assistance from WS, they could seek assistance from other state or federal agencies, and/or they could take no further action. The mission of the national WS program is to provide federal leadership with managing conflicts with wildlife. In some cases, WS may be the only entity available to manage threats to human safety, such as in rural areas or remote air facilities.

Overall, implementation of this alternative would likely result in a higher likelihood of successfully reducing threats to human safety because of the availability of the WS program to provide assistance. In addition, WS' employees have experience with using methods to reduce threats associated with double-crested cormorants effectively.

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

Implementation of this alternative would require the WS program to only recommend and use non-lethal methods to manage and prevent damage caused by double-crested cormorants. WS would provide technical assistance and direct operational assistance under this alternative recommending and using only non-lethal methods. Similar to the other alternatives, other entities could and would likely continue to use lethal methods and those activities could increase in proportion to the reduction of assistance using lethal methods provided by the WS program. Threats to human safety would continue to occur from activities conducted by other entities, including from those people who implement damage management activities on their own similar to Alternative 3 and Alternative 4.

SAFETY OF METHODS AVAILABLE

Non-lethal methods recommended or employed by the WS program have the potential to threaten human safety. Alternative 1 discusses the threats to human safety associated with non-lethal methods that would be available if WS implements this alternative. The threats to human safety associated with non-lethal methods would be the same as those threats that would occur if WS implemented Alternative 1. No adverse effects to human safety have occurred from WS' use of non-lethal methods to alleviate double-crested cormorant damage in the state from FY 2013 through FY 2017. The risks to human safety from the use of non-lethal and lethal methods, when used appropriately and by trained personnel, would be low. Based on the use patterns of methods available to address damage caused by double-crested cormorants, this alternative would comply with Executive Order 12898 and Executive Order 13045.

Other entities could continue to use lethal methods if WS implements this alternative. Those entities would likely continue to employ those lethal methods discussed in Appendix B when authorized by the USFWS. If people used lethal methods in proportion to assistance that the WS program would have provided using lethal methods, the potential threats to human safety from methods available would be similar to Alternative 1. This could result in less experienced persons implementing lethal methods and could lead to greater risks to human safety. Other entities could use lethal methods where the personnel of the WS program may not because WS' personnel would consider threats to human safety when formulating strategies to alleviating double-crested cormorant damage. Lethal methods employed by those persons not experienced in the proper use of those methods could increase threats to human safety.

EFFECTS OF NOT EMPLOYING METHODS TO REDUCE THREATS TO HUMAN SAFETY

As discussed previously, using non-lethal methods can be effective at alleviating damage associated with double-crested cormorants. For example, dispersing double-crested cormorants from winter roosts near aquaculture facilities can be effective (Mott et al. 1998, Reinhold and Sloan 1999, Glahn et al. 2000). As double-crested cormorants arrived at a location to roost for the night, Mott et al. (1998) found that harassment could reduce the number of double-crested cormorants observed at aquaculture facilities near the roosts. However, the continued use of many non-lethal methods can often lead to the habituation of double-crested cormorants to those methods (*i.e.*, showing no response or limited movements), which can decrease the effectiveness of those methods (Mott and Boyd 1995, Mott et al. 1998, Seamans and Gosser 2016).

Section 1.4.3 discusses the need to resolve threats to human safety associated with the double-crested cormorants. Threats to human safety associated with double-crested cormorants are primarily associated with the risks of aircraft striking double-crested cormorants at airports in the state but can include threats of disease transmission where fecal droppings accumulate. Limiting the methods available to alleviate threats could lead to higher risks to human health and safety. For example, double-crested cormorants have the potential to cause severe damage to aircraft, which can threaten the safety of flight crews and passengers. Risks of aircraft strikes could increase if double-crested cormorants near airports and/or military facilities habituate to the use of non-lethal methods and no longer respond to the use of those methods. However, if other entities used lethal methods at a similar level that would occur if WS implemented Alternative 1, risks to human safety would be similar to Alternative 1.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

If WS implements this alternative, WS' personnel would only provide recommendations on methods the requester could use to alleviate damage themselves with no direct involvement by WS. On occasion, WS' personnel could demonstrate the use of methods but WS' personnel would not conduct any direct operational activities to manage damage caused by double-crested cormorants. All of the methods discussed in Appendix B would be available for use by other entities. When conducting activities that could result in the take of double-crested cormorants, the MBTA would continue to require people have authorization from the USFWS.

SAFETY OF METHODS AVAILABLE

If WS implements this alternative, those people that request assistance from WS could conduct activities and use methods recommend by WS' personnel, they could implement other methods, they could seek further assistance from other entities, or they could take no further action. Therefore, the requester and/or other entities would be responsible for using those methods available, including methods recommended by WS. The skill and knowledge of the person applying methods would determine the safety and efficacy of the methods the person was using. If people receiving technical assistance from WS implement methods appropriately and in consideration of human safety, then the effects of implementing this alternative on human health and safety would be similar to those effects if WS implemented Alternative 1. If people implement methods inappropriately, without regard for human safety, and/or use methods not recommended by WS, risks to human health and safety could be higher than those risks associated with the implementation of Alternative 1.

EFFECTS OF NOT EMPLOYING METHODS TO REDUCE THREATS TO HUMAN SAFETY

As discussed previously, if WS implements this alternative, the skill and knowledge of the person using methods would determine how effective those methods were at reducing threats to human health and safety. If people implement methods as intended at a similar level that would occur if WS' personnel were conducting those activities, the ability to reduce threats to human health and safety would be similar. If people attempting to reduce threats to human health and safety applied methods incorrectly or were not as diligent at employing methods, then the ability of those people to reduce threats to human health and safety would be lower than Alternative 1. This would likely occur on a case by case basis because one person may apply methods as intended at a similar intensity level as would occur if WS were conducting the activities while another person may not apply methods as intended or may not apply those methods at a similar intensity level. Therefore, implementing this alternative would likely be effective at reducing threats to human health and safety similar to Alternative 1 in some cases but would not be as effective in other cases. However, implementing this alternative would likely be more effective at reducing threats to human health and safety than the implementation of Alternative 4 because WS would be available to provide technical assistance and demonstration to those persons seeking assistance.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

If WS implements Alternative 4, the WS program in Mississippi would not provide assistance with any aspect of managing damage caused by double-crested cormorants, including providing technical assistance. People could contact WS for assistance but WS would refer those people to other entities, such as the USFWS, MDWFP, and/or private entities. Due to the lack of involvement in managing damage caused by double-crested cormorants, no impacts to human safety would occur directly from WS. This alternative would not prevent those entities from conducting damage management activities in the absence of WS' assistance. Those methods discussed in Appendix B would be available to those persons experiencing damage or threats and, when required, people could continue to take double-crested cormorants lethally when authorized by the USFWS.

SAFETY OF METHODS AVAILABLE

If WS implements this alternative, those people experiencing damage could conduct activities themselves, they could seek assistance from other entities, or they could take no action. The requester and/or other entities would be responsible for using those methods available. Methods available to alleviate or prevent damage associated with double-crested cormorants generally do not pose risks to human safety. Most methods available to alleviate damage involve harassing double-crested cormorants to disperse them from a location. The skill and knowledge of the person applying methods would determine the safety and efficacy of the methods the person was using. If people implement methods appropriately and in consideration of human safety, then the effects of using methods would be similar to those effects if WS implemented Alternative 1. If people implement methods inappropriately, without regard for human safety, and/or use illegal methods, risks to human health and safety could be higher than those risks associated with the implementation of Alternative 1. Although some risks to human safety are likely to occur, those risks would likely be minimal when people use those methods appropriately and in consideration of human safety.

EFFECTS OF NOT EMPLOYING METHODS TO REDUCE THREATS TO HUMAN SAFETY

As discussed previously, if WS implements this alternative, the skill and knowledge of the person using methods would determine how effective those methods were at reducing threats to human health and safety. If people implement methods as intended at a similar level that would occur if WS' personnel were conducting those activities, the ability to reduce threats to human health and safety would be similar. If people attempting to reduce threats to human health and safety applied methods incorrectly or were not as diligent at employing methods, then the ability of those people to reduce threats to human health and safety would be lower than Alternative 1. This would likely occur on a case by case basis because one person may apply methods as intended at a similar intensity level as would occur if WS were conducting the activities while another person may not apply methods as intended or may not apply those methods at a similar intensity level. Therefore, implementing this alternative would likely be effective at reducing threats to human health and safety similar to Alternative 1 in some cases but would not be as effective in other cases. However, implementing this alternative would likely be less effective at reducing threats to human health and safety than the implementation of Alternative 1 because WS would not be available to provide assistance.

3.2.4 Issue 4 - Humaneness and Animal Welfare Concerns of Methods

As discussed previously, a common issue often raised is concerns about the humaneness of methods available under the alternatives for resolving damage and threats and animal welfare concerns. Discussion of method humaneness and animal welfare concerns for those methods available under the alternatives occurs below.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

The issue of humaneness and animal welfare, as it relates to the killing or capturing of wildlife is an important but very complex concept that people interpret in a variety of ways. Schmidt (1989) indicated that vertebrate damage management for societal benefits could be compatible with animal welfare concerns, if *"...the reduction of pain, suffering, and unnecessary death is incorporated in the decision* *making process."* The AVMA has previously described suffering as a *"…highly unpleasant emotional response usually associated with pain and distress"* (AVMA 1987). However, suffering *"…can occur without pain…,"* and *"...pain can occur without suffering…"* (AVMA 1987). Because suffering carries with it the implication of occurring over time, a case could be made for *"…little or no suffering where death comes immediately…"* (California Department of Fish and Game 1991). Pain and physical restraint can cause stress in animals and the inability of animals to effectively deal with those stressors can lead to distress. Suffering occurs when people do not take action to alleviate conditions that cause pain or distress in animals.

Defining pain as a component in humaneness appears to be a greater challenge than that of suffering. Pain obviously occurs in animals. Altered physiology and behavior can be indicators of pain. However, pain experienced by individual animals probably ranges from little or no pain to considerable pain (California Department of Fish and Game 1991). However, research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991, Sharp and Saunders 2008, Sharp and Saunders 2011). Therefore, the challenge in coping with this issue is how to achieve the least amount of animal suffering.

The AVMA has previously stated "*...euthanasia is the act of inducing humane death in an animal*" and "*... the technique should minimize any stress and anxiety experienced by the animal prior to unconsciousness*" (Beaver et al. 2001). Some people would prefer the use of AVMA accepted methods of euthanasia when killing all animals, including wild animals. However, the AVMA has previously stated, "*For wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but terms such as killing, collecting, or harvesting, recognizing that a distress-free death may not be possible*" (Beaver et al. 2001).

Humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal, and people may perceive the humaneness of an action differently. Some individuals believe any use of lethal methods to resolve damage associated with wildlife is inhumane because the resulting fate is the death of the animal. Others believe that certain lethal methods can lead to a humane death. Others believe most non-lethal methods of capturing wildlife to be humane because the animal is generally unharmed and alive. Still others believe that any disruption in the behavior of wildlife is inhumane. Given the multitude of attitudes on the meaning of humaneness and the varying perspectives on the most effective way to address damage and threats in a humane manner, the challenge for agencies is to conduct activities and employing methods that people perceive to be humane while assisting those persons requesting assistance to manage damage and threats associated with wildlife. The goal of WS would be to use methods as humanely as possible to resolve requests for assistance to reduce damage and threats to human safety. WS would continue to evaluate methods and activities to minimize the pain and suffering of methods addressed when attempting to resolve requests for assistance.

Some people and groups of people have stereotyped methods as "*humane*" or "*inhumane*". However, many "*humane*" methods can be inhumane if not used appropriately. Therefore, the goal would be to address requests for assistance effectively using methods in the most humane way possible that minimizes the stress and pain to the animal. When formulating a management strategy using the WS Decision Model, WS' personnel would give preference to the use of non-lethal methods, when practical and effective, pursuant to WS Directive 2.101. Although some issues of humaneness could occur from the use of non-lethal methods, when used appropriately and by trained personnel, those methods would not result in the inhumane treatment of double-crested cormorants.

The non-lethal methods of primary concern would be the use of modified padded foothold traps and hand nets to live-capture double-crested cormorants. Concerns from the use of those non-lethal methods would be from injuries to double-crested cormorants while those methods restrain double-crested cormorants and from the stress of the double-crested cormorant while being restrained or during the application of the method. However, WS' personnel would be present on site during the use of modified padded foothold traps and hand nets; therefore, WS' personnel can quickly address those double-crested cormorants live-captured using those methods. In addition, the use of modified padded foothold traps or hand nets would not occur frequently and would likely be involved with the capture of a limited number of double-crested cormorants that WS' personnel subsequently release. WS anticipates using those methods mainly for research projects where WS may live-capture double-crested cormorants for research biologists. For example, WS' personnel could live-capture double-crested cormorants so a research biologist could place a radio transmitter on the double-crested cormorant to monitor their migrating patterns. Although restraining a double-crested cormorant could cause stress to the double-crested cormorant, attending to the double-crested cormorant immediately after live-capture would minimize suffering. In addition, the stress associated with a modified padded foothold trap or hand net restraining a double-crested cormorant would be temporary because WS' personnel would be on site during the use of those methods and WS' personnel would immediately address any double-crested cormorants captured. When handling double-crested cormorants after live-capture (*e.g*., to collect data, to apply a leg band, to apply a radio transmitter harness), WS' personnel would limit the amount of handling time to the minimal amount needed to accomplish the task.

The only lethal methods WS is considering are the use of a firearm, the use of carbon dioxide after live-capture, and the destruction of double-crested cormorant eggs. The AVMA guidelines on euthanasia list gunshot and carbon dioxide as conditionally acceptable methods for free-ranging wildlife that, when applied appropriately, can meet their definition of euthanasia[9] (AVMA 2013). Although the AVMA guidelines list gunshot as a conditionally acceptable method of euthanasia for free-ranging wildlife, there is greater potential the method may not consistently produce a death that meets their definition of euthanasia but can meet their definition of humane killing[10] (AVMA 2013). The use of euthanasia methods by WS' personnel would comply with WS Directive 2.505.

When WS' personnel deem firearms to be an appropriate method to alleviate damage or threats of damage using the WS Decision Model, WS' personnel would strive to minimize the distress and pain of target double-crested cormorants and to induce death as rapidly as possible. The use of carbon dioxide for euthanasia would occur after WS' personnel live-captured a double-crested cormorant. WS' personnel that use firearms and carbon dioxide would receive training in the proper use of the methods to ensure a timely and quick death. Egg destruction would involve puncturing, breaking, shaking, or oiling an egg. In general, egg destruction would represent a humane method of making an egg unviable. In accordance with WS Directive 2.505, when taking an animal's life, WS' personnel would exhibit a high level of respect and professionalism toward the animal regardless of method.

Personnel from WS would be experienced and professional in their use of management methods (see WS Directive 1.301). WS' personnel would receive training in the latest and most humane devices/methods to manage damage associated with double-crested cormorants. Consequently, WS' personnel would implement methods in the most humane manner possible. People experiencing damage or threats of damage associated with double-crested cormorants could use any of those methods discussed in Appendix B regardless of the alternative implemented by WS. Therefore, the issue of humaneness associated with methods would be similar across any of the alternatives because people could use those methods in the

[9]The AVMA (2013) currently defines euthanasia as "*A method of killing that minimizes pain, distress, and anxiety experienced by the animal prior to loss of consciousness, and causes rapid loss of consciousness followed by cardiac or respiratory arrest and death*".

[10]The AVMA (2013) currently defines humane killing as "*killing performed in a manner that minimizes animal distress, but may not meet the requirements of euthanasia due to situational constraints*".

absence of WS' involvement. Those persons who view a particular method as humane or inhumane would likely continue to view those methods as humane or inhumane under any of the alternatives.

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

If WS implemented this alternative, the WS program would only use non-lethal methods, which most people would generally regard as humane. WS would use non-lethal methods to live-capture, exclude, or disperse double-crested cormorants. The humaneness and animal welfare concerns of non-lethal methods would be identical to those described for Alternative 1 because those same non-lethal methods would be available for use if WS implemented this alternative. Although some issues of humaneness and animal welfare concerns could occur from the use of non-lethal methods, those methods, when used appropriately and by trained personnel, would not result in the inhumane treatment of double-crested cormorants.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

If WS implemented this alternative, the issue of method humaneness and animal welfare concerns would be similar to the humaneness and animal welfare concerns discussed for Alternative 1 because the same methods would be available for people to use. WS would not directly be involved with damage management activities if WS implemented Alternative 3. However, the entity receiving technical assistance from WS could employ those methods that WS recommends. Therefore, by recommending methods and, thus, a requester employing those methods, the issue of humaneness and animal welfare concerns would be similar to Alternative 1.

WS would instruct and demonstrate the proper use of methodologies to increase their effectiveness and to ensure people have the opportunity to use methods to minimize pain and suffering. However, the skill and knowledge of the person applying methods would determine the humane use of the methods the person was using despite WS' demonstration. Therefore, a lack of understanding of the behavior of animals or improperly identifying the damage caused by animals along with inadequate knowledge and skill in using methodologies to resolve the damage or threat could lead to incidents with a greater probability of people perceiving those activities as inhumane. In those situations, people are likely to regard the pain and suffering to be greater than discussed for Alternative 1.

Those persons requesting assistance would be directly responsible for the use and placement of methods and if monitoring or checking of those methods does not occur in a timely manner, captured wildlife could experience suffering and if not addressed timely, could experience distress. The amount of time an animal is restrained under the proposed action would be shorter compared to a technical assistance alternative if those requesters implementing methods are not as diligent or timely in checking methods. It is difficult to evaluate the behavior of individual people. In addition, it is difficult to evaluate how those people will react under given circumstances. Therefore, this alternative can only evaluate the availability of WS' assistance because determining human behavior can be difficult. If those persons seeking assistance from WS apply methods recommended by WS through technical assistance as intended and as described by WS, then those people could apply those methods humanely to minimize pain and distress. If those persons provided technical assistance by WS apply methods not recommended by WS or do not employ methods as intended or without regard for humaneness or animal welfare concerns, then the issue of method humaneness and animal welfare concerns would be of greater concern because the pain and distress of double-crested cormorants would likely be higher.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

WS would not provide any assistance if the WS program in Mississippi implemented Alternative 4. Those people experiencing damage or threats associated with double-crested cormorants could continue to use those methods legally available. Those persons who consider methods inhumane would likely consider those methods inhumane under any alternative because people often label methods inhumane no matter the entity employing those methods.

A lack of understanding regarding the behavior of double-crested cormorants or methods used could lead to an increase in situations perceived as being inhumane to wildlife despite the method used. Despite the lack of involvement by WS under this alternative, those methods perceived as inhumane by certain individuals and groups would still be available to the public to use to resolve damage and threats caused by double-crested cormorants.

3.2.5 Issue 5 - Effects on Waterfowl Hunting from Activities to Disperse Double-crested Cormorant Roosts

The presence of wintering double-crested cormorants in the state coincides with the presence of wintering waterfowl in the state. Hunting seasons for waterfowl often occur during the fall and winter; therefore, activities to address double-crested cormorants could overlap with the annual hunting season for waterfowl in the state. Using data collected from a six county region of Mississippi during the 1998-1999 hunting season for waterfowl, Grado et al. (2001) estimated the economic impact generated from waterfowl hunting in Mississippi was $27.4 million, which supported 512 full- or part-time jobs in the state. During the 2005-2006 hunting season for waterfowl, Grado et al. (2011) estimated the economic impact from waterfowl hunting in Mississippi was $86.8 million, which supported 1,139 full- or part-time jobs in the state. The potential effects on the ability of people to hunt waterfowl associated with implementing the alternative approaches occur below for each alternative.

Alternative 1 – The WS Program would continue the Current Integrated Methods Approach to Managing Damage Caused by Double-crested Cormorants in Mississippi (Proposed Action/No Action)

When implementing Alternative 1, the primary concern would be those methods that use auditory and visual stimuli to elicit a fright response in double-crested cormorants, including the noise associated with discharging a firearm. As discussed in Section 3.2.2, those methods that disperse double-crested cormorants would also likely disperse non-target animals that occur nearby, including waterfowl. Waterfowl present in the state during the fall and winter use aquatic habitats similar to those habitats used by double-crested cormorants, including areas where wintering double-crested cormorants roost and at aquaculture facilities. During the winters in the mid-1980s, Dubovsky and Kaminski (1992) estimated that nearly 41,400 hectares of catfish ponds in Mississippi attracted as many as 150,000 waterfowl and America coots (*Fulica americana*). During the winters of 2002 and 2004, Strickland et al. (2008) reported that researchers found that nearly 42,500 hectares of catfish ponds in the Mississippi Delta region of Mississippi attracted an average of more than 110,000 ducks in winter with nearly 30% of all ducks observed in the Delta region occurring on catfish ponds. Feaga et al. (2015) concluded that idle aquaculture ponds and aquaculture ponds currently in production could be important habitats for wintering waterfowl and other waterbirds in Mississippi.

As discussed in Section 1.2.3 and Section 1.4.9, the geographic scope of the actions and analyses in this EA is statewide and this EA analyzes actions that could occur on federal, tribal, state, county, city, and private lands, when requested. If WS implements Alternative 1, WS and an appropriate landowner and/or manager would sign an agreement allowing WS' personnel to conduct activities on property they own or manage. The agreement would include those methods the property owner and/or manager agrees to allow WS' personnel to use on the property they own or manage. Therefore, the property owner and/or manager would be aware of the methods that WS' personnel could use on their property or properties. WS' personnel would coordinate activities with the property owner and/or manager, which could include consideration of hunting activities that occur on property they own and/or manage. If a property owner and/or manager allowed waterfowl hunting on their property, WS would work with the property owner and/or manager to avoid conflicts with hunters, such as not using a method during the hunting season. In addition, the property owner and/or manager may indicate they do not want activities to occur on the property they own and/or manage during the hunting season for waterfowl. When a property owner and/or manager indicates they do not want activities to occur on the property they own and/or manage or portions of the property they own and/or manage during the hunting season for waterfowl, WS' personnel would not conduct activities in areas indicated by the property owner and/or manager. When signing an agreement to allow WS to conduct activities, the property owner and/or manager would continue to have the ability to restrict activities on the property or properties they own and/or manage, including not allowing WS to conduct activities during the hunting season for waterfowl.

The noise associated with shooting at waterfowl by hunters and the presence of people while hunting waterfowl can often disperse double-crested cormorants from a location (*e.g.*, nighttime roost) or, at a minimum, reducing the number of double-crested cormorants using a location, especially when frequent hunting occurs in the immediate vicinity of the location. Therefore, hunting activities can reduce the need for WS to conduct activities in some areas until the hunting season ends and large numbers of double-crested cormorants begin using those locations again. In addition, the act of hunting itself disperses waterfowl from a location.

When WS conducts activities to disperse double-crested cormorants, WS would attempt to limit the potential exposure of wintering waterfowl to dispersal activities. For example, WS' personnel may disperse incoming flight lines of double-crested cormorants prior to them entering a roost site and dispersing double-crested cormorants from winter roost sites as soon as they form in the fall to condition double-crested cormorants to avoid those sites later in the year when waterfowl are present. Additional actions that WS may implement include using the minimal amount of noise from harassment devices necessary to disperse a winter roost effectively. For example, WS' personnel could use lasers and lights to disperse of roost. WS' personnel could also begin activities early in the afternoon to avoid potential conflicts with night roosting waterfowl. If a property owner/manager does not allow hunting on their property but allows WS to conduct activities to alleviate double-crested cormorant damage, implementation of Alternative 1 may disperse waterfowl from the immediate area to areas where hunting occurs.

Alternative 2 – The WS Program would implement an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi Using Only Non-lethal Methods

Similar to Alternative 1, if WS implemented Alternative 2, the primary concern would be those methods that use auditory and visual stimuli to elicit a fright response in double-crested cormorants. The same non-lethal methods would be available and activities to disperse double-crested cormorants using those methods would be identical to those described for Alternative 1. Although WS' employees would not use firearms if WS implemented Alternative 2, except to use those pyrotechnics that require a firearm, the noise associated with discharging a firearm would be similar to the noise produced when using other auditory methods, such as pyrotechnics and propane cannons. Therefore, the use of non-lethal hazing methods would likely cause a similar fright response in waterfowl as the noise produced when discharging a firearm. Therefore, if WS implemented Alternative 2, the potential effects from activities to disperse double-crested cormorants using only non-lethal methods would be identical to those described if WS implemented Alternative 1.

Alternative 3 – The WS Program would recommend an Integrated Methods Approach to Managing Double-crested Cormorant Damage in Mississippi through Technical Assistance Only

If WS implemented Alternative 3, WS' personnel would make recommendations on methods that people seeking assistance could use to address damage caused by double-crested cormorants. WS' personnel would make recommendations based on site visits or based on information provided by the person or persons seeking assistance. Therefore, WS would have no direct effect on the ability of people to harvest waterfowl in the state. If people using methods recommended by WS considered potential effects on waterfowl hunting during their use of methods, then the potential impacts would be similar to Alternative 1 and Alternative 2. If a property owner and/or manager allowed waterfowl hunting on property they own and/or manage, then they are likely to consider the potential effects on people's ability to hunt waterfowl on their property.

If WS implements Alternative 3, the effects on the ability of people to harvest waterfowl could be lower than those effects described for Alternative 1 and Alternative 2 if those people provided technical assistance do not conduct activities or conduct activities but at a lower intensity level than WS would conduct. In addition, those persons experiencing damage or threats associated with double-crested cormorants may not be able to access areas where double-crested cormorants congregate. For example, people may not have access to watercraft to reach remote roost locations of double-crested cormorants. Double-crested cormorants may roost in one location and then travel to aquaculture facilities to feed; therefore, the aquaculture producer experiencing damage may have to gain permission to access and disperse double-crested cormorants on property owned and/or managed by another entity.

However, WS does coordinate hazing efforts among aquaculture producers as part of efforts to disperse double-crested cormorants from roosts near aquaculture facilities (Glahn et al. 1998). If WS implemented Alternative 3, WS could continue to coordinate and promote efforts by aquaculture producers to disperse double-crested cormorants through technical assistance. WS could work with entities to gain access to areas where double-crested cormorants roost as part of WS' role of providing technical assistance. Therefore, if people were able to conduct similar activities to those activities that WS would have conducted, the effects on the ability of people to hunt waterfowl in those areas would be similar to Alternative 1 and Alternative 2. If aquaculture producers were unable to access roost locations, then the effects of implementing Alternative 3 could be lower than Alternative 1 and Alternative 2.

Similar to Alternative 1 and Alternative 2, the property owner and/or manager would continue to have the ability to restrict activities on the property or properties they own and/or manage, including not allowing entities to conduct activities during the hunting season for waterfowl.

Alternative 4 – The WS Program Would Not Provide Any Assistance with Managing Damage Caused by Double-crested Cormorants in Mississippi

If WS implements Alternative 4, the WS program in Mississippi would refer people seeking assistance with managing damage caused by double-crested cormorants to other entities. Despite no involvement by the WS program in Mississippi, the property owner or manager and other entities could continue to conduct activities to manage damage caused by double-crested cormorants in the state. All of the methods described in Appendix B would be available for use by other entities to manage damage caused by double-crested cormorants. The potential impacts associated with implementation of Alternative 4 would be identical to implementation of Alternative 3 because entities other than WS would conduct activities to alleviate damage caused by double-crested cormorants.

If WS implements Alternative 4, the effects on the ability of people to harvest waterfowl could be lower than those effects described for Alternative 1 and Alternative 2 if those people experiencing damage caused by double-crested cormorants do not conduct activities or conduct activities but at a lower intensity level than WS would conduct. In addition, those persons experiencing damage or threats associated with double-crested cormorants may not be able to access areas where double-crested cormorants congregate similar to Alternative 3. Similar to the other alternatives, the property owner and/or manager would continue to have the ability to restrict activities on the property or properties they own and/or manage, including not allowing entities to conduct activities during the hunting season for waterfowl.

3.3 SUMMARY AND CONCLUSION

Based on the best available information, the analyses in Section 3.2.1 indicate the direct, indirect, and cumulative effects on the double-crested cormorant population associated with implementing Alternative 1 would be of low magnitude. The cumulative lethal removal of double-crested cormorants from all known sources of mortality would not reach a threshold that would cause a decline in the double-crested cormorant population. The implementation of Alternative 2, Alternative 3, or Alternative 4 would likely have similar effects on the double-crested cormorant population to implementing Alternative 1 because the same or similar activities would occur by other entities. Most of the lethal take of double-crested cormorant in Mississippi has occurred by entities other than WS (see Table 4-3 in USFWS (2017)). The USFWS concluded an evaluation of allowed cumulative take levels for double-crested cormorants in the central and eastern United States. The USFWS determined the allowed cumulative take levels authorized in the central and eastern United States, including allowed cumulative take in Mississippi, would maintain the current double-crested cormorant population (see Section 5.4 in USFWS (2017), Table 5-2 in USFWS (2017), and Appendix 1 in USFWS (2017)).

If WS implemented Alternative 1, those methods that WS could use to alleviate damage would essentially be selective for double-crested cormorants because WS' personnel would be present on site to identify double-crested cormorants correctly prior to using those methods. The persistent use of non-lethal methods would likely result in the dispersal or abandonment of those areas where non-lethal methods were employed of both double-crested cormorants and non-target species. Therefore, any use of non-lethal methods would likely elicit a similar response from both non-target animals and double-crested cormorants. Although non-lethal methods do not result in the lethal removal of non-target animals, the use of non-lethal methods could restrict or prevent access of non-target animals to beneficial resources. However, long-term adverse effects would not occur to a species' population because WS would not employ non-lethal methods over large geographical areas or at such intensity levels that resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope. Non-lethal methods would generally have minimal impacts on overall populations of animals because individuals of those species were unharmed.

There is a slight potential for misidentification of other bird species that have a similar appearance to a double-crested cormorant, such as the neotropic cormorant or the anhinga. However, those species are not as common in the state as double-crested cormorants especially during the migration periods and when double-crested cormorants are present in the state during the winter. There is also a concern about the potential for low-level flights to disturb wildlife. In general, the potential for adverse effects appear to occur when overflights are frequent, such as hourly, and over long periods of time, which represents chronic exposure. WS would conduct aerial activities on a very small percentage of the land area within the state; therefore, implementation of Alternative 1 would not expose most wildlife in the state to aerial overflights and would occur infrequently throughout the year. WS has used fixed-wing aircraft and helicopters for aerial operations in areas inhabited by wildlife for many years. No known problems to date have occurred to wildlife from overflights associated with WS' aerial operations and WS does not anticipate any in the future from implementation of Alternative 1.

Most non-lethal methods would be available under all the alternatives analyzed. Impacts to non-target animals from the use of non-lethal methods would be similar to the use of those non-lethal methods under any of the alternatives. Non-target animals would generally be unharmed from the use of non-lethal methods under any of the alternatives because no lethal removal would occur from their use. Similar to the other alternatives, other entities could and would likely continue to use lethal methods and those activities could increase in proportion to the reduction of assistance using lethal methods provided by the WS program. Risks to non-target animals and threatened and endangered species would continue to occur from activities conducted by other entities, including from those people who implement damage management activities on their own similar to Alternative 3 and Alternative 4.

The risks to human health and safety from the use of available methods, when used appropriately and by trained personnel, would be low. The WS program must certify pilots and aircraft under established WS program procedures. Pilots would be highly skilled and would have to pass proficiency tests in the flight environment encountered by the WS program. All WS' personnel associated with aerial operations would follow the policies and directives set forth in WS Directive 2.620, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137. Aerial operations would generally occur in remote locations; therefore, the risk to the public from aviation operations or accidents would be minimal. The WS program aircraft-use policy helps ensure the program conducts aerial activities in a safe and environmentally sound manner, in accordance with federal and state laws. No adverse effects to human safety have occurred from WS' implementation of Alternative 1 in the state from FY 2013 through FY 2017. Based on the use patterns of methods available to address damage caused by double-crested cormorants, implementation of Alternative 1 would comply with Executive Order 12898 and Executive Order 13045.

Because those methods addressed in Appendix B of the EA would be available under all the alternatives, the issue of method humaneness and animal welfare would be similar for those methods across all the alternatives. The ability of WS to provide direct operational assistance under Alternative 1 and Alternative 2 would ensure WS' personnel employed methods as humanely as possible (see WS Directive 1.301, WS Directive 2.505). Under the other alternatives, other entities could use methods inhumanely if used inappropriately or without consideration of humaneness. The skill and knowledge of the person implementing methods to resolve damage would determine the efficacy and humaneness of methods. Despite the lack of involvement by WS under Alternative 4 and WS' limited involvement under Alternative 3, many of those methods perceived as inhumane by certain individuals and groups would still be available for others to use to resolve damage and threats caused by double-crested cormorants.

If WS implemented Alternative 1 or Alternative 2, WS would sign an agreement with the appropriate landowner and/or manager to conduct activities on properties they own and/or manage. As part of the agreement, the property owner and/or manager would have the ability to designate the methods that WS could use on the property or properties they own and/or manage. In addition, the property owner and/or manager could designate when and where activities could occur on property they own and/or manage. Therefore, the property owner and/or manager would continue to have the ability to restrict activities on the property or properties they own and/or manage, including not allowing WS to conduct activities during the hunting season for waterfowl. Implementation of Alternative 1 or Alternative 2 would not adversely affect the ability of people to harvest waterfowl in the state because the property owner and/or manager would maintain the ability to restrict WS' activities on their property. WS would have no direct effect on the ability to harvest waterfowl if WS implemented Alternative 3 or Alternative 4 because WS would only provide technical assistance if WS implemented Alternative 3 or would provide no assistance if WS implemented Alternative 4.

CHAPTER 4: RESPONSES TO PUBLIC COMMENTS

WS and the TVA made the EA available to the public for review and comment by a legal notice published in the *Clarion Ledger* newspaper from April 15, 2019 through April 17, 2019. WS and the TVA also made the EA available to the public for review and comment on the APHIS website on April 22, 2019 and on the federal e-rulemaking portal at the regulations.gov website beginning on April 9, 2019. WS also sent out direct mailings to local known stakeholders and an electronic notification to stakeholders registered through the APHIS Stakeholder Registry. The public involvement process ended on May 24, 2019.

4.1 SUMMARY OF PUBLIC COMMENTS AND WS' RESPONSES TO THE COMMENTS

During the public comment period, WS received four comment responses related to the draft EA from three commenters. Section 4.1 summarizes the comment responses WS received and provides WS' responses to the comments.

Comment - WS just exists to kill wildlife; WS only kills wildlife

Response: The WS Decision Model would be the implementing mechanism for a damage management program under applicable alternatives that WS' personnel would adapt to an individual damage situation. When WS receives a request for direct operational assistance, WS would conduct site visits to assess the damage or threats, would identify the cause of the damage, and would apply the Decision Model described by Slate et al. (1992) and WS Directive 2.201 to determine the appropriate methods to resolve or prevent damage. Discussion of the Decision Model and WS' use of the Model occurs in Section 2.2.2. Appendix B discusses many non-lethal methods that WS' personnel could recommend or employ to resolve damage under the applicable alternatives. In addition, WS would give preference to non-lethal methods when practical and effective (see WS Directive 2.101). WS has used non-lethal methods to disperse double-crested cormorants causing damage or posing a threat of damage (see Figure 4.2). For example, during FY 2017, WS dispersed 139,027 double-crested cormorants to alleviate damage or threats of damage in the state using non-lethal methods. If WS implements Alternative 1, Alternative 2, or Alternative 3, WS would continue to use and/or recommend the use of non-lethal methods.

Comment – WS uses lethal methods just for the money

Response: The activities that WS' personnel conduct when providing assistance would be the basis for funding, not whether WS' employees use non-lethal or lethal methods. As shown in Figure 4.2, WS has previously used non-lethal methods to address damage or threats of damage associated with double-crested cormorants and, if WS implements Alternative 1, Alternative 2, or Alternative 3, WS would continue to use non-lethal methods as part of an integrated methods approach to resolving damage.

Comment – WS used biased literature in the EA; WS used lying techniques; WS used outdated information; WS misused statistics; WS used information related to other bird species instead of double-crested cormorants; WS used information from other states

Response: WS and the TVA disagree with the assertions that WS and the TVA did not use the best available science in the EA, used biased literature, used outdated science, and misused statistics. WS and the TVA also did not lie about any techniques or data in the EA. The EA contains the best available scientific information on double-crested cormorants and the potential impacts of the alternative approaches considered in detail within the EA. In addition, as discussed throughout the EA, WS has previously addressed double-crested cormorants in Mississippi during the winter and during the migration periods. Double-crested cormorants that nest further north are present in the state during activities conducted by WS. Therefore, the EA includes information and data involving double-crested cormorants outside of Mississippi.

The commenter questioned the use of King et al. (1995) on page 12 of the EA because the publication date for the information occurred in 1995. King et al. (1995) published information on the daily activities and movements of roosting double-crested cormorants in the Delta Region of Mississippi using biotelemetry methods. WS and the TVA provided the information to give context to the daily activities of double-crested cormorants in the primary aquaculture producing area of Mississippi and the daily activities of double-crested cormorants that roost in that area during the winter and during the migration periods. The commenter provided no information to indicate the information cited from King et al. (1995) was no longer valid or that the information was inaccurate.

The commenter makes several claims about information on page 45 of the EA. The commenter claimed the double-crested cormorant population is decreasing but provided no information to support the claim. The EA cites many sources that indicate the double-crested cormorant population in North America has generally increased and expanded since the late 1970s following years of reproductive suppression from organochlorine contaminates and unregulated take prior to protection under the MBTA. The commenter incorrectly claims the population of double-crested cormorants in Mississippi is 1,020,000 double-crested cormorants; however, as indicated in the EA, Wetlands International (2019) estimates the double-crested cormorant population in northeast and central North America to be 1,020,000 double-crested cormorants. The commenter also questions the use of data cited as 2010 from the National Audubon Society; however, as indicated in Figure 4.1, the population trend information from the National Audubon Society covers a period from 1966 through 2016. The National Audubon Society recommends citing CBC data gathered from their website as National Audubon Society (2010) despite the database including data beyond 2010. The commenter also questioned the use of information from the Atlantic Flyway Council; however, as indicated in the EA, the document cited was a joint document on double-crested cormorant management from the Atlantic Flyway Council and the Mississippi Flyway Council. Therefore, the citation includes both the Atlantic Flyway Council and the Mississippi Flyway Council. The State of Mississippi is part of the Mississippi Flyway.

On page 50 of the EA, the commenter claims the EA indicates that 10,000 double-crested cormorants nest in Mississippi. However, the EA presents the information in general terms that up to 10,000 double-crested cormorants may occupy one nesting colony in areas where they nest, which can create nesting conditions suitable for other bird species because the nesting activities and the fecal droppings associated with large numbers of nesting double-crested cormorants can kill vegetation. As discussed in Section 3.2.1, the number of double-crested cormorants that nest in Mississippi likely ranges from 200 to 500 breeding pairs (Hunter et al. 2006, Atlantic Flyway Council and Mississippi Flyway Council 2010).

On page 51 of the EA, the commenter questions the use of information related to double-crested cormorants feeding on non-native fish species in Lake Michigan. As stated previously, most activities conducted by WS occur when double-crested cormorants present in the state may nest in other areas, including the Great Lakes. Therefore, the EA evaluates the indirect effects that WS' activities in Mississippi could have on the benefits of double-crested cormorants preying on non-native fish species in areas where they nest.

The commenter also questions the use of literature from 1950 in the EA but did not provide the specific citation or a specific page number for the citation. The only citation in the EA dated 1950 is a publication on the use of cannon nets by Dill and Thornsberry (1950), which describes the development and the first use of a cannon net in the United States to capture waterfowl. The EA uses the Dill and Thornsberry (1950) citation when describing cannon nets because the cannon nets used today function in a similar way as described by Dill and Thornsberry (1950); therefore, the citation is still relevant and provides background information on how cannon nets function and how people use the nets to capture birds.

Comment – WS seeks to deny and silence the voice of the people

Response: As discussed previously in Chapter 4, WS provided the public an opportunity to review the draft EA and provide their comments. WS does not attempt to deny or silence the voice of anyone.

Comment – WS should involve adjacent landowners before providing assistance; landowners lie about problems; some people who have trouble with animals are lazy

Response: As discussed in Section 2.2.1, WS uses a co-managerial approach when receiving a request for assistance. The WS program only provides assistance after receiving a request for such assistance and only after the entity requesting assistance and WS sign a Memorandum of Understanding, work initiation document, or another similar document. Therefore, the decision-maker for what activities WS conducts is the entity that owns or manages the affected property. The decision-makers have the discretion to involve others as to what occurs or does not occur on property they own or manage. Therefore, in the case of an individual property owner or manager, the involvement of others and to what degree others were involved in the decision-making process would be a decision made by that individual.

If WS implements Alternative 1 or Alternative 2, WS' personnel would assess the damage or threat occurring before providing direct operational assistance to the entity requesting assistance. Therefore, WS would verify damage or the threat of damage before providing direct operational assistance. In addition, people experiencing damage associated with double-crested cormorants often attempt to resolve the damage themselves (*e.g.*, see Stickley and Andrews 1989) before contacting WS for assistance.

Comment – WS should receive no taxpayer funding; WS should shutdown

Response: WS and the TVA identified an alternative approach that would require cooperators completely fund activities (see Section 2.2.3). However, WS and the TVA did not consider the alternative in detail for the reasons provided in Section 2.2.3. In those cases where WS receives federal and/or state funding to conduct activities, federal, state, and/or local officials have made the decision to provide funding for damage management activities and have allocated funds for such activities. Additionally, damage management activities are an appropriate sphere of activity for government programs because managing wildlife is a government responsibility.

Comment – People experiencing damage should contact private contractors to conduct work

Response: If WS implements any of the alternative approaches discussed in the EA, those entities experiencing damage caused by double-crested cormorants could contact other entities to provide assistance. Implementation of any alternative approach by WS would not limit the ability of someone to seek assistance from other entities.

Comment – The use of firearms and carbon dioxide are inhumane; the plan is cruel

Response: WS and the TVA identified humaneness and animal welfare concerns of the methods available to manage damage caused by double-crested cormorants (see Section 2.1.1 and Section 3.2.4), including the use of firearms and carbon dioxide. Firearms and carbon dioxide are conditionally acceptable methods of euthanasia according to AVMA guidelines (AVMA 2013). As discussed in Section 3.2.4, WS' personnel would implement methods in the most humane manner possible to minimize pain and distress.

Comment – This plan has been tried before and failed

Response: The commenter references an article from a news service website that discusses a federal plan in Oregon to reduce predation on young salmon in the Columbia River estuary by double-crested cormorants. A large colony of double-crested cormorants nest on an island in the estuary and feed on young salmon that must pass through the estuary on their way to the ocean. The article implies the federal plan "*backfired*" because the activities dispersed the majority of the double-crested cormorants from the island but those double-crested cormorants may have begun nesting elsewhere within the Columbia River basin where predation on young salmon is likely to continue. However, the commenter provides no additional evidence of how any of the alternative approaches discussed in the EA would fail to meet the need for action or provide any link to how the activities in Oregon relate to the activities that WS could conduct if WS implemented the alternative approaches in Mississippi.

As discussed Section 1.2.3, double-crested cormorants occur throughout the year in Mississippi. However, double-crested cormorants are more abundant in the state during the migrations periods and during the winter months when double-crested cormorants that nest further north arrive and spend the winter in the state, which is the period that WS receives most requests for assistance associated with double-crested cormorants. During those periods, WS has previously coordinated efforts to disperse large numbers of double-crested cormorants from nighttime roost locations that occur near aquaculture facilities. If WS implements Alternative 1 or Alternative 2, WS could continue coordinating and conducting nighttime roost dispersals near aquaculture facilities. WS and the TVA identified the issue of dispersing double-crested cormorant roosts on nearby aquaculture facilities; however, WS and the TVA did not consider the issue in detail for the reasons provided in Section 2.1.2.

Conducting uncoordinated nighttime roost dispersal or conducting nighttime roost dispersal activities at a small number of roosts may be ineffective at reducing the number of double-crested cormorants using aquaculture facilities near those nighttime roost locations (Taylor and Strickland 2008). Therefore, WS would conduct a coordinated nighttime roost dispersal effort in the aquaculture producing region of northwest Mississippi to disperse double-crested cormorants from winter roosts near aquaculture facilities to winter roosts closer to the Mississippi River where fish from aquaculture production comprises a smaller percentage of the diet of double-crested cormorants (*e.g.*, see Glahn et al. 1995, Glahn et al. 2000).

Comment – WS is committing ecological suicide

Response: The commenter stated that WS is committing ecological suicide; however, they provide no additional information. Section 3.2 evaluates the environmental consequences associated with implementing the alternative approaches, including potential ecological effects.

Comment – Using shotguns causes pollution

Response: The commenter states that shotguns cause pollution but provides no additional information on how WS' use of shotguns would cause pollution. As discussed in the EA, shotguns are mechanical methods that WS could use to remove a double-crested cormorant lethally and to reinforce the noise associated with non-lethal methods, such as pyrotechnics or propane cannons. In addition, the noise associated with discharging a shotgun can disperse double-crested cormorants. When using a shotgun, WS would use non-lead shot listed in 50 CFR 20.21(j).

CHAPTER 5 - LIST OF PREPARERS, REVIEWERS, AND PERSONS CONSULTED

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APPENDIX A
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APPENDIX B
METHODS AVAILABLE TO MANAGE DAMAGE

WS is evaluating the use of an adaptive approach to managing damage associated with double-crested cormorants, when requested, through the implementation and integration of safe and practical methods based on local problem analyses and the informed decisions of trained WS personnel. WS would formulate integrated method approaches using the WS Decision Model (Slate et al. 1992; see WS Directive 2.201). An integrated approach to resolving requests for assistance using the Decision Model would allow WS' personnel greater flexibility and more opportunity to develop an effective damage management strategy for each request for assistance, such as considerations for threatened, endangered, or candidate species, that could be present in an area.

The goal of the proposed action would be to continue the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques, as deemed appropriate using the WS Decision Model, to reduce damage and threats caused by double-crested cormorants in Mississippi. To meet this goal, WS would continue to respond to requests for assistance with, at a minimum, technical assistance, or when funding was available, direct operational assistance.

Technical Assistance Recommendations

The WS program in Mississippi regularly provides technical assistance to individuals, organizations, and other federal, state, and local government agencies for managing double-crested cormorant damage. Technical assistance would include collecting information about the number of double-crested cormorants involved, the extent of the damage, and previous methods that the requester had attempted to resolve the damage. WS would then provide information on appropriate methods that the cooperator could consider to resolve the damage themselves.

The implementation of methods and techniques to resolve or prevent damage would be the responsibility of the requester with no direct involvement by WS. In some cases, WS may provide supplies or materials that were of limited availability for use by private entities (*e.g.*, loaning of propane cannons). Technical assistance may be provided through a personal or telephone consultation, or during an on-site visit with the requester. Generally, WS would describe several management strategies to the requester for short and long-term solutions to managing damage. WS would base those strategies on the level of risk, need, and the practicality of their application. WS' personnel would use the WS Decision Model to recommend those methods and techniques available to the requester to manage damage and threats of damage. Those persons receiving technical assistance from WS could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from other entities, or take no further action.

Direct Operational Assistance

Operational damage management assistance would include damage management activities that WS' personnel conduct directly or activities that WS' employees supervise. Initiation of operational damage management assistance could occur when the problem could not be effectively resolved through technical assistance alone and there was a written Memorandum of Understanding, work initiation document, or another comparable document signed between WS and the entity requesting assistance. The initial investigation by WS' personnel would define the nature, history, and extent of the damage or threat; species responsible for the damage or threat; and methods available to resolve the request for assistance.

The most effective approach to resolving wildlife damage problems would be to integrate the use of several methods, either simultaneously or sequentially. An adaptive plan would integrate and apply practical methods of prevention and reduce damage by double-crested cormorants while minimizing harmful effects of damage reduction measures on people, other species, and the environment. An adaptive plan may incorporate several lethal and non-lethal methods depending on the characteristics of specific damage problems.

In selecting damage management techniques for specific damage situations, WS' personnel would consider the responsible species and the magnitude, geographic extent, duration and frequency, and likelihood of double-crested cormorant damage. WS' personnel would consider the status of target and potential non-target species, local environmental conditions and impacts, social and legal aspects, and relative costs of damage reduction options. The cost of damage reduction may sometimes be a secondary concern because of the overriding environmental, legal, and animal welfare considerations. WS' personnel would evaluate those factors when formulating damage management strategies that incorporate the application of one or more techniques.

A variety of methods would potentially be available to the WS program in Mississippi relative to the management or reduction of damage caused by double-crested cormorants. Various federal, state, and local regulations and WS' directives would govern WS' use of damage management methods. WS would develop and recommend or implement strategies based on resource management, physical exclusion, and localized population management approaches. Within each approach there may be available a number of specific methods or techniques. WS' personnel in Mississippi could recommend and/or use the following non-lethal and lethal methods.

I. NON-LETHAL WILDLIFE DAMAGE MANAGEMENT METHODS

Non-lethal methods consist primarily of tools or devices used to disperse or capture a double-crested cormorant or a local population of double-crested cormorants to alleviate damage or threats. Non-lethal methods available to WS would also be available to other entities within the state and those entities could employ those methods to alleviate damage caused by double-crested cormorants.

Changes in Cultural Practices: WS' personnel could make recommendations to people on where to locate facilities, the design of facilities, modifications of existing facilities, and fisheries management to reduce the threat of double-crested cormorant damage (*e.g*., see Curtis et al. (1996), Dorr et al. (2016)). WS' personnel could be involved during the planning and designing phases of facilities to make recommendations on where to locate facilities to avoid areas with high double-crested cormorant densities. In addition, WS' personnel could make recommendations on facility design or modifications to existing facilities to minimize the attractiveness of the facilities to double-crested cormorants, such as removing or altering areas where double-crested cormorants can perch and loaf. WS' personnel could also make recommendations on operations management, such as areas to locate vulnerable fish stock, stocking rates, and the timing of releasing vulnerable fish stock. WS' personnel could make recommendations relating to fisheries management, such as releasing fish stock in the evening or at night so the fish have an opportunity to disperse before double-crested cormorants begin feeding in the morning.

Alterations to aircraft flight patterns or schedules: In situations where the presence of double-crested cormorants at or near airports results in threats to human safety and cannot be resolved by other means, WS' personnel could recommend airports or military facilities alter aircraft flight patterns or schedules to avoid risks of striking double-crested cormorants. However, altering operations at airports to decrease the potential for strike hazards involving double-crested cormorants would generally not be feasible unless an emergency exists. Otherwise, the expense of interrupted flights and the limitations of existing facilities generally make this practice prohibitive.

Surface coverings: WS could recommend the use of surface coverings to discourage double-crested cormorants from using areas. For example, covering the surface of a pond with plastic balls that float on the surface of the water can prevent access by double-crested cormorants. However, a "*ball blanket*" would render a pond unusable for boating, swimming, fishing, and other recreational activities. It would also make it difficult to harvest fish from the pond. In addition, this method can be very expensive depending on the area covered and is generally a method recommended for small water retention ponds.

Overhead Lines and wires: Overhead lines and wire consist of a line (*e.g.*, fishing line) or wire (*e.g.*, high-tensile galvanized or stainless steel wire) grid that is stretched over a resource to prevent access by double-crested cormorants (Curtis et al. 1996, Dorr et al. 2016). Curtis et al. (1996) indicated that wires with a spacing of 10 inches appeared to exclude most fish-eating birds. The birds apparently fear colliding with the wires and thus avoid flying into areas that use wire grids. The use of overhead wire grids can deter non-target birds from using areas. Exclusion may be impractical in most settings (*e.g.*, commercial aquaculture); however, wire grids could be practical in small areas (*e.g.*, retention ponds) (Curtis et al. 1996, Dorr et al. 2016).

Netting: In some limited situations, WS could recommend or use netting to exclude double-crested cormorants. Similar to overhead wire grinds, netting is not likely practical in most situations because the size of the area requiring netting would be too large, such as commercial aquaculture facilities.

Mylar tape: Mylar tape has a highly reflective surface that produces flashes of light as sunlight reflects off the surface. In addition, the metallic rattle and quick movement of Mylar tape as it moves in the wind can startle birds. Generally, WS' personnel would attach Mylar tape to a stake and then insert the stake into the ground so the Mylar tape was visible and could move in the wind. In addition, WS' personnel could tie Mylar tape to structures in a similar manner to using a stake. Using Mylar tape at locations where double-crested cormorants roost and loaf may be effective at preventing double-crested cormorants from using those areas (Dorr et al. 2016).

Effigies: Effigies are models or silhouettes of humans (*e.g.*, scarecrows) or predatory animals (*e.g.*, alligators) that applicators can place in areas where double-crested cormorants cause damage or pose a threat of damage. Effigies that pop-up into the air and/or effigies that have moving parts are often more effective at dispersing double-crested cormorants. Effigies are most effective when people move them frequently, when alternating them with other methods, and when people maintain the effigies.

Alarm or distress calls: WS' personnel could also use or recommend the use of electronic devices that mimic the sounds exhibited when double-crested cormorants are alarmed or in distress, which may cause a flight response and disperse double-crested cormorants from an area. Birds often give alarm calls when they detect predators while they give distress calls when captured by a predator (Conover 2002). When other birds hear these calls, they know a predator is present or a predator has captured the bird (Conover 2002). Because birds associate the calls with a predator, the use of alarm and distress calls are often more effective when paired with effigies that look like predators.

Lasers and lights: WS' personnel could use lasers and lights to disperse double-crested cormorants when low-light conditions exist, such as dispersing double-crested cormorants in the evening as they begin arriving at locations to roost for the night. Glahn et al. (2001) demonstrated that low- to moderately-powered lasers could consistently disperse double-crested cormorants from nighttime roost locations. Glahn et al. (2001) stated, "…[double-crested cormorants] *in the field utilized group avoidance behavior to laser light that presented a novel, highly visible stimuli approaching them. Because groups of* [double-crested cormorants] *moved as the laser light approached them, relatively few birds were contacted with the laser light. In fact, movement of the laser light through the tree branches appeared more likely to elicit avoidance than focusing the light on individual* [double-crested cormorants].

Similarly, lights may be novel stimuli that double-crested cormorants act to avoid. Lights would primarily consist of high-powered spotlights. Lasers and lights have advantages over other dispersal methods because they are silent and WS' personnel can use those methods directly at double-crested cormorants. Therefore, WS' personnel can use those methods is areas where disturbing other wildlife is a concern.

Pyrotechnics: The term "*pyrotechnic*" encompasses a number of commercially available devices that produce a loud noise after firing the device. People may refer to some of the common individual devices as "*bird bombs*", "*screamers*", "*bangers*", "*shell crackers*", or "*CAPA*". The most common pyrotechnics are pyrotechnics that people fire from a pyrotechnic launcher or from a shotgun. Those pyrotechnics fired from a launcher or from a shotgun travel approximately 200 to 300 feet downrange. Some types of pyrotechnics emit a loud whistle as they travel while some travel downrange and then explode with a bang. Pyrotechnics that whistle as they travel and those that explode with a bang after travelling downrange generally emit a 100-decibel report that can startle target animals. A long-range pyrotechnic commercially available can travel approximately 1,000 feet downrange and produce a 150-decibel report. Pyrotechnics are one of the primary methods that WS' personnel use to disperse double-crested cormorants.

Propane cannons: These small cannons operate using propane gas. The user attaches the cannon to a propane tank using a hose. Opening the valve on the propane tank releases propane gas into a bladder system on the propane cannon, which begins to fill with propane gas. Once the bladder system fills, it releases the propane gas into the chamber of the cannon and simultaneously, a striking mechanism produces a spark that ignites the gas causing a loud explosion similar to the sound of a firearm firing. Propane cannons use a timing mechanism that people can adjust to vary how often the cannon fires. For example, propane cannons may be set to fire every five minutes. Some models are capable of being set to produce multiple blasts. For example, the user can set the propane cannon to produce a random series of single, double, or triple blasts. In addition, attachments to propane cannons can allow the user to set when the cannon operates during a day. For example, the user may set the cannon to begin firing in the morning and then shut off in the evening. The user can also fit cannons with mechanisms that allow the cannon to rotate so that each firing occurs from a different direction.

Bow nets: Bow nets are suitcase or basket-type traps that people use to primarily live-capture raptors but WS could use bow nets to live-capture double-crested cormorants. Bow nets consist of two semi-circular bows as a frame with loose netting strung between the bows that the user places on the ground. Hinges and springs connect the two semi-circular bows at their bases with one bow fixed to the ground. The other semi-circular frame is folded and held together with the stake portion by a trigger or release mechanism (Bloom et al. 2007). The user typically places an attractant near the center of the circle to attract raptors; however, for double-crested cormorants, the user would place the bow net to envelope a nest on the ground. Therefore, the nest would act as the attractant. When a double-crested cormorant approaches the nest, the user activates the bow net by a line or electronic mechanism that the user pulls or that personnel trigger while monitoring the trap. When activated, the net envelopes the double-crested cormorant. WS' personnel would be present on site during the use of bow nets to address double-crested cormorants live-captured in the net.

Hand nets: The hand nets that WS' personnel could use would be similar to those used during fishing, such as a dip net or hand-thrown net. Generally, dip nets have netting at one end of a long pole that a user uses to scoop up a target animal. A hand-thrown net would be a net that a WS' employee throws over a double-crested cormorant. Hand-thrown nets typically have weights on the edges of the net. WS' personnel would primarily use hand nets to live-capture double-crested cormorants at nesting locations and dip nets at roosts similar to those situations described by King et al. (1994) and King et al. (2000).

Cannon nets: For purposes of this assessment, the term cannon net will refer to net deployment systems that use rockets, cannons, or compressed air to propel a net over a target area. Rocket nets and cannon nets are projectile-type net traps comprised of three to five rockets or cannons and a large net (*e.g*., 33 x 57 foot with 2-inch square nylon mesh) (Dill and Thornsberry 1950, Cox and Afton 1994). The user would anchor the rear of the net to 5- or 10-pound boat anchors or tied with inner tubes to stakes driven into the ground. Smokeless powder or black powder charges propel the rockets or projectiles in the cannons that a user would ignite with an electric squib inside the charge. The user would place the charges inside the rockets or cannon tubes and tested with a galvanometer for electrical continuity. The user would unspool at least 200 to 350 feet of 18 or larger gauge wire and connect one end to the charges and the other end to a blasting machine. When an adequate number of double-crested cormorants gather in front of the net, the user would charge the blasting machine and fire the net. Firing the blasting machine sends an electrical charge down the wire and ignites the charges in the rockets or cannon tubes, which discharge the net. Pneumatic cannon nets deploy under similar methodology as the cannon or rocket nets but do not use smokeless powder or black powder charges to deploy the net. Pneumatic cannons utilize compressed air to deploy the net. The user also remotely discharges the pneumatic air cannon through push button controls wired to a mechanism that releases the compressed air. WS' personnel would primarily use cannon nets along shorelines or other areas where double-crested cormorants routinely congregate or loaf.

Foothold traps: Another live-capture method that WS' personnel could consider is a modified foothold trap with padded jaws. WS' personnel would modify foothold traps by using padded foothold traps and by removing or weakening springs on the trap so that when the jaws snap shut on the leg of a double-crested cormorant, the jaws do not injure the double-crested cormorant. WS' personnel would primarily use modified foothold traps at nest locations to capture double-crested cormorants as they approach their nest. WS' personnel would be present on site during the use of foothold traps to address double-crested cormorants live-captured in traps.

Nest destruction: The destruction of nests involves the removal of nesting materials during the construction phase of the nesting cycle. Nest destruction could also occur after destroying eggs in the nests or after euthanizing nestlings in the nest.

Aircraft: Surveying wildlife from an aircraft is a commonly used tool for evaluating and monitoring damage and establishing population estimates and locations of various species of wildlife. WS could use fixed-winged aircraft and/or helicopters to conduct surveys to locate and/or estimate the number of double-crested cormorants in areas of the state. For example, WS could use fixed-winged aircraft to identify locations where double-crested cormorants roost or conduct roost surveys to estimate the number of double-crested cormorants using a roost. The low-level flights would primarily occur in the fall and during the winter when the number of double-crested cormorants present in the state increases. Surveying could involve circling an area as an observer counts the number of double-crested cormorants present in the area.

WS could also use fixed-winged aircraft and/or helicopters to identify movement patterns of double-crested cormorants. For example, WS' personnel could place radio-transmitting collars on double-crested cormorants and then monitor their movements over a specified period. In general, WS' personnel would then attempt to locate the double-crested cormorant using a hand-held antennae and radio receiver from the ground; however, occasionally double-crested cormorants could travel long distances that would prevent biologists from locating the double-crested cormorant from the ground. In those situations, WS may utilize either fixed wing aircraft or helicopters and elevation to conduct aerial telemetry and locate the specific double-crested cormorant wherever it has moved to.

Unmanned aircraft are receiving increasing attention as a wildlife management tool (Watts et al. 2010, Koh and Wich 2012, Martin et al. 2012). Unmanned aircraft generally produce less noise, use less fuel, and are generally less expensive to operate than manned aircraft (Watts et al. 2010). As with manned aircraft, WS' personnel could use unmanned aircraft to locate and survey areas for double-crested cormorants. In addition, WS could use unmanned aircraft to haze double-crested cormorants.

II. LETHAL METHODS WILDLIFE DAMAGE MANAGEMENT METHODS

In addition to the use of non-lethal methods, WS' personnel could also use lethal methods. The only lethal methods WS is considering are egg destruction, the use of a firearm, cervical dislocation, and the release of carbon dioxide inside a chamber. The lethal removal of double-crested cormorants by WS would only occur when authorized by the USFWS and only at levels authorized. In addition, WS would only use those lethal methods authorized by the USFWS.

Egg destruction: WS' personnel could make eggs of double-crested cormorants unviable in several different ways. Egg destruction would involve puncturing an egg, breaking an egg, shaking an egg, or oiling an egg. WS' personnel could occasionally puncture eggs to make the egg unviable. When puncturing an egg, a person holds the egg securely in a hand that they brace against the ground and then they insert a long, thin metal probe into the pointed end of the egg with slow steady pressure. The person inserts the probe all of the way through the egg until the tip hits against the inside of the shell at the opposite side of entry. While the person has the probe inserted into the egg, the egg is swirled in a circular motion to emulsify the yolk sac, ensuring the embryo is unviable. After removing the metal probe from the egg, a person can seal the puncture hole with a small amount of glue to prevent the contents of the egg from leaking out of the egg. WS' personnel can then place the egg back in the nest so the double-crested cormorants continue to incubate the egg.

WS' personnel could destroy eggs by manually gathering the eggs and breaking them open or by vigorously shaking an egg numerous times, which causes the embryo to detach from the egg sac. Egg oiling involves spraying a small quantity of food grade corn oil on eggs in a nest. The oil prevents exchange of gases through the eggshell and causes asphyxiation of developing embryos. Puncturing eggs, shaking eggs, or oiling eggs often has advantages over breaking an egg open because the adults generally continue to incubate the egg and do not re-nest. The United States Environmental Protection Agency has ruled that use of corn oil for this purpose is exempt from registration requirements under the Federal Insecticide, Fungicide, and Rodenticide Act.

Firearm: WS' personnel could use shotguns or rifles to lethally remove and/or harass double-crested cormorants. Firearms are mechanical methods that WS could use to remove a double-crested cormorant lethally and to reinforce the noise associated with non-lethal methods, such as pyrotechnics or propane cannons. In addition, the noise associated with discharging a firearm can disperse double-crested cormorants. As appropriate, WS' personnel would use suppressed firearms to minimize noise impacts. Pursuant to the standard conditions included with the current depredation permit issued to WS, when using a shotgun, WS' personnel would not use shotguns larger than 10-gauge. In addition, when using shotguns, WS would use non-toxic shot as listed in 50 CFR 20.21(j). When using rifles, WS could use ammunition that contains lead. WS' personnel would retrieve the carcasses of double-crested cormorants to the extent possible and would dispose of the carcasses in accordance with WS Directive 2.515. As noted for pyrotechnics, some commercially available pyrotechnics require the use of a shotgun to fire the pyrotechnic.

Cervical Dislocation: When used by trained personnel, cervical dislocation is a way to euthanize bird species after capturing those birds alive using other methods. The user would stretch the bird and then hyperextend and dorsally twist the neck to separate the first cervical vertebrae from the skull, which may cause the rapid loss of consciousness.

Carbon dioxide: Carbon dioxide is another method that WS' personnel may use to euthanize double-crested cormorants after personnel live-capture those double-crested cormorants using other methods. After capture, WS' personnel would place a double-crested cormorant into a container or chamber that personnel seal shut. WS' personnel would then slowly release carbon dioxide gas into the container or chamber. The carbon dioxide gas would begin to displace oxygen in the container or chamber. At high concentrations, inhaling carbon dioxide can induce anesthesia initially followed by loss of consciousness in bird species.

APPENDIX C
STATE LISTED THREATENED AND ENDANGERED SPECIES IN MISSISSIPPI

MISSISSIPPI NATURAL HERITAGE PROGRAM

Listed Species of Mississippi

- 2015 -

SPECIES NAME	COMMON NAME	GLOBAL RANK	STATE RANK	FEDERAL STATUS	STATE STATUS
BIVALVIA					
Actinonaias ligamentina	Mucket	G5	S1		LE
Cyclonaias tuberculata	Purple Wartyback	G5	S1		LE
Elliptio arctata	Delicate Spike	G3G4	S1		LE
Elliptio dilatata	Spike	G5	S1		LE
Epioblasma brevidens	Cumberlandian Combshell	G1	S1	(LE,XN)	LE
Epioblasma penita	Southern Combshell	G1	S1	LE	LE
Epioblasma triquetra	Snuffbox	G3	S1	LE	LE
Hamiota perovalis	Orange-Nacre Mucket	G2	S1	LT	LE
Medionidus acutissimus	Alabama Moccasinshell	G2	S1	LT	LE
Plethobasus cyphyus	Sheepnose	G3	S1	LE	LE
Pleurobema curtum	Black Clubshell	G1	SX	LE	LE
Pleurobema decisum	Southern Clubshell	G2	S1	LE	LE
Pleurobema marshalli	Flat Pigtoe	GH	SX	LE	LE
Pleurobema perovatum	Ovate Clubshell	G1	S1	LE	LE
Pleurobema rubrum	Pyramid Pigtoe	G2	S1		LE
Pleurobema taitianum	Heavy Pigtoe	G1	SX	LE	LE
Pleuronaia dolabelloides	Slabside Pearlymussel	G2	S1	LE	LE
Potamilus capax	Fat Pocketbook	G1	S1	LE	LE
Potamilus inflatus	Inflated Heelsplitter	G1G2Q	SH	LT	LE
Ptychobranchus fasciolaris	Kidneyshell	G4G5	S1		LE
Quadrula cylindrica cylindrica	Rabbitsfoot	G3T3	S1	LT	LE
Quadrula metanevra	Monkeyface	G4	SX		LE
Quadrula stapes	Stirrupshell	GH	SX	LE	LE
MALACOSTRACA					
Fallicambarus gordoni	Camp Shelby Burrowing Crawfish	G1	S1	C	LE
INSECTA					
Nicrophorus americanus	American Burying Beetle	G2G3	SX	LE	LE
Neonympha mitchellii mitchelli	Mitchell's Satyr	G2T2	S1	LE	LE
OSTEICHTHYES					
Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	S1	LT	LE
Scaphirhynchus albus	Pallid Sturgeon	G1	S1	LE	LE
Scaphirhynchus suttkusi	Alabama Sturgeon	G1	SH	LE	LE
Notropis boops	Bigeye Shiner	G5	S1		LE
Notropis chalybaeus	Ironcolor Shiner	G4	S1		LE
Phenacobius mirabilis	Suckermouth Minnow	G5	S1		LE
Phoxinus erythrogaster	Southern Redbelly Dace[1]	G5	S2		LE
Crystallaria asprella	Crystal Darter	G3	S1		LE
Etheostoma blennioides	Greenside Darter	G5	S1		LE
Etheostoma rubrum	Bayou Darter	G1	S1	LT	LE

MISSISSIPPI NATURAL HERITAGE PROGRAM

Listed Species of Mississippi

- 2015 –

SPECIES NAME	COMMON NAME	GLOBAL RANK	STATE RANK	FEDERAL STATUS	STATE STATUS
Percina aurora	Pearl Darter	G1	S1	C	LE
Percina phoxocephala	Slenderhead Darter	G5	S1		LE
Noturus exilis	Slender Madtom	G5	S1		LE
Noturus munitus	Frecklebelly Madtom	G3	S2		LE
Noturus gladiator	Piebald Madtom	G3	S1		LE
AMPHIBIA					
Rana sevosa	Dusky Gopher Frog	G1	S1	LE	LE
Amphiuma pholeter	One-Toed Amphiuma	G3	S1		LE
Cryptobranchus alleganiensis	Hellbender	G3G4	S1	(PS)	LE
Aneides aeneus	Green Salamander	G3G4	S1		LE
Eurycea lucifuga	Cave Salamander	G5	S1		LE
Gyrinophilus porphyriticus	Spring Salamander	G5	S1		LE
REPTILIA					
Drymarchon corais couperi	Eastern Indigo Snake	G3	SX	LT	LE
Farancia erytrogramma	Rainbow Snake	G5	S2		LE
Heterodon simus	Southern Hognose Snake	G2	SX		LE
Pituophis melanoleucus lodingi	Black Pine Snake	G4T3	S2	C	LE
Caretta caretta	Loggerhead; Cabezon	G3	S1B,SNA	LT	LE
Chelonia mydas	Green Turtle	G3	SNA	(LE,LT)	LE
Eretmochelys imbricata	Hawksbill; Carey	G3	SNA	LE	LE
Lepidochelys kempii	Kemp's Or Atlantic Ridley	G1	S1N	LE	LE
Dermochelys coriacea	Leatherback; Tinglar	G2	SNA	LE	LE
Graptemys flavimaculata	Yellow-Blotched Map Turtle	G2	S2	LT	LE
Graptemys nigrinoda	Black-Knobbed Map Turtle	G3	S2		LE
Graptemys oculifera	Ringed Map Turtle	G2	S2	LT	LE
Pseudemys alabamensis	Alabama Redbelly Turtle	G1	S1	LE	LE
Gopherus polyphemus	Gopher Tortoise	G3	S2	(PS:LT)	LE
AVES					
Charadrius nivosus	Southeastern Snowy Plover	G4T3Q	S2		LE
Charadrius melodus	Piping Plover	G3	S2N	(LE,LT)	LE
Sternula antillarum athalassos	Interior Least Tern[3]	G4T2Q	S2B	(PS:LE)	LE
Calidris canutus	Red Knot	G5	S2N	LT	
Mycteria americana	Wood Stork	G4	S2N	(PS:LT)	LE
Falco peregrinus	Peregrine Falcon	G4	S1N		LE
Grus canadensis pulla	Mississippi Sandhill Crane	G5T1	S1	LE	LE
Vermivora bachmanii	Bachman's Warbler	GH	SXB	LE	LE
Thryomanes bewickii	Bewick's Wren	G5	S2B,S3N		LE
Pelecanus occidentalis	Brown Pelican	G4	S1N		LE
Campephilus principalis	Ivory-Billed Woodpecker	GH	SX	LE	LE
Picoides borealis	Red-Cockaded Woodpecker	G3	S1	LE	LE

SPECIES NAME	COMMON NAME	GLOBAL RANK	STATE RANK	FEDERAL STATUS	STATE STATUS
MAMMALIA					
Puma concolor coryi	Florida Panther	G5T1	SX	LE	LE
Ursus americanus	Black Bear	G5	S1	(PS)	LE
Ursus americanus luteolus	Louisiana Black Bear	G5T2	S1	LT	LE
Myotis grisescens	Gray Myotis	G3	S1	LE	LE
Myotis sodalis	Indiana Or Social Myotis	G2	S1B	LE	LE
Trichechus manatus	Manatee	G2	SZ	LE	LE
PLANTS [3]					
DICOTYLEDONEAE					
Apios priceana	Price's Potato Bean	G2	S1	LE	
Lindera melissifolia	Pondberry	G2	S2	LE	
Schwalbea americana	Chaffseed	G3	SH	LE	
ISOETOPSIDA					
Isoetes louisianensis	Louisiana Quillwort	G3	S2	LE	

[1] *West Mississippi disjunct populations only.*

[2] *Interior populations nesting along the Mississippi River only.*

[3] *Mississippi has no status concerning endangered plants.*

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