ENVIRONMENTAL ASSESSMENT

BIRD DAMAGE MANAGEMENT IN COLORADO

Prepared by:

UNITED STATES DEPARTMENT OF AGRICULTURE

WILDLIFE SERVICES

In Cooperation with:

Colorado Parks and Wildlife
Colorado Department of Agriculture
Colorado Department of Public Health and Environment
Colorado Department of Transportation
United States Fish and Wildlife Service
United States Forest Service
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United States Department of Defense
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EXECUTIVE SUMMARY

In Colorado, wildlife are considered an integral part of the social fabric that comprises the human environment. Abundant wildlife populations interact with close to 5.7 million citizens within the state every day. These animals elicit a multitude of human emotions including: joy, happiness, a greater since of personal well-being, and at times can cause frustration, anxiety, and anger. On rare occasions, people are injured or killed by animals as a result of negative human-wildlife conflicts which are often preceded by illegal feeding. The United States Department of Agriculture, Wildlife Services program (WS) partners with Colorado Parks and Wildlife (CPW), Colorado Department of Agriculture (CDA), Colorado Department of Public Health and Environment (CPDHE), Colorado Department of Transportation (CDOT), U.S. Fish and Wildlife Service (USFWS), U. S. Forest Service (USFS), Bureau of Land Management (BLM), the Department of Defense (DoD), the Federal Aviation Administration (FAA), and other state and federal agencies to manage wildlife populations for the enjoyment of both residents and visitors throughout Colorado. This environmental assessment analyzes the potential environmental impacts of four alternatives for the United States Department of Agriculture (USDA), Wildlife Services Program in Colorado (WS-Colorado) to resolve damage associated with bird species/populations. This damage abatement plan and analysis includes threats to human health and safety, agricultural resources, natural resources (including threatened and endangered species and wildlife species of management concern), property, and disease threats. The proposed wildlife damage management activities would be conducted on private, public, and tribal lands when the property owner or manager requests assistance.

We have identified several species of birds that have the potential to be the subject of Wildlife Services Bird Damage Management activities (BDM) in Colorado including: **blackbirds** (blackbirds, cowbirds, and grackles), **introduced/invasive commensal birds** (feral or Rock pigeons[1], Eurasian collared-dove, European starlings, hereafter noted as starlings for brevity, House sparrows, feral poultry (emus, chickens, peafowl, and guineas), **corvids** (jays, magpies, crows, and ravens), **raptors** (hawks, eagles, kites, harriers, accipiters, vultures, owls, and shrikes), **larids** (gulls and terns), **shorebirds** (plovers, sandpipers, and allies), **wading birds** (herons, egrets, ibis, and bitterns), **waterbirds** (loons, grebes, cormorants, pelicans, and kingfishers), **grassland species** (meadowlarks, buntings, kingbirds, horned larks, pipits, dickcissels, bobolinks, longspurs, orioles, and goldfinches), **native doves and pigeons**, **aerialists** (swifts and swallows), **woodpeckers**, **gallinaceous birds** (pheasant, prairie-chicken, turkey, and quail), **frugivorous birds** (robins, waxwings, and finches), and other **miscellaneous birds** such as hummingbirds and wrens which usually are not involved in damage (many of these requests involve injured birds, birds that get indoors and cannot escape, or nests built in inopportune areas).

Bird species are primarily classified based on the best fit related to BDM (*e.g*., grassland passerines are species that are often encountered at airports). Several of these species may cause localized or seasonal damage to more than one resource, whereas other species impact valuable agricultural and natural resources throughout the year. Other avian species addressed in this environmental assessment rarely are involved in damage but, are analyzed for population level impacts should they inadvertently be captured or lethally removed.

The proposed action (**Alternative 1**) continues the current WS-Colorado Bird Damage Management (BDM) activities that employs a range of practical, scientifically based, nonlethal and lethal methods (in accordance with applicable federal, state, and local statutes) to resolve human-wildlife conflicts. WS-Colorado's BDM activities focuses on protecting human health and safety, property, agriculture, and natural resources from damage or threats of damage associated with avian species.

Wildlife Services personnel directly perform or provide BDM technical expertise to over 76 airports and military installations throughout the state. BDM at these locations largely involves hazing individuals or groups of birds away from sensitive areas (e.g., runways, flight lines) and, to a lesser extent, live trapping, translocating, or lethally

[1] Rock Pigeons in North America were actually from domestic stocks brought to the United States by early settlers and escaped (Johnston 1992). Therefore, they are truly feral domestic pigeons with less genetic variability than wild Rock Pigeons, the species they are derived from, and are referred to as feral or domestic pigeons or Rock Pigeons in this EA. This is similar to the most common domestic ducks which were derived from wild Mallards and Muscovy Ducks (both wild and feral populations exist in Colorado of these two species).

removing large bird species that are of greater risk to cause damage to aircraft (e.g., raptors, geese). These activities protect and preserve the lives of the public, flight crew, and passengers while reducing damage to aircraft as a result of a catastrophic bird strike. Other BDM activities protect Colorado's agricultural crop and livestock (including aquaculture) producers from economically debilitating bird damage. Agricultural BDM requests for assistance involve predation (livestock including aquaculture, crops), disease transmission, and/or fecal contamination (livestock feed or crops). While incidents are primarily resolved through technical assistance, additional services may be provided in the event of a disease outbreak.

Wildlife Services personnel have assisted in threatened and endangered species or species of management concern recovery in the past. This environmental assessment would allow the program to continue to assist in recovery of theses species (e.g. sage grouse).

Numerous property resources are affected by birds and the damage they can cause. While bird damage to property can be alleviated through many different strategies and methods, Wildlife Services will provide technical or operational assistance to land owners and managers. Many types of bird damage to property can be alleviated through hazing, habitat alteration, husbandry, changing human behavior or less often through population management.

As part of a national interagency effort, WS-Colorado frequently conducts wildlife disease surveillance and monitoring. In the past, research and surveillance projects have focused on avian influenza (waterfowl, poultry, game birds) and pathogen detection in raptors captured and translocated at airports. This environmental assessment identifies potential avenues for research that our organization, in collaboration with other wildlife management agencies and local governments, may pursue in the future. We fully support and encourage research project collaborations with local universities, the National Wildlife Research Center, and other agencies aimed at alleviating wildlife damage issues. In the future, WS may participate in additional surveillance projects as warranted by scientifically based research or disease emergence/outbreaks. In the meantime, WS-Colorado will continue to provide technical assistance concerning husbandry practices, implementing no-feed policies, exclusion, hazing, and habitat management practices to abate bird damage at agricultural operations.

Under this alternative, WS-Colorado personnel will continue to provide educational outreach courses to stakeholders and special interest groups. These events serve to educate the public on scientific advancements made in the wildlife damage management field and provide a public forum for professional, scientifically relevant discussions related to human-wildlife conflict resolution. As always, WS-Colorado personnel remain dedicated to identifying multiple solutions for complex wildlife problems and will continue to provide professional technical assistance to resource owners requesting assistance, including completion of Form 37 Migratory Bird Damage Project Reports required for citizens to obtain a federal permit from the Fish and Wildlife Service to legal take a migratory bird to alleviate damage. Our technical assistance activities provide detailed information regarding alternatives available to resource owners/managers, their use, and retail suppliers for this equipment (e.g., propane cannons, pyrotechnics). Lastly, WS-Colorado employs operational damage management activities using an assortment of nonlethal and lethal methods concurrently or sequentially, to alleviate damage associated with wildlife.

Work Plans are developed annually with resource owners and managers to address management activities on public and private lands. For public lands, meetings are held with the US Forest Service and Bureau of Land Management to plan activities, exchange information about wildlife and public use of the national forests and other federal lands, and maintain lines of communication. For community based BDM projects, work plans are negotiated with community elected representatives or are based on a community decision. Work plans for privately owned resources are annually negotiated between a WS representative and the property owner/manager.

The environmental assessment considered 4 alternatives in detail, including:

- **Alternative 1. Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).** This is the Proposed Action as described in **Chapter 1** and **2** and is the No Action

Alternative as defined by the Council on Environmental Quality (40 CFR 1500-1508) for analysis of ongoing programs or activities. Under this action, WS proposes to continue to provide integrated BDM activities.

- **Alternative 2. Nonlethal Bird Damage Management by WS-Colorado Only.** Under this alternative, WS-Colorado would use only nonlethal methods for Bird Damage Management. Also, WS-Colorado would recommend the use of only nonlethal methods.

- **Alternative 3. WS-Colorado Provides Technical Assistance Only for Bird Damage Management.** Under this alternative, WS-Colorado would not conduct operational BDM activities in Colorado. If requested, WS-Colorado would provide affected resource owners with technical assistance information only.

- **Alternative 4. No Federal WS-Colorado Bird Damage Management.** This alternative consists of no federal BDM activities by WS-Colorado.

The environmental assessment provides a detailed analysis of the impacts of each alternative, for the range of issues identified, as relevant to make selections among alternatives by the lead and cooperating agencies. Issues addressed in detail include: impacts on target bird species/ populations; impacts on non-target species populations, including T&E species; impacts on public safety, pets, and the environment; impacts of bird damage management activities on sociocultural resources; and impacts of bird damage management on humaneness and animal welfare concerns. An additional range of issues were discussed with rationale for not addressing the issue(s) in detail for each alternative.

The WS-Colorado program will likely continue the current implementation of an adaptive integrated approach utilizing both nonlethal and lethal techniques, in accordance with the WS Decision Model, to reduce damage and threats associated with individual birds and guilds within Colorado (Slate et al. 1992). Under this alternative, WS-Colorado will primarily provide technical assistance to citizens who request help in abating bird damage. In addition to disseminating information to individuals or stakeholders experiencing damage, WS will provide demonstrations to producers, state and county agents, colleges and universities, and other interested groups. Additionally, technical papers will be presented at professional meetings and conferences so that the public will be informed as to developments in damage management techniques, laws and regulations, agency policies, and activity updates. Technical assistance will primarily consist of collecting information about bird species associated with damage, available methods for alleviating damage, conducting site visits to affected property, written communication, telephone communications, and/or presentations. Operational damage management assistance may be provided when a problem is unable to be alleviated through technical assistance alone and funding is provided. In such instances, WS will obtain signed cooperative service agreements, MOUs, and any other documents required by federal, state, or local government agencies prior to performing operational activities. Preference will be given to the use of nonlethal methods when their use is deemed to be effective and practical in dealing with BDM situations. These methods include but are not limited to: habitat/behavior modification, nest/egg removal, visual deterrents, live traps, relocation, exclusionary devices, frightening devices, and chemical repellents. Possible lethal methods available for use in tandem with nonlethal activities or sequentially include: take during legal hunting seasons, the application of DCR-1339, firearms, pneumatic devices, carbon dioxide exposure, and cervical dislocation. All available lethal methods are considered acceptable forms of euthanasia for free-ranging birds with conditions[2] (AVMA 2013). Some birds may be donated to charitable organizations for human or exhibit animal consumption (e.g., zoo) or as food for wildlife recovering at animal hospitals or rehabilitation facilities.

[2] The AVMA (2013) defines acceptable with conditions as *"A method considered to reliably meet the requirements of euthanasia when specified conditions are met."*

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ACRONYMS USED

AI	Avian Influenza
BBS	Breeding Bird Survey
BDM	Bird Damage Management
BO	Biological Opinion
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
CAFO	Confined Animal Feeding Operation
CBC	Christmas Bird Count
CDA	Colorado Department of Agriculture
CDOT	Colorado Department of Transportation
CFO	Colorado Field Ornithologists
CFR	Code of Federal Regulations
CPW	Colorado Parks & Wildlife
CRS	Colorado Revised Statutes
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FR	Federal Register
FY	Fiscal Year
HP	Highly Pathogenic
IWDM	Integrated Wildlife Damage Management
LD50	Lethal Dose that Orally Kills 50%
MA	Methyl-anthranilate
MBTA	Migratory Bird Treaty Act
MIS	Management Information System
MOU	Memorandum of Understanding
NAS	National Audubon Society
NASS	National Agricultural Statistics Service
NEP	Nonessential Experimental Population
NEPA	National Environmental Policy Act
NHPA	National Historical Preservation Act
NWRC	WS-National Wildlife Research Center
P	Probability
PIF	Partners in Flight
RMBO	Rocky Mountain Bird Observatory
RMS	Rocky Mountain States
SLS	Sodium Lauryl Sulfate
SMC	Species of Management Concern
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
TB	Tuberculosis
TGE	Transmissible Gastroenteritis Virus
USC	U.S. Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WDM	Wildlife Damage Management
WS	Wildlife Services

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

1.1 Purpose and Need

This chapter provides the groundwork for:

- Understanding why wildlife damage occurs and the practice of bird damage management (BDM).
- The framework for this National Environmental Policy Act (NEPA) document, the rationale for preparing an environmental assessment (EA), program goals, and resolutions to be made by WS-Colorado.
- Determining if the proposed WS-Colorado BDM activities have significant impacts on human environment(s) based on previously conducted activities.
- Specifying the roles of federal agencies, state agencies and Tribes in managing damage caused by resident and migratory bird species in Colorado.
- Evaluating the reasons why private, commercial, federal, state, tribal, and local government agencies request assistance from WS-Colorado.
- Relating how WS-Colorado cooperates and assists private and commercial resource owners and federal, tribal, state, and local government agencies in managing bird damage.
- Defining the geographic scope of this environmental assessment (EA) and where WS-Colorado actions occur.
- Assessing the effectiveness and cost-effectiveness associated with BDM in the United States.
- Detailing the notification process used by WS-Colorado to facilitate public involvement during the creation of this EA.
- Considering additional issues and alternatives to managing damage associated with birds in Colorado.

The purpose of this EA is to evaluate the impact of ongoing BDM activities conducted by WS in Colorado in managing damage and threats of damage to human health and safety, property, agricultural resources, and natural resources associated with bird species listed in **Chapter 1**. The analysis in this EA, will aid in determining if the proposed bird damage management activities could have a significant impact on the quality of the human environment based on previously conducted activities and anticipated requests for assistance by the public and other entities. This EA is intended to apply to actions that may occur within the scope of Colorado as part of a coordinated program between WS, USFWS, USFS, BLM, DoD, FAA, CPW, CDA, CPDHE, CDOT, and other government, tribal, commercial, organizational, or private persons.

Chapter 2 identifies the issues analyzed and describes the proposed action and alternatives evaluated in detail, with the rationale why some alternatives are not considered in detail, as required by the Council on Environmental Quality (CEQ) implementing regulations for NEPA at 40 CFR 1502.14(a). Specifics of applied wildlife damage management (WDM) methodologies are included in **Chapter 2**. **Chapter 3** provides comprehensive comparative analysis of the direct, indirect, and cumulative impacts of the proposed action(s) and alternatives on the quality of the human environment.

Introduction

As human populations encroach, fragment, and or destroy wildlife habitat, human-wildlife interactions will continue to increase in both frequency and magnitude (Soulsbury and White 2015). Not surprisingly, at a local and state level, as wildlife populations increase in abundance due to low numbers of natural predators, a lack of hunting, excellent breeding habitat conditions, habituation to human disturbance, abundant food resources, augmented survival rates of offspring, and longer life-spans than those normally seen in rural areas Colorado residents will continue to request assistance in resolving human-wildlife conflicts (Adams and Lindsey 2010). Within Colorado, the population has increased from 1.32 million (1950) to 5.7 million (2019) with an average of 52 people per square mile (World Population Review 2019). This gradual urbanization, has led to fundamental land use changes across Colorado, especially along the Front Range, and has the potential for increased human/wildlife interactions; justifying the need

for WDM. This EA evaluates the conceivable environmental impacts under each alternative for Wildlife Services-Colorado (WS-Colorado's) involvement in BDM throughout the state.
Wildlife is a shared resource in North America and is managed cooperatively by both state and federal agencies with regards to the public's interest. The US Department of Agriculture (USDA), Wildlife Services (WS) program is the federal agency authorized to protect American resources from damage associated with wildlife {The Acts of March 2, 1931, as amended, and December 22, 1987, 7 U.S.C. §§ 8351-8353}.

WS utilized a combination of both nonlethal techniques (cultural practices, habitat management, repellents, frightening devices, and physical exclusion) and lethal techniques to prevent or reduce damage caused by individual animals or localized populations. In certain situations, the ultimate goal may be to eradicate an invasive species within the state. Activities are performed to reduce damage and hazards to humans, and to protect livestock health and safety, agricultural resources, property, and natural resources as part of the WS Decision Model (Slate et al. 1992).

WS supports local government entities and communities by alleviating damage caused by, or associated with, wildlife through the implementation of WDM procedures. Wildlife damage management is the science of reducing damage or other problems associated with wildlife behavior, and is recognized as an integral part of wildlife management (The Wildlife Society 2015). This profession is a delicate balance of preserving rare species, regulating species populations, monitoring the consumptive uses of wildlife, and preserving both wildlife habitat and the environment in the midst of wildlife and human populations while preserving social sensitivities.

1.2 In Brief, What is this Environmental Assessment About?

The purpose of this EA is to analyze the impacts of WS's integrated bird damage management (BDM) activities on the human environment, specifically within Colorado, as a result of managing damage associated with bird species or species groups, and by conducting disease surveillance in wild bird populations. This EA examines the current impact(s) of BDM in Colorado, as well as future requests for assistance, and evaluates 4 alternative approaches to performing these activities. We thoroughly discuss the impacts associated with continuing our BDM on all land classes, including federal, tribal, state, county, municipal, airports, and private properties in rural, urban and suburban areas where WS-Colorado personnel have been and may be requested to assist, based on agreements between WS-Colorado and the requesting entity. From this point, we will refer to the overall strategies and approaches used by WS-Colorado as "BDM."

The need for BDM action in Colorado arises from requests for assistance related to five major resources including: human health and safety, agriculture, property, natural resources (including threatened and endangered species) and disease threats. BDM is an integral component of WS-Colorado's activities. WS-Colorado has identified bird species most likely to pose a threat to or damage pertinent resources (**Table 1.1, 1.2, 1.3, 1.4**). BDM assistance is provided statewide and is available upon request by resource owners and managers. For the Federal Fiscal Year (FY) 2013 to 2017 (a fiscal year is September 30 to October 31) we provided technical and operational assistance involving 25,756 requests: 20,481 (80%) aviation safety; 2,757 (11%) disease surveillance; 1,750 (7%) property damage; 397 (2%) conflicts involving feedlots, dairies or CAFOs; 236 (1%) human health and safety; 86 (<1%) aquaculture; 25 (<1%) protect crops or pasture; 13 (<1%) farm-raised game birds or poultry; and 11 (<1%) threatened or endangered species or bird species of management concern. During the 5-year period, FY2013-2017, BDM was conducted on 888,815 acres of land statewide comprised of 554,428 acres of county or city land (62%); 281,551 acres private land (32%); 27,395 acres Department of Defense lands (3%); 25,000 acres federal public lands (3%); 251 acres other public lands (<1%); and 192 acres state land (<1%). The State of Colorado encompasses about 104,000 mi^2 (66,635,566 acres) in 64 Counties (**Figure 1.2**). The human population has grown from 1.75 million citizens in 1960 to 5.5 million citizens in 2016 making Colorado the second fastest growing state (Murphy 2016, Census Scope 2001). Thus, BDM is conducted on 1.3% of the land area of the State of Colorado.

The Colorado Field Ornithologists (CFO) lists 503 species of wild birds that have been documented in Colorado (CFO 2017) and these are listed in taxonomic order as given in the American Ornithologists Union (2017). Colorado has 309 species of birds that reside for some part of the year in Colorado. Additionally, almost 192 more species have been accidentally seen inside the state from outside their normal range. Most will not be the focus of a BDM project, but all are listed in the following Tables to let readers know the diversity of birds in the state. WS - Colorado expects to conduct BDM for relatively few of these species and anticipates that BDM will have minimal effect, if any, on species in Colorado and the Central and Pacific BBS Regions.

Table 1.1. Bird Species in Colorado. Common and scientific names are given for the 199 wild bird species that typically reside for some part of the year in Colorado (as recorded by Colorado Field Ornithologists), that have the potential of being involved in a BDM project. Most of these species, however, will be targeted only if they occur within airport environments and present a risk of an aircraft bird strike, which threatens human health and safety. Outside the airport environment, WS-Colorado is likely to receive requests for BDM assistance for 98 species of birds. WS-Colorado may receive requests to provide BDM assistance for any of the species listed in the EA. If the species has the potential to be involved in a request for assistance other than BDM at airports, it is noted (as referenced by superscript numbers). *All data from tables based on the American Ornithologists Union, Colorado Field Ornithologist, National Audubon Society, and the U.S. Fish and Wildlife Service 2008; 2016.

Species	*Scientific Name**	Status
Order Anseriformes - Waterfowl		
American Wigeon[6]	*Mareca americana*	R
Blue-winged Teal	*Spatula discors*	S
Bufflehead[1]	*Bucephala albeola*	W
Cackling Goose[2]	*Branta hutchinsii*	W
Canada Goose[2,4,5,6]	*Branta canadensis*	R
Canvasback	*Aythya valisineria*	W
Cinnamon Teal	*Spatula cyanoptera*	S
Common Goldeneye[1]	*Bucephala clangula*	W
Common Merganser[1]	*Mergus merganser*	R
Gadwall	*Mareca strepera*	R
Greater White-fronted Goose[2]	*Anser albifrons*	M
Green-winged Teal	*Anas crecca*	R
Hooded Merganser[1]	*Lophodytes cucullatus*	M
Lesser Scaup	*Aythya affinis*	W
Mallard[2,4,5,6]	*Anas platyrhynchos*	S
Northern Pintail	*Anas acuta*	R
Northern Shoveler	*Spatula clypeata*	R
Red-breasted Merganser[1]	*Mergus serrator*	M
Redhead	*Aythya americana*	R AR
Ring-necked Duck[1]	*Aythya collaris*	W
Ross's Goose[2]	*Anser rossii*	M
Ruddy Duck	*Oxyura jamaicensis*	S
Snow Goose[2]	*Anser caerulescens*	M
Tundra Swan[2]	*Cygnus columbianus*	M
Wood Duck[2]	*Aix sponsa*	R
Order Galliformes – Pheasants, Grouse, Turkeys, and Quail		
Chukar	*Alectoris chukar*	R
Dusky Grouse	*Dendragapus obscurus*	R
Gambel's Quail	Callipepla gambelii	R
Greater Prairie-Chicken	*Tympanuchus cupido*	R
Greater Sage-Grouse	*Centrocercus urophasianus*	R FC SC AR
Gunnison Sage-Grouse	*Centrocercus minimus*	R FC SC
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	R FC **ST ES**
Northern Bobwhite[2]	*Colinus virginianus*	R
Ring-necked Pheasant[2]	*Phasianus colchicus*	R
Scaled Quail	*Callipepla squamata*	R AY
Sharp-tailed Grouse	*Tympanuchus phasianellus*	R SE*SC**
White-tailed Ptarmigan	*Lagopus leucura*	R
Wild Turkey[2]	*Meleagris gallopavo*	R
Family Gavidae - Loons		
Common Loon[1]	*Gavia immer*	M
Family Podicipedidae - Grebes		
Clark's Grebe[1]	*Aechmophorus clarkii*	S AY
Eared Grebe[1]	*Podiceps nigricollis*	S
Horned Grebe[1]	*Podiceps auritus*	M
Pied-billed Grebe[1]	*Podilymbus podiceps*	R
Western Grebe[1]	*Aechmophorus occidentalis*	S
Order Suliformes– Frigatebirds, Boobies, and Cormorants		
Double-crested Cormorant[1]	*Phalacrocorax auritus*	S
Black-crowned Night-Heron[1,4,6]	*Nycticorax nycticorax*	S
Cattle Egret[1,4,6]	*Bubulcus ibis*	S
Great Blue Heron[1]	*Ardea herodias*	R
Great Egret[1,4,6]	*Ardea alba*	M
Green Heron[1]	*Butorides virescens*	S
Snowy Egret[1,4,6]	*Egretta thula*	S
White-faced Ibis	*Plegadis chihi*	S
Yellow-crowned Night-Heron	*Nyctanassa ciolacea*	M
Order Acciptriformes – Vultures, Osprey, Kites, Hawks, and Eagles		
Bald Eagle[1, 2]	*Haliaeetus leucocephalus*	R SC BC AR
Cooper's Hawk[3]	*Accipiter cooperii*	R
Ferruginous Hawk	*Buteo regalis*	R SC BC
Golden Eagle[3]	*Aquila chrysaetos*	R BC
Mississippi Kite[4]	*Ictinia mississippiensis*	S
Northern Goshawk	*Accipiter gentilis*	R
Northern Harrier	*Circus cyaneus*	R
Osprey[1]	*Pandion haliaetus*	S
Red-tailed Hawk[3]	*Buteo jamaicensis*	R
Rough-legged Hawk	*Buteo lagopus*	W
Sharp-shinned Hawk[3]	*Accipiter striatus*	R
Swainson's Hawk	*Buteo swainsoni*	S AR
Turkey Vulture[3,4,6]	*Cathartes aura*	S
Order Falconiformes –Caracaras, Falcons		
American Kestrel	*Falco sparverius*	R
Merlin	*Falco columbarius*	W
Peregrine Falcon	*Falco peregrinus*	R SC# BC
Prairie Falcon	*Falco mexicanus*	R BC
Order Gruiformes – Rails and Cranes		
American Coot[6]	*Fulica americana*	R
Sandhill Crane[2]	*Antigone canadensis*	S SC## AY
Order Charadriiformes – Shorebirds, Gulls, and Terns		
American Avocet	*Recurvirostra americana*	S
American Golden-Plover	*Pluvialis dominica*	M AY
Baird's Sandpiper	*Calidris bairdii*	M
Black Tern[1]	*Childonias niger*	S
Black-bellied Plover	*Pluvialis squatarola*	M
Black-necked Stilt	*Himantopus mexicanus*	S
Bonaparte's Gull[1,4]	*Chroicocephalus philadelphia*	M
California Gull[1,4,6]	*Larus californicus*	S
Caspian Tern[1]	*Hydroprogne caspia*	M
Common Tern[1]	*Sterna hirundo*	M AY
Dunlin	*Calidris alpina*	M
Forster's Tern[1]	*Sterna forsteri*	S
Franklin's Gull[1,4]	*Leucophaeus pipixcan*	M
Greater Yellowlegs	*Tringa melanoleuca*	M
Herring Gull[1,4]	*Larus argentatus*	W
Killdeer	*Charadrius vociferus*	S
Least Sandpiper	*Calidris minutilla*	M
Lesser Yellowlegs	*Tringa flavipes*	M
Long-billed Curlew	*Numenius americanus*	S SC BC AR
Long-billed Dowitcher	*Limnodromus scolopaceus*	M

Order Pelecaniformes – Pelicans, Egrets, Herons, and Ibises		
American Bittern[1]	*Botaurus lentiginosus*	S BC
American White Pelican[1]	*Pelecanus erythrorhynchos*	S

Marbled Godwit	*Limosa fedoa*	M AY
Mountain Plover	*Charadrius montanus*	S **FT** SC

Pectoral Sandpiper	*Calidris melanotos*	M
Piping Plover	*Charadrius melodus*	M **FT ST AR**
Red-necked Phalarope	*Phalaropus lobatus*	M
Ring-billed Gull[1,4,6]	*Larus delawarensis*	M
Ruddy Turnstone	*Arenaria interpres*	M AR
Sanderling	*Calidris alba*	M
Semipalmated Plover	*Charadrius semipalmatus*	M
Semipalmated Sandpiper	*Calidris pusilla*	M
Short-billed Dowitcher	*Limnodromus griseus*	M AR
Snowy Plover	*Charadrius nivosus*	S SC BC AY
Solitary Sandpiper	*Tringa solitaria*	M
Spotted Sandpiper	*Actitus macularius*	S
Stilt Sandpiper	*Calidris himantopus*	M AY
Upland Sandpiper	*Bartramia longicauda*	S BC
Western Sandpiper	*Calidris mauri*	M
Whimbrel	*Numenius phaeopus*	M
White-rumped Sandpiper	*Calidris fuscicollis*	M AY
Willet	*Catoptrophorus semipalmatus*	M
Wilson's Phalarope	*Phalaropus tricolor*	S
Wilson's Snipe	*Gallinago delicata*	R
Order Columbiformes– Doves and Pigeons		
Band-tailed Pigeon[2]	*Columba fasciata*	S
Eurasian Collared Dove[6]	*Streptopelia decaocto*	R
Mourning Dove[2]	*Zenaida macroura*	R
Rock Pigeon[2,3,4,5,6]	*Columba livia*	R
White-winged Dove[2]	*Zenaida asiatica*	M
Order Cuculiformes – Cuckoos, Roadrunners, Anis		
Greater Roadrunner[5]	*Geococcyx californianus*	R
Order Strigiformes - Owls		
Barn Owl[4,6]	*Tyto alba*	R
Burrowing Owl	*Athene cunicularia*	S **ST** BC
Great Horned Owl[3]	*Bubo virginianus*	R
Long-eared Owl	*Asio otus*	R
Short-eared Owl	*Asio flammeus*	R AY
Order Caprimulgiformes - Goatsuckers		
Common Nighthawk	*Chordeiles minor*	S
Order Apodiformes – Swifts, Hummingbirds		
Black Swift	*Cypseloides niger*	S AY
Chimney Swift[4,6]	*Chaetura pelagica*	S
White-throated Swift	*Aeronautes saxatalis*	S
Order Coraciiformes - Kingfishers		
Belted Kingfisher[1]	*Megaceryle alcyon*	R
Order Piciformes - Woodpeckers		
American Three-toed Woodpecker[2,6]	*Picoides dorsalis*	R
Downy Woodpecker[2]	*Picoides pubescens*	R
Hairy Woodpecker[2]	*Picoides villosus*	R
Lewis's Woodpecker[6]	*Melanerpes lewis*	R BC AR
Northern Flicker[2,6]	*Colaptes auratus*	R
Red-headed Woodpecker[2,6]	*Melanerpes erythrocephalus*	S AY
Red-naped Sapsucker[2,6]	*Sphyrapicus nuchalis*	S
Williamson's Sapsucker[6]	*Sphyrapicus thyroideus*	S AY
Yellow-bellied Sapsucker[2,6]	*Sphyrapicus varias*	M
Order Passeriformes – Perching Birds		
Family Tyrannidae – Flycatchers		
Cassin's Kingbird	*Tyrannus vociferans*	S
Eastern Kingbird	*Tyrannus tyrannus*	S
Eastern Phoebe	*Sayornis phoebe*	S
Say's Phoebe	*Sayornis saya*	S
Western Kingbird	*Tyrannus verticalis*	S
Family Laniidae – Shrikes		
Loggerhead Shrike	*Lanius ludovicianus*	R
Northern Shrike	*Lanius excubitor*	W
Family Corvidae – Crows and Jays		

*T. p. jamesii **T. p. columbianus

#F. p. anatum ##-G. c. tabida

American Crow[2,3,4,6]	*Corvus brachyrhynchos*	R
Black-billed Magpie[2,3,4,5,6]	*Pica hudsonia*	R
Blue Jay[2,4,6]	*Cyanocitta cristata*	R
Chihuahuan Raven[2,3,4,5,6]	*Corvus cryptoleucus*	S
Clark's Nutcracker[2,4,6]	*Nucifraga columbiana*	R
Common Raven[2,3,4,5,6]	*Corvus corax*	R
Gray Jay[2,4,6]	*Perisoreus canadensis*	R
Pinyon Jay[2,4,6]	*Gymnorhinus cyanocephalus*	R BC AY
Steller's Jay[2,4,6]	*Cyanocitta stelleri*	R
Woodhouse's Scrub-Jay[2,4,6]	*Aphelocoma woodhouseii*	R
Family Alaudidae - Larks		
Horned Lark	*Eremophila alpestris*	R
Family Hirundinidae - Swallows		
Bank Swallow	*Riparia riparia*	S
Barn Swallow[3,6]	*Hirundo rustica*	S
Cave Swallow[6]	*Petrochelidon fulva*	
Cliff Swallow[6]	*Petrochelidon pyrrhonota*	S
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	S
Purple Martin[6]	*Progne subis*	S
Tree Swallow[6]	*Tachycineta bicolor*	S
Violet-green Swallow	*Tachycineta thalassina*	S
Family Turdidae – Robins and Thrushes		
American Robin[2]	*Turdus migratorius*	R
Family Mimidae – Mockingbirds and Thrashers		
Northern Mockingbird[4]	*Mimus polyglottos*	S
Family Sturnidae - Starlings		
European Starling[2,3,4,5,6]	*Sturnus vulgaris*	R
Family Motacillidae - Pipits		
American Pipit	*Anthus rubescens*	M
Sprague's Pipit	*Anthus spragueii*	M
Family Bombycillidae - Waxwings		
Bohemian Waxwing	*Bombycilla garralus*	W
Cedar Waxwing[2]	*Bombycilla cedrorum*	W
Family Calcariidae - Longspurs		
Lapland Longspur	*Calcarius lapponicus*	W
McCown's Longspur	*Rhynchophanes mccownii*	S BC
Snow Bunting	*Plectrophenax nivalis*	W
Family Emberizidae –Sparrows		
American Tree Sparrow	*Spizella arborea*	W
Lark Bunting	*Calamospiza melanocorys*	S BC AY
Savannah Sparrow	*Passerculus sandwichensis*	S
White-crowned Sparrow	*Zonotrichia leucophrys*	S
Family Cardinalidae - Cardinals		
Northern Cardinal[4]	*Cardinalis cardinalis*	S
Dickcissel	*Spiza americana*	S
Family Icteridae – Blackbirds and Meadowlarks		
Bobolink	*Dolichonyx oryzivorus*	S AY
Brewer's Blackbird[2,3,6]	*Euphagus cyanocephalus*	R
Brown-headed Cowbird[2,3,5,6]	*Molothrus ater*	S
Common Grackle[2,3,6]	*Quiscalus quiscula*	S
Great-tailed Grackle[2,3,4,6]	*Quiscalus mexicanus*	R
Red-winged Blackbird[2,3,6]	*Agelaius phoeniceus*	R
Western Meadowlark	*Sturnella neglecta*	R
Yellow-headed Blackbird[2,3]	*Xanthocephalus xanthocephalus*	S
Family Fringillidae - Finches		
American Goldfinch	*Spinus tristis*	R
Black Rosy-Finch	*Leucosticte atrata*	W BC AY
Brown-capped Rosy-Finch	*Leucosticte australis*	R BC AY
Cassin's Finch	*Carpodacus cassinii*	R BC
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	W
House Finch[2,4,,6]	*Carpodacus mexicanus*	R
Lesser Goldfinch	*Spinus psaltria*	S
Family Passeridae – Weaver Finches		
House Sparrow[2,3,4,6]	*Passer domesticus*	R

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BC = Birds of Conservation Concern (USFWS 2016)
AY/AR - Audubon's Watch List (NAS 2008) Yellow/Red Species where Yellow = Concern, Red = High Concern
1 = Aquaculture; 2 = Crops; 3 = Livestock and feed; 4= Human Health and Safety; 5 = Natural resources; 6 = Property

	**-T. p. jamesii* *##-G. c. tabida*	***-T. p. columbianus #F. p. anatum*

Table 1.2. Common and scientific names are given for the 112 bird species commonly occurring in Colorado that have little or no potential to be involved in a BDM project including BDM projects at airports because these species are mostly limited in their distribution in Colorado, not associated with any type of damage, and are typically not found in habitat associated with areas of potential damage (*e.g.,* urban areas, croplands, airport operating areas). WS-Coloraod does not anticipate that it will conduct BDM for these species, but the possibility could always arise. WS-Colorado may receive requests to provide BDM assistance for any of the species listed in the EA.

Species	*Scientific Name**	Status
American Dipper	*Cinclus mexicanus*	R
American Redstart	*Setophaga ruticilla*	S
Ash-throated Flycatcher	*Myiarchus cinerascens*	S
Bell's Vireo	*Vireo bellii*	S BC AY
Bewick's Wren	*Thryomanes bewickii*	R
Black Rail	*Laterallus jamaicensis*	M AR
Black-capped Chickadee	*Poecile atricapillus*	R
Black-chinned Hummingbird	*Archilochus alexandri*	S
Black-headed Grosbeak	*Pheucticus melanocephalus*	S
Black-throated Gray Warbler	*Setophaga nigrescens*	S
Black-throated Sparrow	*Amphispiza bilineata*	S
Blue Grosbeak	*Guiraca caerulea*	S
Blue-gray Gnatcatcher	*Polioptila caerulea*	S
Boreal Owl	*Aegolius funereus*	R
Brewer's Sparrow	*Spizella breweri*	S BC AY
Broad-tailed Hummingbird	*Selasphorus platycercus*	S
Brown Creeper	*Certhia americana*	R
Brown Thrasher	*Toxostoma rufum*	S
Bullock's Oriole	*Icterus bullockii*	S
Bushtit	*Psaltriparus minimus*	R
Calliope Hummingbird	*Stellula calliope*	S AY
Canyon Towhee	*Melozone fuscus*	S
Canyon Wren	*Catherpes mexicanus*	R
Cassin's Sparrow	*Peucaea cassinii*	S
Cassin's Vireo	*Vireo cassinii*	M
Chestnut-collared Longspur	*Calcarius ornatus*	S BC AY
Chipping Sparrow	*Spizella passerina*	S
Clay-colored Sparrow	*Spizella pallida*	S
Common Poorwill	*Phalaenoptilus nuttallii*	S
Common Yellowthroat	*Geothlypis trichas*	S
Cordilleran Flycatcher	*Empidonax occidentalis*	S
Couch's Kingbird	*Tyrannus couchii*	M
Curve-billed Thrasher	*Toxostoma curvirostre*	M
Dark-eyed Junco	*Junco hyemalis*	R
Dusky Flycatcher	*Empidonax oberholseri*	S
Eastern Bluebird	*Sialia sialis*	M
Eastern Screech-Owl	*Megascops asio*	R
Evening Grosbeak	*Coccothraustes vespertinus*	R
Field Sparrow	*Spizella pusilla*	M
Flammulated Owl	*Otus flammeolus*	S BC AY
Fox Sparrow	*Passerella iliaca*	S
Golden-crowned Kinglet	*Regulus satrapa*	R
Grace's Warbler	*Setophaga graciae*	S BC AY
Grasshopper Sparrow	*Ammodramus savannarum*	S BC
Gray Catbird	*Dumetella carolinensus*	S
Gray Flycatcher	*Empidonax wrightii*	S
Gray Vireo	*Vireo vicinior*	S BC AY
Great Kiskadee	*Pitangus sulphuratus*	M
Green-tailed Towhee	*Pipilo chlorurus*	S
Hammond's Flycatcher	*Empidonax hammondii*	S
Harris's Sparrow	*Zonotrichia querula*	M
Hermit Thrush	*Catharus guttatus*	S
Hoary Redpoll	*Acanthis hornemanni*	W
House Wren	*Troglodytes aedon*	S
Indigo Bunting	*Passerina cyanea*	S
Juniper Titmouse	*Baeolophus ridgwayi*	S BC
Lark Sparrow	*Chondestes grammacus*	S
Lazuli Bunting	*Passerina amoena*	S
Least Flycatcher	*Empidonax minimus*	M
Lincoln's Sparrow	*Melospiza lincolnii*	S
MacGillivray's Warbler	*Geothlypis tolmiei*	S
Marsh Wren	*Cistothorus*	S
Mountain Bluebird	*Sialia currucoides*	R
Mountain Chickadee	*Poecile gambeli*	R
Northern Pygmy-Owl	*Glaucidium gnoma*	R
Northern Saw-whet Owl	*Aegolius acadicus*	R
Northern Waterthrush	*Parkesia*	M
Olive-sided Flycatcher	*Contopus cooperi*	S AY
Orange-crowned	*Oreothlypis celata*	S
Orchard Oriole	*Icterus spurius*	S
Ovenbird	*Seiurus*	S
Pine Grosbeak	*Pinicola enucleator*	R
Pine Siskin	*Spinus pinus*	R
Plumbeous Vireo	*Vireo plumbeus*	S
Purple Sandpiper	*Calidris maritima*	M
Pygmy Nuthatch	*Sitta pygmaea*	R
Red Crossbill	*Loxia curvirostra*	R
Red-breasted Nuthatch	*Sitta canadensis*	R
Red-eyed Vireo	*Vireo olivaceus*	M
Rock Wren	*Salpinctes obsoletus*	S
Rose-breasted Grosbeak	*Pheucticus*	M
Ruby-crowned Kinglet	*Regulus calendula*	S
Rufous Hummingbird	*Selasphorus rufus*	M
Sagebrush Sparrow	*Amphispiza*	S AY
Sage Thrasher	*Oreoscoptes*	S
Scott's Oriole	*Icterus parisorum*	S
Song Sparrow	*Melospiza melodia*	S
Sora	*Porzana carolina*	S
Spotted Owl	*Strix occidentalis*	R **FT^^**
Spotted Towhee	*Pipilo maculatus*	S
Swainson's Thrush	*Catharus ustulatus*	S
Swamp Sparrow	*Melospiza*	M
Townsend's Solitaire	*Myadestes*	R
Veery	*Catharus fuscescens*	S BC
Vesper Sparrow	*Pooecetes*	S
Virginia Rail	*Rallus limicola*	R
Virginia's Warbler	*Oreothlypis*	S AY
Warbling Vireo	*Vireo gilvus*	S
Western Bluebird	*Sialia mexicana*	R
Western Screech-Owl	*Megascops*	R
Western Tanager	*Piranga ludoviciana*	S
Western Wood-Pewee	*Contopus sordidulus*	S
White-breasted	*Sitta carolinensis*	R
White-throated Sparrow	*Zonotrichia*	S
White-winged Crossbill	*Loxia leucoptera*	R
Willow Flycatcher	*Empidonax traillii*	S **FE SE**
Wilson's Warbler	*Cardellina pusilla*	S
Winter Wren	*Troglodytes*	M
Yellow Warbler	*Setophaga petechia*	S
Yellow-billed Cuckoo	*Coccyzus*	S FT^
Yellow-breasted Chat	*Icteria virens*	S
Yellow-rumped Warbler	*Setophaga coronata*	S

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E = Endangered **T** = Threatened **C** = Candidate
M = Migratory **W** = Winter

BC = Birds of Conservation Concern (USFWS 2008)
AY/AR - Audubon's Watch List (NAS 2007) Yellow/Red Species where Yellow = Concern, Red = High Concern
*Southwestern Willow Flycatcher (*E. t. extimus*)
^- western pop. (DPS) ^^- *S. o. lucida*

*All data from **Tables** based on the American Ornithologists Union, Colorado Field Ornithologist, National Audobon Society, and the U.S. Fish and Wildlife Service 2008; 2016).

Table 1.3. Common and scientific names are given for the 192 bird species that are infrequently or accidentally seen in Colorado (does not include extinct or extirpated species). Most of the following species have been designated by Colorado Field Ornithologists (2017) as review species (1 was not included here, the Sparague's Pipit because they have been documented to occur rarely in Colorado (designated by bold species names)). Some of these species have the potential of being the focus of a BDM project. Species in shaded cells (90) will not be or are not likely to ever be involved in a BDM project. Little information on these species is discussed in the Environmental Assessment because they occur so infrequently or in such remote areas on the border, especially southwest and southeast Colorado, that it is highly unlikely in any given span of years that these would be the focus of a single BDM project. These are given to let the reader know that Wildlife Services is aware of the other species potentially present in Colorado.

Species	*Scientific Name**	*Status*
Acadian Flycatcher	*Empidonax virescens*	M
Acorn Woodpecker	*Melanerpes formicivorus*	R
Alder Flycatcher	*Empidonax alnorum*	M
American Black Duck	*Anas rubripes*	M
American Woodcock	*Scolopax minor*	M AY
Ancient Murrelet	*Synthliboarmphus antiquus*	M AY
Anhinga	*Anhinga anhinga*	S
Anna's Hummingbird	*Calypte anna*	M
Arctic Loon	*Gavia arctica*	M
Arctic Tern	*Sterna paradisaea*	M
Baird's Sparrow	*Ammodramus bairdii*	S AR
Baltimore Oriole	*Icterus galbula*	M
Barred Owl	*Strix varia*	M
Barrow's Goldeneye	*Bucephala islandica*	W
Bay-breasted Warbler	*Setophaga castanea*	M AY
Bendire's Thrasher	*Toxostoma bendirei*	M BC AR
Black Phoebe	*Sayornis nigricans*	S
Black Scoter	*Melanitta americana*	M
Black Skimmer	*Rhynchops niger*	M AR
Black Vulture	*Coragyps atratus*	S
Black-and-white Warbler	*Mniotilta varia*	M
Black-bellied Whistling-Duc	*Dendrocygna autumnalis*	S
Black-billed Cuckoo	*Coccyzus erythropthalmus*	S
Blackburnian Warbler	*Setophaga fusca*	M
Black-chinned Sparrow	*Spizella atrogularis*	S
Black-headed Gull	*Chroicocephalus ridibundu*	M
Black-legged Kittiwake	*Rissa tridactyla*	W
Blackpoll Warbler	*Setophaga striata*	M
Black-throated Blue Warbler	*Setophaga caerulescens*	M AY
Black-throated Green Warble	*Setophaga virens*	M
Blue-headed Vireo	*Vireo solitarius*	M
Blue-throated Hummingbir	*Lampornis clemenciae*	S AY
Blue-winged Warbler	*Vermivora pinus*	M AY
Brambling	*Fringilla montifringilla*	W
Brant	*Branta bernicla*	M AY
Broad-billed Hummingbird	*Cynanthus latirostris*	S
Broad-winged Hawk	*Buteo platypterus*	S
Bronzed Cowbird	*Molothrus aeneus*	M
Brown Booby	*Sula leucogaster*	M
Brown Pelican	*Pelecanus occidentalis*	M
Brown-crested Flycatcher	*Myiarchus tryannulus*	M
Buff-breasted Flycatcher	*Empidonax fulvifrons*	M
Buff-breasted Sandpiper	*Tryngites subruficollis*	M AR
Canada Warbler	*Cardellina canadensis*	M AY
Cape May Warbler	*Setophaga tigrini*	M
Carolina Wren	*Thryothorus ludovicianus*	M
Cerulean Warbler	*Setophaga cerulea*	M AY
Chestnut-sided Warbler	*Setophaga pensylvanica*	M
Common Black-Hawk	*Buteogallus anthracinus*	S
Common Gallinule	*Gallinula galeata*	S
Common Ground-Dove	*Columbina passerina*	M
Common Redpoll	*Acanthis flammea*	W
Connecticut Warbler	*Oporornis agilis*	M
Eastern Meadowlark	*Sturnella magna*	S
Eastern Towhee	*Pipilo erythrophthalmus*	S
Eastern Whip-poor-will	*Caprimulgus vociferus*	M
Eastern Wood-Pewee	*Contopus virens*	M
Eskimo Curlew	*Numenius borealis*	M AR*
Eurasian Wigeon	*Mareca penelope*	W
Fulvous Whistling-Duck	*Dendrocygna bicolor*	S
Garganey	*Spatula querquedula*	W
Glaucous Gull	*Larus hyperboreus*	W
Glaucous-winged Gull	*Larus glaucescens*	W
Glossy Ibis	*Plegadis falcinellus*	S
Golden-crowned Sparrow	*Zonotrichia atricapilla*	M
Golden-winged Warbler	*Vermivora chrysoptera*	M AY
Gray-cheeked Thrush	*Catharus mimimus*	M
Great Black-backed Gull	*Larus marinus*	W
Great Crested Flycatcher	*Myiarchus crinitus*	M
Greater Scaup	*Aythya marila*	M
Groove-billed Ani	*Crotophaga sulcirostris*	M
Gyrfalcon	*Falco rusticolus*	W
Harlequin Duck	*Histrionicus histrionicus*	M
Harris's Hawk	*Parabuteo unicinctus*	S
Henslow's Sparrow	*Ammodramus henslowii*	M AR
Hepatic Tanager	*Piranga flava*	S
Hermit Warbler	*Setophaga occidentalis*	M AY
Hooded Oriole	*Icterus cucullatus*	M
Hooded Warbler	*Setophaga citrina*	M
Hudsonian Godwit	*Limosa haemastica*	M AY
Iceland Gull	*Larus glaucoides*	W AY
Inca Dove	*Columbina inca*	S
Ivory Gull	*Pagophila eburnea*	W AR
Kelp Gull	*Larus dominicanus*	M
Kentucky Warbler	*Geothlypis formosus*	M AY
King Rail	*Rallus elegans*	M AY
Ladder-backed Woodpecker	*Picoides scalaris*	R
Laughing Gull	*Leucophaeus atricilla*	M
Lawrence's Goldfinch	*Spinus lawrencei*	S
Le Conte's Sparrow	*Ammodramus leconteii*	M AY
Least Bittern	Ixobrychus exilis	M
Least Tern	*Sternula antillarum*	M **FE**SE AR**
Lesser Black-backed Gull	*Larus fuscus*	R
Lesser Nighthawk	*Chordeiles acutipennis*	S
Little Blue Heron	*Egretta caerulea*	S
Little Gull	*Hydrocoloeus minutus*	W
Long-billed Murrelet	*Brachyramphus perdix*	M
Long-billed Thrasher	*Toxostoma longirostre*	S
Long-tailed Duck	*Clangula hyemalis*	M
Long-tailed Jaeger	*Stercorarius longicaudus*	M

Costa's Hummingbird	*Calypte costae*	M AY
Crested Caracara	*Caracara cheriway*	S
Curlew Sandpiper	*Calidris ferruginea*	M
Dusky-capped Flycatcher	*Myriarchus tuberculifer*	M
Pacific Wren	*Troglodytes pacificus*	W
Painted Bunting	*Passerina ciris*	M AY
Painted Redstart	*Myioborus pictus*	S
Palm Warbler	*Setophaga palmarum*	M
Parasitic Jaeger	*Stercorarius parasiticus*	M
Phainopepla	*Phainopepla nitens*	S
Philadelphia Vireo	*Vireo philadelphicus*	M
Pine Warbler	*Setophaga pinus*	M
Pomarine Jaeger	*Stercorarius pomarinus*	M
Prairie Warbler	*Setophaga discolor*	M AY
Prothonotary Warbler	*Protonotaria citrea*	M
Purple Finch	*Carpodacus purpureus*	W
Purple Gallinule	*Porphyrio martinica*	S
Pyrrhuloxia	*Cardinalis sinuatus*	S
Red Knot	*Calidris canutus*	M AR T
Red Phalarope	*Phalaropus fulicarius*	M
Red-bellied Woodpecker	*Melanerpes carolinus*	S
Reddish Egret	*Egretta rufescens*	S AY
Red-faced Warbler	*Cardellina rubrifrons*	S AY
Red-necked Grebe	*Podiceps grisegena*	M
Red-shouldered Hawk	*Buteo lineatus*	M
Red-throated Loon	*Gavia stellata*	M
Rivoli's Hummingbird	*Eugenes fulgens*	S
Roseate Spoonbill	*Ajaia ajaja*	S AY
Ross's Gull	*Rhodostethia rosea*	M AY
Royal Tern	*Thalasseus maxima*	M
Ruby-throated Hummingbir	*Archilochus colubris*	M
Ruff	*Philomachus pugnax*	M
Ruffed Grouse	*Bonasa umbellus*	R
Rufous-crowned Sparrow	*Aimophila ruficeps*	S
Rusty Blackbird	*Euphagus carolinus*	M AY
Sabine's Gull	*Xema sabini*	M
Sandwich Tern	*Thalasseus sandvicensis*	M
Scarlet Tanager	*Piranga olivacea*	M
Scissor-tailed Flycatcher	*Tyrannus forficatus*	S
Sedge Wren	*Cistothorus platensis*	M
Sharp-tailed Sandpiper	*Calidris acuminata*	M
Slaty-backed Gull	*Larus schistisagus*	M
Smith's Longspur	*Calcarius pictus*	M AY
Snowy Owl	*Bubo scandiacus*	W
Sooty Tern	*Onychoprion fuscatus*	M
Streak-backed Oriole	*Icterus pustulatus*	W
Sulphur-bellied Flycatcher	*Myiodynnastes luteiventris*	M
Summer Tanager	*Piranga rubra*	M
Surf Scoter	*Melanitta perspicillata*	M
Swainson's Warbler	*Limnothylpis swainsonii*	M AY
Swallow-tailed Kite	*Elanoides forficatus*	M AY
Tennessee Warbler	*Oreothlypis peregrina*	M
Thick-billed Kingbird	*Tyrannus crassirostris*	M
Townsend's Warbler	*Setophaga townsendi*	M
Tricolored Heron	*Egretta tricolor*	S
Tropical Parula	*Setophaga pitiayumi*	M
Trumpeter Swan	*Cygnus buccinator*	W AY
Tufted Duck	*Aythya fuligula*	W
Varied Thrush	*Ixoreus naevius*	S AR
Vaux's Swift	*Chaetura vauxi*	M
Vermillion Flycatcher	*Pyrocephalus rubinus*	S
White Ibis	*Eudocimus albus*	S
White-eared Hummingbird	*Hylocharis leucotis*	S
White-eyed Vireo	*Vireo griseus*	M
White-winged Scoter	*Melanitta fusca*	M
Whooping Crane	*Grus americana*	M FE SE AY
Wood Stork	*Mycteria americana*	S AY
Wood Thrush	*Hylocichla mustelina*	M AY
Worm-eating Warbler	*Helmitheros vermivorum*	M
Yellow Rail	*Coturnicops noveboracensis*	M AR
Yellow-bellied Flycatcher	*Empidonax flaviventris*	M

Louisiana Waterthrush	*Parkesia motacilla*	M
Lucy's Warbler	*Oreothlypis luciae*	S AY
Magnificent Frigatebird	*Fregata magnificens*	M AR
Magnolia Warbler	*Setophaga magnolia*	M
Mew Gull	*Larus canus*	M
Mexican Whip-poor-will	*Caprimulgus arizonae*	M
Mexican Violetear	*Colibri thalassinus*	S
Mottled Duck	*Anas fulvigulas*	M
Mourning Warbler	*Geothlypis philadelphia*	M
Nashville Warbler	*Oreothlypis ruficapilla*	M
Nelson's Sparrow	*Ammodramus nelsoni*	M AY
Neotropic Cormorant	*Phalacrocorax brasilianus*	S
Northern Parula	*Setophaga americana*	M
Pacific Loon	*Gavia pacifica*	M
Yellow-throated Vireo	*Vireo flavifrons*	M
Yellow-throated Warbler	*Setophaga dominica*	M
Zone-tailed Hawk	*Buteo albonotatus*	S

F = Federal **S** = State **R** = Resident
E = Endangered **T** = Threatened **C** = Candidate
M = Migratory **W** = Winter

BC = Birds of Conservation Concern (USFWS 2016)
AY/AR - Audubon's Watch List (NAS 2007) Yellow/Red Species where Yellow = Concern, Red = High Concern
Species not likely to cause damage are shaded
*- Likely extinct **-Interior pop.
*All data from **Table**s based on the American Ornithologists Union, Colorado Field Ornithologist, National Audubon Society, and the U.S. Fish and Wildlife Service 2008; 2016).

Yellow-billed Loon	*Gavia adamsii*	M AR
Yellow-crowned Night Heron	*Nyctanassa violacea*	S

Table 1.4. Several species of waterfowl and gallinaceous birds have been released from captivity into the wild and periodically are the focus of a BDM project or affect it (prevalent species listed). The most common species involved in feral poultry damage management projects are the captive-reared Mallard, Muscovy duck, Graylag and Chinese goose, peafowl, and feral chickens. Several other species of birds escape from private collections and have the possibility of being seen and the focus of a BDM project. None of these species are listed by Colorado Field Ornithologists (2017) as being established in Colorado. *All data from Tables based on the American Ornithologists Union, Colorado Field Ornithologist, National Audobon Society, and the U.S. Fish and Wildlife Service 2008; 2016.

Species	*Scientific Name*
Captive-reared Graylag Goose	*Anser anser*
Captive-reared Swan Goose (*Chinese Goose*)	*Anser cygnoides*
Mute Swan	*Cygnus olor*
Captive-reared Muscovy Duck	*Cairina moschata*
Captive-reared Mallard	*Anas platyrhynchos*
Helmeted Guineafowl	*Numida meleagris*
Feral chicken (*Red Junglefowl*)	*Gallus gallus*
Common Peafowl	*Pavo cristatus*
California Condor	*Gymnogyps californianus*
African Collared-Dove	*Streptopelia risoria*

The majority of BDM conducted by WS-Colorado is to protect human health and safety through implementation of BDM at airports. WS-Colorado provides BDM services to over 76 airports in Colorado.

Several species of large birds and mammals are commonly involved in wildlife-aircraft collisions (wildlife strikes). Airport wildlife hazard management projects, place an emphasis on hazing birds away from aircraft, perform habitat modifications to discourage bird abundances, in addition to augmenting wildlife hazard reductions by relocating or lethally removing individual birds and/or species. These activities serve to reduce potential wildlife-aircraft collisions and thus, protect flight crews, passengers, civilians, and aircraft from catastrophic events and large economic loss.

To a lesser extent, WS-Colorado provides BDM technical assistance and/or operational projects in order to protect agriculture resources, property, and natural resources. While BDM for protection of these resources is a smaller component of the WS-Colorado activities, it is crucial. For example, WS-Colorado conducts BDM to protect livestock, their health, or foodstuffs, as well as cultivated crops. During FY13-FY17 WS-Colorado provided technical assistance on an average of 216 agricultural related BDM work tasks per year averaging a value of $908,780/yr (cattle, sheep, hoof stock, fowl, depredation; livestock feed losses; grain, fruit, and other crop losses; and aquaculture) (**Table 1.5**). BDM projects involving "property" (vehicles, equipment/machinery, landscape/garden, general property, buildings/houses, utilities, and bridges/dams totaled an average of 257 work tasks per year for an average value of $138,438 per year (**Table 1.5**). Work tasks performed on "natural resources" (protecting threatened and endangered species; recreational areas; and wildlife) averaged 15 work tasks over five years for an average value of $6,241 per year (**Table 1.5** and **1.6**). Finally, "human health/safety" (aviation; general) averaged 3,607 work tasks per year between FY13-17 (**Table 1.6**).

Table 1.5. Requests for assistance (RA) performed and monetary value reported for Resources protected including: Livestock (Cattle, Sheep/Goats, Other Hoof Stock, Poultry/Eggs, and Livestock Feed); Crops (Grains, Fruit, and Other Crops); and Aquaculture (Food Fish).* Data extracted from MIS.

Category	Resource	FY13		FY14		FY15		FY16		FY17		Average	
		RA	$ Value	RA	$ Value	RA	$ Value	RA	$ Value	RA	$Value	RA	$ Value
Livestock	Cattle	26	$ -	35	$ -							12	$ -
	Sheep/Goats			3	$250			5	$20,732	4	$ 3,000	2	$ 4,796
	Other Hoof Stock											0	$ -
	Poultry/Eggs	6	$ -	7	$ -	79	$3,725,000	70	$ -			32	$ 745,000
	Livestock Feed	102	$87,650	341	$155,610	81	$3,375	83	$ -	1	$ -	122	$ 49,327
Livestock Subtotal		**134**	**$87,650**	**386**	**$155,860**	**160**	**$3,728,375**	**158**	**$20,732**	5	**$ 3,000**	**169**	**$ 799,123**
Crops	Grains	1	$20,000	15	$20,000			14	$19,063			6	$ 11,813
	Fruit	1	$1,200	24	$2,200							5	$ 680
	Other Crops			10	$ -	3	$49,840	4	$17,480	1	$ -	4	$ 13,464
Crops Subtotal		**2**	**$21,200**	**49**	**$22,200**	**3**	**$49,840**	**18**	**$36,543**	**1**	**$ -**	**15**	**$ 25,957**
Aquaculture	Food Fish	27	$130,750	44	$160,750	35	$58,000	36	$38,000	22	$ 31,000	33	$ 83,700
Aquaculture Subtotal		**27**	**$130,750**	**44**	**$160,750**	**35**	**$58,000**	**36**	**$38,000**	**22**	**$ 31,000**	**33**	**$ 83,700**
TOTAL AGRICULTURE		**163**	**$239,600**	**479**	**$338,810**	**198**	**$3,836,215**	**212**	**$95,275**	**28**	**$ 34,000**	**216**	**$908,780**

Table 1.6. Requests for assistance (RA) and monetary value reported for Property and Resources protected including: Property (Aircraft, Vehicles, Equipment/machine(s), Landscaping/Garden, General Property, Buildings/Houses, Utilities, Bridges/Dams); Natural Resources (T& E Species, Recreational Areas, Wildlife/Aquaculture); and Human Health/Safety (Aviation, General). *Data extracted from MIS. * Damage can be significant in one year to the loss of an aircraft or significant parts such as an engine, and thus data can be skewed to a given year when losses are significant.

Category	**Resource**	**FY13**		**FY14**		**FY15**		**FY16**		**FY17**		**Average**	
		RA	$Value	RA	$Value	RA	$Value	RA	$Value	RA	$Value	**RA**	**$Value**
Property	Aircraft*	34	-	7	-	7	-	6	-	1	$200	11	$40
	Vehicles	18	$2,500	16	-			2	-			7	$500
	Equipment/Machine			10	-	2	-	2	-	1	-	3	$0
	Landscaping/Garden	2	$3,000	2	-	8	$1,290	94	$4,600			21	$1,778
	General Property	1	-			3	$20,000	2	-			1	$4,000
	Buildings/Houses	292	$285,100	128	-	335	$248,400	249	$127,300	93	$311,100	219	$194,380
	Utilities	28	-	14	-	5	-	10	-			11	$0
	Bridges/ Dams	1	-	3	-	3	-	3	-			2	$0
TOTAL PROPERTY		376	$290,600	180	-	363	$269,690	368	$131,900			257	$138,438
Natural Resources	T&E Species			2	-	2	-	7	-	6	-	3	$0
	Wildlife/Aquaculture	6	$31,206	55	-	1						12	$ 6,241
TOTAL NAT. RESOURCES		6	$31,206	57	-	3	-	7	-			15	$ 6,241
Human Health/ Safety	Aviation	5,305	-	5,020	-	4,099	-	3,343	-	174	-	3,588	$0
	General	46	-	62	-	59	-	101	-			54	$0
TOTAL HUMAN HEALTH/SAFETY		5,351	-	5,082	-	4,158	-	3,444	-			**3,607**	**$0**

Table 1.7. Bird damage incidences reported to WS-Colorado from FY 2013 to FY 2017 by resource category including estimated total cost of bird damage loss based on the value of the resource and number of incidences.

Resource Category	Resource	Damage Species	Damage Threat	Incidence	Value	Total
Agriculture	Grain (Non-livestock)	Rock Pigeon	Consumption Contamination	1	$ 20,000	$ 20,000
Aquaculture	Rainbow Trout	American White Pelican	Predation	3	$ 3,500	$ 10,500
	Rainbow Trout	Black-crowned Night Heron	Predation	1	$ 658	$ 658
	Rainbow Trout	Great Blue Heron	Predation	1	$ 658	$ 658
	Rainbow Trout	Double-crested cormorant	Predation	1	$ 7,500	$ 7,500
	Trout	American White Pelican	Predation	4	$ 1,375	$ 5,500
	Trout	Belted Kingfisher	Predation	10	$ 3,900	$ 39,000
	Trout	Black-crowned Night Heron	Predation	8	$ 2,625.00	$ 21,000
	Trout	California Gull	Predation	8	$ 2,249	$ 17,998
	Trout	Common Merganser	Predation	3	$ 1,666	$ 5,000
	Trout	Double-crested cormorant	Predation	7	$ 3,142	$ 22,000
	Fish - Other	Double-crested cormorant	Predation	3	$ 8,130	$ 24,390
	Trout	Franklin's Gull	Predation	5	$ 900	$ 4,500
	Trout	Great Blue Heron	Consumption Contamination	1	$ 10,000	$ 10,000
	Trout	Great Blue Heron	Predation	16	$ 7,812	$ 124,996
	Fish - Other	Great Blue Heron	Predation	3	$ 8,000	$ 24,000
	Trout	Herring Gull	Predation	7	$ 964	$ 6,750
	Trout	Ring-billed Gull	Predation	5	$ 700	$ 3,500
Crops	Fruit - Cherries	American Robin	Consumption Contamination	1	$ 1,200	$ 1,200
	Alfalfa	Canada Goose	Damage	1	$ 19,063	$ 19,063
	Hayfield	Canada Goose	Damage	1	$ 10,991	$ 10,991
Livestock	Feed	European Starlings	Consumption Contamination	25	$ 4,617	$ 115,434
	Feed	Rock Pigeon	Consumption Contamination	5	$ 875	$ 4375
	Feed	Red-winged Blackbird	Consumption Contamination	1	$ 480	$ 480
	Sheep - Adult	Black-billed Magpie	Predation	2	$ 122	$ 244
	Sheep - Lambs	Golden Eagle	Predation	7	$ 1,085	$ 7,599

Property	Buildings	American Robin	Damage	1	$ 100	$ 100
	Buildings	Cliff Swallow	Damage	4	$ 17,250	$ 69,000
	Buildings	Downy Woodpecker	Damage	7	$ 1,699	$ 11,899
	Buildings	Hairy Woodpecker	Damage	2	$ 1,350	$ 2,700
	Buildings	Lewis's Woodpecker	Damage	1	$ 500	$ 500
	Buildings	Northern Flicker	Consumption Contamination	2	$ 4,000	$ 8,000
	Buildings	Northern Flicker	Damage	269	$ 4,498	$1,209,967
	Buildings	Pygmy Nuthatch	Damage	3	$ 433	$ 1,300
	Buildings	Red-headed Woodpecker	Damage	1	$ 500	$ 500
	Buildings	Rock Pigeon	Damage	6	$ 4,821	$ 28,930
	Buildings	White-breasted Nuthatches	Damage	27	$ 1,873	$ 50,590
	Aircraft	Canada Goose	Wildlife Strike	1	$10,000,000	$10,000,000
	Aircraft	Eurasian Collared-Dove	Wildlife Strike	1	$ 1,000	$ 1,000
	Aircraft	Swainson's Hawk	Wildlife Strike	1	$ 200	$ 200
	Bridges/Dams/Impoundments	Rock Pigeon	Damage	1	$ 1,000	$ 1,000
	General	European Starlings	Damage	1	$ 20,000	$ 20,000
	Golf Course	Canada Goose	Consumption Contamination	3	$ 1,267	$ 3,800
	Golf Course	Canada Goose	Damage	2	$ 145	$ 290
	Landscaping/Garden	Canada Goose	Consumption Contamination	2	$ 1,000	$ 2,000
	Landscaping/Garden	Canada Goose	Damage	1	$ 3,000	$ 3,000
	Landscaping/Garden	Brewer's Blackbirds	Damage	3	$ 18,776	$ 56,329
	Vehicle	European Starlings	Damage	1	$ 2,500	$ 2,500

Ordinarily, according to Wildlife Services procedures in implementing the National Environmental Policy Act (NEPA), individual WDM actions, and research and developmental activities may be categorically excluded (7 Code of Federal Regulation (CFR) 372.5(c), 60 Fed. Reg. 6000-6003, 1995). Over the years, WS-Colorado has received occasional requests for individual actions related to several species regarding BDM. Less than 10 requests for assistance are completed annually by WS for 36 out of 93 species listed in **Table 1.7**. Of these, 16 species average ≤ 1 request for assistance annually. Many of these instances are handled with technical assistance only, suggesting that these activities should be categorically excluded from NEPA analysis. Nonetheless, this EA has been prepared for BDM in Colorado to facilitate planning and interagency coordination, facilitate the migratory bird damage permit process with the USFWS, to streamline program management, and to involve the public and obtain their input through comments and feedback. The EA documents the need for BDM in Colorado and assesses potential impacts and effects of various methods to resolve bird damage problems.

This EA also provides sufficient analysis of impacts to determine if a Finding of No Significant Impact (FONSI) or and environmental impact statement (EIS) is appropriate. The alternatives considered in this EA vary regarding the degree of WS-Colorado involvement in BDM, the degree of technical assistance and operational assistance (advice, information, education, and/or demonstrations), of operational field assistance (active management of nuisance bird(s), species, and/or guilds), and the degree of lethal and nonlethal methods available for use.

Based on the scope of this EA, the decisions to be made are:

- Should BDM as currently implemented by WS-Colorado be continued in the state?
- If not, how should WS-Colorado fulfill its legislative responsibilities for managing bird damage in the state?
- What protective measures should be implemented to lessen identified potential impacts?
- Do WS-Colorado BDM activities have significant impacts requiring preparation of an EIS?

If a new issue arises or the analysis in monitoring reports concludes that WS-Colorado BDM activities are outside the scope of this EA, the EA would be supplemented or an EIS written to include the new information and sent out for public review. Moreover, many new species have the potential for being involved in BDM, especially at airports and disease surveillance projects, and this EA will discuss all species that could potentially be involved in BDM in Colorado, though many likely never will be. See **Chapter 2** for details on the three alternatives evaluated in this EA, and **Chapter 3** for associated impact analysis on the human environment.

1.3 What Species are Included in this EA?

This EA includes the following avian species (in order of proportion of take by WS-Colorado; **Table 1.3**)**.** Over 305 species of birds have been documented to regularly occur in Colorado depending upon locale, habitat, season, and time of year. An additional 198 species have been intermittently documented in Colorado, outside of their species' normal range and are considered accidental occurrences; some of these species are seen annually and a few may even nest, but not in any notable abundance or regularity. Ten additional feral domestic species (*e.g.,* guineafowl), exotics (*e.g.,* Mute Swan), or experimentally released species (*e.g.,* California condor) have been seen). Of the 503 bird species that may occur in Colorado 199 are relevant to WS-Colorado BDM project(s); however, only 98 of those would likely be targeted to protect resources other than aircraft and human health and safety at airports. This EA addresses avian species that may occur in Colorado, known to cause problems, and listed in (**Table 1.7, 1.8**).

1.4 How Do People Feel About Wildlife?

Human perceptions, attitudes, and emotions differ in regards to wildlife, depending on the emphasis a person places on their intrinsic value. The desire to "use" different wildlife species and how they interact with an individual or group of animals various among people. Birds are generally regarded as providing ecological, educational, economic, recreational, and aesthetic value (Decker and Goff 1987, Chan et al. 2016, Piccolo 2017). These values vary based past experiences, upbringing, and day-to-day circumstances. For example, observing a group of Canada geese swimming by during a kayaking trip may be viewed as a positive experience, while seeing the same group of geese pursuing your toddler around the park may be frustrating. Watching a Turkey Vulture soar over the river may be exciting, while having twenty Turkey Vultures roost on your house may be highly undesirable. Feeding pigeons in the park may be enjoyable to watch, while the same pigeons in your barn, stable, hen house, or attic is undesirable.

For others, wildlife symbolizes "the ecological wild" and people are willing to spend substantial amounts of money traveling to see these species in their native habitats. Knowing that wildlife exists, although they may have never seen them, illustrates that parts of America are still "wild and untamed." Conversely while people value wildlife, animals that cause damage to property, economic security, or that pose a threat to people are expected to be removed and sometimes killed, with justification.

Managing wildlife in urban landscapes (e.g. cities, towns, parks, airports, and private properties) has become increasingly challenging (Adams et al. 2006, Adams and Lindsey 2010, Hudenko 2012, McCance 2017). When prolific, adaptable species compete with human expansion, land management conflicts often arise. Because of the prolific nature of these species, site fidelity, longevity, size, and tolerance for human activity, many are associated with situations where damage or threats occur. For instance, free-ranging waterfowl are highly adaptable to urban landscapes that allow them to nest, raise young, molt, feed, and loaf in relative safety. These species are difficult to manage due to their mobile nature and ability to exploit a variety of habitat types within an area. Within problematic areas, it is rarely desirable or possible to remove or disperse all problem birds. In such cases, a BDM Plan may reduce the species population to an acceptable tolerance level.

1.5 At What Point Do People or Entities Request Help with Managing Wildlife Damage?

As a society, our attitudes towards wildlife have gradually shifted from viewing wildlife species as threats or nuisances to valuing them under socially-acceptable circumstances. Tension over the use of public funds and/or laNonds to support a variety of private/individual uses or incomes (not related to wildlife) is a federal and/or state governmental policy consideration. An example of this tension may involve individuals who believe Canada goose populations should not be managed in urban areas, or that migratory bird depredation permits should not be issued for common species such as Northern flickers or other woodpecker species.

When individual animals are associated with damage to a property, agriculture, economic security, threaten managed or protected wildlife species, and/or threaten human health and safety; agencies, entities, and/or individuals request assistance in reducing, removing, or dispersing wildlife. The threshold for triggering a request for assistance is often unique to the individual person/entity requesting assistance and is influenced by several factors (e.g., economic, social, aesthetic). In general, the definition of damage caused by wildlife is unique to the individual person requesting assistance. However, the term "damage" is consistently used to describe situations where individuals have determined the losses associated with wildlife requires assistance (i.e., has reached an individuals' threshold). The term "damage" is most often defined as an economic loss to resources or a threat to human safety although, it may also be used to describe a loss in aesthetic value, and other behaviors deemed unacceptable by an individual. Often, people try to resolve wildlife problems themselves, by building barriers, buying commercially advertised equipment, or killing animals they perceive as causing the damage. In many cases, these attempts to mitigate the damage themselves results in the misidentification of wildlife responsible for the damage, a waste of time and money, and the misuse of exclusionary devices, repellents, traps, firearms, or pesticides. Addressing wildlife damage problems requires consideration of both the resource owners' and society's levels of acceptability and tolerance, as well as the ability of ecosystems and local wildlife populations to absorb change without long-term or short-term adverse impacts.

"Biological carrying capacity," as we use it here, is the maximum number of animals of a given species that can, in a given ecosystem, survive through the least favorable conditions occurring within a stated time interval (in other words, the largest number of animals that can sustainably survive under the most restricting ecological conditions, such as during severe winters or droughts; The Wildlife Society 1980, Wilson 2008, Jacobs 2009, Hudenko 2012). The "wildlife acceptance capacity," or "cultural carrying capacity," is the limit of human tolerance for wildlife or its behavior and the number of a given species that can coexist compatibly with local human populations. The mere presence of a wild animal may be considered threatening or a nuisance to people with low tolerance or inexperience with the ways of wild animals, or when the animals are viewed as cruel, aggressive, or frightening. These phenomena are especially important because they define the sensitivity of a person or community to coexisting with a wildlife species.

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 of people sharing that habitat is lower. Once the wildlife acceptance capacity is met or exceeded in a particular circumstance, people take or request help for taking action to alleviate the damage or address threats.

1.5.1 What is Wildlife Damage Management?

Wildlife damage management is an integral component of wildlife management and is defined as the science of alleviating damage or other associated problems caused by or related to the behavior of wildlife (Leopold 1933, The Wildlife Society 1980; 2015; Berryman 1991, McCance et al. 2017). The pending threat, whether real or perceived, of damage or loss of resources is often sufficient justification for mitigation actions. Interactions between humans and wildlife species are often complicated by a range of public perceptions, damage associated with wildlife, and wildlife damage management actions. While one individual may deem wildlife damage to be unacceptable, another may view it as a consequence of living with wildlife. WS uses a wildlife damage management (WDM) approach including nonlethal strategies such as the modification of the habitat or offending animals' behavior, as well as management of the offending animals or local population of the offending species with lethal or nonlethal methods. The goal of WDM is to stop wildlife damage and/or reduce it to a tolerable level. Here "damage" is defined as economic losses to resources or threats to human safety; however, it may also be defined as a loss in aesthetic value and in other situations where actions/behaviors of wildlife are no longer tolerable to an individual person. Wildlife management often involves balancing wildlife populations and human perceptions, while struggling to preserve threatened and endangered species, regulate species populations, oversee the consumptive uses of wildlife, and conserve wildlife habitats for wildlife resources.

1.5.2 What Are the Science and Practices of Wildlife Damage Management?

Wildlife damage management focuses on addressing specific situations instead of broad-scale population management. The Wildlife Society, a professional non-profit scientific and educational association, recognizes wildlife damage management as a specialized field within wildlife management and requires responsible wildlife professionals to adhere to professional standards.

In regards to WDM, The Wildlife Society states:
(WDM; The Wildlife Society 2016; http://wildlife.org/wp-content/uploads/2016/04/SP_WildlifeDamage.pdf):

"Prevention or management of wildlife damage, which often includes removal of the animals responsible for the damage, is an essential and responsible part of wildlife management…"
"Wildlife sometimes causes significant damage to private and public property, other wildlife, habitats, agricultural crops, livestock, forests, pastures, and urban and rural structures. Some species may threaten human health and safety or be a nuisance. Prevention/ management of wildlife damage, often includes removal of the animals responsible for the damage, is an essential and responsible part of wildlife management. Before wildlife damage management programs are undertaken, careful assessment should be made of the problem, including the impact to individuals, the community, and other wildlife species. Selected techniques should be incorporated that will be efficacious, biologically selective, and socially appropriate."

"The policy of The Wildlife Society in regard to wildlife [in part] and the alleviation of wildlife problems is to:…Recognize that wildlife damage management is an important part of modern wildlife management."

"The science of wildlife damage management is accomplished through the use of an Integrated Wildlife Damage Management (IWDM) approach. This approach involves considering and applying nonlethal and lethal options, tools, and techniques either alone or in combination, to halt wildlife damage and/or reduce it to a tolerable level; as situations warrant, while minimizing economic, health, and environmental risks to the community."

WS-Colorado's BDM activities use an Integrated Wildlife Damage Management (IWDM) approach (WS Directive 2.105) in combination with other methods to reduce wildlife damage. The challenge is to develop strategies that include the most effective combination of techniques. For example, separating the asset to be protected from the problem animals, removing the problem animals before or when they cause the problem, harassing them away, and/or educating the resource owner on how to coexist with the animals or to remove the attractant(s).

Per WS Directives 2.101 and 2.105, when selecting and applying a particular method or methods, *"consideration must be given to the species responsible and the frequency, extent, and magnitude of damage. In addition to damage confirmation and assessment, consideration must be given to the status of target and potential non-target species, local environmental conditions, relative costs of applying management techniques, environmental impacts, and social and legal concerns."*

The WS Directive 2.105 states:

"The WS program applies the IWDM (commonly known as Integrated Wildlife Damage Management) approach to reduce wildlife damage. As used and recommended by the WS program, IWDM encompasses the integration and application of all approved methods of prevention and management to reduce wildlife damage. The IWDM approach may incorporate cultural practices, habitat modification, animal behavior management [such as repellents, frightening devices, and physical exclusion], local population reduction [such as removing offending animals or groups of animals] or a combination of these approaches.

The selection of wildlife damage management methods and their application must consider the species causing the damage and the magnitude, geographic extent, duration, frequency, and likelihood of recurring damage. In addition, consideration is given to non-target species, environmental conditions and impacts, social and legal factors, and relative costs of management options. WS personnel shall apply and use the IWDM approach to efficiently and effectively prevent or reduce damage caused by wildlife. In applying IWDM to wildlife damage management, the WS program may offer technical assistance, direct management, or a combination of both in response to requests for help with wildlife damage problems."

1.5.3 What is the History of Urban Wildlife Damage Management?

Wildlife management in urban, suburban, peri-urban, and exurban environments has become increasingly relevant as human populations increase and expand. In the US, these populations have increased from approximately 200 million in 1970, to over 300 million in 2010, to a projected 363 million people in 2030 (Fagerstone 2014). Considering that 80% of these people live in suburban/urban areas, it is likely that human-wildlife conflicts will continue to increase as humans encroach, fragment, and develop wildlife habitat.

While some of these human-wildlife interactions elicit a positive experience, others fall short of those portrayed by the entertainment media. This disparity between reality and marketed media experiences may result in strong reactions from individuals and quickly escalate as an individual's problem becomes a community issue. For example, one individual's well-meaning idea of feeding, a perceived starving coyote, may quickly lead these animals to lose their fear inhibition and embolden them to approach other humans (including children), jump fences to prey on pets, or enter homes through pet doors in search of food.

While one coyote, approaching children or people walking small pets, may not immediately be perceived as a community threat. An individual coyote that teaches or recruits other coyotes to an area, perceived to have easier food item abundances, may lead to the formation of packs of coyotes that capitalize on readily available human food subsides (i.e., trash, human feedings, small pets); or may lead to increased disease transmission (e.g. mange, rabies, distemper). These human-wildlife conflicts often lead to demands from impacted communities for relief.

Often, these increasingly common human-wildlife conflicts become less of a wildlife management challenge and more so, become an exercise in navigating political platforms. As human-wildlife conflicts continue to escalate in severity, human-health and safety ultimately becomes the collective initiative for all parties involved. Once considered "nuisance and damage control" and largely ignored by mainstream wildlife professionals and biologists alike, for a career focused on managing "game" and "endangered" species (i.e. deer, elk, big horn sheep, wolves) in "natural" environments; today many agencies and professionals realize the importance of urban wildlife management as more and more constituents request assistance in solving human-wildlife conflicts (McCance 2017).

Here, constituents or stakeholders, are any individual or group that is significantly impacted by wildlife or wildlife management decisions or actions (McCance et al. 2017, Decker et al. 2012). These stakeholders bring a variety of ecological, sociocultural, political, and economic drivers to the table when evaluating, developing, and creating management solutions. And although, urban wildlife management attempts to enhance both societal outcomes for current and future generations, while preserving the natural environment and biodiversity; it can be impossible to simultaneously achieve all of these objectives suggested by community stakeholders and those of management agencies.

Therefore, urban wildlife agencies continue to progressively engage in community: outreach, negotiations, strategic partnerships, and decision making so that all the parties involve understand one another's perspective.

Modern Urban Wildlife Management

During the late 1800s and early 1900s the over-exploitation, and eventual extinction, of several wildlife species commercially marketed for fur, hides, plumage, and meat lead to the creation of what is today known as wildlife management (McCance et al. 2017). High profile conservation activists such as George Bird Grinnell, Ding Darling, and Theodore Roosevelt exposed the excessive exportation of wildlife to the public and were instrumental in creating wildlife refuges and preserves.

Such early conservation efforts were focused on "saving" species and their rural natural habitats with little attention being given to urban environments. Until the 1980s and 1990s, urban wildlife management was largely ignored until national surveys in the US and Canada found that millions of people participated in wildlife photography, bird watching, and other activities and highly valued wildlife conservation and outdoor recreation (Gray et al. 1993, Bowker et al. 1999, Cordell et al. 2008, McCance et al. 2017). During this time, urban constituents also began to petition the federal government to support nongame and urban wildlife management activities.

Post WWII, increasing human population expansion into urban and rural areas in the Southern and Western US, along with the adaptability of wildlife to urban areas, and the recovery of several wildlife species, lead to urban ecosystems becoming "unbalanced" (McCance et al. 2017). These unbalanced ecosystems suffered from extensive habitat fragmentation, and an overabundance of prey species due to a lack of natural predators. In these new settings, suburban areas were interconnected to create "the limitless city;" and suburbs were no longer defined as low-density residential housing (Gillham 2002). In such areas, the greater affluence an individual had the more likely they were to seek intangible products or experiences such as those with wildlife (McCance et al. 2017).

Periods of Wildlife Exploitation, Recovery, and Management

1500s to 1800s No Management, Pre-management

The no management or pre-management period of the 1500s to 1800s, predated the Industrial Revolution and was characterized by natural wildlife population fluctuations that were not directly impacted from habitat degradation, land-use activities, or the over-exploitation of a species. This changed, as human populations began to expand and technological advances lead to greater land clearing and agricultural practices. The advent of modern transportation along with firearm and trapping efficiencies lead to larger human impacts on wildlife populations. The availability of these technological advances in combination with an immense westward migration of European Americans in the late 1800s (largely driven by the discovery of gold in California) and a lack of wildlife harvest regulation and enforcement, lead to wildlife being harvested for food, material, or to protect agriculture and livestock.

1890s to 1990s Wildlife Recovery

During the late 19th century wildlife populations continued to decline, however, increased public concern for these species lead to the North American conservation movement. Members of this movement advocated for sustaining wildlife populations by limiting harvest and implementing laws that regulated hunting and the take of wildlife for commercial use. Several of these regulations included the Lacey Act that terminated the commercial sale of wildlife, except for regulated fur harvest; the Migratory Bird Conservation Act that outlawed the take of some traditionally harvested bird species; and the Pittman-Robertson Act, that addressed wildlife restoration and management.

Following societies philosophical shift towards wildlife conservation, universities began offering wildlife management courses and researchers began exploring wildlife restoration projects. The Wildlife Recovery period largely focused on conserving and restoring wildlife populations, habitat, and consumptive wildlife activities in rural areas (McCance et al. 2017). Here, wildlife management developed as a response to the scarcity of wildlife, with a focus on production and regulated harvest from managed populations, with a lack of attention being given to urban wildlife management.

1990s to Present Impact Management

Presently, wildlife professionals find it increasingly challenging to find socially and ecologically sustainable resolutions to human-wildlife conflicts. In urban situations, human-wildlife conflicts and their eventual resolution are largely influenced by human emotions that can have positive or negative results. Although, urban residents may feel that they frequently experience wildlife interactions, these events are often superficial (i.e. observing common birds and mammals). These low-levels of wildlife related experiences combined with a lack of professional knowledge, can lead to unrealistic expectations and misconceptions about the feasibility and effectiveness of wildlife management options in urban environments. Therefore, some residents may suggest or prefer low-cost, "quick-fix" solutions that typically only serve to aggravate the severity of the wildlife issue (McCance et al. 2017).

To find solutions to urban wildlife issues, wildlife professionals and their associated communities must develop reasonable expectations regarding:

- Wildlife behavior and how it relates to human and pet health and safety and property.
- Acceptable forms of human- wildlife interactions
- Boundaries for human and wildlife space and where wildlife is acceptable in urban situations.
- The progression and required on-going nature of urban wildlife management that ensures a net positive outcome that allows humans and wildlife to co-exist.
- Improved community-based or co-management efforts between individuals, communities, and agencies in resolving wildlife issues while maintaining societal confidence.
- The development and distributing of effective outreach presentation and publications regarding human-wildlife conflicts, risk perceptions, and wildlife management resolutions.

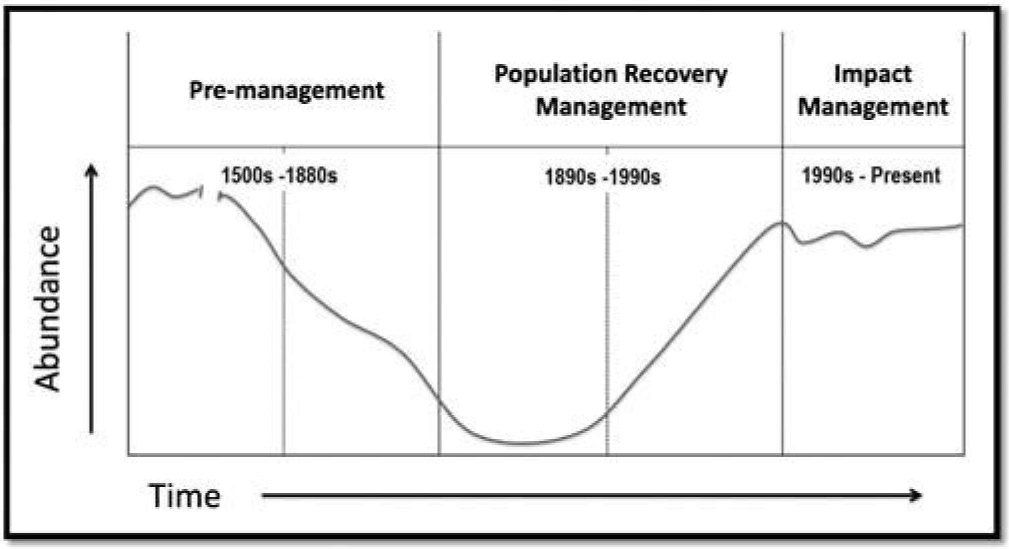

Figure 1.1. Periods of wildlife population exploitation, recovery, and impact management in North America (McCance et al. 2017).

1.6 What is the Precedence for WS Performing BDM in Colorado?

USDA is authorizedto protect American agriculture and other resources from damage associated with wildlife. The Animal Damage Control Act of 1931 [7 USCA 8353; 46 Stat. 1468], as amended in the FY2001 Agriculture Appropriations Bill, authorizes WS to protect American resources by conducting wildlife damage management (WDM) activities. The following paragraph describes a portion of this responsibility as applied to bird damage management (BDM). Although much of the information will be provided here, additional information will be referenced in the EA.

WS's mission, developed through a strategic planning process (USDA 2004), is to *"... provide Federal leadership in managing problems caused by wildlife. WS recognizes that wildlife is an important public resource greatly valued by the American people. By its very nature, however, wildlife is a highly dynamic and mobile resource that can damage agricultural and industrial resources, pose risks to human health and safety, and affect other natural resources. The WS program carries out the Federal responsibility for helping to solve problems that occur when human activity and wildlife are in conflict with one another*." This is accomplished through:

- Training of wildlife damage management professionals;
- Developing and improving strategies to reduce economic losses and threats to humans from wildlife.
- The collection, evaluation, and dissemination of management information.
- Developing and implementing cooperative WDM activities.
- Informing and educating the public on how to reduce wildlife damage.
- Providing technical advice and a source for limited-use management materials to the public.

WS' Policy Manual[3] reflects this mission, and provides guidance for engaging in WDM activities. WS-Colorado cooperates with land and wildlife management agencies when appropriate, and as requested, to combine efforts to effectively and efficiently resolve wildlife damage problems in compliance with all applicable federal, state, and local laws and Memorandums of Understanding (MOUs) between WS and other agencies. Before WDM is conducted, *Work Initiation Documents* must be executed by WS-Colorado and land owners/administrators, or *WS-Colorado Work Plans* established in consultation with federal land management agency representatives. At the State level, WS-Colorado has current MOUs or similar documents with CDA and CPW that specify roles and functions of each agency with regards to Wildlife Damage Management. The MOUs with CDA and CPW specifically address which agency is responsible for the different species causing damage and for what types of damage. National level MOUs have been signed between WS and the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) that transferred the responsibilities for WDM and related compliance with NEPA from BLM and USFS to WS when WS-Colorado is conducting WDM in response to requests from permittees on their lands or USFS or BLM, as appropriate. WS also operates under two additional MOUs with the USFWS for the management of migratory bird damage, and a multiagency MOU for management of wildlife hazards on and around airports.

1.6.1 What Are the Roles of Wildlife Services in BDM?

The WS mission is broad, and includes the resolution of wildlife damage conflicts in rural, urban, and suburban areas; the conservation of natural resources (including threatened and endangered species, and managed wildlife populations), the protection of public, private, commercial property, and assets; and the management of invasive species and disease vectors. Over the years, WS has increasingly become involved in minimizing wildlife threats to public health and safety and to the nation's vital agricultural base.

In this regard, WS' success is largely based on its corresponding activities of operations (in the field) and research staff. The USDA's National Wildlife Research Center (NWRC) is an internationally recognized leader in wildlife damage management science. Scientists and support staff develop practical methods to resolve human wildlife conflicts related to agriculture, natural resources, property, and human health and safety. Research studies focus on alleviating animal damage while ensuring that methods are biologically sound, safe, effective, economical, and acceptable to the public. The operations branch of WS, provides a testing ground for these novel technologies and technics providing real-world situations to evaluate their efficacy, efficiency, and effectiveness in managing wildlife challenges. Publications cooperative created through this exchange of ideas provides valuable data and expertise to the public and scientific community. This collaboration ensures that WS will continue to advance the science of wildlife damage management by developing and employing new technology and techniques to resolve human wildlife conflicts as effectively and humanely as possible.

1.6.2 How Does WS Operate?

WS personnel respond to requests for assistance with particular problems, by using the WS Decision Model to determine whether wildlife caused the problem, and, if so, identifying which species of

[3] WS Policy Manual provides guidance for WS personnel to conduct WDM activities through Directives. WS Directives referenced in this EA can be found in the manual but will not be referenced in the Literature Cited Section.

wildlife caused the problem, and then recommending to the requester one or more courses of actions they can take to minimize the risk of further damage (WS Directive 2.201). This first type of action is called "technical assistance" wherein WS personnel recommend actions that can be implemented by the resource owner or manager, such as better fencing, closer husbandry of livestock, or removing the offending animal themselves compliant with applicable laws.

WS field personnel may also take action directly in response to a request for assistance, called "operational assistance" activities. These actions can include nonlethal techniques such as harassment and/or lethal measures that remove the offending animal(s), such as capturing them with specialized equipment and conducting euthanasia when needed. The actions can occur in urban or field settings, including secured and limited use areas such as military bases and airports. Before wildlife damage management of any type is conducted, a WID must be signed by a representative of WS-Colorado and the land owner or manager, or, for work on federal lands, an Annual Work Plan is discussed and agreed upon by the land management administrator or agency representative and WS-Colorado (per MOUs with the USFS and BLM).

The ultimate intent of WS personnel responding to a request for assistance is to develop and, when appropriate, implement strategies to alleviate and/or avoid wildlife damage and threats to human/pet health or safety, using one or more of the following strategies:

- Manage the resource being damaged so it is more difficult for the wildlife to cause the damage.
- Manage the wild animals responsible for or associated with the damage in lethal and/or nonlethal ways so they cannot continue to cause damage and potentially train their young or conspecifics to cause such damage, and/or
- Create physical separation of the protected resource and the problem animals so that the damage is inherently minimized.

All WS actions are consistent with applicable federal, state, and local laws and regulations (WS Directive 2.201). All actions must be consistent with memoranda of understanding and agreements with federal and state agencies, such as the CPW, USFWS, USFS, or BLM, if the actions involve those agencies. Most importantly, as a federal agency, all WS actions must be in compliance with the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), and Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as well as the federal and state statutes discussed in this EA.

When requested to assist with BDM problems, the WS-Colorado decision is whether or not to participate based on authority, jurisdiction, funding, and a professional determination of the scientific appropriateness and effectiveness of the strategy proposed by the requester, especially if the requester is the CPW or USFWS. The USFWS is authorized to manage ESA-listed species, migratory birds, and eagles (**Table 1.1, 1.2, 1.3, 1.4**). Therefore, when requested by CPW or the USFWS to conduct BDM for protection or management of species under their jurisdiction, especially if the requested action involves localized population reduction, WS-Colorado evaluates the potential effectiveness and appropriateness of their involvement before making a final decision to assist.

1.6.3 How Does WS Ensure the Implementation of Professional Wildlife Damage Management (WDM) Practices?

Each WS state office carries out the WS mission in accordance with the differing management goals of its state. WDM activities can include providing assistance with WDM for the purposes of managing property and asset damage and losses, protecting special status wildlife, reducing or eliminating invasive species, protecting human health or safety, managing diseases that can be passed from wildlife to people or domestic animals (zoonosis), and conducting research.

Per WS policy and practice, WS State Directors and District Supervisors are professional wildlife biologists. Supervisors oversee teams of highly trained and specialized wildlife biologists and other field personnel.

WS field personnel must be experienced in wildlife management and ecological principles and practices, and highly competent in identifying predator sign, field skills, and developing and implementing effective strategies within a wide diversity of challenging conditions and circumstances. They are highly trained in the use of firearms, capture techniques, pyrotechnics, field chemicals, and other methods described in detail in **Chapter 2** per WS Directives. They must also be experienced in working with people, and in using clear strategic skills in applying their experience, expertise, and training in applying the WS Decision Model in effective and creative ways.

All field personnel, as needed and appropriate, are trained, with periodic refreshers, in:

- The safe and proficient use of firearms (WS Directive 2.615);
- The safe involvement in aerial operations (WS Directives 2.620 and 2.305);
- The safe and proficient use of explosives and pyrotechnics (WS Directive 2.625);
- The safe use and management of hazardous materials (WS Directive 2.465);
- The safe and compliant use of pesticides (WS Directive 2.401); and
- The safe and humane use of immobilizing and euthanizing drugs (WS Direct 2.430).

1.6.4 What is the Federal Law Authorizing Wildlife Services' Actions?

WS is the federal agency authorized by Congress to protect American resources from damage associated with wildlife. The Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 8351) states:

"The Secretary of Agriculture may conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program….

The Act was amended in 1987 (Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 8353) to further provide:

On or after December 22, 1987, the Secretary of Agriculture is authorized, except for urban rodent Management, to conduct activities and to enter into agreements with State, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the Management of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under such agreement into the appropriation accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities."

1.6.5 What is WS-Colorado?

WS-Colorado is a cooperatively funded, service-oriented, section of the United States Department of Agriculture (USDA). Besides the state agencies, WS-Colorado works within the state and focuses most BDM efforts in areas where funding becomes available from interested cooperators and where there is a need for assistance. Cooperators include private citizens, businesses, organizations, cities, county governments, state agencies and federal agencies.

Colorado encompasses about 104,185 mi^2 (66,678,400 acres) in 64 Counties (**Figure 1.1**). WS-Colorado has divided the State into three geographic Districts: Western Slope (northwestern Colorado), Northeast (Front Range and northeastern Colorado), and Southern (southern tier and southeastern Colorado). WS-Colorado receives requests for BDM throughout Colorado. At a minimum, all requesters are provided with technical assistance (self-help information). **Figure 1.1**; however, assistance may be provided anywhere in Colorado where a need exists and funding is available to cover such actions.

WS-Colorado is divided into 3 geographical districts with different emphasis on services provided because wildlife species, conflicts and resources vary across Colorado (**Figure 1.1**). Staffing and services provided by district are detailed with focus on BDM only.

<u>Northeast District</u>

BDM in northeastern Colorado is diverse in protecting numerous resources from bird damage and conflicts. The largest service provided is protecting aviation safety from bird strikes followed by disease surveillance, then protecting property from resident Canada goose damage to county and city owned parks and businesses and woodpecker damage to buildings. Less often but important damage management services are protecting dairies, feedlots and CAFOs from blackbird, starling and pigeon damage; aggressive waterfowl and kingbirds attacking people; and waterfowl and blackbird damage to crops. Staff are located at Denver International Airport, Buckley Air Force Base and one wildlife biologist services the remaining 73 public use and publicly owned airports throughout Colorado providing Federal Aviation Administered training, wildlife surveys, recommendations and limited wildlife damage mitigation. The remaining staff have other primary duties and less often assist landowners with urban resident Canada goose conflicts in metropolitan Denver, Fort Collins and smaller urban/suburban jurisdictions; managing damage at 20 dairies, feedlots and CAFOs with the toxicant DRC-1339, provide technical assistance and WS Form 37 for applicants wanting a Migratory Bird Depredation Permit, conduct bird capture and hazing at oil spill sites, and assist one wildlife biologist with disease surveillance activities. Staff at airports rely on hazing and shooting birds to reduce risk. Over 100 raptors per year are trapped in bal chatri or Swedish goshawk traps for relocation off the airport. The airports implement habitat alteration, environmental education and husbandry and exclusion to reduce risk to aviation safety. Canada goose damage management projects utilize a lot of technical assistance to modify human behavior (e.g., don't feed the geese), capture geese during the molt with corral traps and oil eggs with corn oil. Geese may be hazed with pyrotechnics, dogs, remote controlled boats and vehicles, or other noise making devices. Landowners are encouraged to modify habitat in urban/suburban areas to reduce goose abundance. Most activities in the Northeast District occur on county or city owned lands or private lands.

<u>Western Slope District</u>: The Western District infrequently conducts bird damage management but assists landowners and county and city governments upon requests. The limited BDM projects conducted include managing starlings at 2 dairies, urban vulture roost dispersal, resident Canada goose management at golf courses and other urban properties. Starlings at 2 dairies were reduced in

abundance with the registered toxicant DRC-1339. Vulture roosts are dispersed using lasers, 15 mm pyrotechnics, effigies and limited shooting. Canada geese are dispersed with pyrotechnics, 15 mm pyrotechnics, hazing and some shooting. Nests and eggs have been treated with corn oil. Technical assistance is provided to livestock producers experiencing magpie, raven or eagle depredations. A handful of ravens depredating sheep were shot and more were harassed by trained dogs. In the past, WS-Colorado has managed raven predation on newborn calves with DRC-1339 in egg baits. Staff have also managed ravens to protected threatened Gunnison sage grouse. Staff in the Western District primarily work on protecting livestock and wildlife species of management concern or threatened and endangered species from mammalian predators. The staff infrequently work on bird damage conflicts or issues.

Southern District: BDM in the Southern District is diverse but occur frequently in the eastern half of the district and rarely in the western half of the district. In the several staff conduct BDM at least 50% of the time. Other employees infrequently conduct BDM at least 20% of the time. BDM projects include managing rock dove (pigeon) damage in several small towns by walk-in cage traps and shooting. The registered toxicant DRC-1339 has infrequently been used in the past to manage rock doves in towns. Canada geese have been managed with an integrated approach of hazing with pyrotechnics, lasers, chasing with golf carts, shooting to reinforce hazing, nest and egg treatments and corral traps. There has been limited shooting to remove woodpeckers damaging buildings. Full-time wildlife biologists at Peterson Air Force Base and the Air Force Academy conducted bird surveys, hazing, technical assistance, trapping raptors with bal chatri and Swedish goshawk traps for relocation, using cage traps for non-native birds, and shooting to reinforce hazing. Birds are hazed with dogs, distress calls, lasers, shooting firearms, 15 mm pyrotechnics, and vehicles at both air bases. A technician works part-time about 10 hours per week hazing birds at Colorado Springs Regional Airport. He will remove and haze birds from the airport with similar methods as at the air bases. Some urban bird work is conducted on invasive pigeons in about 4 towns in the eastern half of the Southern District where cage traps and shooting during the day and at night are used. DRC-1339 is used to remove starlings from 3 feedlots in the eastern portion of the district.

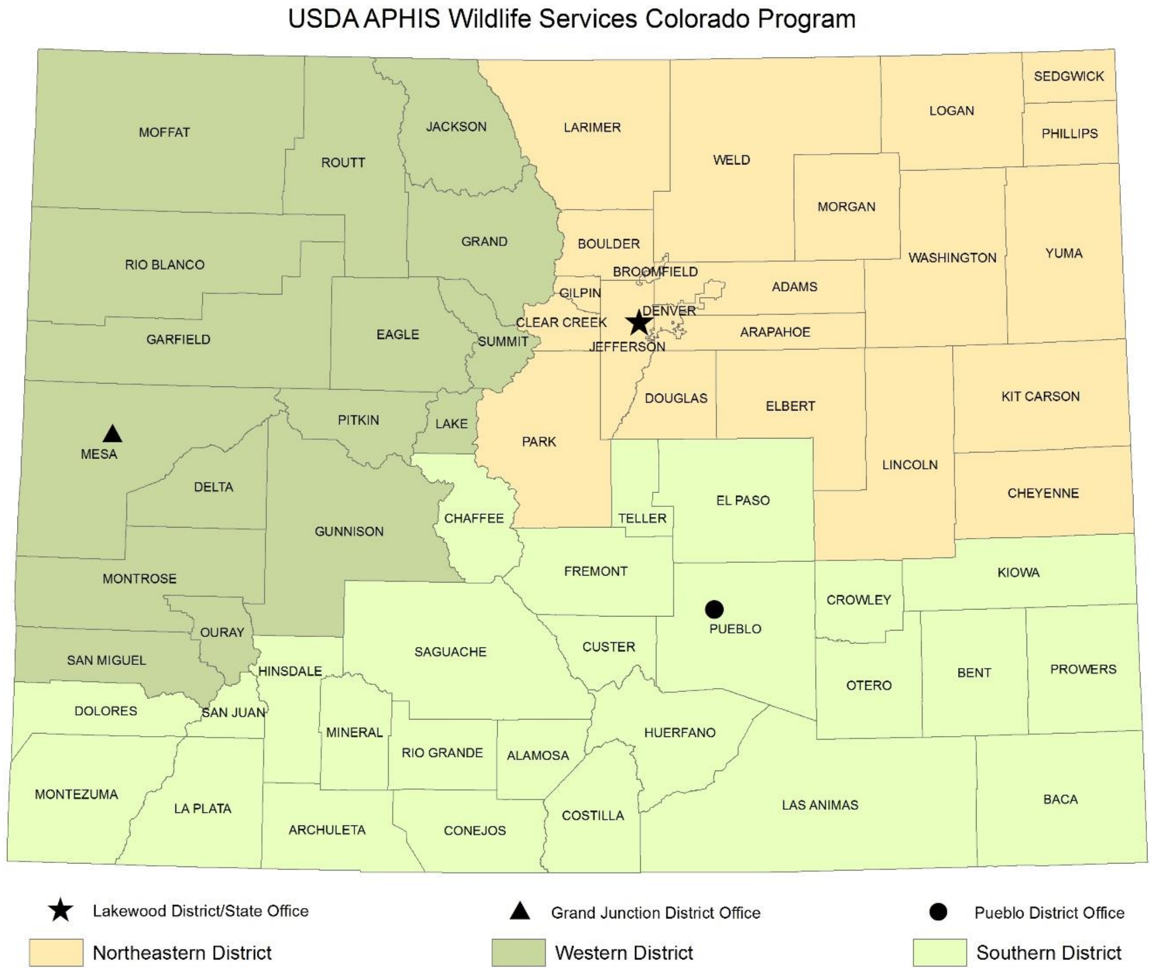

Figure 1. 2. WS in Colorado has three Districts (Lakewood, Pueblo, and Grand Junction) that have personnel to respond to bird damage complaints in Colorado's 64 Counties.

Table 1.8. Counties by regions of Colorado[A] where bird damage management activities were conducted by the Wildlife Services program of the United State Department of Agriculture, Animal and Plant Health Inspection Service to protect livestock or wildlife species of management concern from predation, FY2013 – 2017.

Western Slope	Northeast	Southeast
Delta	Adams	Alamosa
Garfield	Arapahoe	Bent
Jackson	Denver	Crowley
Mesa	Jefferson	El Paso
Moffat	Larimer	Otero
Montrose	Logan	Prowers
Rio Blanco	Phillips	Pueblo
	Morgan	
	Weld	

A. There are 64 counties in Colorado.

1.6.6 What Are WS' and WS-Colorado's Mission, Goals, and Objectives?

WS' mission is to provide professional federal leadership in improving the coexistence of people and wildlife. The agency is funded by Congressional appropriations and by funds provided by governmental, commercial, private, and other entities that enter into an agreement with WS for assistance. In Colorado, BDM activities are funded by Congressional appropriations (about 31%), federal and state interagency agreements (about 18%), and private, commercial, or other cooperators (about 51%). Cooperators are always responsible for contributing a proportion of the costs, including WS-Colorado administrative overhead.

WS' stated mission, developed through a strategic planning process:

- *"To provide leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and*
- *To safeguard public health and safety" (WS Directive 1.201)."*

  To facilitate long-term strategic planning, WS identified a list of core program functions in the WS 2013-2017 Strategic Plan (WS 2013), including these functions relevant to WS-Colorado:

- Bird damage management for the protection of human health and safety
- Protection of natural resources (including threatened and endangered species) from other injurious wildlife
- Protection of agricultural resources and property from wildlife damage
- Airport wildlife hazard management
- Conducting wildlife damage research

WS responds to requests for assistance from private and public entities, tribes and other federal, state, and local governmental agencies (WS Directive 1.201 and 3.101).

Directive 1.301 states:

"*WS is specifically authorized to enter into cooperative programs with Government agencies, public or private institutions, organizations associations or private citizens to manage conflicts with wild animals. By coordinating Federal Government involvement in managing wildlife conflicts and/or damage, WS officials help ensure that wildlife management activities are environmentally sound and conducted in compliance with applicable Federal, State, and local laws and regulations, including two significant environmental laws, the Endangered Species Act and the National Environmental Policy Act (NEPA)."*

"Wildlife Services' successes in developing and providing its expertise in WDM methodologies, and strategies have increasingly created methodologies, strategies, and opportunities for private industry to provide similar WDM services. WS activities are differentiated from commercial WDM activities by among other things, adherences to the environmental protection requirements promulgated under NEPA….WS may implement methods approved exclusively for WS personnel who are the only individuals, public or private, that are trained and certified in their use. WS cooperates with private businesses by 1) providing technical training at State, regional, and national conferences; 2) developing certain WDM methods and registering certain chemical or pesticide WDM products for use by the industry and the public, and 3) assisting businesses by applying WS-specific management methods when requested."

Wildlife Services carries out its federal mission for helping to solve problems that occur when human activity and wildlife are in conflict with one another through:

- Providing training to governmental and commercial wildlife damage management professionals when requested;
- Developing and improving strategies to reduce economic losses and threats to humans from wildlife;
- Collecting, evaluating, and disseminating information on wildlife damage management techniques;
- Responding to requests for assistance with wildlife damage management situations, including providing technical advice and a source for loaned, limited-use management materials and equipment such as cage traps and pyrotechnics; informing and educating the public and cooperators on how to avoid or reduce wildlife damage; and/or addressing the problem through direct action.

The goal of WS-Colorado is to respond in a timely and appropriate way to all requests for assistance. Responses, whether over the phone, remotely, or in the field, follow a formal decision process (WS Decision Model, WS Directive 2.201) to evaluate, formulate, and implement or recommend the most effective strategy. The recommended strategy is designed to reduce or eliminate damage and risks caused by the offending animal(s) to resolve conflicts with humans and their valued resources, health, and safety. These strategies may be both short term and long term, are often a combination of methodologies, and are based on WS' mission of professionally supporting the coexistence of humans and wildlife.

The WS-Colorado objectives are to:

- Professionally and proficiently respond to all reported and verified losses or threats associated with bird species/species groups using the BDM approach using the WS decision model (WS Directive 2.201). BDM must be consistent with all applicable federal, state, and local laws, WS policies and directives, cooperative agreements, MOUs, and other requirements as provided in any decision resulting from this EA.
- Implement BDM so that cumulative effects do not negatively affect the viability of any native bird species populations.
- Ensure that actions conducting within the BDM strategy fall within the management goals and objectives of applicable wildlife damage management plans or guidance as determined by the jurisdictional state, tribal, or federal wildlife management agency.
- Minimize non-target effects by using the WS Decision Model (WS Directive 2.201) to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.
- Incorporate the use of appropriate and effective new and existing lethal and nonlethal technologies, where appropriate, into technical and operational assistance strategies.

WS-Colorado activities are conducted in accordance with applicable federal, state, and local laws, Work Initiation Documents (WIDs), cooperative agreements, agreements for control, Memoranda of Understanding (MOU) and other applicable agreements and requirements, and the directives found in the WS Program Policy Manual, updated April 20, 2016 (https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/sa_ws_program_directives). These documents establish the need for requested work, legal authorities allowing the requested work, and the respective responsibilities of WS and its cooperators.

1.7 What are the Needs for the WS-Colorado Bird Damage Management Activities?

WS-Colorado conducts integrated wildlife damage management activities utilizing a mix of nonlethal and lethal methods to alleviate bird damage involving 88 different bird species for the period federal fiscal year 2013 to 2017 (**Table 1.9**). During this 5-year period 1,540,858 birds were hazed or dispersed by WS-Colorado employees and 272,964 birds were taken to reduce damage or reinforce hazing activities. Of the birds lethally taken from FY2013-2017, 84% (N=230,317 birds) were comprised of two non-native invasive species: European starlings and feral pigeons. An additional 1,045 birds were captured and relocated to alleviate damage during the same 5-year period. All relocated birds were owls, hawks, falcons, or bald eagles. The yearly averages of birds damage management activities were comprised of 308,172 hazed or dispersed, 54,593 birds killed, and 209 birds relocated.

During the 5-year period, 5 non-target birds representing 2 bird species (common raven and black-billed magpie) were killed (**Table 1.9**). An additional 31 non-target birds representing 6 species were captured and released unharmed (**Table 1.9**). Total non-target birds killed or captured and released was 36 birds which is a phenomenally low percentage. One of the three non-target species was an invasive bird species (i.e., Eurasian dove). Thus, non-target take of migratory birds account for 6 birds from a total 54,593 birds taken (**Table 1.9**), an average of one non-target bird killed per year. No threatened or endangered species were taken or hazed. Six bald eagles and one golden eagle were captured and relocated from an airport under federal permits issued by the Fish and Wildlife Service. An additional 991 bald eagles and 134 golden eagles were hazed at airports. The dispersal of these bald and golden eagles from the airports saved the eagles' lives because eagles at an airport generally die from bird strikes with aircraft (Washburn et al. 2015). An additional 2 peregrine falcons were dispersed from an airport. No eagles or peregrine falcons were killed by damage management actions by WS-Colorado during the 5-year period FY2013-2017.

Of the birds taken, a majority of the birds were taken at three airports (17%) or feedlots or dairies (74%) by WS-Colorado BDM activities. Birds were dispersed primarily at 3 airports or air bases with 86% percent of dispersals. Birds taken at feedlots and dairies were comprised of European starlings (99%), red-winged blackbirds (1%) and pigeons (<1%). A total of 1,138 birds were captured and sampled for disease surveillance (e.g., avian influenza), the captures were often conducted with Colorado Parks and Wildlife and the Fish and Wildlife Services (national wildlife refuge programs) as part of those agencies bird banding and monitoring activities from FY2013-2017.

As stated previously, in some cases, cooperators likely tolerate negligible damage and loss until the damage reaches a threshold where the damage becomes an economic, physical, or emotional burden. The appropriate level of tolerance or threshold before using nonlethal and lethal methods differs among cooperators, their economic circumstances, and the extent, type, duration, and chronic nature of damage situations. The level of tolerance would be lower for situations in which human safety or the potential for disease transmission from wildlife to humans is at risk. For example, action must be taken immediately in the case of aircraft striking bird species/species groups at an airport that may lead to significant property damage and risks to passenger safety, or when birds aggressively defend nests in residential areas and injure bystanders. In cases where the affected entity is concerned with the threat of damage, the entity has often experienced damage in the past and it is reasonably foreseeable to assume that damage will occur again.

The point at which a particular entity affected by bird damage reaches their tolerance threshold and requests assistance is affected by many variable specific to the affected entity. Therefore, it is not possible to set a pre-determined threshold before a need for BDM is determined to exist. To address these concerns, the effects of the alternatives on populations for the target species are examined. To fully understand the need for BDM, it is important to have knowledge about the species that cause damage and the likelihood of damage. Full accounts of life histories for these species can be found in bird reference books. Some background information is given here for the bird species in Colorado covered by this EA, especially information pertaining to their seasonal movements in Colorado. Species are primarily given in order of WS BDM efforts directed towards them, their subsequent take, and the occurrence and value of damage that the species cause in Colorado. However, less damaging species may be combined with species that cause more damage where life history and damage are somewhat similar. Finally, it should be noted that jurisdiction and management of these species mostly lies with USFWS and CPW.

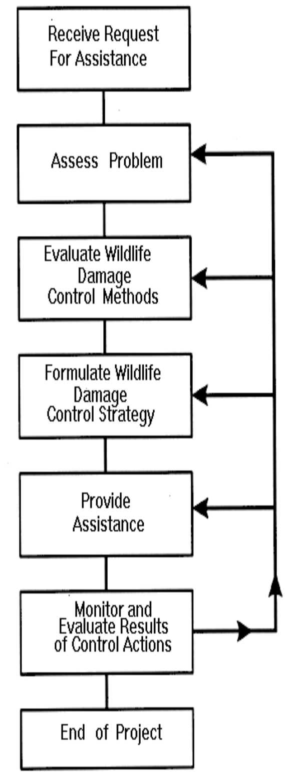

Figure 1.3. WS Decision Model used at the field level (Slate *et al.* 1992).

WS-Colorado is not required to assess the economic value of a particular loss or threat of loss before taking a BDM action, and WS-Colorado responds regardless of the resource needing protection. However, WS does use a standard methodology for evaluating the value of a verified loss using national data and other factors, as well as economic values provided by the cooperator at the time of evaluation and service. Additionally, WS-Colorado recognizes that increasing numbers of people moving into rural areas or living in urban areas with increasing populations of wildlife are often unfamiliar with wildlife and may become anxious with wildlife encounters. Therefore, WS-Colorado commonly provides technical assistance, including advice, training, and educational materials, to individuals, communities, and groups to better understand how to coexist with wildlife and reduce the potential for conflicts. Whenever possible, WS-Colorado personnel recommend that citizens take nonlethal action when effective in addition to lethal actions taken by WS-Colorado personnel. However, the appropriate strategy for a particular set of circumstances must be determined on a case-by-case basis, using the WS Decision Model (**See Figure 1.3**).

The proposed action is to continue the current activities in Colorado in response to requests for BDM to protect human health and safety; agricultural resources such as livestock feed, livestock, livestock health, aquaculture, nurseries, and crops; property such as turf, landscaping, and structures; and natural resources such as T&E species, other wildlife, in Colorado. The three primary components of the WS BDM activities in Colorado have been the reduction of threats or hazards to human health and safety at airports, the protection of livestock feed and the risk of bird-related livestock health problems caused by starlings[4] and blackbirds (includes blackbirds, grackles, cowbirds, and starlings

[4] Starling in this EA refers only to the European Starling, the only starling introduced into the United States.

in the "Mixed Blackbird" MIS category – see **Table 1.5**) at dairies and feedlots, and property protection from feral pigeons. Additionally, property damage from waterfowl; livestock and T&E species losses from predatory birds (e.g., Common ravens) are a minor component. BDM goals are to minimize damage and/or the risk of damage to other agricultural resources, natural resources such as wildlife species, property, or other public or private resources from birds, and conduct disease surveillance.

1.7.1 Why Do Wildlife Damage and Risks to Human Health and Safety Occur?

Wildlife habitat across the United States have been significantly altered as human populations continue to encroach and fragment uninhabited landscapes. Anthropogenic developments frequently compete with the needs of wildlife and increase the potential for negative interactions between humans and wildlife. As humans continue to expand into undeveloped landscapes they tend to concentrate resources into areas of intensive use. These resources include: livestock, non-native species of plants and animals, food crops, refuse, water resources, buildings, and other infrastructure (roads, railroads, waterways, etc…). While some wildlife populations readily habituate and adapt to exploiting these anthropogenic sources (e.g. food, water, shelter, lack of predators, new nest sites, etc.) and reach unnatural population overabundances and/or a lack of fear during human interactions; other less adaptable species experience population declines and disappear from urban landscapes.

Although humans tend to anthropomorphize wildlife, by attributing human traits, emotions, and intentions to non-humans, wildlife themselves do not share these perceptions. Wildlife species adapt to fluctuating environment(s) to meet their basic needs for survival including: reproducing, foraging, shelter, and resting. Tension and conflict arise as wildlife struggle to meet these needs and their activities result in lost economic value of resources or threaten human safety. In these situations, wildlife may destroy crops; damage livestock, property, and natural resources; and pose serious risks to public health and safety.

Additionally, introduced, feral, or invasive species may outcompete native species, damage property, and/or introduce novel parasites and disease(s). As pressure from expanding human populations bring humans and wildlife into closer contact, infections occurring in remote areas can be transported to city epicenters in a matter of hours. Expanding agricultural practices may additionally intensify contact and transmission of disease between domestic and wildlife species. Disease transmission may occur directly through physical contact or indirectly via environmental contaminates (feces, tainted food, other bodily fluids, infected objects). Finally, as humans move from urbanized locals into rural or newly developed areas, people often are unfamiliar with wild animals, their habitat or, behaviors. Individual animals may become habituated to the point they lose their natural fear of humans, instead choosing to live near residences, prey on pets and livestock, and/or attack or intimidate people.

Table 1. 9. Migratory and feral birds reported to Wildlife Services – Colorado that depredated, damaged or threatened resources in Colorado from Federal Fiscal Year 2012 through 2017.

Resource	Species causing damage	No. of Incidents[A]
Aircraft	Doves, collared Eurasian	1
	Geese, Canada	1
	Hawks, Swainson's	1
Aquaculture	Cormorant, Double-crested	16

Resource	Species causing damage	No. of Incidents[A]
	Crow, American	2
	Ducks, merganser, common	4
	Gulls, California	13
	Gulls, Franklin	8
	Gulls, Herring	10
	Gulls, Ring-billed	12
	Heron, Great Blue	36
	Heron, Night, Black-crowned	14
	Kingfisher, belted	15
	Pelican, White	12
	Raven, Common	3
Buildings	Flickers, northern	326
	Geese, Canada	1
	Hawks, red-tailed	1
	Nuthatch, pygmy	3
	Nuthatch, white-breasted	33
	Pigeons, feral	17
	Ravens, common	1
	Robins, American	1
	Starlings, European	1
	Swallows, cliff	8
	Vulture, turkey	1
	Woodpecker, downy	8
	Woodpecker, Lewis's	1
	Woodpecker, red-headed	1
	Woodpeckers, hairy	2
Feed, Livestock	Blackbird, red-winged	2
	Pigeons, feral	7
	Starlings, European	35
Fruit (cherries)	Robin, American	1
Golf course	Geese, Canada	5
Grain, Stored	Pigeon, feral	1
Hayfields/pastures	Geese, Canada	4
Human health & safety (aviation)	46 species (top 11 species listed)	491
	Doves, mourning	31
	Ducks, mallard	23
	Geese, Canada	33
	Kestrel, American	21
	Harrier, northern	22
	Hawk, red-tailed	38

Resource	Species causing damage	No. of Incidents[A]
	Hawk, Swainson’s	22
	Lark, horned	27
	Meadowlark, western	22
	Ravens, common	25
	Vulture, turkey	22
Human health & safety (general)	Crow, American	2
	Doves, mourning	1
	Flickers, northern	3
	Geese, Canada	2
	Grackles, common	3
	Hawks, Swainson’s	1
	Killdeer	2
	Kingbird, western	2
	Owl, great horned	1
	Pigeon, feral	1
	Sparrow, house	3
	Starling, European	3
	Swallow, barn	5
	Swallow, cliff	3
	Vulture, turkey	2
Livestock (Sheep) (ewes, rams, lambs)	Magpie, black-billed	2
	Eagle, golden	5
	Raven, common	2
Livestock (Poultry)	Ducks, gadwall	1
	Ducks, mallard	2
	Ducks, blue-winged teal	1
	Hawks, red-tailed	1
Property (general)	Blackbird, Brewer	3
	Geese, Canada	5
	Starlings, European	3
	Vulture, turkey	1
T&E birds	Gulls, California	4
T&E fish	Ducks, merganser, common	2
	Gulls, Franklin	2
	Gulls, Ring-billed	2
	Herons, great-blue	2
	Herons, night, black-crowned	2
	Kingfisher, belted	2
	Pelicans, American white	2
Utilities	Owl, great horned	1

A. An incident can involve one or more animals.

1.7.2 What is the Need to Alleviate the Threat of Aircraft Striking Wildlife at Airports and DoD Facilities?

From 1990 to 2015, 169,856 strikes were reported to the Federal Aviation Administration (FAA) in the United States (Dolbeer et al. 2016). Birds were involved in 95.8 percent of strikes reported to civil aircraft and predominately occurred between July and October (Dolbeer et al. 2016). The number of bird strikes actually occurring is likely much greater since Dolbeer (2009) estimated that only 39% of wildlife strikes were reported annually. For commercial and general aviation aircraft, 71% and 73% of bird strikes, respectively occurred at or below 500 feet above ground level (AGL) (Dolbeer et al. 2016). Above 500 feet AGL bird strikes decline by 34% for each 1,000-foot gain in height for commercial aircraft and by 44% in general aviation aircraft (Dolbeer et al. 2016). In the United States from 1990 to 2015, 529 species of birds were identified as struck by aircraft. Strikes between waterfowl, gulls, and raptor species typically result in the most damaging events.

As birds enter or exit roosts in large populations at or near airports or when present in large populations foraging on or near an airport, those species represent a safety threat to aviation. For example, Canada geese, wild turkeys, vultures, and raptors present a risk to aircraft due to their large body mass and slow-flying/soaring behavior. For every 100 gram increase in body mass, there is a direct correlative increase of 1.26% that a strike will cause damage (Dolbeer et al. 2016). Vultures are considered the most hazardous bird for an aircraft to strike based on the frequency of strikes, effect on flight, and amount of damage caused by vultures throughout the country (Dolbeer et al. 2000). Mourning doves also present risks when their late summer behaviors include creating large roosting and loafing populations. Their feeding, watering, and gritting behavior on airport turf and runways further increases the risk of bird-aircraft collisions. European starlings populationing behavior, especially during winter, present risks to aircraft in the airport environment when discovered roosting in surrounding trees or buildings. From 1990 to 2010, 44 strikes involving waterfowl resulted in injuries to 49 people and 29 strikes involving vultures resulted in injuries to 32 people (Dolbeer et al. 2016).

BDM activities at airports serve as a large part of WS-Colorado's activities. Protecting the public from catastrophic events, including the loss of life due to a bird strike, remains a high priority for our activities. Bird strikes (collisions between birds and aircraft) are regularly reported to the Federal Aviation Administration. Although, sparsely manned airports are unable to perform this service as readily as some of the larger commercial facilities. Unfortunately, in the 1990s it was assumed that, at most, about 20% of the strikes were reported. Over the years, pilots have become more aware of the importance of bird strike reporting through increased education and outreach trainings. Today, the Colorado aviation community has become more cognizant of the importance of bird strike reporting and strike reports continue to increase annually. However, there is a caveat to consider when analyzing this data. Air traffic movements have steadily increased along with rising populations of migratory birds since the 1990s. Obviously, while there is likely a positive association between increased educational outreach to pilots regarding bird strike reporting it is hard to quantify those efforts in relation with concurrent increases in both air traffic and bird populations. Additionally, some species that are reported as a bird strike in Colorado may have been hit in another state at the beginning of a flight and entered by the pilot at their final location.

Below we discuss bird strikes that resulted in substantial damage to aircraft from FY13 to FY17.

In FY13, five bird strikes causing substantial damage were reported with one aircraft being destroyed at Colorado airports:

- In March, a Gulfstream V struck a Red-tailed Hawk on departure climb. The bird struck the landing light causing the glass to shatter and be ingested through the #1 engine. The aircraft was ferried to another location for repairs and taken out of service for 240 hours. The reported cost of repairs was $250,000.

- In May, a C-21 military aircraft struck a Swainson's Hawk on landing. Damage to the aircraft resulted in $34,929 in repairs.

  In FY14, five bird strikes causing substantial damage were reported with one aircraft being destroyed at Colorado airports:

- In November, a BE-300 King struck eleven unknown gulls on approach. Damage to the aircraft resulted in $18,648 in repairs.

- In January, a Boeing 757-200 struck one Rock pigeon during a departure climb. The plane was diverted and damage was sustained to the left front fuselage and right engine. Engine was replaced resulting in $50,000 in repairs.

- In June, a Boeing 767-300 struck two Canada geese during a departure climb. Two geese were ingested and pieces of engine fan blades were located along the runway. Total cost of repairs $3,909,837.

In FY15, four bird strikes causing substantial damage were reported at Colorado airports:

- In January, a Citation struck several unknown small bird during a landing roll. Damage to the aircraft resulted in $20,000 in repairs.

- In September, a Gulfstream G 280 struck three American White pelican on approach. The left leading edge of the wing sustained three dents and the left main landing gear was bent. Damage to the aircraft resulted in $200,000 in repairs.

In FY16 one bird strike that experienced substantial damage in Colorado:

- In November, a Boeing 737-300 struck several Canada geese during departure while climbing. Damage was sustained to turbines in engine number 2 and the aircraft had to return to the airport. No information was available as to cost of repairs.

In FY17, there were no bird strikes reported that resulted in substantial damage to an aircraft.

To date, no documented bird strikes have resulted in loss of human life in Colorado; however, strikes continue to occur, increasing the risk for a catastrophic event (Dolbeer 2016, FAA 2016). Such was the case at Elmendorf Air Force Base, Alaska in September 1995 where 24 human lives were lost when an "AWACS" aircraft crashed after ingesting four Canada Geese during takeoff (Cleary and Dolbeer 1999).

Table 1.10. Reported bird strikes to aircraft in Colorado as reported to the Federal Aviation Administration from FY13 to FY17. The species included are only those that are recorded as causing

an aircraft/wildlife strike in Colorado. An estimated 48,849 wildlife strikes were recorded in the United States from 2011 to 2015 and 2,538 occurred in Colorado from FY 13 to FY17.

	Colorado Bird/Aircraft Strikes (FY13 - FY17)				
	Number of CO Strikes	**% of all WILDLIFE Strikes in CO**	**Number of Damaging CO Strikes**	**% of CO Strikes w/ Damage**	**# of CO Strikes w/o Damage Data**
Waterfowl (Geese, Ducks, Cranes…)					
Blue-winged teal ducks	2	0.08%	0	0.00%	2
Cackling geese	3	0.12%	0	0.00%	3
Canada geese	10	0.39%	4	6.78%	6
Gadwall ducks	2	0.08%	0	0.00%	2
Mallard ducks	6	0.24%	2	3.39%	4
Northern pintail ducks	2	0.08%	1	1.69%	1
Northern shoveler ducks	1	0.04%	0	0.00%	1
Ruddy ducks	1	0.04%	0	0.00%	1
Sandhill cranes	1	0.04%	0	0.00%	1
Unidentified ducks	1	0.04%	1	1.69%	0
Unidentified geese	4	0.16%	1	1.69%	3
Waterfowl Total	**33**	**1.30%**	**9**	**15.25%**	**21**
Waterbirds (Grebes, Pelicans, Cormorants…)					
American white pelicans	1	0.04%	1	1.69%	0
Western grebes	2	0.08%	0	0.00%	2
Unidentified grebes	1	0.04%	0	0.00%	1
Waterbird Total	**4**	**0.16%**	**1**	**1.69%**	**3**
Wading Birds (Herons, Egrets, Cranes…)					
American coots	5	0.20%	0	0.00%	5
Black-crowned night herons	1	0.04%	0	0.00%	1
Great blue herons	1	0.04%	0	0.00%	1
Sora	1	0.04%	0	0.00%	1
Wading Bird Total	**8**	**0.32%**	**0**	**0.00%**	**8**
Raptors (Vultures, Hawks, Eagles, Owls…)					
American kestrel falcons	86	3.39%	1	1.69%	85
Bald eagles	1	0.04%	0	0.00%	1
Barn owls	8	0.32%	0	0.00%	8
Burrowing owls	30	1.18%	0	0.00%	30
Cooper's hawks	3	0.12%	1	1.69%	2
Ferruginous hawks	3	0.12%	0	0.00%	3
Golden eagles	5	0.20%	0	0.00%	5
Great-horned owls	23	0.91%	1	1.69%	22
Merlin hawks	1	0.04%	0	0.00%	1

	Colorado Bird/Aircraft Strikes (FY13 - FY17)				
	Number of CO Strikes	**% of all WILDLIFE Strikes in CO**	**Number of Damaging CO Strikes**	**% of CO Strikes w/ Damage**	**# of CO Strikes w/o Damage Data**
Northern harrier hawks	2	0.08%	0	0.00%	2
Osprey	1	0.04%	0	0.00%	1
Peregrine falcons	8	0.32%	0	0.00%	8
Prairie falcons	3	0.12%	0	0.00%	3
Red-tailed hawks	57	2.25%	8	13.56%	49
Rough-legged hawks	9	0.35%	1	1.69%	8
Short-eared owls	3	0.12%	0	0.00%	3
Swainson's hawks	7	0.28%	4	6.78%	3
Turkey vultures	1	0.04%	0	0.00%	1
Unidentified hawks	5	0.20%	1	1.69%	4
Unidentified owls	2	0.08%	0	0.00%	2
Raptor Total	**258**	**10.17%**	**17**	**28.81%**	**241**
Shorebirds (Plovers, Sandpipers…)					
Baird's sandpipers	1	0.04%	0	0.00%	1
Black-necked stilts	1	0.04%	0	0.00%	1
Killdeer	37	1.46%	0	0.00%	37
Stilt sandpipers	1	0.04%	0	0.00%	1
Western sandpipers	1	0.04%	0	0.00%	1
Wilson's phalarope	2	0.08%	2	3.39%	0
Unidentified rails	1	0.04%	0	0.00%	1
Shorebird Total	**44**	**1.73%**	**2**	**3.39%**	**42**
Larids (Gulls)					
Franklin's gulls	3	0.12%	1	1.69%	2
Ring-billed gulls	5	0.20%	0	0.00%	5
Unidentified gulls	9	0.35%	2	3.39%	7
Gull Total	**17**	**0.67%**	**3**	**5.08%**	**14**
Invasive Species (Doves, Starlings, Sparrows…)					
European starlings	6	0.24%	0	0.00%	6
Eurasian collared-doves	7	0.28%	0	0.00%	7
House sparrows	4	0.16%	0	0.00%	4
Rock pigeons	79	3.11%	3	0.12%	76
Invasive Species Total	**96**	**3.78%**	**3**	**0.12%**	**93**
Native Doves and Pigeons					
Mourning doves	205	8.08%	2	3.39%	203
Unidentified pigeons	1	0.04%	0	0.00%	1
Dove Total	**206**	**8.12%**	**2**	**3.39%**	**204**

	Colorado Bird/Aircraft Strikes (FY13 - FY17)				
	Number of CO Strikes	**% of all WILDLIFE Strikes in CO**	**Number of Damaging CO Strikes**	**% of CO Strikes w/ Damage**	**# of CO Strikes w/o Damage Data**
Aerialists (Nightjars, Swifts, Swallows…)					
Bank swallows	8	0.32%	0	0.00%	8
Barn swallows	13	0.51%	0	0.00%	13
Black-chinned hummingbirds	1	0.04%	0	0.00%	1
Cliff swallows	124	4.89%	2	3.39%	122
Common nighthawks	6	0.24%	0	0.00%	6
Tree swallows	1	0.04%	0	0.00%	1
Unidentified swallows	4	0.16%	0	0.00%	4
Aerialist Total	**157**	**6.19%**	**2**	**3.39%**	**155**
Grassland Species (Larks, Longspurs, Sparrows…)					
Brewer's sparrows	7	0.28%	0	0.00%	7
Brown-headed cowbird	1	0.04%	0	0.00%	1
Chipping sparrows	2	0.08%	0	0.00%	2
Clay-colored sparrows	2	0.08%	0	0.00%	2
Dark-eyed juncos	1	0.04%	0	0.00%	1
Eastern meadowlarks	2	0.08%	0	0.00%	2
Grasshopper sparrows	7	0.28%	1	1.69%	6
Horned larks	701	27.62%	2	3.39%	699
Lapland longspurs	3	0.12%	0	0.00%	3
Lark buntings	28	1.10%	0	0.00%	28
Lark sparrows	5	0.20%	0	0.00%	5
Lazuli buntings	1	0.04%	0	0.00%	1
Savannah sparrows	6	0.24%	0	0.00%	6
Song sparrows	8	0.32%	0	0.00%	8
Vesper sparrows	6	0.24%	0	0.00%	6
Western meadowlarks	272	10.72%	2	3.39%	270
White-crowned sparrows	4	0.16%	0	0.00%	4
Unidentified sparrows	32	1.26%	0	0.00%	32
Unidentified larks	2	0.08%	0	0.00%	2
Unidentified meadowlarks	3	0.12%	0	0.00%	3
Grassland Total	**1,093**	**43.07%**	**5**	**8.47%**	**1,088**
Corvids (Ravens, Crows, Magpies…)					
American crows	3	0.12%	0	0.00%	3
Black-billed magpies	3	0.12%	0	0.00%	3
Common ravens	1	0.04%	0	0.00%	1
Northwestern crows	1	0.04%	0	0.00%	1

	Colorado Bird/Aircraft Strikes (FY13 - FY17)				
	Number of CO Strikes	% of all WILDLIFE Strikes in CO	Number of Damaging CO Strikes	% of CO Strikes w/ Damage	# of CO Strikes w/o Damage Data
Corvid Total	**8**	**0.32%**	**0**	**0.00%**	**8**
Woodland Birds (Chickadees, Thrushes, Warblers…)					
American goldfinch	1	0.04%	0	0.00%	1
American pipits	2	0.08%	0	0.00%	2
American robins	5	0.20%	0	0.00%	5
Blackpoll warblers	1	0.04%	0	0.00%	1
Blue jays	1	0.04%	0	0.00%	1
Bullock's orioles	1	0.04%	0	0.00%	1
Mountain bluebirds	17	0.67%	0	0.00%	17
Mountain chickadees	1	0.04%	0	0.00%	1
Purple finches	1	0.04%	0	0.00%	1
Red-eyed vireos	1	0.04%	0	0.00%	1
Rock wrens	1	0.04%	0	0.00%	1
Swainson's thrushs	1	0.04%	1	1.69%	0
Wilson's warblers	2	0.08%	0	0.00%	2
Yellow-rumped warblers	3	0.12%	0	0.00%	3
Unidentified cuckoos	1	0.04%	0	0.00%	1
Woodland Total	**39**	**1.54%**	**1**	**1.69%**	**38**
Open Woodland Birds (Flycatchers, Wrens, Thrashers…)					
Blue grosbeaks	1	0.04%	0	0.00%	1
Eastern bluebirds	1	0.04%	0	0.00%	1
Eastern phoebes	1	0.04%	0	0.00%	1
House wrens	1	0.04%	0	0.00%	1
Nashville warblers	3	0.12%	0	0.00%	3
Sage thrashers	3	0.12%	0	0.00%	3
Say's phoebes	5	0.20%	0	0.00%	5
Sulfur-bellied flycatcher	1	0.04%	0	0.00%	1
Western bluebirds	1	0.04%	0	0.00%	1
Western kingbirds	23	0.91%	0	0.00%	23
Winter wrens	2	0.08%	0	0.00%	2
Open Woodland Total	**42**	**1.65%**	**0**	**0.00%**	**42**
Blackbirds (Blackbirds, Grackles, Orioles…)					
Common grackles	3	0.12%	0	0.00%	3
Red-winged blackbirds	12	0.47%	0	0.00%	12
Yellow-headed blackbirds	3	0.12%	1	1.69%	2
Blackbird Total	**18**	**0.71%**	**1**	**1.69%**	**17**

	Colorado Bird/Aircraft Strikes (FY13 - FY17)				
	Number of CO Strikes	**% of all WILDLIFE Strikes in CO**	**Number of Damaging CO Strikes**	**% of CO Strikes w/ Damage**	**# of CO Strikes w/o Damage Data**
Other Unidentified Bird Strikes					
Unidentified birds	515	20.29%	13	22.03%	502
Other Un-Identified Total	**515**	**20.29%**	**13**	**22.03%**	**502**
	Colorado Bird/Aircraft Strikes (FY13-17)				
	Number of CO Strikes	**% of all WILDLIFE Strikes in CO**	**Number of Damaging CO Strikes**	**% of CO Strikes w/ Damage**	**# of CO Strikes w/o Damage Data**
All BIRD Strike Totals	**2,538**	**1**	**59**	**1**	**2,468**

1.7.3 What is the Need in Colorado to Alleviate Bird Damage to Agricultural Crops?

Intensified agricultural practices across the U.S. have unintentionally created an abundance of highly palatable food resources for avian herbivores including European starlings, blackbird spp., and waterfowl sp. As a whole, while our society continues to increase agricultural production in order to meet the growing resource demands of our communities, societal opinions concurrently demand the maintenance of environmental quality and animal welfare standards. At the forefront of this debate, natural resource agencies are faced with the task of mitigating damage associated with wildlife while still maintaining viable wildlife populations for public enjoyment

Since colonial times, conflicts have regularly arisen between humans and populations of roosting blackbird sp. and foraging waterfowl species. These avian herbivores travel long distances to selectively feed on various agricultural landscapes. In the United States, bird damage associated with agricultural crops, primarily results from grazing, trampling, fecal dropping contamination, and the consumption of crops (i.e. loss of crop and revenue) (White et al. 1985, Depenbusch et al. 2011). Within Colorado, most of the state's agricultural losses, associated with bird damage, were reported to occur in alfalfa, and hayfields.

In 2015, corn was the leading crop sold in Colorado generating an average of $507 million annually in sales (NASS 2016). Damage to sweet corn (human consumption) and silage corn (livestock feed) associated with birds, results in unmarketable ears of corn. Since the damage is unsightly to the consumer (sweet corn) and potentially contaminated by bird fecal material (silage corn) (Besser 1985, Stone et al. 1973, Dolbeer and Linz 2016, Iglay et al. 2017). Most of the reported damage to sweet corn production has been attributed to large populations of red-winged blackbirds, grackles, and starlings (Besser 1985, Dolbeer and Linz 2016). Damage occurs when birds tear or pull back the husk exposing the partially developed corn kernels. Physical plant injury, typically begins at the tip of the corn ear during the milk-to-soft dough stage of development when the kernels are soft and filled with a milky liquid. Once punctured, the damaged ear of corn will become discolored and more susceptible to mold, rot and disease (Besser 1985, Linz et al. 2015).

Several studies have notably demonstrated that blackbird spp., grackle sp., crows, and waterfowl sp. are associated with economic damage to grain crop producers (Besser et al. 1968, Dolbeer et al. 1978, Feare 1984, Besser 1985, Dolbeer and Linz 2016, Iglay et al. 2017). Damage is often not widespread, but localized within short flying distances (~5 miles) of nighttime roosts (Dolbeer and Linz 2016). Grackles, crows, red-winged blackbirds and common ravens have been known to pull out or dig up sprouting seed kernels (Stone and Mott 1973, Besser 1985, Linz et al. 2015, Dolbeer and Linz 2016). Starlings have also been observed pulling up sprouting grains and feeding on the planted seed kernels (Johnson and Glahn 1994, Linz et al. 2015, Dolbeer and Linz 2016). Damage to sprouting corn is usually localized to areas near breeding colonies of grackles or other bird species (Stone and Mott 1973, Rogers and Linehan 1977, Linz et al. 2015, Dolbeer and Linz 2016). To accurately estimate blackbird damage in agricultural fields, producers should examine at least 10 different locations within a plot by walk staggered distances of 100 feet along every 10th row to examine the extent of damage (Dolbeer and Linz 2016). At each location, producers should randomly select 10 plants and visually estimate the damage to the nearest 1% (Dolbeer and Linz 2016). For corn, 1% represents 6 kernels that have been damaged, for sunflowers the seed head should be divided into quarters and then estimate the number of seeds missing (Dolbeer and Linz 2016). In the end, an average of 100 plants should be examined to give an approximation of the percentage of crop lost per field. By multiplying this percentage by the expected yield producers can calculate a rough estimate of yield loss. On average, grackles can damage two corn sprouts per minute in corn fields planted near breeding colonies (Rogers and Linehan 1977). WS has recorded an average of 19 incidents associated with protecting crops in Colorado annually resulting in an average of $26,157 in reported damage by birds annually (**Table 1.5**) from FY13 to FY17. The main species involved in these damaging events were Canada geese, American Robins, and Rock Pigeons.

Blackbird sp. damage to crops has often been identified as a serious problem in sunflowers, sorghum, rice, millet, corn, and milo. Damage associated with these species is readily identifiable due to the presence of large populations of birds associated with visible signs of damage. However, it is crucial to identify and observe specific species of birds causing damage to agricultural crops before management actions are taken. As mentioned previously, there are ten species of birds associated with the term blackbird. While starlings may superficially resemble red-winged blackbirds and occasionally feed in corn fields, they are typically feeding on insects such as armyworms and are not directly damaging the crop (Dolbeer and Linz 2016). Furthermore, populations of red-winged blackbirds may feed in unripe corn and sunflower fields on insects such as rootworm beetles and sunflower weevils without damaging the crop itself (Dolbeer and Linz 2016). While examining crop damage, producers should examine the area for bird fecal droppings and look for hulls or whole seeds scattered around the area. In some cases, the absence of bird fecal droppings and the presence of whole seeds may indicate seed shatter in sunflower fields associated with wind.

Visual surveillance of agricultural fields generally overestimate bird damage and in turn economic losses due to: the conspicuousness of blackbird populations, the human eye naturally focuses on bird-damaged plants, bird damage tends to be the most localized and severe along field edges, and damage caused by other wildlife (including raccoons, deer) or wind is often mistaken for bird damage (Dolbeer and Linz 2016). Overall, studies conducted during the last four decades analyzing blackbird damage and agricultural crops have found that on a statewide or regional bases, the overall damage is less than 1% (Dolbeer and Linz 2016). This translate on a national scale to $150 million in combined losses for corn, sunflower, and rice (calculated at 2012 prices) (Dolbeer and Linz 2016). While many of the larger agricultural producers experience less than a 1% loss in total yield, other smaller producers may experience serious economic hardship and loss.

Federal and state governments recognize that blackbirds are important depredators of agricultural commodities. Although they are migratory birds, blackbirds are currently provided limited protection under provisions of the Migratory Bird Treaty Act when they cause or threaten damage to crops (see 50 CFR, Part 21.43). No one blackbird management method has proven to be entirely satisfactory in alleviating crop damage (Dolbeer and Linz 2016). Hence, WS-Colorado currently recommends and uses BDM activities to reduce blackbird damage. BDM methodologies are continuously updated as new blackbird management tools become available.

Foraging waterfowl including Canada geese, snow geese, American coots, and duck sp. have all been implicated in agricultural crop damage within the U.S. (Cummings 2016). Direct structural damage to plants occurs through the removal of foliage, roots and other plant portions and grubbing activities contribute to soil erosion (Fox et al. 2017). Large populations of waterfowl often trample and compact damp soil with their large webbed feet causing young green sprouting crops to wither and die. Soil compaction in such areas, leads to alterations in soil aeration, water content, temperature, and loosens the plant's root system affecting plant growth (Fox et al. 2017).

Canada geese and snow geese predominately contribute to crop damage by grazing on agricultural crops including: winter wheat, rye, sprouting soybeans, barley, alfalfa, and corn (Cummings 2016). Over the past 30 years, evolving agricultural practices have resulted in intensive wheat growing methods capable of yielding approximately 100 bushels per acre; however, these crops are unable to sustain even light grazing pressure without experiencing losses in yield. Costs associated with agricultural damage involve replanting grazed crops (e.g., corn), purchase of replacement hay, decreased yields, removal of introduced noxious/invasive plants, and implementing nonlethal wildlife management practices. While damage to agricultural crops associated with waterfowl is difficult to quantify, surveys of agricultural producers suggest that some areas are experiencing substantial economic losses. In Oregon, wintering Canada geese reduced winter wheat and rye grass yields by 25% (Cummings 2016). A population of geese in the fall, winter, or spring can reduce the yield of winter wheat by 16 to 30% and reduce plant growth by more than 40% in a single intense grazing event (Flegler et al. 1987, Conover 1988, Patterson et al. 1989, Summers 1990, Borman et al. 2002). Geese often graze on harvest grain waste and stubble fields in autumn and early winter and shift to grass based diets in late winter (Lorenzen and Madsen 1986, Patterson et al. 1989). During the late winter, competition between waterfowl and livestock may lead to reduced forage availability and/or reductions in hay and silage yields (Bruinderink 1989, Perciveal and Houston 1992). Significant reductions (15-25%) in harvestable hay biomass have been documented at waterfowl spring stopover sites (Bedard et al. 1986, Bedard and Lapointe 1987). Intensive grazing at these sites may be attributed to geese stockpiling calories in preparation for migration and reproduction (Bedard et al. 1986, Fox and Abraham 2017, Fox et al. 2017). Herbivorous grazing on winter crops reduce grain yield, may delay plant maturity and harvest time, and increase weed abundances (Summers 1990, Fox et al. 2017).

Fruit Crop Damage

Other agricultural commodities frequently damaged by blackbird sp. include fruit crops. Several bird species commonly associated with damage to fruit crops include American crows, American robins, European Starlings, Common Grackles, House Finches, House Sparrows, and other blackbird spp. Damage to these fruit crops typically occurs as fruit reaches maturity. Here, damage, consists of birds consuming berries, mechanically damaging fruits with their beaks, or knocking produce from the bushes/trees. For apples, crops experience the most damage on early-maturing cultivars and those that turn red early during the season. Similarly early-ripening cherry and grape crops experience the most damage during the growing season. The correlation between bird damage and early-ripening fruit crops may be due to the lack of other fruits being unavailable.

Of the fruit crops in Colorado, WS-Colorado documented most damage during FY13-FY17 occurred to cherries ($1,200) due to American Robin predation. Estimated bird damage to fruit crops (i.e., grapes, cherries, and blueberries) exceeds $1 million annually in the United States (Besser 1985, Linz et al. 2015, Dolbeer and Linz 2016, Iglay et al. 2017).

Bird Damage Management to Protect Agricultural Crops

The key to managing bird damage associated with agricultural crops is the integrated use of several management methods that are synergistic in their overall effect. When developing an integrated wildlife damage management plan, habitat modification recommendations should form the foundation and be supplemented with other management techniques such as the use of pyrotechnics. By building upon this foundation, producers are provided long-term protection in addition to being able to deploy reactive management solutions when emergency situations arise. As with any management plan, it is important to continually monitor agricultural crops and apply proactive BDM methods before or as soon as damage occurs. Agricultural producers often waste resources when management techniques are applied after substantial bird damage has occurred and are in the process of moving to another location or the economic cost of managing the damage exceeds the cost of damage itself. Most habitat modification and exlusion techniques are performed by the landowner following technical assistance given by WS-Colorado. If the damage is not alleviated, then WS-Colorado may be asked by the landowner to implement other strategies and methods.

Habitat Modification

One habitat modification strategy to mitigate blackbird spp. damage is to plant non-attractive crops such as soybeans, wheat, potatoes, or hay within 5 miles of bird roosting sites. If this is not a viable options, we suggest that producers provide alternative feeding sites to reduce the feeding pressure on cash crops such as corn, or sunflowers (Dolbeer and Linz 2016). Another viable option would be to delay the tilling or plowing of recently harvested fields near known roosting sites, thus providing an alternative food source. Producers should also try to synchronize their planting with other rotations within their area. This ensures that no single field matures in isolation from the other fields in the area and reduces the likelihood of intensive predation.

Timing of harvest is also important in reducing bird damage. Promptly harvesting mature crops at the peak time of fresh-market harvest ensures that birds have a limited amount of time to cause damage. For example, to prevent or reduce blackbird sp. damage to sweet corn. Producers should regularly monitor and track corn maturity since corn crops are most attractive during the milk stage of production. Other cash crops such as sorghum, rice, and sunflowers should be harvested as soon as possible since birds do not readily consume immature grains. In some cases, it may be advisable to use a pre-harvest desiccant that will advance harvest by 7-10 days enable farmers to harvest mature sunflowers.

Another viable alternative to mitigate agricultural bird damage is to plant hybrid crop variants that are less attractive to damaging bird species. Researchers have developed hybrid corn species with long husk extensions and thicker husks that are more resistant to bird predation. Other hybrid cash crops that are less attractive to predating bird species include: sorghum hybrids with higher tannin content, confectionery sunflower seed hybrids, and other sunflower cultivars with thick seed hulls heads whose seed heads fall downward as they mature.

Exclusion

The exclusion of blackbird spp. and waterfowl sp. from agricultural crops such as corn, sunflowers, sorghum is not a viable management strategy for many commercial producers but may be useful for small gardens, high-value fruit crops, and experimental plots. To protect small fruits and isolated trees, netting should be stretched over an existing framework directly over the plants or bushes to prevent birds from reaching the fruit. Although the initial investment for bird netting is expensive, if properly maintained and stored during winter, it can be a long-term bird damage management solution.

Hazing/Harassing

Hazing and Harassing bird species from agricultural crops can be effective but relies on persistent diligent and long hours for producers or operations personnel. These frightening devices (visual, auditory, auditory-visual, or chemical) must be deployed at key times (such as early morning hours when the majority of bird feeding activity occurs) to keep birds from habituating to their use. For crops such as sorghum and sunflowers that are vulnerable to depredation, a detailed integrated pest management plan protocol using such devices must be followed to ensure its success. Furthermore, the effectiveness of such devices and techniques depends on the persistence of the operator, their skill in using the device, the attractiveness of the crop, the number of birds present, and the availability of alternative feeding sites (Dolbeer and Linz 2016).

Propane canons are a popular frightening device that automatically ignite propane gas to create loud explosive blasts. Elevated cannons, at least one per every 10 acres, should be mounted on a portable platform and then moved around agricultural fields every few days. Producers should also consider pairing this method with shooting a firearm or launching pyrotechnics over the top of the crop to frighten birds. Pyrotechnics fired from a 12-gauge break action shotgun or a pistol-type launcher (e.g. bangers and screamers) are also effective deterrents. This technique however is not as effective in moving birds since they have a limited range of 75-100 yards. Obviously, care must be taken to ensure human health and safety along with applicable government rules and regulations.

Other visual bird frightening devices may also be employed as part of a management activity including helium filled balloons tethered in fields, reflective Mylar tape, animated scarecrows, predatory decoys, and radio-controlled drones or planes. Additionally, the EPA has registered a few chemical deterrents including: Avitorl ® (acive ingredient 4-aminopyridine) for blackbirds and other pest birds and bird repellents with the active ingredient methy anthranilate or benzyl diethyl ammonium saccharide. Avitrol ® was used in the 1970s to early 2000s to deter birds from consuming corn and sunflower crops. Today however, this product is no longer registered for field use but can be used in non-crop areas. Once birds ingest products treated with this formulation, their flight becomes erratic, they emit distress calls, and usually succumb to death. Other chemical formulations are used as repellents to reduce bird damage on maturing grain (sunflower or fruit crops) and freshly planted or sprouting corn, rice, and other crops. As the registration status and trade names of this products often change we recommend you check with your local county extension agents or WS-Colorado personnel for products currently being used. Additionally, always read the product label and refer to local, state, and federal restrictions prior to using any pesticide product.

Trapping

Certain species of blackbird may readily be trapped using either decoy or corral based traps respectively. Although, it should be noted that additional permits will need to be obtained prior to their installation and subsequent deployment. Decoy traps are used to capture red-winged blackbirds, brown-headed cowbirds, and common grackles. The trap measures approximately 20’ x

20’ x 60’ and is constructed of poultry wire or netting and houses 10 to 20 live decoy birds provided with food and water. A 2’x 4’ wire covered opening on the top of the enclosure allows free-ranging birds to drop to the bait (cracked corn) below. A small gathering cage (2’ x 2’ x 3 foot) with a sliding door attached is used to collect trapped birds. This style of trap often catches 10 to 50 blackbird spp. and starlings daily and near roosting sites may trap up to 300 individuals in per day. Non-target songbirds and other species should be released immediately when accidentally captured.

1.7.4 What is the Need in Colorado to Alleviate Bird Damage to Livestock and Agricultural Resources?

Although birds are a conspicuous part of both livestock and agricultural landscapes, they often inflect direct and indirect damage to: livestock through predation and disease transmission (cattle, sheep, poultry); livestock feed (consumption and contamination); and agricultural crop consumption (fruit, grain, fish-farming), contamination, and destruction (tramping crops). Bird damage to these resources cost producers directly through monetary costs (e.g. damage to livestock or agricultural crops) and indirectly through changes in production (e.g. weight loss in livestock, milk yield, crop yield, replanting of fields). WS-Colorado protects three primary areas of agricultural production from bird damage including livestock, aquaculture, and crops. Ranchers may experience significant monetary damage associated with birds, in the form of livestock death and/or loss or contamination of foodstuffs. Without effective BDM to protect these resources, depredation losses may exceed associated tolerated limits as seen similarly with mammal predator management (Howard and Shaw 1978, Howard and Booth 1981, O'Gara et al. 1983). During FY13-17, WS-Colorado received 216 requests for bird damage assistance associated with livestock and agricultural resources with annual producer losses averaging $908,780 per year (**Table 1.5**). Many requests are received prior to the occurrence of damage, especially in areas with historic damage occurrence. Much of the assistance is technical assistance where WS recommends hazing methods to reduce damage. Though damage associated with birds may not significantly impact sales for large commercial operations, smaller local producers may suffer detrimental financial losses each season.

Livestock Feed Direct and Indirect Impacts Bird Damage

During late fall and early winter, livestock operations throughout the United States frequently experience economic losses due to wild birds consuming cattle rations, fecal contamination of feed, and indirect losses due to cattle weight loss, reduced milk production, and veterinary costs associated with disease transmission (Besser et al. 1968, Feare 1984, Bentz et al 2007, Shwiff 2012, Tupper et al. 2014, Homan et al. 2017). Starlings, House sparrows, red-winged blackbirds, common grackles, and feral domestic pigeons often cause damage at cattle feedlots, dairies, and other CAFOs (Tupper et al. 2014, Homan et al. 2017). Significant losses frequently occur in winter and early spring months when thousands of birds converge upon dairies and CAFOs. Large populations of starlings are harder to disperse during late fall and winter due to a lack of alternative food sources (Homan et al. 2017). Smaller clusters of red-winged blackbirds, cowbirds, and common grackles may also inter-disburse within these larger species aggregations. CAFO facilities commonly feed their livestock with open feeder systems. These open air style food bunks provide starlings with easily assessable high quality livestock rations. Exact estimates of livestock feed lost due to wild birds at U.S. dairies, Concentrated Animal Feeding Operations (CAFOs), and feedlots does not exist. However, Pimentel et al. (2005) estimated that yearly starling damage to agriculture may reach $800 million in losses. Similarly, Glahn and Otis (1981) estimated that 1,000 starlings consume up to 630 lbs of cattle rations for every 1 hour spent foraging at open feed facilities. Colorado has approximately 900 cattle CAFOs (dairies and feedlots) that market almost $3 billion cattle annually (NASS 2016); although every operation does not experience heavy damage associated with these species, others frequently request BDM. WS-Colorado provides both technical and operational management assistance to these cooperators including lethal and nonlethal BDM techniques. WS-Colorado personnel responded to an average of 122 complaints involving livestock feed annually from FY13 to FY17 (**Table 1.5**) with an average of $49,327 in reported losses per dairy or CAFO annually.

European Starlings

European starlings (*Sturnus vulgaris*) are glossy, dark-colored, lightly speckled, robin-sized birds weighing around 3.2 ounces (Johnson and Glahn 1994). Although native to Europe, southwest Asia, and Northern Africa, today robust populations can be found on every continent except Antarctica (Rollins et al. 2009). In 1891, 100 starlings were released into New York's Central Park in an attempt to introduce every bird mentioned in William Shakespeare's plays to North America (Cabe 1993). Sixteen pairs of the original founder population survived and began to prolifically reproduce and by 1928 starlings had reached the Mississippi River. In 1939, starlings were observed for the first time in Colorado and by 1942 populations had reached California. For years this invasive species has continued to make the "100 World's Worst" list of globally invasive species (Lowe et al 2000, Rollins et al. 2009, Linz et al. 2018). European starlings are not protected under the Migratory Bird Treaty Act however, local or state laws may prohibit certain management techniques. WS-Colorado personnel should be contacted prior to any management efforts.

Over one hundred and fifteen thousand starlings are estimated to be breeding within Colorado adding to a total populations of fifty-seven million starlings throughout North America (Partners in Flight 2017, Bird Conservancy of the Rockies 2017). With a nesting success rate of 49-79%, the major limiting factors for this species are predation, disease, availability of nesting sites, and starvation (Linz et al. 2018). Outside of breeding season, in the late fall and winter, starlings form large populations that feed and roost together. Fall-roosting populations are generally smaller than winter roosting populations and may range from several hundred to several thousand birds. While these populations tend to be smaller, they typically forage over a greater area than winter-populations and are responsible for widespread agricultural damage. Larger winter-roosting populations may exceed 1 million birds and are often confined to a few acres (Johnson and Glahn 1994). Throughout the day, starlings typically leave their roosts at sunrise and travel 15 to 30 miles from their roosting sites to foraging sites (Johnson and Glahn 1994, Linz et al. 2018). Foraging sites are usually comprised of granaries, landfills, food processing plants, feedlots, dairies, and CAFOs (Linz et al. 2018).

In late fall and winter large populations of starlings, at times numbering over 100,000, converge on feedlots, dairies, and CAFOs due to a lack of alternative food resources (Homan et al. 2017, Linz et al. 2018). Livestock housed at these operations, are fed through an open feeder system which provides starlings easy access to high quality cattle rations and protects them from predators. Within the last decade, several behavioral studies have examined the daily movement patterns of such populations to develop effective management strategies. Homan et al. (2013) captured and radio-tagged starlings at dairies in Ohio and found that captured birds spent 58% of each day at these sites. Additionally, he found that birds spent more time at dairies located 1.3 kms apart versus dairies located 4.1 -11 km apart. In another study, Homan et al. (2010) radio-tagged three separate cohorts of starlings at feedlots in Texas and found that all three groups spent anywhere from 48% to 95% of their day foraging at these sites. All three cohorts utilized various roosting locations depending upon the habitat surrounding the feedlots. The feedlot where starlings spent the majority of their time foraging (95%) was surrounded by open fields and pastures. Whereas the other two sites, where the groups spent 48% and 50% of their time foraging was located within an urban area and utilized other roost throughout the area in addition to a nearby CAFO. In the third study, Gaukler et al. (2012) monitored the winter movements of radio-tagged starlings between two CAFOs in Kansas. They found that starlings remained on the site where they were initially captured 68% and 55% of the time with minimal exchange between them (9%). The author suggested that reducing the numbers of starlings at the feedlots might lower the risk of the spread of disease. These and other studies, indicate that starlings are highly adaptable to surviving in both rural and urban environments and the distances they forage away from roosting sites depends on the availability of food resources.

Blackbirds

The term blackbird is loosely used to describe approximately ten species of birds in North America including: Red-winged blackbird *(Agelaius phoenicus*), Common grackle (*Quiscalus quiscula*), Great-tailed grackle (*Quiscalus mexicanus*), Brown-headed cowbird (*Molothrus ater*), Yellow-headed cowbird (*Xanthocephalus xanthocephalus*), Brewer's blackbird (*Euphagus cyanocephalus*) and Rusty blackbird (*Euphagus carolinus*). Within this diverse group of species, the correct identification of the species involved is crucial in damage management. Many species, especially females, superficially resemble each other and their populationing behavior may predispose them to join larger populations of birds that are causing damage. Species categorized within the blackbird category consist of males that are predominately iridescent or black in color and females that are slightly smaller and brown in color. When examining the range and distribution of blackbird species it is important to note that while some of these species are year-round residents others migrate and utilize different resources and locals seasonally. In examining the species categorized in this group, Red-winged blackbirds inhabit most of North America and typically winter throughout the southern U.S. Common grackles inhabit landscapes east of the Rockies and often form populations during the winter in the southern U.S. with other species of blackbirds. Great-tailed grackles are abundant year-round in the southwestern U.S. and Mexico but have recently expanded into the central Great Plains. Cowbirds, once associated with bison, are now a regular occurrence throughout North America. This species often roosts with other blackbird species and winters throughout the central and southern U.S. Yellow-headed blackbirds nest in deep-water marshes in the Great Plains and western U.S. During the winter, this species migrates to Mexico where they stay until spring. Brewer's blackbirds occupy the northern Great Plains and western states, although during winter they migrate in populations to the central and southern Plains. Rusty blackbirds are commonly found in Canada, Alaska, New England, and Michigan. During winter this species migrates to the southern U.S.

Of the blackbird species, red-winged blackbirds are one of the most abundant birds in North America. Within the continental U.S. in July, after the young have fledged, population rates exceed 300 million birds (Dolbeer and Linz 2016). The second most abundant species within this group is the common grackle with a population of approximately 200 million. Most other blackbird species have similarly abundant species except for the rusty blackbird and tricolored blackbird (*Agelaius tricolor*). Blackbird species and grackles reach sexual maturity in 1 year and nesting occurs from April to July. Females lay 3 to 5 eggs in a clutch and hatch after approximately 12 days of incubation. Blackbirds and grackles have a 50-60% survival rate for adults and higher mortality rates in chicks are usually offset by a reproductive rate of 2 to 5 offspring fledged per female per year. Due to their abundant nature, blackbird species are an important prey-base food source for a variety of avian and mammalian predators. Other important sources of mortality include: exposure to inclement weather, disease, and physical contact with wires, buildings, and windows.

Outside of nesting season, blackbirds are commonly observed feeding and roosting in populations consisting of several to several million individuals (Dolbeer and Linz 2016). Such populations may consist of a single species but more often, are convergences of multiple blackbird species and non-blackbird species (e.g. European starlings and American robins). The Federal Migratory Bird Treaty

Act protects native migratory birds, including blackbirds, in the U.S. Although most species of blackbirds may be lethally removed when they are found "committing or about to commit depredations upon agriculture or ornamental crops, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance" in accordance with the Depredation Order for Blackbirds, Cowbirds, Grackles, Crows, and Magpies (50 CFR 21.43).

As mentioned previously, damage to livestock operations can occur from large aggregations of birds (such as starling and blackbirds) consuming livestock feed, the subsequent contamination of livestock rations, and the increased risk of disease transmission associated with these species. Understandably, although bird damage and the threat of disease transmission may occur throughout the year, the risk of such events is notably heightened during bird migration periods and during the winter months when food resources are limited and birds are concentrated into larger populations. The populationing behavior of blackbird species (red-winged blackbirds, grackles, cowbirds, crows) and subsequent economic damage associated with their feeding on livestock rations has been documented in the U.S., France, and Great Britain (Besser et al. 1968, Dolbeer et al. 1978, Glahn and Otis 1986, Glahn 1983, Feare 1984). Besser et al. (1968) found that livestock producers in Denver, CO lost approximately $84 per 1,000 starling and blackbirds observed feeding in feedlots. Similarly, Williams (1983) estimated that a feedlot in south Texas lost nearly 140 tons of livestock feed valued at $18,000 due to bird damage associated with five species of blackbirds.

Feral Pigeons

Another bird associated with economic damage at livestock and dairy facilities is the Rock Dove (*Columba livia*), commonly known as feral pigeons. These granivorous birds remain connected to human populations as a consequence of their domestication and their proclivity to arid and rocky habitats. Worldwide, feral pigeon populations are drawn to anthropogenic environments due to an abundance of agricultural habitats and human dwellings (Giunchi 2011). Several factors contribute to these bird's capacity to cause damage including: high reproductive rates, group foraging, colonial behaviors, and capacity to serve as a disease reservoir/vector. Rock pigeons in particular have been linked to economic costs at livestock at facilities due to bird feed consumption and pathogen transmission (Williams and Corrigan 1994, Pedersen and Clark 2007). Due to their highly mobile nature wild birds, including pigeons, have the potential to transmit microbial pathogens relatively quickly over large distances (Hernandez et al. 2003, Hubalek 2004, Carlson et al. 2011). Pigeons in particular, are known carriers of several disease pathogens including: *Histoplasma capsulatum*, *Listeria monocytogenes*, western equine encephalitis, West Nile virus, Newcastle disease, *Cryptococcus neoformans*, *Toxoplasma gondii*, and *Salmonella enterica* (Haag-Wackernagel and Moch 2004, Carlson et al. 2011). Approximately 176 cases of disease transmission from pigeons to livestock were documented from 1941 to 2003 including, but not limited to, *Salmonella enterica kiambu*, *Clamydophila psittaci*, and *Cryptococcus neoformans* (Haag-Wackernagel and Mock 2004). Similarly, studies have demonstrated that pigeons can serve as carriers of *S. enterica* at dairies (Kirk et al. 2002, Pedersen et al. 2006). Pedersen et al. (2006) isolated the same serotypes of *S. enterica* from cattle feces, water troughs, cattle feed, and pigeons within dairy facilities indicating that pigeons are potentially transmitting *S. enterica* within these environments. Habitat-use studies suggest that pigeons prefer to feed within livestock facilities because these sites consistently provide abundant and highly nutritious food sources compared to other sites (e.g. agricultural crops, urban dumpsters, rural houses, and landfills) (Carlson et al. 2011). In these studies, birds tended to congregate in grain elevators and equipment barns and subsequently contaminate livestock feed. While pigeons are known to have close associations with such damaging events, few studies have directly quantified the operational costs and economic losses related to this species in urban and rural habitats.

Integrated Bird Damage Management

Populations of starlings and blackbirds congregating around dairies, feedlots, and CAFOs should be hazed or frightened away in order to prevent or abate economic losses and disease transmission to livestock and humans. The most effective method in dispersing starlings from roosts is the use of frightening devices such as pyrotechnics (e.g. shell-crackers, bangers, and screamers), propane cannons (i.e. propane exploders), lights (lasers), distress calls, and/or bird repellents. However, if any one of the methods are used exclusively to disperse birds from an area, individuals will gradually habituate and no longer disperse from the area. Populations of birds should be harassed before a routine is established. Frightening devices should be deployed for 5 to 7 consecutive nights at roosting sites until birds no longer return. Following this, a combination of other harassment methods should be combined and integrated throughout the property varying locations, intensity of actions, and duration of methods used. In the winter, when snow accumulates and covers naturally available food sources bating and other techniques may prove more effective than frightening techniques.

Pyrotechnics, as defined here, consist of 15 mm cartridges or 12-gauge shotgun shells filled with a firework type explosive. Once fired from the appropriate launcher, these charges reach 25 to 75 yards into the air before exploding. By far, these devices seem to provide the most benefit for the relatively low purchasing costs. On a larger scale, propane cannons (propane exploders) remotely detonate propane gas creating a 125-dB explosion. Various styles and models of these type devices are available from wildlife control suppliers and range from $100 - $1,000. One unique feature of this device is that it can be programed to remotely detonate at select intervals throughout the day to ensure that even when producers are not on site, harassment efforts are continuing to occur. Roosting populations of starlings may also be dispersed with lights and lasers and should be used in a similar method as described for pyrotechnics. Electronic distress or alarm call generators are most effective when used in combination with a visual stimulus such as a raptor decoy. These devices utilize speakers to broadcast species specific distress and alarm calls over large areas to reduce bird damage. Linz et al. (2018) found that broadcast calls used at a Pinot noir vineyard saved an estimated $700 per ha. Finally, bird repellents such as 4-aminophyridine (Avitrol) a restricted-use chemical frightening agent, may be applied to livestock feed or grains in order to frighten populations away from an area. When consumed, this agent causes birds to behave erratically and emit distress calls.

Physical barriers are also useful in excluding starlings from particular areas. Openings larger than 1 inch should be barricaded or sealed in some way to prevent starlings from entering buildings and other structures. In high traffic areas where people, machinery, or livestock enter and exit frequently, installing heavy plastic PVC or rubber strips above open cargo holding areas, doorways of farm buildings, and other structures has been shown to exclude starlings with some success. Ten inch wide strips of plastic or rubber should be installed with a 2.0 inch gap in between. These plastic strips may also be used to protect livestock feed bunks. To exclude starlings from larger structures such as barns, ledges, rafters, roof beams, and other structures producers have the option of installing plastic or nylon netting. Installing metal, wood, or plexiglass coverings at a 45° angle will exclude starlings from roosting, nesting, and perching in these areas. Other tactics include installing porcupine wires or similar metal protectors on ledges and roof beams to deter roosting.

Populations of starlings in feedlots, dairies, and CAFO areas can additionally be managed by WS-Colorado to a tolerable level depending on the management goals of the producers. WS-Colorado approaches each human-wildlife conflict on a case by case basis and depending on the number of starlings present, their location, the extent of damage, among other factors, lethal removal may be the only viable option. USDA uses a specially formulated EPA restricted slow acting toxicant DRC-

1339 to mitigate starling populations in certain situations. DRC-1339 is only available for use by USDA employees or under their direct supervision. In research studies, starlings have been shown to be highly susceptible to DRC-1339 with a single application causing death in one to three days (Eisemann et al. 2003, Linz et al. 2018). Typically, starlings lethally removed with DRC-1339 are not found at the initial bait site. Following the first few hours of bait consumption, birds do not exhibit any adverse behaviors. Most birds succumb to the toxicant while roosting at night. DRC-1339 has no secondary effects on predators or scavengers because the chemical is quickly metabolized and excreted prior to death (Eisemann et al. 2003).

At CAFOs and other urban settings, the primary goal should be to limit the amount of food, water, and shelter available to starlings. Dense vegetation, emerging vegetation, and tree stands should be thinned to disperse or prevent roosting. At times, roosts may be located near buildings near air leaks. To deter such roosts, property owners should test buildings for air tightness, caulk and install weather stripping, use foam sealant on larger gaps around windows and doors, and tightly close door when not in use.

Livestock Facilities Cultural Practices

Altering cultural practices at feedlots, dairies, and CAFOs can also help to reduce or alleviate starling and blackbird damage especially those located near roosting sites. The following practices used in combination should reduce: livestock feed loss, disease transmission, and the cost of bird management. The practices we recommend implementing are: immediately clean up any spilled grain or livestock feed; store livestock feed and grain in facilities that exclude birds; use enclosed style feeders (flip-top feeders, automatic-release feeders, or lick wheels) to dispense livestock rations; feed livestock in covered sheds, feed livestock cubes or blocks 3/8th to 1/2 inch diameter; mix protein supplements really well with other rations (silage, etc…); adjust livestock feeding schedules when starlings are less active (feeding at night if possible); and draining unnecessary water pooling around livestock facilities (Johnson and Glahn 1994, Carlson et al. 2018). Producers should feel free to contact WS-Colorado with any questions regarding the implementation of any of these methods.

1.7.5 What is the Economic loss to Livestock Resources from Bird Damage?

Livestock production in the United States significantly contributes to local economies. The primary livestock protected by WS-Colorado BDM are cattle, sheep, poultry, and, to a minor extent, other hoofed stock. Aquaculture sales, accounts for 0.03% of the agriculture in Colorado and consists mostly of trout production (NASS 2007, 2016), but private sport fisheries are not included in NASS (2009, 2011, 2016) and account for some BDM activities in Colorado. Colorado produces a wide variety of livestock. Cattle and calf production is the states' primary agricultural commodity with an annual average from 2012 to 2015 of $3.8 billion in sales from 13 million cows (NASS 2016); in Colorado, cattle were responsible for 76% of the livestock sales and 56% of all agricultural sales alone (NASS 2016). Annual significant sales of livestock and other associated products from 2009 to 2013 (annual average) included hogs ($220 million), sheep and lambs ($108 million – NASS discontinued collection of this data in 2011), other livestock including poultry and eggs ($158 million), trout ($2 million), and dairy ($695 million).

High quality cattle diet rations make up a majority of both cattle and bird diets as it provides a readily available source of nutrients, fiber, and protein. Ration formulations primarily consist of silage, supplemented with a high energy protein pellet or grain such as corn, milo, or barley. Starlings and other bird species (e.g. blackbirds) selectively remove the high energy protein components thus decrease the energetic value of the cattle diet rations. The removal of this component reduces milk yields, weight gains, and significantly impacts the economic gains of the cattle producers (Feare 1984). Homan et al. (2017) found that a population of 1,000 starlings feeding at a CAFO for 60 days during the winter will consume 1.5 tons of cattle feed. This represents a loss of $200-$400 per 1,000 starlings. Similarly, a population of ~ 250,000 starlings in a Midwestern feedlot increased the cost of cattle rations (steam-flaked corn) by $43 per heifer over a 47 day period in mid-January and March (Homan et al. 2017). Essentially, the producer is losing $1.00 per animal in lost livestock weight gained per unit feed consumed. Producers can estimate the cost of livestock feed rations lost to starling by using one of two formulas. The first formula was developed for data in Colorado: Cost of livestock rations consumed per day = [Estimated starling populations (to nearest 1,000)] x [Portion of birds feeding at trough] x [Cost of food rations per pound (0.4536 kg)] x [0.0625 pounds (0.02813 kg)] x [Consumed per starling per day] (Johnson and Glahn 1994). The second formula is more general in terms of geographic area: Cost of livestock food rations consumed per day = [Estimated starlings entering trough] x [0.0033 pounds (0.0015 kg) consumed per starling entry] x [Cost of livestock feed ration per pound (04536 kg)] (Johnson and Glahn 1994). After calculating the costs associated with starlings consuming or contaminating livestock feed over a three to four-month period producers can better evaluate the costs and benefits of implementing a bird damage management activity.

1.7.6 How does Livestock Depredations involve predatory birds?

WS-Colorado personnel infrequently respond to predatory bird depredation losses throughout Colorado. Such reports are thoroughly investigated and substantiated by WS-Colorado personnel prior to BDM mitigation actions. "Depredation" of livestock is defined as the killing, harassment, or injury of agricultural resources (cattle, sheep, pigs, goats, poultry, rabbits etc…) resulting in monetary losses. Black-billed Magpies, Common Ravens, and Golden Eagles were primarily responsible for predatory bird depredation activities from FY13 to FY17; although, to a lesser extent, several other bird species can kill or injuring small/young livestock (i.e., rabbits, poultry) and incapacitating adult hoof-stock (i.e., calving) including Red-tailed hawks, Common ravens, and American crows (**Table 1.7**). Verified losses are defined as those examined by a WS specialist during a site visit and identified to have been caused by a specific bird species or guilds. Often a WS specialist can determine the species by physical observations and/or by signs associated with the damage. For example, predatory birds may not be at the kill site when a WS Specialist responds to a predation complaint. However, bird depredation events can typically be distinguished from mammals, but determination of the bird responsible for the damage often depends on the species that are present in the area. Some species' damage may be similar to other bird species damage, thus WS specialists and biologists often observe the birds in the area and examine forensic evidence to determine the bird species involved. Several predatory bird species have characteristic hunting behaviors that are species specific; for example, poultry captured by Great Horned owls often exhibit wide talon marks on the back and have the head only partially consumed. Another example, Black-billed magpies peck open sores or wounds on the backs of sheep and cattle exposing the animal to potential shock, infection, and possibly death. Confirmation of the depredating species is a vital step toward establishing the need for bird damage management and allocating the resources necessary to resolve the problem. WS specialists make every attempt to confirm the species involved in the depredating event as well as recording the extent of the damage when possible.

As an initial course of action, WS-Colorado considers the use of nonlethal dispersal techniques (WS Directive 2.105) when practical and effective (i.e., pyrotechnics, live trapping and relocation, modified animal husbandry practices, lasers) to disperse bird species causing damage. However, in situations where birds have little to no response to nonlethal techniques, or where the use of these techniques are impractical, lethal methods may prove more effective in resolving wildlife issues. Population reduction or removal of individual birds by live trapping and relocation, trapping and euthanasia, shooting, and the selective use of the avicide DRC-1339 at feedlots and dairies may be required to resolve specific conflicts. Additionally, WS may recommend resource owners or managers obtain depredation permits issued by USFWS for lethal management of certain species to abate bird damage. Avian depredation is often difficult to manage and eagle depredation is of particular concern due to federal laws.

Damage to Livestock

Hawk and Owl Depredation on Poultry

For years, free-ranging farmyard poultry and game bird producers have experienced raptor depredation problems. These specialty producers often have modular hen houses or aviaries that are periodically moved across pastures and meadows to provide a varied nutritious diet for their populations. Unlike traditional commercial operations, that raise birds intensively inside barns, these specialty producers often suffer heavily from raptor species predation. The main raptor species associated with depredation events in Colorado are Red-tailed hawks and Great Horned Owls. "Organic, free-range, and cage-free" chickens, ducks, geese, turkeys, and fancy pigeon breeds are especially vulnerable to avian depredation as they tend to be highly conspicuous, naïve to danger, and unwary of predation. Confined populations of birds, when chased by a predator, often times panic and flee to a corner of their cage attempting to escape. Furthermore, predatory birds have learned that by attacking these enclosed mobile aviaries, panicked poultry flying wildly around the enclosure, are easily grabbed by the raptor's talons and consumed through the wire mesh. In addition to the birds that are captured through the wire mesh, other birds may become injured or killed as they collide with posts, fencing, wire mesh, or each other; and if predator harassment persists, producers may notice a decline in reproductive success. Common signs of hawk and owl predation include: piles of feathers torn from the carcass at the site of the kill, head and neck have been eaten (owl), and/or a side of the carcass has been torn out an eaten (hawk). WS-Colorado assisted 3 specialty market companies and individuals in the last 5 years. While predatory losses are expected in this industry, some producers suffer higher losses due to predatory birds becoming specialized at killing birds in these enclosures. Once a pattern has become established these specialized predators will not stop until a majority of the population is dead. WS-Colorado provides technical assistance to individuals and producers regarding exclusion and husbandry techniques in addition to habitat modifications (removal of roost and loafing trees) to lessen predation.

To prevent hawk and owl depredation, producers are encouraged to move free-ranging poultry into coops or houses at dusk. Then if damage persists, outdoor enclosures should be reinforced with a secondary wire fence, nylon netting, or overhead wires. Overhead grid wires should be spaced 5 to 6 inches apart to prevent owls from reaching penned birds. Additionally, mobile aviaries should be kept 100 yards or more away from perching and roost sites. Trees and other perching surfaces allow hawks and owls to survey an area prior to attacking prey items. Hawks and owls that are roosting or nesting in nearby buildings should be frightened away or live trapped and removed. After the hawks and owls are removed from a building, any open windows or other entryways should be repaired and closed. Consult with your local USDA Wildlife Services office prior to live trapping as all of these species are protected under federal and state laws.

Frightening/Hazing devices may also be used to scare hawks and owls away from an area where they are causing damage. However, the effectiveness of using these techniques varies depending upon the bird species involved, the season, the surrounding area, and the application method. Pyrotechnics are the most commonly used and easily implemented hazing technique. These exploding or noise-generating devices are launched from a handheld pistol-style device and are projected 25 to 75 yards in the air before exploding or emitting a loud whistle. Similarly, shell crackers are launched from a break-open 12-gauge shotgun 50 to 100 yards in the air before they explode. Your local USDA Wildlife Services employee can provide additional information as to suppliers for bird damage management control equipment.

Raven Predation

In the western U.S. as humans alter the landscape by reducing habitat for some species such as sage grouse and provide anthropogenic subsidies for other species, this enables small generalist predators, such as Common Ravens, to become more prevalent, thus upsetting the balance between two species that co-evolved (Bui et al. 2010). Within the last 40 years Common Ravens population distributions have increased by as much as 1,000% within areas near anthropogenic resources (Bui et al. 2010, Sauer et al. 2011, Howe et al. 2014, Sauer et al. 2017, National Audubon Society 2010). Such drastic increases in species populations are typically seen when natural landscapes are transitioned to anthropological developments, providing more readily available food resources and nesting sites (Howe et al. 2014). Ravens are often considered to be subsidized predators that exploit or subsist on anthropogenic resources such as road-killed animals, refuse from landfills and dumpsters, gut piles from hunting operations, animal foodstuffs from livestock operations, and livestock (Howe et al. 2014, Coates et al. 2016).

Livestock operations in particular, provide ravens with a number of direct and indirect food subsidies. Ravens consume feed grain, dung, invertebrates found within the dung, and insects flushed during grazing activities (Engel and Young 1989). In arid landscapes, water troughs provide ravens with a vital source of available water (Knight et al. 1998). Moreover, livestock operations may offer an abundance of carrion for raven populations at open-air carcass disposal sites as well as, afford them the opportunity to feed directly on live newborn calves and lambs (Engel and Young 1989, Larsen and Dietrich 1970). Typically, ravens drop down onto the ground near newborn calves and lambs, before the animals can rise to their feet, to prey on them. They kill these animals by driving their beaks into eye sockets into their skulls and then feed on the eyes, tongue, tail-head, and hips. Ravens focus their attacks on animals that are not moving or have not moved much, such as newborns. Some general signs of a raven predation include: large wounds caused by pecking around the head and hind end of animals, bleeding around wound sites, and hemorrhaging in the internal tissues. Cattle producers report that ravens prey mostly on young calves, freshly branded cattle, and long bodied bulls. Sheep producers report finding numerous dead lambs across the landscape that have been killed through ravens pecking their eyes out and puncturing their skulls. Other lambs have been found with their eyes and tongues removed and may be partially disemboweled.

Over the last five years, WS-Colorado assisted 2 cattle and sheep producers and private individuals in alleviate depredation events caused by ravens. These people reported the loss of 8 animals valued at $5,951 dollars. To prevent raven depredation, producers are encouraged to consult with WS-Colorado; maintain accurate records recording the times damage occurs the location, the number of animals involved, and the type of damage seen; bury and dispose of all deceased animals; move injured calves and lambs away from the areas where the predation occurred; and if possible, allocating a protected area of land for livestock birthing. WS-Colorado also utilizes the toxicant 3-chloro-p-toluidine hydrochloride (DRC-1339) to manage raven populations that are damaging livestock, species of concern, or pose a risk to human health and safety. This toxicant is often injected into chicken eggs or applied to dog food and placed at the site where the damage is occurring (Peebles and Conover 2016).

Black-billed Magpie Predation

Black-billed magpies are one of the most frequently observed corvids throughout Colorado. Though, populations of these long-tailed black-and-white birds are more plentiful along the western slope and mountainous regions of the state. Infrequently, magpies peck at open wounds on the backs of adult sheep and cattle during winter or early spring months (Berry 1922). Many western sheep producers, shear their sheep in the spring to removing their wool and take it to market. During the shearing process, sheep may accidentally be cut exposing their flesh to opportunistic avian predators. As the shorn sheep are moved into "bunk-pastures," areas where they remain fenced following shearing, populations of magpies can number 20 or more birds and harass and injure these animals. Similarly, these populations of birds will gather around cattle operations and peck at open sores, new brands, and any other wound causing them to become infected and in some cases, to die from their injuries. Magpie predation is typically characterized by wounds on the back of the animal (sheep and cattle) and/or on the sides (cattle – near brands). Magpies are protected by the Migratory Bird Treaty Act, but a provision called a Depredation Order (50 CFR 21.43) allows take of black-billed magpies when committing or about to commit depredations on agricultural resources (livestock). Livestock producers are allowed to lethally remove a few birds to stop the injuries and disperse the remaining birds. WS-Colorado will receive 1-3 requests each year for assistance with this depredation. Over the last five years, WS-Colorado assisted 4 sheep, goat, and cattle producers and private individuals in alleviate depredation events caused by black-billed magpies. These people reported the loss and or damage/injury of 7 animals valued at $832 dollars.

Eagle Predation

Golden Eagles (*Aquila chrysaetos*) and to a lesser extent Bald Eagles (*Haliaeetus leucocephalus*) have been a source of considerable controversy throughout ranching communities of the western U.S. Once nearly exterminated, through poisoning, nest destruction, and shooting, eagle populations have once again become widely distributed across the landscape. Although the majority of Golden Eagle and Bald Eagle diets consist of prairie dogs, ground squirrels, rabbits, and other rodents, occasionally they do prey upon domestic fowl and livestock such as sheep and goats (Olendorff 1976, Avery 2004, USFWS 2016). So much so, that a common practice for many sheep and goat producers is to keep populations away from pastures where predation is severe until the young of the year are several weeks old. While this practice may reduce the exposure of the population to known areas where eagle predation occurs, it is not always effective at reducing depredation events. In many cases, the removal of a population from a known pasture where eagle depredation arises simply shifts the eagle's search for prey to another nearby sheep herd. Eagles often hunt in open areas where they have a wide field of vision and are able to attack from above. They seize lambs and kids from the front or side by the head, neck, or body. Talon punctures wounds are made by the hallux and one or two of the opposite talons. Adult animals or lambs weighting 25 lbs or more may have puncture wounds in the upper ribs and/or back. When captured, the lamb or kids large internal arteries (frequently the aorta) are punctured. The main cause of death in these individuals is shock as a result of massive internal hemorrhaging and/or collapsed lungs. After their prey has been subdued, eagles skin the animal turning the hide of the animal inside out with the skull still attached to the hide. On newborn animals, the ribs are often detached near the backbone and eaten. Eagles may also eat the nose, ears, and lower jaw of some animals and remove the palate and part of the connected skull to reach the brain. Depredated carcasses are often very clean, as eagles consume visible hemorrhages off the skin and clip ears, noses, tendons, and other tissues.

Producers are encouraged to house lambs and goat kids in pens around buildings or pasture them in brushy wooded areas, where they are less susceptible to eagle depredation. While the use of densely wooded areas may not completely prevent eagle predation it may help protect lambs and kids up to 4 to 6 weeks of age. Eagles rarely prey upon lambs and kids once they reach this developmental milestone. Depending upon the availability of pasture, season, weather, and labor, shifting the lambing/kidding season to an earlier or later date may also help to reduce eagle depredation losses. Ewes and Does may also be placed inside lambing and kidding sheds during birthing. Obviously, this practice is limited by the availability of space, the number of pregnant livestock, the cost and quality of feed needed for ewe and doe milk production, and the amount of time needed for the population to lamb. Newborn lambs and kids should be confined in these sheds for up to a month to protect from eagle predation when they are most vulnerable. Predation is most severe on lambs and kids that are 2 to 4 weeks old that are running and playing on the fringes of the population. Livestock Guardian Dogs may also afford the herds some protection, although their effectiveness on deterring eagle predation warrants further research. Finally, carrion should be removed as soon as possible to limit the size of local eagle populations. However, if the local eagle populations are highly dependent on carrion they may kill lambs or kids if an alternative food source is unavailable.

Over the last five years, WS-Colorado assisted 3 sheep and goat producers and private individuals in alleviate depredation events caused by eagles. These people reported the loss of 28 animals valued at $69,600 dollars. In order to alleviate eagle depredation, producers are encouraged to consult with WS-Colorado and protect ewes and does while they are lambing and kidding. It should be noted that Bald and Golden Eagles are protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (16 USC 668-668c). The Bald and Golden Eagle Act prohibits the taking, possessing any of parts, or transporting eagles, nests, or eggs of such birds without prior authorization. "Take" is defined as to pursue, shoot, shoot at, poison, wound, kill capture, trap, collect, destroy, molest, or disturb (50CFR22.3). "Disturb" means to agitate or bother a bald or golden eagle to a degree that cause, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." (16 USC 668-668c). Activities that directly or indirectly lead to the take of Eagles is prohibited without a permit being issued from the US Fish and Wildlife Service. Note that in Region 6, the USFWS **requires** persons conducting any hazing or harassment, nest removal, egg destruction, and trapping and relocation activities to obtain a Bald and Golden Eagle Depredation Permit pursuant to 50CFRPart22. Further information about the different types of permits available for the take, possession, and transportof Bald and Golden Eagles may be found at:https://www.fws.gov/midwest/midwestbird/eaglepermits/index.html.

1.7.7 What is the Need in Colorado to Prevent Bird Damage to Aquaculture?

Colorado has a longstanding history as being one of the first states to develop aquaculture production facilities. In 2005, American aquaculturists sold a variety of aquaculture products for an estimated $1.1 billion (NASS 2007). In Colorado, aquaculturists raise aquaculture products including tilapia, black crappie, brown trout, fathead minnow, walleye, largemouth bass, wiper, channel catfish, rainbow trout, alligator gar, sunfish, sturgeon, striped bass, cutbow trout, brook trout, white bass, golden trout, and carp; but, only trout production sales exceeded the threshold to be counted (NASS 2016). For decades, Colorado has produced rainbow trout for recreational and foodstuff markets. During recent years, Colorado has ranked fifth among total trout sales (Colorado Aquaculture Association 2016). From 2011 to 2016, trout species sales in Colorado averaged $1.9 million annually

(NASS 2017). However, Colorado's growing aquaculture industry is not without its problems, as aquaculturists report that fish-eating birds are responsible for substantial economic loss (Gorenzel et al. 1994, Gorenzel et al. 2005, Hoy 2017).

Aquaculture facilities within Colorado predominantly rely on flow-through and integrated recycling fish farming systems. The flow-through or raceway style farming systems are commonly used by inland aquaculture facilities and consist of artificial rectangular canals or basins made of concrete that are outfitted with water inlets and outlets. Water cycles through the raceways at around 30 liters per second in order to meet the respiratory dissolved oxygen requirements of the fish, although optimum flow rates may vary depending on the species. Freshwater species commonly raised in raceways systems in Colorado include: trout, catfish, and tilapia. Prior to construction, aquaculture facilities must ensure that a constant supply of fresh water including streams, reservoirs, springs, or deep wells are located nearby since the raceways must be regularly flushed in order to maintain proper water quality parameters. Furthermore, when evaluating potential fish farming locations producers must also consider locating facilities away from known bird concentrations such as migratory bird routes, roosting sites, wetlands, and rookeries. Obviously, such large open-water areas with un-naturally high densities of fish serve as notable attractant for fish-eating birds. (Agri-Facts 1999, Falker and Brittingham 1998)

Colorado aquaculturists also rely on indoor rearing productions throughout the state. In fact, Colorado Parks and Wildlife researchers have several artificial fish breeding facilities geared toward the recovery of populations of state threated species, species of concern, and/or sportfish species. Currently, Fish Research Hatchery personnel are working on rearing several species of sportfish including Hofer brood and Harrison Lake brood rainbow trout (believed to be more resistant to the whirling disease parasite), state threatened Greenback Cutthroat trout, Roan Creek Cutthroat trout, Mountain whitefish, and millions of rainbow trout. Annually, researchers and volunteers travel to remote locations to harvest wild fish species gametes and return them to the lab. Once secure, the gametes are manually combined in order to promote cross-fertilization between large quantities of individuals and retain genetic diversity in these isolated populations. The resulting larvae are reared in-house until they reach a size sufficient to be either re-introduced into the wild or moved to larger outdoor grow-out tanks. (http://cpw.state.co.us/learn/Pages/ResearchAquaticHatchery.aspx)

Growing public demand for sustainable, healthy, affordable food sources has stimulating the demand for farm-fresh fish raised in contaminant-free indoor tank systems in Colorado. Indoor recirculation aquaculture systems (RAS) enable producers to raise fish year-round in colder climates where outdoor temperatures may inhibit fish growth, reduce transportation distances, and allow producers to harvest their fish when prices are the most profitable. They also maximizing fish production in relatively small areas of land and use 80% less water than similar open water facilities (Helfrich and Libey). In a 5,000 sq ft building RAS producers can harvest over 100,000 pounds of fish (Helfrich and Libey). Fish may be grown in rearing tanks ranging from 500 to 500,000 gallons and constructed of various materials including plastic, wood, glass, rubber, and metal. These large enclosed systems allow producers to recycle the fish waste into nearby Hydroponic beds and produce a secondary agricultural crop and essentially doubles the crops and profits for the operation. Obviously, these enclosed indoor facilities are not as substantially impacted by bird damage as the outdoor flow-through systems.

Damage Identification and Management

Reducing the damage caused by fish-eating birds relies on accurately identifying the species involved and realizing that not all of the bird species found at aquaculture facilities harm production. Fish-eating birds in Colorado, such as American white pelicans, Double-crested cormorants, American crows, Belted kingfishers, Common ravens, Great Egrets, Common grackles, and California, Franklin's, Herring, and Ring-billed Gulls are highly mobile and adaptable predators that readily exploit these densely populated outdoor aquaculture rearing facilities. Since most fish-eating birds are diurnal (active during daylight hours) direct observation is the most common tool for confirming bird species presence associated with damage. Obvious signs of bird damage at aquaculture facilities consist of birds perching on trees or wires near raceways or ponds, hovering overhead and plunging into the water, stalking or standing along water edges, and/or swimming or diving in water bodies. Some species, including Black-crowned Night-herons feed at dusk and night, when aquaculture personnel may not be present (Hoy 2017). As most fish are swallowed whole, few direct signs of bird predation remain following wading bird depredation.

On average, wading birds such as herons and egrets, consume 4-24 minnows per day at production facilities (Hoy 2017). These species tend to feed in large populations and often damage fish by puncturing or slicing holes in the back or side(s) (Hoy 2017). Fish in aquaculture facilities may show signs of scars from past predatory attempts. Herons and cormorants often injure fish, enabling bacterial and fungal infections to invade aquaculture facilities. The presence of Great egrets at aquaculture facilities can also indicate underlying signs of disease. In the spring and fall aquaculture facilities experiencing Great egret predation often are concurrently having outbreaks of enteric septicemia (Glahn et al. 1999). Hodges (1989) similarly reported that Great egrets were attracted to and feeding on ponds where catfish were already dead or dying. Thus, it is likely that the fish consumed by Great egrets may have been lost regardless of predation due to enteric septicemia. Due to the adaptability and high mobility of fish-eating birds, the severity of damage at these facilities varies depending upon the species present, the proximity of nesting or roosting sites, the availability of alternative food sources, and whether the birds are year-round residents or seasonal migrants.

Glahn et al. (1999) found that trout farms where Great blue heron were present 9.1-39.4% of the time, experienced $8,000 to $66,000 in lost biomass production. Necropsies of lethally removed Great blue herons contained almost exclusively trout (Glahn et al. 1999). From FY12 to FY16 Colorado aquaculturalists experienced an average annual loss of $81,500 in biomass production due to Great blue herons and Black-crowned night herons predation. Occasionally such depredation events may remain undetected at aquaculture facilities, until fish biomass harvests fall below production expectations. Such drastic declines in biomass, may be due to birds feeding at night and/or infrequent human observations at rearing facilities.

In Colorado, from FY13 to FY17 there were work tasks for American White pelicans (12 work tasks), Double-crested cormorants (16), Great Blue herons (36), Black-crowned Night-herons (14), American crows (2), Belted-kingfishers (15), Common ravens (3), and California (13), Franklin's (8), Herring (10), and Ring-billed gulls (12) affected trout, tilapia, catfish, and privately stocked sport fish aquaculture operations. When producers at these facilities are experiencing economic losses due to predatory fish-eating species, short of completely enclosing the ponds or raceways with nets, no single control method will resolve these issues. Mitigation activity should start early before the birds become a recurrent issue by adjusting fish management activities and integrating both nonlethal control such as exclusion, or impediment methods, hazing, and lethal removal. In most cases, WS-Colorado only provides advice (technical assistance) to aquaculture facility operators on how to resolve such problems through primarily nonlethal means such as barrier/deterrent wires or harassment. In some cases, facility managers are advised to obtain migratory bird depredation permits from the USFWS to lethally remove problematic bird species and reinforce hazing activities. Lethal methods would generally be recommended to taking the minimum number of birds required to reinforce harassment and exclusionary techniques. Typically, the extent of losses due to fish-eating bird depredation will dictate the amount of money and resources producers are willing to invest in bird damage management. The loss of biomass due to predatory bird consumption can be estimated by the following formula: (Average number of birds observed per hour) x (Bird Feeding Rate – fish taken per hour) x Hours birds are present per day) x Days birds are present per year). Several measurements should be taken throughout the day during the season the damage is occurring since bird numbers may be variable throughout the day. (Agri-Facts 1999)

Besides consuming fish, birds may also injure fish, disrupt feeding activity, disturb brood stock breeding, and contribute to the spread of parasites and disease in aquaculture ponds and raceways. Bird fecal accumulations degrade water quality, increase bacterial activity, and reduce dissolved oxygen levels. The severity of bird damage varies among the bird species present, their number, and whether these species are resident or migratory populations. In recent decades, populations of migratory birds have been reported to remain near aquaculture facilities year-round (Hoy 2017). Furthermore, the proximity of nearby nesting/roosting sites and alternative feeding sites are also important factors in bird population abundances.

Fish Management

The ability of producers to adjust their procedures based on the variable bird habits are essential to helping control bird predation. Since fingerlings, young fish, are more susceptible to bird predation due to their large concentrations, small size, and naïve behavior, aquaculture producers are advised to locate their containment areas closest to human activity. For ponds smaller than 5 acres, screening or covering ponds combined with intense bird harassment may deter bird depredation. Furthermore, we advise against the use of floating fish food rations as it allows American crows, Common ravens, Common grackles, gull sp., and starlings to more easily capture fingerlings. Parkhurst et al. (1992) found Common grackles feeding on trout fry at nine out of ten locations studied. Among all predatory bird species studied, grackles captured and removed the most fish per day per site at an estimated 145,035 fish removed per year per site (Parkhurst et al. 1992). As fingerlings mature and become larger, stocking ponds or raceways with these larger individuals should make them less vulnerable to predation.

Exclusion/Barriers

As mentioned previously, the only assured method of eliminating bird predation at outdoor facilities is the total exclusion of birds from ponds or raceways. While this may be a feasible option at smaller production facilities, it may be impractical for larger producers due to monetary constraints and/or interference with management operations. However, it should be noted that while exclusion options may initially be costly, the long-term benefits generally outweigh the costs; and conversely while many other management options may be less costly initially, they often are short-term solutions to a long-term problem.

When evaluating physical barriers to prevent bird predation producers should evaluate completely enclosing ponds and/or raceways with netting or wire as well as partially enclosing facilities. When completely enclosing a facility, all structural materials should be able to withstand the weight of several large predatory birds without sagging, be visible to birds to prevent injuries, be constructed of durable materials, can provide a long-term solution, and not impede or inhibit facility personnel. Partially covered systems may consist of installing overhead lines and wires constructed of high-tensile galvanized stainless-steel wire or heavy gauge monofilament lines that discourage predatory bird feeding behavior. Overhead lines should be suspended in either a grid pattern or in one direction over the surface of the water and spaced appropriately based on the species causing the most damage. For example, while properly spaced overhead wires may effectively deter gulls from feeding on fingerlings, smaller birds such as belted kingfishers may require finer netting or mesh to be installed to prevent predation. Overhead wiring or line systems are most effective against gull species, cormorants, ospreys, and other flying predatory species. Other predatory bird species, such as wading birds, may be able to circumvent these overhead systems by landing on shore embankments and walking to the water's edge. In such cases, an additional perimeter fence or nonlethal electric fence should be constructed to prevent such incursions.

Harassment/Hazing

Frightening devices and techniques can also be used to discourage birds from roosting, feeding, or populationing at aquaculture facilities. By utilizing these techniques, birds are frightened away from an area using sight and/or sound stimuli (pyrotechnics use, vehicle hazing, noise generators, propane cannons, shotgun cracker shells). Prior to implementing a harassment/hazing regime, producers should be trained to proper bird identification techniques and match the bird species causing damage to the most effective combination of frightening devices. Long term results are typically achieved by combining a variety of noise devices including: distress calls (recordings of species-specific birds in distress); cracker shells (modified cartridges fired from a shotgun that replicate fireworks); whistle bombs, screamers, bangers, screamer rockets (15 mm cartridges with pyrotechnic explosives that are fired from a hand-held launcher using black powder blanks); automatic exploders (propane gas or acetylene gas operated small canon equipped with an electronic timing mechanisms, and emits a loud explosion at programed intervals); and alternating their use.

These techniques should be used before birds establish a regular feeding pattern. Once feeding pattern has been established, it is unlikely that frightening techniques alone will be able to break this inherent behavior. When initially implementing their use, frightening techniques should be used for short periods (5 to 7 days). During this period, most birds will leave the area. During repeated use, bird populations will lose their initial fear and become habituated to the devices. Once the effectiveness of the hazing techniques begins to decline, additional negative reinforcements (lethal take with rifles or shotguns with a permit) will need to be incorporated. The effectiveness of a hazing/harassment regime using frightening devices depends on the operator's adherence to a carefully planned activity.

Lethal Methods

Predatory fish-eating bird species can cause substantial monetary damage at aquaculture facilities. Aquaculture producers are encouraged to consult with their local USDA Wildlife Services personnel as soon as damage begins to occur. Specially trained Wildlife Biologist will assist producers in identifying the species of bird(s) involved and will recommend effective control techniques to alleviate the associated damage. If nonlethal control techniques prove ineffective, producers may be encouraged to apply for a Migratory Bird Depredation Permit from the US Fish and Wildlife Service. It should be noted that it is illegal to trap or shoot all of the fish-eating birds included within this environmental assessment (except for blackbirds, crows, and grackles) without first obtaining the afore mentioned permit. Additionally, waterfowl may be legally taken during hunting seasons once a hunting license and federal and state duck stamps have been purchased. Please consult your local ordinances prior to discharging firearms near buildings or roads. Furthermore, bird damage abatement activities may not completely eliminate bird depredating species in an area but, merely reduce the damage that is occurring at one facility or location while increasing damage at another location (Aderman and Hill 1995, Tobin et al. 2002).

1.7.8 What is the Need in Colorado to Alleviate Bird Damage in order to Protect Natural Resources and Property?

Property encompasses a wide range of resources that are damaged by birds, generally by bird feces. Feral pigeons congregate under bridges and on buildings, where their feces are left corroding protective finishes and structural beams. Utility towers are sometimes used by turkey vultures for roosting where they, as well as other populationing birds such as starlings and crows, can cause damage problems, primarily from their fecal droppings. Other property can be damaged because birds will feed on it such as landscaping, grass, and flowers. Finally, the bulky nests of some species can be damaging, but most are more of a fire hazard when built in or on structures.

Habitat degradation can occur from continuous accumulations of bird fecal droppings under roosting and nesting colonies. Over time, such accumulations can lead to the loss of vegetation due to ammonium nitrogen toxicity. Herbert et al. (2005) found that Double-crested cormorant fecal droppings negatively impacted vegetation densities on some islands in the Great Lakes. Notable damage may also occur during bird nesting season. Geese, other waterfowl, crows etcetera can strip surrounding plants of leaves for nesting material. At some locations, were large colonies of nesting birds exist, this behavior may severely impact or denuded areas of vegetation (Hicks 1979, Cuthbert et al. 2002). The degradation of vegetation from some areas may additionally reduce the nesting habitat for other birds and wildlife, including T&E species (Korfanty et al. 1999).

Feral domestic and wild waterfowl may also remove waterway vegetation, causing soil erosion, and negatively impact water quality in sensitive areas. Severe grazing at golf courses, parks, recreational areas, and other manmade structures resulting in the loss of turf, responsible for stabilizing subsequent soil horizons. At these sites, excessive grazing may necessitate re-planting resulting in significant monetary expenditures. Disproportionate populations of Canada geese and other waterfowl species contribute to excessive nutrient loading via bird fecal deposits leading to the eutrophication of water bodies along with the potential introduction of disease pathogens. Fecal dropping accumulations in these water systems, leads to increased nitrogen levels, algae blooms, and depleted dissolved oxygen levels resulting in the death of aquatic vertebrates and invertebrates (Harris et al. 1981, Scherer et al. 1995).

Migratory waterfowl also play an important, and often overlooked, role in the dispersal of invasive plant species (Reynolds et al. 2015, Green 2016). Both terrestrial and aquatic plant and invertebrate species have been transported by waterfowl in their guts (endozoochory), on their plumage, and/or on beaks or feet (ectozoochory or epizoochory) (Green 2016). Green et al. (2016) found that 13 species of ducks, one swan, seven shorebirds, one coot, one rail, five species of geese, two herons, five gulls, can act as vectors for 79 invasive species of terrestrial and aquatic plants and eight species of invasive invertebrates. As early as the 1960s, scientists conducted experimental investigations examining the length of time invasive plant seeds remained viable within duck and shorebird digestive tracts. De Valming et al. (1968) and found that seeds remained viable up to 29 hours after being consumed. Furthermore, Proctor (1968) found that certain species of invasive plants remained in shorebird gizzards for up to 152 hours. Best and Arcese (2009) demonstrated that Canada geese were able to disperse invasive grasses and forbs by endozoochory (seed dispersal via ingestion by vertebrate animals). The introduction of invasive species leads to a lack of biodiversity, and in many cases, may lead to increased use of herbicides.

1.7.9 What Is the Need for WS-Colorado to Assist in Protecting Threatened and Endangered Species or Species of Special Concern?

Some species of wildlife including those listed as Threatened or Endangered (T&E) under the Endangered Species Act (ESA) of 1973 are preyed upon or otherwise adversely affected by certain bird species. Other bird species are of conservation importance to the USFWS or CPW due to declining abundance (**Table 1.11**). These species may be candidate species for listing under federal or state endangered species laws. The risk and harm one bird species has on another could be from predation, competition for food resources and nesting locations, or nest parasitism. The harm to listed species usually is caused by man's activities altering the balance in ecosystems or human changing habitats which makes a species more vulnerable to predation or interspecific competition with other wildlife. Direct predation has been shown to seriously limit the recovery of T&E and sensitive bird species, particularly ground nesting birds, WS-Colorado has been involved in protecting threatened and endangered species and species of concern within Colorado including: mountain plover (*Charadrius montanus*),Gunnison sage-grouse (*Centrocercus minimus*), and Greater sage-grouse (*Centrocercus urophasianus*).

Mountain Plover

Recently, the USFS contacted WS-Colorado to assist in the conservation and protection of mountain plover populations at Pawnee National Grassland. The mountain plover is a North American shorebird and is considered a sensitive species within the Rocky Mountain Region (Region 2 USFS). It is associated with xeric upland landscapes as seen throughout northeast Colorado. Within the National Forest system, a sensitive species is defined as a plant or animal whose population is experiencing a significant decline or is predicted to have a reduction in its distribution. Sensitive species often require special management considerations and facilitate collaboration among wildlife entities. Major threats to mountain plover populations include the loss of nesting habitat, a reduction in grazing pressure on native landscapes creating unsuitable nesting habitat, and alterations in vegetation composition on native landscapes. Mountain plovers are protected under the US Migratory Bird Treaty Act and locally by the USFWS (Mountain Plover Management Strategy). Breeding populations of mountain plovers vary within eastern Colorado, central Wyoming, and eastern Montana (Knopf 1996). Northeastern Colorado is considered the epicenter of the mountain plover breeding habitat although, other areas of the state including South Park and southeastern Colorado may maintain large aggregates of nesting pairs (Carter et al. 1996, Kienning and Kingery 1998, Dinsmore 2003). Throughout their range, mountain plovers selectively nest within active black-tailed prairie dog colonies (Knowles et al. 1982, Dinsmore 2002; 2003). Within the last decade, black-tailed prairie dog colonies have experienced disruptive population declines due to sylvatic plague outbreaks and pest management practices (Knowles 1999, Dinsmore 2003). In an effort to conserve and recover mountain plover populations within the Pawnee National Grasslands; the USFWS has partnered with WS-Colorado to protect and maintain current populations of black-tailed prairie dogs where mountain plovers have historically nested.

To ensure the survival of black-tailed prairie dogs within these breeding areas, WS applies a commercially available insecticide to active burrows to prevent the spread of sylvatic plague vectors (fleas). This helps ensure that Mountain plover populations remain viable within the Pawnee National Grassland ecosystem for years to come.

Gunnison and Greater Sage Grouse

In addition to mountain plovers, WS-Colorado assists other governmental agencies in the conservation of sage-grouse populations throughout Colorado. Gunnison sage-grouse are native to southeastern Utah and southwestern Colorado. They are federally listed under the Endangered Species Act as a threatened species. Currently, around 3,500 breeding Gunnison sage-grouse are located throughout Gunnision Basin, Colorado and southeast Utah within seven separate breeding populations. Similarly, another sage-grouse species, the Greater sage-grouse, is listed as a species of concern within northwestern Colorado. The southernmost edge of the Greater sage-grouse range is located in Northwestern Colorado. Both of these species of sage-grouse face population declines due to the loss and fragmentation of habitat, habitat degradation, the introduction of invasive species, and predation (Braun 1998, Schroeder et al. 2004, Bui et al. 2010).

One common avian predator, the Common raven (*Corvus corax*), is thought to be responsible for declines in sage-grouse nesting success due to egg and chick depredations (Coates et al. 2008, Bui et al. 2010, Coates and Delehanty 2010, Peebles et al. 2017). Within the last 40 years, Common raven populations have more than quadrupled in the United States (Sauer et al 2014). Colorado Christmas Bird Count data identified 3,362 Common ravens occupying the landscape in 2010, a 1,778% increase when compared to population counts performed in 1971 (National Audubon Society 2010). Often considered subsidized predators, ravens exploit or subsist on anthropogenic resources and travel to adjacent native habitats to prey on vulnerable species (e.g. sage-grouse). Within urban environments, anthropogenic food and water sources attract ravens across vast distances (kilometers). As a result, these resources drastically increase raven reproductive success and fledgling survival rates due to the close proximity of readily accessible resources (Webb et al. 2009). Bui et al. (2010) found that raven population reach unnaturally elevated densities within cities and sharply decline ~1.86 miles outside of the city limits. In addition to food and water subsidies, anthropogenic developments provide convenient nesting and roosting sites in the form of structures, utility poles, ornamental trees, roof tops, and other non-natural features (Dunk et al. 1997, Kristan and Boarman 2007, Howe et al. 2014). Prior to breeding, ravens are highly social, however once a pair has established a breeding territory, individuals aggressively defend their nests and exhibit strong site fidelity at established locations (Roth et al. 2004). Non-breeding juveniles disperse to similar anthropogenic resource subsidies such as near roads, human developments, landfills, and water sources (Webb et al. 2009, Roth et al. 2004). At these locations, unnaturally abundant raven populations disrupt vulnerable ecosystems through "spillover predation" (Boarman 1993). Multiple studies indicate that increased raven populations directly correlate to increased mortality rates in sage grouse populations due to egg and chick depredation (Bui et al. 2010, Coates and Delehanty 2010, Coates et al. 2008, Lockyer et al. 2013, Schroeder and Baydack 2001). Although Common ravens are omnivores, their diet is mostly comprised of prey based items (carrion, road-kill, eggs, chicks, etcetera) (Knight and Call 1980). Anecdotally, ravens are thought of as highly intelligent predators due to their ability to utilize tools, memorize where food caches are located, and learn adaptable food-gathering tactics (Knight and Call 1980).

Sage-grouse species predators typically fall into two categories: visual and olfactory predators. Being that ravens are visual predators and one of the greatest limiting factors on sage-grouse populations; sage-grouse populations in heavily predated areas have adapted to selecting nesting sites that offer greater visual concealment (Conover et al. 2010, Dinkins et al. 2012). At a local scale, Dinkin et al. (2012) found that sage-grouse actively selected nesting sites that offered additional canopy cover in areas where avian predation was abundant (Connelley et al. 2004, Doherty et al. 2010, Kirol et al. 2012).

Batterson and Morse (1948) documented that sage-grouse populations, located in areas with common ravens, exhibited limited nest survival rates (3%) compared to areas where ravens were lethally removed (Schroeder and Baydack 2001). Similarly, Manzer and Hannon (2005) found that Sharp-tailed grouse nest success increased 8 fold when corvid populations were limited to three per square kilometer. Coates and Delehanty (2010) documented that for every one raven introduced per ten square kilometers the odds of nest predation increased by 7.4%. Peebles et al. (2017) found that when ravens were removed at specific locations reduced raven densities at a landscape level; and that the percent change in raven density correlated with greater lek counts within one year following lethal removal. Thus it is conceivable that on a landscape-scale, if given the choice, sage-grouse would prefer nesting in areas where avian predators are less abundant (Dinkins et al. 2012). With this in mind, Colorado WS will continue to assist federal, state, and local agencies in gaining a better understanding of the impacts raven depredation has on established sage-grouse population management goals.

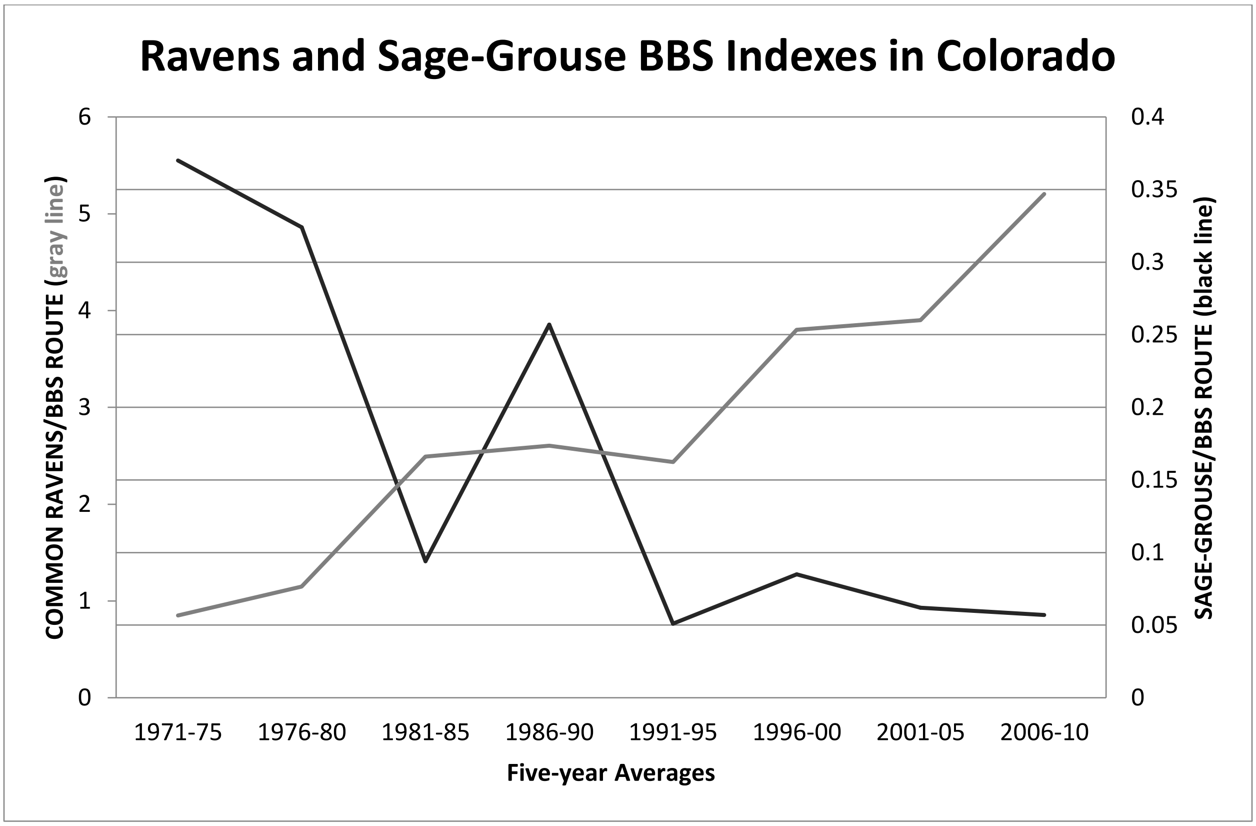

Figure 1.4. Common Raven, and Greater and Gunnison's Sage Grouse, combined, BBS indexes for 5-year averages Colorado from 1971 to 2010. The Colorado Common Raven increased 612% in this time and the sage-grouse population, which includes the Gunnison's and Greater in Colorado, decreased 85%.

Lesser Prairie Chickens

Since the 1800s, the distribution and populations of Lesser Prairie-chickens (*Tympanuchus pallidicinctus*) have declined by as 90% from historical levels (Taylor and Guthery 1980, Giesen 1994). Due to long-term population declines the species has been listed as a species "warranted but precluded" for listing under the ESA (Fed. Reg. Notice 63(110):31400-31406). Lesser Prairie-chickens were once a common feature on the Colorado sand sagebrush landscape in southeastern Colorado. Currently, Colorado's population is located on the Comanche National Grassland near Campo in southeastern Colorado, the breeding population within the state is estimated to contain less than 500 breeding birds, and is administered by the U.S. Forest Service. The availability of suitable nesting habitat along with habitat fragmentation and predation are the primary limiting factors for the Lesser Prairie-chicken population declines. Research has shown that predator management, including predatory birds, in fragmented habitats can enhance prairie-chicken recruitment (Schroeder and Baydack 2001). The primary raptor predators of Lesser Prairie-Chickens include Red-tailed hawks, Rough-legged hawks, Ferruginous hawks, Prairie falcons, Great Horned owls, Golden eagles, and Northern harriers.

Lewis Woodpecker

The population distribution of Lewis's woodpecker is listed in Colorado as a Tier 2 Species of Greatest Conservation Need (CPW 2015). In Colorado, these small woodpeckers, named after the explorer Meriwether Lewis, breed in over half of the counties throughout the state. The primary limiting factor for cavity nesting bird breeding success is the limited availability of suitable nest cavities (Ingold 1994). Invasive secondary cavity nesters, such as European starlings, compete with native woodpecker species, such as the Lewis's woodpecker for nesting sites (Howell 1943, Reller 1972, Jackson 1976, Ingold 1994). Similarly, Weitzel (1988) reported 9 native species of birds in Nevada had been displaced by starling nest competition, and Mason et al. (1972) reported starlings evicting bats from nest holes. The management operations proposed under the current activities may reduce local starling populations. However, it is not likely to reduce starling populations to noticeable levels unless BDM activities are specifically focused on reducing and removing starlings prior to or during breeding season. While reductions in nest site competition would benefit Lewis's woodpecker species along with other cavity nesters in limited areas within the state, these reductions are unlikely to significantly impact large areas.

Southwestern Willow Flycatcher

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) was federally listed as endangered in March of 1995 (U.S. Fish and Wildlife Service 1993). Nine pairs of southwestern willow flycatchers have been documented breeding in southwestern Colorado (Finch and Stoleson 2000). Brown-headed cowbirds pose a major threat to the success of southwestern willow flycatchers through brood parasitism (Brown 1988, Harris 1991, Whitfield and Sogge 1999, Sogge et al. 1997). Cowbirds reduce host nest success rates by removing some of the host's eggs and replacing them with their own. Although some host species may then abandon parasitized nests, when nests are not abandoned, brown headed cowbirds eggs hatch earlier and provide a competitive advantage over the host's own young (McGeen 1972, Brittingham and Temple 1983). Where studied, brown-headed cowbird parasitism has been shown to directly correlate with population declines in southwestern willow flycatcher populations (Whitefield 1994, Sogge et al. 1997, Finch and Stoleson 2000). Cowbirds have been shown to parasitize nests of over 100 different species of birds. Female cowbirds may lay as many as 40 eggs per year in surrogate host nests (Lowther 1993). Such brood parasitism events can jeopardize endangered species nesting success. Historically WS agencies in Arizona, California, Michigan, and Texas, have conducted cowbird trapping and other population management activities at feedlots and roost locations in an attempt to reduce nest parasitism in areas where host bird populations have been significantly impacted. The only T&E species in Colorado that has been impacted by the cowbirds is the Southwestern Willow Flycatcher (Sedgwick 2000).

Regardless of the species involved, WS-Colorado is dedicated to assisting local, state, and federal entities in protecting and managing threatened and endangered species and species of concern within Colorado.

Table 1. 91. Colorado Federally listed endangered and threatened species, their location, habitat, diet, and potential for impact from Bird Damage Management (BDM).

SPECIES	Scientific Name	Status	Locale	Habitat	Diet**	BDM
MAMMALS						
Preble's Meadow Jumping	*Zapus hudsonius preblei*	T	Central-North central	W	Gi	-, 0, +
New Mexico Meadow Jumping	*Zapus hudsonicus luteus*	E	Las Animas	GW	GI	-, 0, +
Black-footed Ferret* NEP	*Mustela nigripes*	E	Statewide	R	S	-, 0, +
Canada Lynx	*Lynx canadensis*	T	West, Central Mountains	F	Sl	-, 0, +
BIRDS						
Gunnison Sage-Grouse	*Centrocercus minimus*	T	Central-West central	R	GI	-, 0, +
Piping Plover	*Charadrius melodus*	T	East	W	I	-, 0, +
Least Tern (Interior Population)	*Sterna antillarum*	E	East	W	AI	-, 0, +
Yellow-billed Cuckoo (Western	*Coccyzus americanus*	T	West	F	I	0
Mexican Spotted Owl	*Strix occidentalis lucida*	T	West	F	S	0
Southwestern Willow	*Empidonax traillii extimus*	E	Southwest	F	I	-, 0, +
FISHES						
Greenback CutthroatTrout	*Oncorhynchus clarki stomias*	T	Central	LSg	AI	-, 0, +
Colorado Pikeminnow	*Ptychocheilus lucius*	E	West	Lg	A	0
Humpback Chub	*Gila cypha*	E	West	LSg	A	0
Bonytail Chub	*Gila elegans*	E	West	LSg	A	0
Razorback Sucker	*Xyrauchen texanus*	E	West	Lg	A	0
INVERTEBRATES						
Uncompahgre Fritillary	*Boloria acrocnema*	E	Southwest	F	N	0
Pawnee Montane Skipper	*Pseudocopaeodes eunus obscurus*	T	Douglas/Jefferson/Park/Tell	G	N	0
PLANTS						
Mancos Milk-vetch	*Astragalus humillimus*	E	Montezuma	R	-	0
Osterhout Milk-vetch	*Astragalus osterhoutii*	E	Grand	R	-	0
Clay-loving Wild Buckwheat	*Eriogonum pelinophilum*	E	Delta/Montrose	R	-	0
Penland Alpine Fen Mustard	*Eutrema penlandii*	T	Lake/Park/Summit	RW	-	0
Colorado Butterfly Plant	*Gaura neomexicana var.*	T	North Central	RW	-	0
Pagosa Skyrocket	*Ipomopsis polyantha*	E	Archuleta	FG	-	0
Dudley Bluffs Bladderpod	*Lesquerella congesta*	T	Rio Blanco	R	-	0
Knowlton Cactus	*Pediocactus knowltonii*	E	La Plata	R	-	0
Parachute Beardtongue	*Penstemon debilis*	T	Garfield	R	-	0
Penland Beardtongue	*Penstemon penlandii*	E	Grand	R	-	0
North Park Phacelia	*Phacelia formolusa*	E	Jackson/Larimer	R	-	0
DeBeque Phacelia	*Phacelia submutica*	T	Garfield/Mesa	R	-	0
Dudley Bluffs Twinpod	*Physaria obcordata*	T	Rio Blanco	R	-	0
Colorado Hookless Cactus	*Sclerocactus glaucus*	T	Delta/Garfield/Mesa/Montr	R	-	0
Mesa Verde Cactus	*Sclerocactus mesae-verdae*	T	Montezuma	R	-	0
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	Northwest-North central	RW	-	0, +

* - believed extirpated

**Diet - Capitals = large proportion of diet - Lower case = small proportion of diet.

STATUS

E - Endangered
T - Threatened
P - Proposed

HABITAT

F - Forests/riparian borders
G - Grassland/meadow
R - Range/sage/high desert
W - Wetland/marsh/sandbar
L - Lakes, Rivers
S - Springs/creeks/ponds
g – gravel bottom
B – boreal, alpine

DIET

A - Aquatic- fish/invertebrates/plants
G - Grains/grass/brush/seeds
L - Large Vertebrates
M - Mast/fruit & nuts
N - Nectar/sap
S - Small vertebrates (i.e. rodents, birds, amphibians, reptiles)
C- Carrion
I – Insects
P – plants, algae

BDM - Impacts

(-) - Negative
0 - none
(+) - Positive

1.7.10 What is the Need in Colorado for the Protection of Other Property Damage Associated With Birds?

In urban areas, many species of wildlife have become habituated to the presence of humans through the lack of harassing, or threatening behavior, abundant anthropogenic food resources, and nesting or roosting habitat. As wildlife species become habituated to the presence of humans, they demonstrate a lack of apprehension which can lead to these species exhibiting threatening or abnormal behavior towards people. Threatening behavior may be displayed as aggressive posturing, a general lack of apprehension toward approaching humans, and/or abnormal behavior. Birds can harass and injure people especially those protecting nests and can pose a concern where they carry potentially infectious or unsanitary items at landfills and open water treatment plants. They may also cause more general concerns because of their presence, but without causing any monetary loss. Examples of the latter include birds that make excessive noise (i.e., communal bird roosts, nesting crows, feral peacocks, woodpeckers drumming houses), are stuck in a building (i.e., Cooper's hawk in a warehouse, European starling in a flue), leave excrement on sidewalks (i.e., geese, ducks, starlings, swallows), create an unpleasant stench (i.e., droppings at communal bird roosts near residences, vulture roosts from vomitus and droppings, pigeon nests near air-intake to buildings), or when they are injured (i.e., wrapped with fishing line, or struck by a car and need to be trapped/hand captured to be taken to a rehabilitator).

Property damage associated with bird fecal droppings frequently occurs on private property or public facilities. Bird fecal deposits can also cause damage to structures such as houses on private property or public buildings and bridges where fecal material may decrease the functional life of some building roofs by 50% (Weber 1979). Additionally, uric acid from bird fecal droppings is highly corrosive and can damage metal structures and painted finishes, including automobiles. Corrosion damage to metal structures and painted finishes, including those on automobiles and aircraft, can occur because of uric acid from bird fecal droppings. Several incidents involving bird fecal droppings on vehicles, equipment, and aircraft in storage buildings at airports and airbases create concerns. Electrical companies experience power outages due to birds and their associated fecal droppings shorting out transformers and substations. Such shortages may result in hundreds if not hundreds of thousands of dollars in outage time for power companies. Larger bird species such as Turkey Vultures have also been shown to interfere with critical cell phone and radio tower structures through their roosting behaviors.

Woodpeckers sometimes cause structural damage to wood siding and stucco on homes. Damage to buildings by birds was the most frequent property damage complaint in Colorado averaging 64 requests per year with a recorded average value of about $58,897from FY13-FY17. The Northern Flicker was the most frequent species involved in these damage complaints (269 incidences FY13-17). Most all property owners were given technical assistance to resolve the problem.

Landfills serve as a major food resource attractant to multiple bird species including: ravens, magpies, pigeons, crows, Canada geese, starlings, bald and golden eagles and gull sp. In Colorado, several species of gulls are regularly seen in these habitats including: ring-billed, California, Thayer's, Franklin's, and herring gulls. In the United States, gulls use landfills as feeding and loafing areas throughout the year (Mudge and Ferns 1982, Patton 1988, Belant et al. 1995a, Belant et al. 1995b, Belant et al. 1998, Gabrey 1997). During migration season, large populations of gull sp. resting in these areas cause health concerns and structural damage to buildings and equipment by distracting heavy machinery operators, carrying waste off site, creating large amounts of bird fecal droppings, and potentially exposing/transmitting diseases to workers and neighboring residents.

Nesting behaviors of some bird species, may also cause damage to property. Nesting materials and fecal accumulations on private residences and public structures can be a human health and safety issue and aesthetically displeasing. Colonial nesters and birds that have the young from previous years help to raise their young can cause damage to urban and industrial structures. Larger nests, made by bird such as ravens, may also pose a human health and safety issue when large limbs and/or partially consumed carrion fall upon building residents. Gulls sp. nesting on roofs often peck and remove rubber roofing material, caulking, and spray on roof liners. Regardless of the species of bird involved, large amounts of nesting materials and food remains can obstruct roof drainage systems causing rooftop flooding and resulting in roof failure and/or structural damage (Vermeer et al. 1988, Blokpoel and Scharf 1991, Belant 1993). Raptor species and some passerines, at times, may aggressively defend their young, nests, and nesting areas from perceived threats and swoop down to strike pets, children, and adults. Crows that have been hand-raised and subsequently released by caregivers also pose a serious threat to human health and safety. These birds, habituated to humans, terrorize elementary school children by stealing barrettes and pins for their caches. WS responds to at least one aggressive nuisance incident, involving birds, per year.

Although rare, aggressive behavior by birds does occur especially during breeding/nesting seasons. Colorado-WS receives complaints yearly involving waterfowl (Canada Geese, feral Mute Swans) raptors (Swainson's hawk, Red-tailed hawk) and passerine species (Western kingbird). Species within these groups of birds may aggressively defend their nests, nesting areas, and young and commonly swoop from above to attack children, pets, and adults (Smith et al. 1999). Feral waterfowl often nest in high abundances in residential areas and when humans or pets approach nests, actively pursue unwitting intruders. In such cases, injuries may occur due to high accumulations of fecal material on docks, walkways, and other heavily trafficked areas (VerCauteren and Marks 2004). These bird fecal dropping accumulations can pose a slipping hazard and could result in injuries to people. Regular cleanup is often required to remove fecal matter from parks, beaches, and sports fields that have high densities of waterfowl which can be economically burdensome. In Denver County, Canada geese have been documented attacking employees while nesting outside the entrance to a federal facility. One blind employee was struck and injured when he tripped and fell to the ground trying to get away from an aggressive adult male goose defending his nest. After several repeated attacks and threats to individuals nearby, WS personnel resolved the issue by coordinating and hand capturing the male goose. Once the male goose was removed, the aggressive, defensive behavior ceased and the problem was resolved.

Other species of birds, such as waterfowl may cause damage to golf courses, parks, business and residential complexes, and recreational areas that have ponds or watercourses. Large congregations of these species can cause damage by overgrazing turf, aggressively defending their nests, and depositing large amounts of bird fecal droppings. The costs associated with removing bird fecal droppings from parking lots, sidewalks, patios, laws, public use areas, and business, recreational, and residential locations can lead to a loss in revenue and result in economic damage.

Finally, as discussed for livestock, predatory bird species can depredate pets and zoo animals and/or potentially be involved in the transmission of disease. For example in Colorado, small dogs, cats, and other small exotic prey species found at zoos may be preyed upon by large raptor or owl species such as Great horned owls. Wild raptor species living in and around open zoo enclosures pose serious predation threats to sensitive zoo species. In 2016, three Chilean flamingo chicks valued at over $5,000 were killed by a Great horned owl at the Denver Zoo. WS-Colorado responded to a request for help by the zoo and in 2017 several Chilean flamingo chicks were re-introduced into the outdoor enclosure. Additionally, zoo officials requested assistance from WS in removing deceased Double-crested cormorants from waterbodies surrounding zoo enclosures. Cormorants pose a serious disease threat through the spread of toxins concentrated in bird carcasses. Avian botulism is a paralytic disease of birds resulting from the ingestion of the toxins produced by the bacterium, *Clostridium botulinum* (Friend et al. 1999, Locke and Friend 1989). Seven serotypically distinct botulinum neurotoxins exist including types A through G. The most well-known botulinum neurotoxin, Type C, is responsible for causing most waterfowl die-offs (Locke and Friend 1989). Avian botulism affects many species of birds and some mammals. However, waterfowl, shorebirds, and gulls are most frequently affected. Botulism outbreaks occur historically year after year although some locations may have localized “hot spots.” The onset of outbreaks typically occurs, following water temperature fluctuations during warm summer months. Elevated water temperatures produce high mortality in invertebrate fauna and leads to rapid bacterial growth and toxin production within wetland environments. Once animals begin to succumb to disease, *Clostridium botulinum* bacteria replicate exponentially and are consumed by fly-larvae. These maggots, once consumed by other waterfowl, lead to neurotoxin toxicity and eventual death. Outbreaks typically occur from July to September and environmental conditions where avian botulism has been detected should be regularly monitored to insure that carcasses are removed to prevent and/or control the spread of the disease.

WS-Colorado responded to an annual average of 3,607 human health and safety complaints totaling 18,035 work tasks (**Table 1.7**) involving birds from FY13 to FY17. Of these, 17,941were work tasks associated with protection of people at airports. Species that typically cause most complaints in Colorado are hawks, pigeons, blackbirds/starlings, wading birds/cormorants, waterfowl, and small populationing birds attracted to airfields (*e.g.*, Horned Larks).

1.8 How Does WS address Threats of Disease Transmission?

Many times, individuals or property owners that request assistance with feral domestic pigeons, nuisance blackbirds, waterfowl, or starling issues are concerned about potential disease risks but are unaware of the types of diseases that can be associated with these birds. In some situations, BDM is requested because fecal droppings left by concentrations of birds are aesthetically displeasing and can result in continual clean-up costs. WS-Colorado collaborates on a regular basis with universities and other government agencies to conduct surveillance/research on disease agents potentially carried by wild birds, particularly emerging diseases and those which could potentially be introduced to North America. As such disease agents may be detrimental to humans, livestock, native wildlife (including birds), or a combination thereof.

In addition to economic losses due to cattle ration consumption, wild birds including starlings, potentially harbor and transmit pathogenic organisms (Feare 1984, Clark and McLean 2003, LeJeune et al. 2008, Carlson et al. 2012). Pathogens (*e.g.,* coccidiosis, salmonella, etc…) are primarily transmitted to cattle through the ingestion of food, water, and/or grass contaminated with bird feces containing infectious viral, bacterial, fungal, and parasitic organisms (**Figure 1.3**). In addition to biological transmission (e.g. bird fecal droppings) starlings may also transmit pathogens through mechanical (e.g. feet, beak) interactions with livestock (Weber 1979, Johnson and Glahn 1994, Kirk et al. 2002, Nielsen et al 2004, Pedersen et al. 2006, Linz et al. 2007, LeJeune et al. 2008, Medhanie et al. 2014, Homan et al. 2017). Starlings have been implicated in the transmission of avian salmonellosis (including *Salmonella enterica*) and shiga toxin-producing *Escherichia coli* (STEC) to humans, livestock, and poultry along with Johne’s disease (*Mycobacterium avium paratuberculosis*) in cattle (Feare 1984, Clark and McLean 2003, Carlson et al. 2011, Linz et al. 2018). Based on behavioral observations, it appears that starlings mechanically transmit contaminated cattle fecal material from cattle pens to water and feed troughs throughout livestock facilities (Carlson et al. 2011). At these facilities, starlings covered in cattle fecal material were regularly observed bathing in shallow water troughs and foraging in food troughs (Carlson et al. 2011). Disease transmission events at these facilities were likely compounded since contaminated water troughs and food bunks were not cleaned daily and contaminants accumulated over multiple days. However, Carlson et al.

(2011) found that starling control operations directly correlated with decline in *S. enterica* bacteria in the cattle feed bunks and water troughs. We will discuss a few of these diseases herein.

Livestock facility operations staff may also contract certain zoonotic diseases (diseases transmitted from wildlife to humans) through direct exposure to bird fecal material on fences, shade canopies, equipment, and other structures. Fecal accumulations can additionally accelerate the corrosion of metal components and be aesthetically unattractive. Birds feeding in open troughs or food bunks deposit feces which are in turn consumed by livestock. Fecal droppings contaminate water and other surface areas throughout livestock facilities and as a result, public health agencies continuously monitor livestock production herds for disease outbreaks (due to multiple routes of transmission). At the turn of the century, public health service agencies began to study the spread of disease pathogens through unpasteurized milk products. Through these studies they concluded, by implementing standardized sanitation procedures in production, handling, pasteurization, and milk distribution, milk borne disease outbreaks could effectively be eliminated.

In 1995 the United States Public Health Services and Food and Drug Administration (FDA) created the *Grade A Pasteurized Milk Ordinance* stipulating sanitary procedure regulations for milk and milk products. This ordinance states "Cows should not have access to piles of manure, in order to avoid the soiling of udders and the spread of diseases among cattle" and "that manure may not accumulate so as to permit the soiling of udders." Furthermore, some states restrict fowl (poultry, etc…) from having access to milking barns, stables, cow yards, and loafing in cattle housing areas to prevent pathogen transmission.

Another important food borne illness in the cattle industry, STEC costs producers $267 million annually (NCBA 2004). Food products, especially ground beef, are highly susceptible to STEC contamination. Direct medical cost associated with STEC and *Salmonella spp.* cost approximately $400 million per year. Similarly, *Salmonella spp.* outbreaks at dairies cost an average of $400 per incident per farm (Linz et al. 2018). Salmonellosis is more common in livestock than either STEC or *M. avium*. In fact, starlings numbering 1,000 to 10,000 birds can cost dairy producers 38% more than those without starlings due to veterinary bills and loss of livestock feed (Shwiff et al. 2012). Identifying and mitigating sources of salmonellosis contamination is crucial in reducing production losses. An outbreak of salmonellosis in a herd could mean substantial economic losses for livestock producers in terms of carcasses contaminating slaughter houses and/or pathogen transmission to human consumers and workers.

Johne's disease is caused by the bacterium *Mycobacterium avium paratuberculosis* and commonly infects the small intestine of cattle and other ruminants (Ott et al. 1999, Beard et al. 2001, Linz et al. 2018). This chronic contagious disease may have severe economic impacts on cattle, goat, and sheep herds. Livestock often become infected through manure contaminated feed bunks and water troughs. Individuals with advanced stages of infection often exhibit clinical signs such as: acute or intermittent diarrhea, weight loss, decreased milk production, and in terminal stages may result in death. The common route of disease transmission is through the fecal-oral route when animals consume fecal-contaminated feed or water (Collins 2003). Johne's disease also known as paratuberculosis and costs the U.S. dairy industry $200-$250 million of damage annually (Beard et al. 2001). In addition to impacting livestock, spread of this disease can also impact wildlife in Colorado, specifically bighorn sheep and mountain goats (Williams et al 1979, Quist 1998).

Migratory populations of starlings and blackbird sp. have also been linked with outbreaks of transmissible gastroenteritis virus (TGE), tuberculosis (TB), and coccidiosis in livestock (Matthews and McDiarmid 1979, Weber 1979, Corn et al. 2005). TGE is a rapidly spreading viral disease that infects pigs. Naïve pigs become infected by ingesting livestock feed contaminated with infected fecal material. Once introduced into a production facility, the virus may persist in the environment especially during colder months. The virus destroys the gastrointestinal cell lining resulting in diarrhea and dehydration. Producers may suffer massive losses of swine (in some cases up to 10,000 worth $1 million) in one month due to TGE infections associated with infected starlings (Pilchard 1965, Bohl and Saif 1975, Johnson and Glahn 1994, Linz et al. 2018).

Another avian-borne disease, coccidiosis, is caused by a protozoan parasite that spreads easily between animals via the fecal-oral route. Young animals are more susceptible due to their naïve immune systems. Coccidiosis commonly affects young calves, puppies, chickens, lambs and kids between ages of 1 and 6 months of age. Disease outbreaks frequently occur shortly after weaning when young animal immune systems are still developing. Clinical coccidiosis can be deadly, and requires immediate veterinary treatment. Infected animals appear malnourished, gaunt, and may exhibit rough hair coats. Staining around the tail may be observed as a result of diarrhea. As the disease progresses, animals become weak, anemic, and unthrifty and may die of severe dehydration and diarrhea. Thus, coccidiosis disease outbreaks should be responded to quickly before producers experience catastrophic losses. WS assists producers in mitigating bird damage occurring around livestock facilities.

Wild Bird Disease Transmission to Farm-raised Game Birds

Over the last few decades, commercial or ornamental game bird breeding facilities have increasingly become popular. Frequently, producers raise bobwhite quail, Pharaoh quail, mallards, ring neck pheasants, chukar partridges, ornamental pheasants, and other waterfowl species for hunting purposes, private collections, or restaurant markets. The size of these game bird breeding facilities frequently vary depending upon the resources available to the producer, the amount of capital, scale of the operation, and the propagation techniques that are use. Typically producers combine a combination of both indoor and outdoor propagation areas. The brood stock and chicks are kept in indoor facilities until they have begun to feather out. Then they are transferred into outdoor pens and allowed to forage during the day and return indoors during the night. Once gamebirds reach maturity, they may be transferred to large outdoor flight pens in preparation for their eventual release into the wild. These pens often contain more natural vegetation (agricultural crops, shrubs, etc…), allowing the birds to develop stronger leg and wing muscles, while preparing the birds to survive on a more natural landscape. Although these flight pens are essential for developing strong hunting stock, they potentially provide more opportunities for contact between captive and wild bird populations. Increased exposure to wild bird populations concomitantly increases the risk of disease transmission to commercially raised fowl. Over 100 species of wild birds serve as natural reservoirs for avian influenza (AI) Type A viruses. Many of these viruses infect waterfowl species worldwide and can be transmitted to domestic poultry and other game bird species through direct and indirect contact. Typically naturally infected waterfowl species show no outward appearance of disease, however these viruses are highly contagious among birds and certain strains may sicken and even kill some domestic fowl species. Infected birds often shed avian influenza type A viruses through saliva, nasal secretions, other bodily fluids, and fecal droppings. Naïve birds may become infected through direct contact with these infected individuals and/or through contact with contaminated fomites (objects) in the environment.

Symptoms of avian influenza infection include: ruffled feathers, declines in egg production, diarrhea, thriftiness, and general malaise. Populations infected with low pathogenic avian influenza (LPAI) strains may experience low mortality rates while those infected with highly pathogenic avian influenza (HPAI) strains may sustain 100% mortality. WS-Colorado provided technical assistance to 21 game bird breeders and individuals in the last 5 years. In an effort to prevent or reduce the spread of AI, producers are encouraged to locate outdoor pens away from ponds and waterways used by migratory waterfowl. Repair any structural damage to flight pens to prevent smaller species from entering (starlings and sparrows). Thoroughly disinfect any equipment that is being transferred between bird pens and/or facilities. Carefully screen any new birds being introduced from other breeding facilities for signs of disease. Make sure to isolate sick birds from the remainder of your population and maintain records of all purchase and sales transactions in case of a disease outbreak.

Disease	Livestock affected	Symptoms	Comments
		BACTERIAL	
erysipeloid	cattle, swine, horses, sheep, goats, chickens, turkeys, ducks	Pigs - arthritis, skin lesions, necrosis, septicemia Sheep – lameness	serious hazard for the swine industry, rejection of swine meat at slaughter due to septicemia, also affects dogs
salmonellosis	all domestic animals	abortions in mature cattle, mortality in calves, decrease in milk production in dairy cattle Colitis in pigs,	over 1700 serotypes
Pasteurellosis	cattle, swine, horses, rabbits, chickens, turkeys	Chickens and turkeys die suddenly without illness pneumonia, bovine mastitis, abortions in swine, septicemia, abscesses	also affects cats and dogs
avian tuberculosis	chickens, turkeys, swine, cattle, horses, sheep	Emaciation, decrease in egg production, and death in poultry. Mastitis in cattle	also affects dogs and cats
Streptococcosis	cattle, swine, sheep, horses, chickens, turkeys, geese, ducks, rabbits	Emaciation and death in poultry. Mastitis in cattle, abscesses and inflammation of the heart , and death in swine	feral pigeons are susceptible and aid in transmission
Yersinosis	cattle, sheep, goats, horses, turkeys, chickens, ducks	abortion in sheep and cattle	also affects dogs and cats
Vibriosis	cattle and sheep	In cattle, often a cause of infertility or early embryonic death. In sheep, the only known cause of infectious abortion in late pregnancy	of great economic importance
Listeriosis	Chickens, ducks, geese, cattle, horses, swine, sheep, goats	In cattle, sheep, and goats, difficulty swallowing, nasal discharge, paralysis of throat and facial muscles	also affects cats and dogs
		VIRAL	
Meningitis	cattle, sheep, swine, poultry	inflammation of the brain, newborn calve unable to suckle	associated with Listeriosis, salmonellosis, cryptococcosis
encephalitis (8 forms)	horses, turkeys, ducks	drowsiness, inflammation of the brain	mosquitoes serve as vectors
		MYCOTIC (FUNGAL)	
aspergillosis	cattle, chickens, turkeys, and ducks	abortions in cattle	common in turkey poults
		Rarely	affects horses, dogs and cats
candidiasis	cattle, swine, sheep, horses, chickens, turkeys	In cattle, mastitis, diarrhea, vaginal discharge, and aborted fetuses	causes unsatisfactory growth in chickens
cryptococcosis	cattle, swine, horses	chronic mastitis in cattle, decreased milk flow and appetite loss	also affects dogs and cats
histoplasmosis	horses cattle and swine	(in dogs) chronic cough, loss of appetite, weakness, depression, diarrhea, extreme weight loss	also affects dogs; actively grows and multiplies in soil and remains active long after birds have departed
		PROTOZOAL	
Coccidiosis	poultry, cattle, and sheep	bloody diarrhea in chickens, dehydration, retardation of growth	almost always present in English sparrows; also found in pigeons and starlings
American trypanosomiasis	infection of mucous membranes of eyes or nose, swelling	possible death in 2-4 weeks	caused by the conenose bug found on pigeons
toxoplasmosis	cattle, swine, horses, sheep, chickens, turkeys	In cattle, muscular tremors, coughing, sneezing, nasal discharge, frothing at the mouth, prostration and abortion	also affects dogs and cats
		RICKETTSIAL/CHLAMYDIAL	
chlamydiosis	cattle, horses, swine, sheep, goats, chickens, turkeys, ducks, geese	In cattle, abortion, arthritis, conjunctivitis, enteritis	also affects dogs and cats and many wild birds and mammals
Q fever	affects cattle, sheep, goats, and poultry	may cause abortions in sheep and goats	can be transmitted by infected ticks

Figure 1.5. Diseases of livestock linked to feral pigeons, starlings, blackbirds, and House Sparrows (*taken from* Weber 1979).

1.8.1 What is the Need to Alleviate Disease Transmission to Humans?

Of the known threats to human health and safety, emerging zoonotic diseases have the most potential to impact our health and economy. The transmission of these pathogens is greatly influenced by the ecology, sociology, and behaviors of both animals and humans. Numerous species of wild and domestic birds are capable of serving as zoonotic disease pathogen reservoir hosts. The majority of human infections are accidental or due to a "spill-over" event where humans are inadvertently exposed to disease pathogens through interactions with insect vectors or infected animals. According to the Institute of Medicine (2009), in the past six decades, 65% of the emerging infectious disease events were due to zoonotic pathogens (Narrod et al. 2012). Obviously, such disease epidemics negatively impact human health and activity in addition to influencing economic sectors. As a whole, the direct costs associated with zoonotic diseases has been estimated to be more than $20 billion with indirect losses totaling over $200 billion (Narrod et al. 2012).

Overtime, human population growth, mobility, increased urbanization, and lifestyle behaviors have served as drivers for zoonotic disease transmission. Eventually, this interconnectedness has led to the One Health concept. "One Health" is a worldwide strategy for expanding interdisciplinary collaborations and communications between environmental health, ecology, veterinary medicine, public health, human medicine, molecular and microbiology, and health economic professionals. The premise behind this strategy is that by taking a closer look at human health and the health of the world's ecosystem's we can positively impact our overall population health since zoonotic infections and comparative/translational medicine broadly overlap underneath an umbrella of these professions. When properly implemented, this One Health strategy will help protect millions of lives around the world and in generations to come.

While the transmission of infectious diseases or pathogens, from birds to humans, is poorly understood the potential for transmission exists (Luechtefeld et al. 1980, Wobeser and Brand 1982, Hill and Grimes 1984, Pacha et al. 1988, Blankespoor and Reimink 1991, Graczyk et al. 1997, Dho-Moulin and Fairbrother 1999, Saltoun et al. 2000, Kassa et al. 2001, Wasteson 2002, Russo and Johnson 2003, Manges 2016, Stromberg et al. 2017). Frequently birds serve as reservoir hosts, or hosts in which pathogens survive in but do not reproduce or cause clinical disease. Parasites survive within these host species until more competent hosts become available (i.e., hosts in which parasites cause clinical disease and reproduce). Subclinical infections, within reservoir species, allow the rapid transmission of disease causing organisms from isolated areas to multiple locales.

Humans are primarily infected by zoonotic pathogens through direct contact with contaminated fecal material. Accumulations of bird feces are considered a threat to human health and safety due to the close association of humans and potentially infectious pathogens. These fecal accumulations often occur where bird species aggregate in large numbers (i.e. parks, ponds, golf courses, etc…) for extended periods of time during foraging or loafing activities. In such cases, human health and safety is the primary reason for requesting assistance due to the potential for zoonotic disease transmission. For people with undeveloped immune systems (e.g., children) or immunocompromised and/or immunosuppressed individuals bacterial infections from such pathogens may lead to life threatening situations and even death (Roffe 1987, Graczyk et al. 1997, Wasteson 2002, Rothenburger et al. 2017, Stromberg et al. 2017). Financial costs associated with monitoring human health and safety threats associated with fecal contamination from birds, includes water testing for coliform bacteria, cleaning and sanitizing public-use areas, contacting and obtaining assistance from public health officials, and implementing nonlethal and lethal methods of wildlife damage management to reduce risk. WS-Colorado defers to the authority and expertise of local and state health officials who in turn, rely on the EPA to determine what constitutes a threat to public health and safety.

Several bird species listed **Table 1.12** have been directly or indirectly associated with zoonotic disease transmission including: West Nile virus, encephalitis, psittacosis, and histoplasmosis to humans. In fact, over 65 zoonotic pathogens associated with feral pigeons, European starlings, and House sparrows have been shown to cause disease in both humans and domestic animals (Weber 1979, Wobeser 2006, LeJeune 2008, Homan et al. 2017). These include viral diseases such as meningitis and seven different forms of encephalitis; bacterial diseases such as erysipeloid, salmonellosis, paratyphoid, Pasteurellosis, and Listeriosis; mycotic (fungal) diseases such as aspergillosis, blastomycosis, candidiasis, cryptococcosis, histoplasmosis, and sarcosporidiosis; protozoal diseases such as American trypansomiasis and toxoplasmosis; and rickettsial/chlamydial diseases such as chlamydiosis and Q fever (**Figure 1.4**). Limited studies have been conducted on the occurrence, transmission, and prevalence of zoonotic pathogens in wild bird populations. Such studies are complicated by the fact that birds may contract pathogens from other environmental sources. It should also be noted that disease transmission from birds to humans is relatively uncommon.

Species such as blackbirds, vultures, waterfowl, gulls, crows, starlings and pigeons exhibit gregarious roosting behavior and their close association with human dwellings make them ideal vectors for spreading zoonotic pathogens. The populationing behavior of these species during roosting, nesting, and/or feeding can lead to an increased risk of disease transmission in areas where birds defecate. Populations of these bird species occur throughout the year, but primarily occur during migration periods and winter months when food sources are limited. Further problems arise as resident Canada geese and other waterfowl become accustomed to urban habitats. These resident geese populations are progressively becoming more prevalent around public parks, lakes, housing developments, hotels, and golf courses and contribute to attacks on humans.

The threat to human health from high fecal coliform (*e.g., Escherichia coli*) levels and other pathogens including *Cryptosporidium parvum*, *Giardia lambia*, and *Salmonella spp*. is also associated with large amounts of bird fecal droppings (Clark 2003). Over 200 serotypes of *Escherichia coli* have been isolated from the feces of warm-blooded animals (such as birds). Although the majority of these isolates are harmless to humans, *E. coli* O157:H7 is known to cause severe, acute hemorrhagic diarrhea, and abdominal cramps (Gallien and Hartung 1994, Dho-Moulin and Fairbrother 1999, Wasteson 2002, Russo and Johnson 2003, Manges 2016, Stromberg et al. 2017). Transmission of this bacteria and others, occurs via fecal-oral transmission. Presently, many communities monitor water quality levels for bacterial pathogens at swimming beaches, lakes, and ponds but lack financial resources to identify the source(s) of the contamination. Sources of fecal coliform bacteria may be humans, livestock, wildlife, and domestic animals. When fecal coliform counts at these locations exceed established thresholds, locations are temporarily closed to prevent disease transmission the source is identified and corrective actions are taken.

Internal parasites such as *Cryptosporidium* and *Giardia* infect a wide array of vertebrate hosts, including birds. Humans infected with these parasites, typically experience persistent diarrhea for 1 to 3 weeks. Hosts become infected through consuming feces-contaminated water. In the U.S., it is estimated that 80 to 96% of surface waters are contaminated with Cryptosporidium and Giardia (Hansen and Ongerth 1991, Moore et al. 1994). Kuhn et al. (2002) found that populations of wild duck sp. cryptosporidium and giardia were present in 49% and 29% respectively. Recent population explosions of waterfowl sp., and their increased presence in urban environments, highlights the risk of disease transmission to humans. Especially so, considering the cycts of these parasites can survive most water treatment treatments (Bown et al. 1999).

Cryptosporidiosis caused by the parasite, *Cryptocporidium parvum*, can cause gastrointestinal disorders and produce life-threatening infections. Animals has humans become infected through drinking contaminated water or direct contact with infected fecal material (CDC 1998). People and pets may also become infected by swimming in lakes, ponds, streams, and pool or from swallowing contaminated water while swimming (Colley 1995). Kassa et al. (2001) found that Cryptosporidium was present in 77.8% of water samples collected from parks and golf courses. Similarly, Giardiasis is caused by the parasite, *Giardia lambia,* is contracted by consuming contaminated water or by direct contact with objects that are contaminated with infective fecal material. Symptoms include: cramps, nausea, and diarrhea.

Bird fecal dropping accumulations at sites can facilitate the growth of disease pathogens through soil enrichment. Once such pathogen, *Histoplasma capsulatum*, an ascomycetous fungus, is strongly associated with populationing bird species such as starlings and blackbirds. Classic histoplasmosis outbreaks are associated with the disturbance of soil or bird fecal droppings under bird roosts where *H. capsulatum* organisms become airborne. Once airborne, microscopic fungal spores are inhaled and those with weakened immune systems may develop severe infections.

Salmonella (*Salmonella* spp.) bacteria live in the intestinal tracts of humans and other animals, including wild birds, poultry, amphibians and reptiles. Humans become infected by handling materials soiled with infective bird feces (Friend and Franson 1999). In 2010, Carlson et al. isolated Salmonella bacteria from starling gastrointestinal tracts at livestock facilities. Symptoms of acute gastroenteritis include sudden onset of diarrhea, abdominal cramps, fever, nausea, vomiting, and headache.

Chlamydosis (*Chalmydiosis psitticai*) is another common bacterial pathogen found in birds. Infected birds shed the bacteria through fecal and nasal secretions as well as, aerosolized particles (Wobeser and Brand 1982). Severe cases of chlamydiosis have been documented in people that commonly handle waterfowl, pigeons, and other bird species (Wobeser and Brand 1982). If not treated with antibiotics, such infections may prove fatal. In North America, herons, pigeons, and waterfowl are the most commonly infected species (Wobeser and Brand 1982).

Avian influenza (AI) is a disease caused by influenza viruses within the Orthomyxoviruses group. Virus strains are further divided into two categories: highly pathogenic and low pathogenic avian influenza based on their pathogenicity (ability to cause disease in domestic poultry). Avian influenza is commonly spread between infected and healthy birds through secretions from the nostrils, mouth, eyes, and fecal droppings. Highly pathogenic avian influenza is commonly spread to humans through direct contact with dead or dying infected birds and secreted fluids. Wild waterfowl and shorebirds species are natural reservoirs for avian influenza strains (Davidson and Nettles 1997, Alexander 2000, Stallknecht 2003, Pedersen et al. 2010). While many strains of AI do not cause severe illness in birds, viruses classified as H5 and H7 tend to be highly virulent and very contagious. Other virus strains, while not as virulent, have the potential to become virulent and transmissible to other species through mutation and reassortment (Clark and Hall 2006). In wild avian species low pathogenic avian influenza rarely causes disease and is not considered an important mortality factor (Davidson and Nettles 1997, Clark and Hall 2006). However, highly pathogenic avian influenza virus is highly contagious among birds and can be deadly, especially in domestic species.

This EA discusses the need to monitor, and possibly conduct BDM to reduce the risk of disease transmission to humans, livestock, and other wildlife. WS has increasingly received requests for assistance with disease surveillance in wild and feral birds. For example, in 2006 to 2017, WS participated along with several other agencies and organizations in surveillance for Highly

Pathogenic Avian Influenza (HPAI) virus serotypes in North American migratory birds. Waterfowl and shorebirds were primarily targeted due to their potential to co-mingle with birds from countries where the virus had been previously detected. Wild birds, waterfowl and shorebirds in particular, are considered natural reservoirs for avian influenza (AI) viruses (Clark and Hall 2006).

Table 1. 12. Bird species sampled for various diseases from FY2013-2017 by WS-Colorado.

FY	Species	Disease	Samples
FY13	Eurasian Collared Dove	Exotic Newcastle Disease	3
	Mourning Dove	Exotic Newcastle Disease	4
	American Kestrels Falcon	Exotic Newcastle Disease Toxoplasmosis	27
	Lark Bunting	Exotic Newcastle Disease	1
	Red-winged Blackbird	Exotic Newcastle Disease	1
	Merlin Falcon	Toxoplasmosis	1
	Peregrine Falcon	Toxoplasmosis	2
	Prairie Falcon	Toxoplasmosis	10
	House Finch	West Nile Virus	2
	Canada Geese	Exotic Newcastle Disease Toxoplasmosis	17
	Common Grackle	West Nile Virus	1
	Broad-winged Hawk	Toxoplasmosis	1
	Cooper's Hawk	Toxoplasmosis	24
	Ferruginous Hawk	Exotic Newcastle Disease Toxoplasmosis	7
	Northern Goshawk	Toxoplasmosis	2
	Northern Harrier	Toxoplasmosis	6
	Red-tailed Hawk	Exotic Newcastle Disease Toxoplasmosis West Nile Virus	117
	Rough-legged Hawk	Toxoplasmosis	14
	Sharp-shinned Hawk	Toxoplasmosis	2
	Swainson's Hawk	Toxoplasmosis West Nile Virus	17
	Western Kingbird	Exotic Newcastle Disease	2
	Mississippi Kite	Toxoplasmosis	1

	Western Meadowlark	Exotic Newcastle Disease	1
	Osprey	Toxoplasmosis	2
	Burrowing Owl	Toxoplasmosis	1
	Common Barn Owl	Exotic Newcastle Disease	5
		Toxoplasmosis	
	Eastern Screech Owl	Toxoplasmosis	1
	Great Horned Owl	Exotic Newcastle Disease	108
		Toxoplasmosis	
	Northern Saw-whet Owl	Toxoplasmosis	10
	Short-eared Owl	Toxoplasmosis	1
	Rock Pigeon	Exotic Newcastle Disease	1
	House Sparrow	West Nile Virus	20
	Turkey Vulture	Toxoplasmosis	5
FY14	Rough-legged Hawk	Exotic Newcastle Disease	3
	Great Horned Owl	Exotic Newcastle Disease	5
FY15	Gadwall	Avian Influenza	45
	Mallard	Avian Influenza	271
	Northern Pintail	Avian Influenza	2
	Northern Shoveler	Avian Influenza	8
	Blue-winged Teal	Avian Influenza	10
	Cinnamon Teal	Avian Influenza	50
	American Wigeon	Avian Influenza	15
	American Kestrels Falcon	Avian Influenza	1
	Prairie Falcon	Disease (other)	1
	Canada Geese	Avian Influenza	1
	Ferruginous Hawk	Avian Influenza	3
		Disease (other)	
		Disease (non-specific)	
	Red-tailed Hawk	Avian Influenza	8
		Disease (other)	
		Disease (non-specific)	
	Swainson's Hawk	Avian Influenza	2
	Common Barn Owl	Avian Influenza	1
	Great Horned Owl	Avian Influenza	6
		Disease (non-specific)	

FY16	Canvasback	Avian Influenza	9
	Gadwall	Avian Influenza	96
	Mallard	Avian Influenza	541
	Northern Pintail	Avian Influenza	17
	Redhead	Avian Influenza	4
	Northern Shoveler	Avian Influenza	62
	Blue-winged Teal	Avian Influenza	29
	Cinnamon Teal	Avian Influenza	106
	Green-winged Teal	Avian Influenza	79
	American Wigeon	Avian Influenza	35
	Prairie Falcon	Avian Influenza	1
	Great Horned Owl	Avian Influenza	4
FY17	Bufflehead	Avian Influenza	1
	Gadwall	Avian Influenza	146
	Common Goldeneye	Avian Influenza	1
	Mallard	Avian Influenza	439
	Northern Pintail	Avian Influenza	8
	Redhead Duck	Avian Influenza	12
	Ruddy Duck	Avian Influenza	4
	Northern Shoveler	Avian Influenza	32
	Blue-winged Teal	Avian Influenza	31
	Cinnamon Teal	Avian Influenza	40
	Green-winged Teal	Avian Influenza	46
	American Wigeon	Avian Influenza	24
	Wood Duck	Avian Influenza	1
Total FY2013-FY2017			**2,617**

1.9 How Does WS-Colorado Comply with NEPA?

WS-Colorado BDM activities are subject to the National Environmental Policy Act (NEPA) (Public Law 9-190, 42 USC 4321 et seq.). In addition, WS-Colorado follows the USDA (7 CFR 1b) and USDA –APHIS Implementing Guidelines (7CFR 372) as part of the decision-making process. Those laws, regulations, and guidelines generally outline five broad types of activities to be accomplished as part of any project: public involvement, analysis, documentation, implementation, and monitoring. The NEPA also sets forth the requirement that all major federal actions be evaluated in terms of their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts. Federal activities affecting the physical and biological environment are regulated in part by the Council on Environmental Quality (CEQ) through regulations in 40 CFR 1500-1508. In accordance with the CEQ and USDA-APHIS regulations, APHIS guidelines concerning the implementation of the NEPA, as published in the Federal Register (44 FR 50381-50384), provide guidance to WS-Colorado regarding the NEPA process. NEPA sets forth the requirement that all federal actions be evaluated in terms of:

- Their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts;
- Making informed decisions; and
- Including agencies and the public in their NEPA planning in support of informed decision-making.

Updates regarding WS-Colorado implementation of BDM in Colorado have prompted WS-Colorado to initiate this new analysis. The analyses contained in this (EA) are based on information and data derived from WS' Management Information System (MIS) database; published and, when available, peer-reviewed scientific documents; interagency consultations; public involvement; and other relevant sources.

1.9.1 What is the Geographic Scope of this EA and in What Areas Would WS-Colorado Actions Occur?

The determination of the relevant geographical region to be covered by an EA falls within the informed discretion and expertise of the agency responsible for conducting the proposed action (*Kleppe v. Sierra Club,* 427 U.S. 390, 414 (1976)). WS-Colorado has considered both the proposed action and the geographic area involved and has determined that the preparation of this EA to address WS-Colorado' BDM activities on a statewide basis for the state of Colorado is the appropriate approach to take. Wildlife populations, with the exception of T&E species, are monitored over large geographic areas (*e.g*., the West, the state of Colorado) and smaller geographic areas (*e.g.*, game management units, CPW "Data Analysis Units").

Most species of birds addressed herein, can be found throughout the year across Colorado where suitable habitat exists for foraging, loafing, roosting, and breeding. Many of these species utilize a variety of these habitats and requests for assistance to manage damage or threats could occur in multiple locations. The areas affected by bird damage management activities could include those in and around commercial, industrial, public, and private buildings, facilities, and properties where birds may be utilizing suitable habitat. Examples of areas where bird damage management may occur include: residential buildings, golf courses, athletic fields, recreational areas, swimming lakes, parks, corporate complexes, subdivisions, businesses, industrial parks, schools, agricultural areas, wetlands, restoration sites, cemeteries, public parks, bridges, industrial sites, urban/suburban woodlots, hydro-electric dam structures, reservoirs and reservoir shore lands, fossil power plant sites, substations, transmission line right-of-ways, landfills, military bases, or at any other sites where birds may roost, loaf, or nest. Damage management activities may also be conducted at dairies, ranches, livestock operations, agricultural fields, orchards, and grain handling areas (e.g. railroad yards) where birds destroy crops, feed on spilled grains, or contaminate food products for human or livestock consumption. Additionally, activities could be conducted at airports and surrounding properties where birds represent a threat to human health and aviation safety.

WS-Colorado does not anticipate having any adverse impacts on recreational activities in Colorado, involving: hunting, photography, wildlife viewing, and enjoyment of seclusion. At this time, WS-Colorado does not conduct any BDM activities nor does it anticipate conducting any of these activities, unless requested by USFWS, BLM, CPW, or any other federal agencies on Special Management Areas (SMAs), including Wilderness Areas (WAs) and Wilderness Study Areas (WSAs).

1.9.2 For What Period of Time is this EA Valid?

If WS-Colorado determines that the analyses in this EA indicate that an EIS is not warranted (impacts are not significant per 40 CFR §1508.27; Section 1.10), this EA remains valid until WS-Colorado determines 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.

WS-Colorado monitors BDM activities conducted by its personnel and ensures that those activities and their impacts remain consistent with the activities and impacts analyzed in the EA and selected as part of the decision. Monitoring includes review of adopted mitigation measures and target and non-target take reported and associated impacts analyzed in the EA. Monitoring ensures that wildlife damage management activity effects are within the limits of evaluated/anticipated take in the selected alternative. 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.

1.9.3 Why is WS-Colorado Preparing an EA Rather than an EIS?

The primary purpose of an EA is to determine if impacts of the proposed action or alternatives might be significant, to determine if an EIS is appropriate (40 CFR 1508.9(a)(3) and 40 CFR 1501.4). Lead agencies have the discretion to determine the geographic scope of their analyses under the NEPA (*Kleppe v Sierra Club*, 427 U.S. 390, 414 (1976), CEQ 1508.25). According to USDA-APHIS NEPA Implementing Procedures, WS' individual wildlife damage management actions could be categorically excluded (7 CFR 372.5(c)). The intent in developing this EA is to determine if the proposed action would potentially have significant individual and/or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS. This EA is prepared so that WS-Colorado can make an informed decision on whether or not an EIS is required for the WS-Colorado BDM activities included in this EA.

In terms of considering cumulative effects, one EA analyzing impacts for the entire state would provide a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. If a determination were made through this EA that the proposed action or the other alternatives might have a significant impact on the quality of the human environment, then an EIS would be prepared. Based on previous requests for assistance, WS-Colorado would continue to conduct bird damage management on a small percentage of the land area in the state where damage is occurring or likely to occur.

1.9.4 What is the Appropriateness of Preparing an EA (Instead of an EIS) for Such a Large Area?

Some individuals might question whether preparing an EA for an area as large as Colorado would meet the NEPA requirements for site specificity. WS' mission is to manage damage caused by wildlife, not overall wildlife populations. As an agency that exists to manage specific types of damage, WS-Colorado can predict the types of locations or situations where damage is likely to occur. However, due to any number of variable circumstances, WS-Colorado has no absolute control over when a request for BDM assistance will be received nor can WS-Colorado predict specific individual times and locations of most bird damage situations. Therefore, WS-Colorado must be ready and able to provide assistance on short notice about anywhere in Colorado to protect any resource. The missions of other federal and state wildlife management agencies generally concentrate on management for wildlife abundance and are not equipped or prepared to prevent bird damage problems without resorting to extreme and extensive population management strategies that, in most cases, would be neither prudent nor affordable. Given the numbers of birds, past experiences, and BDM activity monitoring, WS-Colorado believes this EA addresses most potential needs and issues associated with providing BDM at any given location in Colorado.

If a determination is made through this EA that the proposed action would have a significant environmental impact, then an EIS would be prepared. In terms of considering cumulative impacts, one EA analyzing impacts for the entire State may provide a better analysis than multiple EA's covering smaller zones, especially considering the mobility of birds and impacts on their populations.

1.9.5 How Does NEPA Apply to WS-Colorado's BDM Activities?

This EA describes the needs for resolving bird damage problems for which WS-Colorado is typically requested to assist. The EA identifies the potential issues associated with reasonable alternative ways and levels of providing that assistance. It then evaluates the environmental consequences of the alternatives for WS-Colorado involvement in BDM.

To assist with understanding applicable issues and reasonable alternatives to managing bird damage in Colorado and to ensure that the analysis is complete for informed decision-making, WS-Colorado has made this EA available to the public, agencies, tribes and other interested or affected entities for review and comment prior to making and publishing the decision (either preparation of a Finding of No Significant Impact (FONSI) or a Notice of Intent to prepare an Environmental Impact Statement (EIS)). Public outreach notification methods for an EA include postings on the national WS NEPA webpage and on www.regulations.gov, a direct mailing to known local stakeholders, electronic notification to registered stakeholders on www.GovDelivery.com, and notification in the legal section of the *Denver Post* newspaper. The public will be informed of the decision using the same venues, including direct mailed notices to all individuals who submit comments and provide physical addresses.

Wildlife damage management is a complex issue requiring coordination among state and federal agencies and the tribes. To facilitate planning, efficiently use agency expertise, and promote interagency coordination with meeting the needs for action, WS-Colorado is coordinating the preparation of this EA with cooperating and consulting partner agencies, including CPW, CDA, FS, BLM, and USFWS. WS-Colorado also recognizes the sovereign rights of Native American tribes to manage wildlife on tribal properties, and has invited all federally recognized tribes in Colorado to cooperate or participate in the development of this EA. WS-Colorado is committed to coordinating with all applicable land and resource management agencies including tribes when BDM activities are requested.

1.9.6 How Will this EA Be Used to Inform WS-Colorado's Decisions?

Although WS-Colorado only conducts bird damage management when requested by a governmental, commercial, or private entity, as a federal agency, it is required to comply with NEPA for its activities. WS-Colorado is the lead for BDM activities in Colorado. WS-Colorado has the technical expertise in managing damage associated with individual birds, species, and/or groups of birds and their accompanying behaviors. Cooperating agencies in the development of this EA include BLM, USFS, FAA, USFWS, DoD, CPW, CDA, CDOT, and CDPHE. Each of the cooperating agencies are asked to review the draft document and provide input and direction to WS-Colorado to ensure that actions are in compliance with applicable federal and state regulations and policies, federal land management plans and joint MOUs, and cooperative agreements.

WS-Colorado will use the analyses contained within this EA to help direct WS-Colorado decision-making process, including whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI); and whether or not to continue WS-Colorado BDM activities and, if so, to determine how and to what degree such activities would be implemented. WS-Colorado previously prepared EAs for its bird damage management activities in Colorado.

WS-Colorado has decided that one EA analyzing potential operational impacts for the entire State of Colorado 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.

Upon public notification of the signed decision for the appropriate NEPA document for WS-Colorado BDM activities, the following species-specific WS-Colorado EAs and FONSIs, as well as the previously listed regional BDM EAs and FONSIs, will be superseded and replaced.

1.9.7 How Does this EA Relate to Site-Specific Analyses and Decisions, Using the WS Decision Model?

BDM actions may be taken to reduce threats to human health and safety, reduce damage to agricultural resources, alleviate property damage, and protect native wildlife, including T&E species. Many of the bird species addressed here can be found statewide within suitable habitat, and damage or threats of damage can occur wherever those species occur and overlap with human presence, resources, or activities. Planning for the management of bird damage management must be viewed as being conceptually similar to the actions of other entities whose mission is to prevent adverse consequences from anticipated future events. Notably wildlife damage management events occur randomly throughout the state and the exact timing, location, and number of requests for assistance can be difficult to predict. Similar examples of emergency response agencies include: fire departments, police departments, emergency clean-up organizations, and insurance companies. The threshold triggering a request for bird damage management assistance from WS is often unique to the individual; and therefore this EA emphasizes major issues as those related to specific areas where possible. However, Colorado-WS would only conduct BDM activities including both nonlethal and/or lethal removal of bird species as requested by the appropriate resource owner or manager, with only those actions permitted by USFWS (when required), and only at the levels specified.

NEPA leaves substantial discretion to an agency to determine how to best gather and assess information about a project's environmental impacts. WS-Colorado is not required by NEPA to specify the precise locations or time these actions would occur within the state of Colorado where BDM assistance would occur. WS-Colorado conducts BDM based on the need for BDM assistance. WS-Colorado cannot anticipate where every BDM project will occur due to the unpredictable nature of the work. WS-Colorado's accounts for any uncertainty about site specific impacts in the EA by analyzing the maximum anticipated take for each species within the state of Colorado for the proposed action and by adhering to the conservations measures listed in Chapter 3 of the EA.

The main goals and objectives of WS are to provide services to reduce threats to human health and safety, reduce damage to resources, property, and protect wildlife when requested, within the constraints of available funding and workforce, it is conceivable that addition efforts may be needed on short notice. Thus, this EA analyzes the potential impacts of alternative approaches to managing damage associated with birds that could be conducted on private and public lands in Colorado where Colorado-WS and the appropriate entities have entered into an agreement through a cooperative service agreement, MOU, or other comparable document. This EA also address potential impacts of bird damage management actions in areas where cooperative service agreements, MOUs, or other documents may be signed in the future and it anticipates emergency response situations or where additional efforts are needed within a short time frame as part of the alternatives.

The standard WS Decision Model (Slate et al. 1992) is the site-specific procedure for individual actions conducted by Colorado-WS in the State. Decisions made using the model are in accordance with NEPA decisions, and include WS' directives, Protective measures (Protective Measures), relevant laws and regulations, interagency agreements and memoranda of understanding, and cooperative agency policy and procedures.

The analyses in this EA are intended to apply to any action that may occur in any locale and at any time within Colorado for which WS-Colorado may be requested for assistance. Using the Decision Model for field operations, this EA meets the intent of NEPA with regard to site-specific analysis, informed decision-making, and providing the necessary timely assistance to agencies and cooperators per WS-Colorado objectives.

1.9.8 How will WS-Colorado Evaluate Significant Impacts?

The process for determining if a project or activity may have significant impacts is based on the CEQ regulations at 40 CFR §1508.27. WS-Colorado 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, context may be considered when the resource is rare, vulnerable, not resilient, or readily changed long-term with even a short-term stressor.

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 impacted, not a determination of no adverse impact at all. Therefore, WS-Colorado evaluates the impacts to resources and documents the predicted effects in the EA. These effect analyses are used to determine if the levels of impact are indeed "significant" impacts for which a FONSI would not be appropriate. If WS-Colorado determines that the levels of impacts are not significant, then, per the CEQ regulations, the agency will document the rationale for not preparing an EIS in a publicly available FONSI.

The factors identified in 40 CFR §1508.27 are not checklists, nor do they identify thresholds of impacts; they are factors for consideration by the agency while making the decision regarding whether to prepare a FONSI based on the impact analyses in an EA or an EIS. The agency will determine how to consider those factors in its decision on whether to prepare a FONSI or an EIS. WS-Colorado will determine the *degree* to which a factor applies or does not apply to the impacts documented in the EA.

The following discussion outlines how WS-Colorado will use this EA and the criteria at 40 CFR §1508.27 to make the decision regarding whether an EA or an EIS is appropriate for the WS-Colorado BDM activities.

1.9.9 How Will WS' Address 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 WS informed decision-making.

1.9.10 What is the Potential for 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 or unique or unknown risks (40 CFR §1508.17(b)(5)), especially related to population numbers and trends and the extent and causes of mortality of target and non-target species.

Throughout the analyses in **Chapter 3** of this EA, WS-Colorado uses the best available data and information from wildlife and land management agencies having jurisdiction by law (CPW, CDA, BLM, USFS, and USFWS; 40 CFR §1508.15), as well as the scientific literature, especially peer-reviewed scientific literature, to inform its decision-making. Data provided by livestock producers, especially regarding the economic value of livestock lost to predation as reported for inclusion in the WS MIS database, is inherently subjective to some degree, and is therefore used only as an indicator for the costs associated with livestock depredation.

Population and mortality data for many native target species are typically non-existent from any credible source, in or outside of Colorado. WS-Colorado recognizes that estimating wildlife populations over large areas can be extremely difficult, labor intensive, and expensive. CPW, or, for that matter, any state wildlife management agency, has limited resources for estimating population levels and trends for bird damage species that are not managed as game. Therefore these state agencies do not directly set population management objectives for these species. States may choose to monitor population health using factors such as sex ratios, age distribution of the population, 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 CPW when available, and peer-reviewed literature to assess potential impacts to bird species and non-target wildlife species.

If population estimates are available, then the analyses in Chapter 3 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 CPW and the USFWS and providing the opportunity for agency review of and involvement in this EA ensure that analyses are as robust as is possible. The analyses in Chapter 3 provide information for WS-Colorado to determine if WS-Colorado contribution to cumulative mortality from all sources would adversely affect population levels for each bird species considered.

1.9.11 What are some of the Cumulatively Significant Impacts?

Another common comment involves the criterion for the analysis of "cumulatively significant impacts" (40 CFR §1508.27(b)(7)), which is considered in this EA in various ways. Many of the issues evaluated in detail are inherently cumulative impact analyses including, for example:

- Impacts to target species' populations, as each population has many sources of mortality, only one of which is take by WS-Colorado;
- Impacts to non-target species' populations, as each population has many sources of mortality, loss of habitat, climate change, and/or other stressors, and only one source of mortality is take by WS-Colorado;
- Impacts to populations of ESA-listed species, 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;
- Potential ecological impacts caused by removal of apex predators (Eagles, etc…), as many ecological factors contribute to any resulting impacts; and
- Potential for lead from ammunition to impact environmental and human factors, as there are many sources of lead in the environment, including lead from hunting activities and ingesting game meat shot with lead ammunition, and lead may chronically enter the environment and people over time.

1.9.12 How Does WS-Colorado monitor target bird populations and non-target take for the State?

A common issue when addressing bird damage management involves the impacts of those actions on the populations of target species. Methods available to alleviate damage or threats to human safety are categorized into nonlethal and lethal methods. Nonlethal methods include dispersal or habitat modification including altering an area to make it less attractive to the target species causing damage. Lethal methods would also be considered to remove individual bird(s) responsible for causing damage or posing threats to human health and safety. Therefore, if lethal methods were employed, the removal of a bird or birds would result in local population reductions in the area where bird damage management actions occurred. The number of individuals from a target species that could be removed from a population using lethal methods under the alternatives would be dependent on the number of requests for assistance received, the number of individual birds associated with the threat, and the efficacy of the methods employed to manage the issue.

The analysis to determine the magnitude of impacts on the population of those species addressed in this EA attributed to lethal methods would be based on a measure of the number of individuals lethally removed in relation to that species' abundance. Magnitude may be determined either quantitatively or qualitatively. Quantitative determinations would be based on population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations would be based on population trends and harvest trend data, when available. Take would be monitored by comparing the number of birds lethally removed with the overall populations or trends. Lethal methods would only be used by WS-Colorado at the request of a cooperator seeking assistance and only after the take of migratory bird species had been permitted by the USFWS pursuant to the MBTA.

1.9.13 What is the Environmental Status Quo?

NEPA regulations require federal agencies to analyze the potential impacts of their actions on the "human environment." During this process federal agencies review their actions, and review any foreseeable direct or indirect impacts of these actions on the human environment. They also identify and examine, the actions other agencies, individuals, or entities would take, if the federal agency conducting these actions, no longer provided these services. As defined by NEPA the "human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment" (50 CFR 1508.14).

Here, the "environmental status quo" is identified as the current BDM actions of WS-Colorado and how these actions relate to solving bird damage throughout the state. In preparing this environmental assessment we discuss the past and present impacts, over five fiscal years, of WS-Colorado BDM activities on an environment that is heavily influenced by human actions not only from WS-Colorado, but by other federal, state, and local agencies, and individuals.

In situations where a non-federal individual or entity (e.g. private companies, counties, agricultural producers) attempt to alleviate damage associated with a bird or bird species, they must first identify the species involved. Most native bird species are afforded protection under the Migratory Bird Treaty Act (50 CFR 10.13) or through local state regulations (e.g. game bird species). If a bird species is protected under the Migratory Bird Treaty Act, the individual or entity must obtain a Migratory Bird Depredation permit before addressing the damage. Once a Migratory Bird Depredation Permit has been issued by the US Fish and Wildlife Service, a limited number of birds, per species requested, will be allowed to be removed using restrictive methods (i.e. trapping, relocation, euthanasia, shooting); with an annual report of take being submitted each year by the permittee. Migratory Bird Depredation Permit is not required to address damage or threats of damage associated with invasive species such as European starlings, house sparrows, feral pigeons, Eurasian–collared doves, or feral domestic waterfowl.

Unless a federal permit, such as a Migratory Bird Depredation permit, is required bird, damage management activities conducted by non-federal entities or individuals are not regulated by NEPA due to a lack of federal involvement in the action. A federal agency is only responsible for NEPA compliance when that agency or individual is involved in the actions. When a federal agency is involved, such as in this case, the environmental status quo must be viewed as the environment that includes resources managed or impacted by the actions of both the federal agency and the actions of non-federal entities in the absence of the federal action being proposed.

In situations where WS-Colorado is not involved in the action, the environmental status quo would not be impacted since, another entity could take similar actions in the absence of WS-Colorado's involvement. Furthermore, most wildlife damage management techniques and methods are available to the public and other entities for use. Although, it should be noted that WS-Colorado's actions may have less of an impact on target and non-target species than a non-federal entity or individual due to professional expertise in managing wildlife damage. Notably, a lack of expertise and knowledge of methods could lead to the persistence of bird damage, attempts to resolve bird damage using inappropriate techniques or methods, or threaten human health and safety.

In Chapter 3, we discuss the current WS-Colorado BDM proposed action/no action alternative (Alternative 1) as the environmental status quo; using the best available information to determine the direct and indirect impacts of the proposed action and alternatives on the human environment.

1.10 How Can Impacts Can Be Both Beneficial and Adverse?

Some commenters may believe that, because the protection of human and pet health and safety, livestock and other property, and wildlife is extremely beneficial, an EIS must be prepared, based on 40 CFR §1508.27(b)(1). It is important that beneficial outcomes and effects be identified as well as adverse effects as contributions to informed decision-making. This EA describes the various needs to which WS-Colorado responds when requested, and evaluates the impacts associated with BDM actions in **Chapter 3**.

1.11 What Actions Are Outside of WS' Authority?

It is important to remember that WS does not have any authority to manage wildlife other than the authority provided by Congress for assisting with wildlife-caused damage. WS policy is to respond to requests for assistance with managing wildlife damage. Managing wildlife populations and even individual wild animals is under the legal jurisdiction of state wildlife agencies, the USFWS/NMFS for ESA-listed species, the USFWS for migratory birds and eagles, and tribal governments on tribal lands, and WS defers to the applicable laws.

WS has no authority to determine national policy regarding use and commitment of local, state, tribal or federal resources or lands for economic use by private entities, such as livestock grazing or timber growth and harvest, nor use of private land, such as for livestock feedlots, or government, commercial, or residential development.

WS does not make public land use management decisions. Policies that determine the multiple uses of public lands are based on Congressional acts through laws such as the Taylor Grazing Act of 1934 and the Federal Land Policy and Management Act (FLPMA) for the BLM, and the Forest Service Organic Act of 1897 and the Multiple Use-Sustained Yield Act of 1960 for the Forest Service. Congressional appropriations support the implementation of these authorities. In contrast, WS-Colorado only addresses damage management requests on federal public lands upon request (WS Directive 2.201).

WS-Colorado cannot use pesticides unless they are approved by the U.S. Environmental Protection Agency (EPA) per FIFRA and are registered for use in Colorado. WS-Colorado must ensure that all storage, use, and disposal by WS-Colorado personnel is consistent with FIFRA label requirements and WS Directive 2.401.

WS does not make wildlife management decisions. Each state has full authority and jurisdiction to manage the native wildlife within its boundaries, unless authority is granted to another governmental entity, such as the US Fish and Wildlife Service per the ESA, MBTA, or the Bald and Golden Eagle Protection Act (BGEPA).

In Colorado, most native wildlife species are managed by CPW per Senate Bill 42. A few wildlife species that harm livestock are managed by CDA in a limited capacity. The US Fish and Wildlife Service (USFWS, Department of Interior) and the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA NMFS, Department of Commerce) have authority regarding wildlife and plant species listed per the Endangered Species Act (Public Law 93-205, 15 USC 1531 as amended). The State of Colorado has its own Endangered Species Act, **Table 1.11** includes and identifies a list of bird and animal species.

Migratory birds are managed by the USFWS per the Migratory Bird Treaty Act (MBTA). The USFWS also manages waterfowl hunting and take of migratory birds, whether intentional or incidental to other activities pursuant with this law. A permit from the USFWS is required for all activities that would involve take of native migratory birds, which includes pursuing, hunting, taking, capturing, or killing migratory birds, or destroying any active nest or live egg. The USFWS is also the authority for managing intentional and non-purposeful take of bald and golden eagles through the issuance of permits under the Bald and Golden Eagle Protection Act (BGEPA 16 USC 668). Note that in Region 6, USFWS **requires** all persons hazing or harassing, removing nests, destroying eggs, or trapping and relocating bald or golden eagles to obtain an Eagle Depredation Permit prior to conducting these actions.

WS-Colorado has no authority for determining the appropriate management of wildlife populations that are under the jurisdiction of CPW and CDA per their statutes, regulations, and species management plans and strategies, or management of species regulated in accordance with the ESA, the MBTA, or the BGEPA. Rather, WS-Colorado responds to governmental and non-governmental requesters for assistance in managing wildlife damage and threats.

1.12 How is the Public Involved?

Issues related to bird damage management and the alternatives to these actions were initially developed by Colorado-WS in consultation with the USFWS, CPW, CDPHE, USFS, CDA, and BLM. These issues were defined and preliminary alternatives were identified through the scope process. As part of this process, as required by the CEQ and USDA's NEPA implementing regulations, this document will be made available to the public for review and comment. This EA will be made available to the public through legal notices published in local print media, and by uploading the document on www.regulations.gov.

Colorado-WS will make this EA available for a minimum of 30 days for the public and interested parties to provide new issues, concerns, and/or alternatives. Through the involvement of the public, WS will clearly communicate to the public and interested parties the analysis of potential environmental impacts on the quality of the human environment. New issues or alternatives identified after the publication of notices announcing the availability of the EA will be fully considered to determine whether the EA should be revisited and, if appropriate, revised prior to issuance of a Decision.

1.13 What Agencies were involved in the Interdisciplinary Development of the EA?

Comments were solicited from the BLM, USFS, CDA, CPW, CDPHE, CDOT, FAA, DoD, and USFWS to facilitate an interdisciplinary approach to analysis. Comments are maintained in an administrative file located at the WS-Colorado State Office, 12345 West Alameda Parkway, Suite 204, Lakewood, CO 80228.

1.13.1 Authority of Federal and State Agencies for BDM in Colorado.

1.13.2 WS Legislative Authority

USDA is authorized and directed by law to protect American agriculture and other resources from damage associated with wildlife. The primary statutory authority for USDA is the *Act of March 2, 1931* and the *Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988 (7 USC 426-426c; 46 Stat. 8353)*, as amended in the Fiscal Year 2001 Agriculture Appropriations Bill, which provides that:

“The Secretary of Agriculture may conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program. The Secretary shall administer the program in a manner consistent with all of the wildlife services authorities in effect on the day before the date of the enactment of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2001.”

Since 1931, with the changes in societal values, WS policies and activities place greater emphasis on the part of the Act discussing "bringing [damage] under management," rather than "eradication" and "suppression" of wildlife populations. In 1988, Congress strengthened the legislative authority of WS with the Rural Development, Agriculture, and Related Agencies Appropriations Act. This Act states, in part:

"That hereafter, the Secretary of Agriculture is authorized, except for urban rodent management, to conduct activities and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the management of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under any such agreement into the appropriation accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities."

WS-Colorado conducts WDM in cooperation with and under the authorities of CDA and CPW. WS-Colorado works cooperatively with local livestock associations and county governments to provide BDM assistance for its constituents. BDM assistance is provided statewide in areas where funding has been provided. BDM activities occur on both private and public lands, but the use of foothold traps, snares, and toxicants is very limited on public lands, due to the limited exceptions permitted under Amendment 14. WDM methods that can be used in different wildlife damage situations are discussed in detail in **Chapter 3**.

1.13.3 The United States Fish and Wildlife Service (USFWS)

The mission of the United States Fish and Wildlife Service is to work in collaboration with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The USFWS is a bureau within the Department of the Interior. The Services assists in the development an application of an environmental stewardship ethic for our society and is based on scientific knowledge, sound ecological principles, and an overriding sense of moral responsibility. The stewardship ethic serves as a guide in the conservation, development, and management of America’s fish and wildlife resources and administer a national program to provide the public with opportunities to understand, appreciate, and be better stewards of fish and wildlife resources. Responsibilities are shared with other Federal, State, Tribal, and local entities; however, the USFWS has specific responsibilities for the protection of threatened and endangered (T&E) species under the Endangered Species Act (ESA), migratory birds, inter-jurisdictional fish, as well as for lands and waters that the USFWS administers for the management and protection of these resources. Additionally, the USFWS also manages the lands under the National Wildlife Refuge System.

Bird species that are listed as migratory under the MBTA, those listed as T&E under the ESA are managed by the USFWS. The take of such bird species are also prohibited by the MBTA unless a depredation permit is issued based on criteria pursuant to the MBTA. Depredation permits are issued to remove migratory birds damaging or threatening to damage resources.

The USFWS authority for migratory bird management is based on the MBTA of 1918 (as amended), which implements treaties with the United States, Great Britain (for Canada), the United Mexican States, Japan, and the Soviet Union. Section 3 of this Act authorized the Secretary of Agriculture:

"From time to time, having due regard to the zones of temperature and distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, to determine when, to what extent, if at all, and by what means, it is 25 compatible with the terms of the convention to allow hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any such bird, or any part, nest, or egg thereof, and to adopt suitable regulations permitting and governing the same, in accordance with such determinations, which regulations shall become effective when approved by the President."

The authority of the Secretary of Agriculture, with respect to the MBTA, was transferred to the Secretary of the Interior in 1939 pursuant to Reorganization Plan No. II. Section 4(f), 4 FR 2731, 53 Stat. 1433.

1.13.4 The United States Environmental Protection Agency (EPA)

The EPA is responsible for implementing and enforcing the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) which regulates the registration and use of pesticides, including repellents for dispersing birds and avicides available for use to lethally take birds. United States Food and Drug Administration (FDA) The FDA is responsible for protecting the public health by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, our nation's food supply, cosmetics, and products that emit radiation. The FDA is also responsible for advancing the public health by helping to speed innovations that make medicines and foods more effective, safer, and more affordable; and helping the public get the accurate, science-based information they need to use medicines and foods to improve their health.

1.13.5 Federal Aviation Administration (FAA)

The Federal Aviation Administration is a governmental body within the United States of America that regulates all aspects of civil aviation. The FAA's roles include developing and carrying out programs to control aircraft noise and other environmental impacts, regulating civil aviation, developing air traffic control systems and navigational aids for civil and military aircraft, researching and developing U.S. commercial space transportation, regulating flight inspection standards, and issuing, suspending, or revoking pilot certificates.

1.13.6 Colorado Parks and Wildlife (CPW)

Colorado Parks and Wildlife currently has an MOU and Cooperative Service Agreement (CSA) with Colorado-WS which establishes a cooperative relationship between WS and CPW and outlines roles and responsibilities for resolving wildlife damage management situations in Colorado. The mission of CPW is to protect and manage the state's fish and wildlife to maximize their long-term biological, recreational, and economic values for all residents and visitors. The CSA between CPW and Colorado-WS includes a work and financial plan, combining state and federal expertise which handles wildlife damage management problems and activities involving resident game and furbearer species, as well as species of greatest conservation need such as Gunnison sage-grouse, Greater sage-grouse, Lesser prairie-chicken, Plains sharp-tailed grouse, Southern white-tailed ptarmigan, Western yellow-billed cuckoo, and Mountain Plover. CPW typically forwards citizens' request for migratory bird damage management to Colorado-WS. WS and CPW cooperatively assist CO airports with wildlife hazard management issues related to mammals, such as Mule deer, and Elk. The Colorado 2015 State Wildlife Action Plan is a "strategy for conserving wildlife in Colorado to secure wildlife populations so that they do not require protection via federal or state listing regulations. "CPW's Species Conservation Program works in conjunction with other stakeholders, using the best available science to conserve Colorado's at-risk species and habitats." (CPW 2015)

1.13.7 Colorado Department of Public Health and Environment (CDPHE)

The mission of the CDPHE is to join communities and families in providing opportunities for citizens to achieve health and independence. Of the CDPHE major responsibilities, the CDPHE recognizes its responsibility to improve access to health care, to ensure its quality and to control costs through improved purchasing, planning and organization of health care services. The Department will work to prevent disease and to protect and improve the health and safety of all citizens through regulatory and health promotion efforts.

1.13.8 Colorado Department of Agriculture (CDA)

The mission of the Department of Agriculture is to strengthen and advance Colorado agriculture; promote a safe and high-quality food supply; protect consumers' and foster responsible stewardship of the environment and natural resources. CDA strives to create a strong and vibrant agricultural community, become a world supplier of safe, abundant and high-quality food and agricultural products, and be a key driver of the state's economy. CDA has partnered with the WS-Colorado to provide wildlife damage management to assist in reducing predation in livestock in participating counties.

1.13.9 Colorado Department of Transportation (CDOT), Division of Aeronautics

The mission of the CDOT Division of Aeronautics is to support Colorado's multi-modal transportation system by advancing a safe, efficient, and effective statewide air and space system through collaboration, investment and advocacy. In partnership with WS-Colorado, a dedicated airport wildlife biologist provides on-call technical and operational assistance to 76 general aviation and part 139 airports throughout the state.

1.14 How Do Key Statutes and Executive Orders Apply to the WS-Colorado Activities and How does it relate to Other Environmental Documents?

Several federal laws authorize, regulate, or otherwise affect WS-Colorado BDM activities. WS-Colorado complies with these laws, and consults and cooperates with other agencies as appropriate.

1.14.1 National Environmental Policy Act.

Most Federal actions are subject to NEPA (Public Law 91-190, 42 U.S.C. 4321 et seq.) and its implementing regulations established by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508). In addition, WS-Colorado follows USDA (7 CFR 1b) and USDA (7 CFR 372) NEPA implementing regulations as a part of the decision-making process. When WS operational assistance is requested by another federal agency, NEPA compliance is the responsibility of the other agency.

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

The Migratory Bird Treaty Act provides the USFWS regulatory authority to protect native species of birds classified as "migratory" and are listed in 50 CFR 10.13 (most all bird species except gallinaceous (e.g. Wild Turkey, grouse) and introduced birds (e.g. feral pigeon, starling). The law prohibits any "take" of these species, eggs, and nests except as permitted by the USFWS. Therefore, the USFWS issues permits to private and public entities, including WS, for reducing bird damage. A draft Memorandum of Understanding (MOU) for the purpose of migratory bird conservation is being developed between WS and USFWS to comply with Executive Order 13186 of January 10, 2001, the Responsibilities of Federal Agencies to Protect Migratory Birds. Such take falls outside the scope of this EA, which is limited to management of damage associated with avian species within Colorado. Starlings, feral domestic pigeons, House Sparrows, domestic waterfowl, and other non-native birds as well as resident, non-migratory birds such as grouse are not classified as protected migratory birds and therefore, have no protection under this Act. USFWS depredation permits are not required to kill blackbirds (Rusty Blackbird not included), cowbirds, all grackles, crows, or magpies in Colorado found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. Based on evidence that migratory game birds have accumulated in such numbers to threaten or damage agriculture, horticulture or aquaculture, the Director of the USFWS is authorized to issue a depredation order to permit the killing of such birds (50 CFR 21.42-47).

1.14.3 Endangered Species Act

The ESA states that all federal agencies shall seek to conserve T&E species and shall utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). WS-Colorado conducts consultations with the USFWS, as required by Section 7 of the ESA, to use the expertise of the USFWS, 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 species or threatened species…*" (Sec.7(a)(2)). WS-Colorado has conducted a biological assessment of potential effects on T&E species listed or proposed for listing in the State and prescribing reasonable and prudent measures for avoiding jeopardy (WS 2011), and obtained a letter of concurrence from USFWS (USFWS 2011).

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

Executive Order 13186 of January 10, 2001 directs federal agencies taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement, within 2 years, an MOU with USFWS that shall promote the conservation of migratory birds. WS currently has been working with USFWS on the MOU to cover such activities.

1.14.5 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940 (16 USC, 668-668d), as amended, allows for the protection and preservation of Bald Eagles and Golden Eagles by prohibiting, except under certain specified conditions, the taking, possession, and commerce of these birds. The Secretary of the Interior can permit the taking, possession, and transportation of specimens for scientific or exhibition purposes or for the religious purposes of Native American Tribes if the action is determined to be compatible with the preservation of the Bald or Golden Eagle. USFWS has recently drafted an EA to amend the Act to allow the "incidental take" of both Bald and Golden Eagles. Incidental take was formerly allowed only for the endangered Bald Eagle (USFWS 2016). Note Regions 6, of the USFWS requires all persons hazing or harassing bald or golden eagles to obtain a Bald and Golden Eagle Depredation Permit prior to conducting these actions (50CFR22).

BDM (Bird Damage Management) could benefit eagles by providing protection from a direct wildlife threat to birds, nests or eggs by predation or disease, protection to individuals from being killed by aircraft strikes, or prevent eagles from being killed illegally by frustrated or careless individuals experiencing eagle damage or damage threats to resources. Although limited in Colorado, depredation of livestock and wildlife has been documented for both Bald Eagles and Golden Eagles. Generally, though, most predation of livestock is associated with Golden Eagles. Any interaction with eagles by WS is further tempered by WS Policy (WS Directive 2.315).

1.14.6 Executive Order 13112 - Invasive Species

Nonnative plants and animals that inadvertently find their way to the United States are of increasing concern as they threaten our natural resources. One study estimated that the total cost of invasive species in the United States amounted to more than $100 billion each year (Pimentel et. al. 1999; 2005). Invasive species impact nearly half of the species currently listed as T&E under ESA. On February 3, 1999, Executive Order 13112 was signed establishing the National Invasive Species Council. The Council is an inter-Departmental body that helps coordinate cost-effective federal activities regarding invasive species and ensure that activities are complementary. Council members include the Departments of the Interior, Agriculture, Commerce, State, Treasury, Transportation, Defense, and Health and Human Services, EPA, and the U.S. Agency for International Development. Together with the Invasive Species Advisory Committee, stakeholders, concerned members of the public, and member departments, the National Invasive Species Council (2001) formulated an action plan for the nation. The Council issued the National Invasive Species Management Plan early in 2001 to provide an overall blueprint for federal action. The Plan recommends specific action items to improve coordination, prevention, control and management of invasive species by the federal agency members of the National Invasive Species Council.

1.14.7 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA requires the registration, classification, and regulation of pesticides used in the United States. All pesticides used or recommended by WS-Colorado are registered with and regulated by the Environmental Protection Agency (EPA) and CDA. WS-Colorado uses the chemicals according to labeling procedures and requirements as regulated by EPA and CDA.

1.14.8 Food, Drug, and Cosmetic Act

This Act, as amended, gives the FDA the authorization to regulate the study and use of animal drugs. FDA regulates A-C and other immobilization drugs used by WS under this Act.

1.14.9 National Historical Preservation Act of 1966, as amended (NHPA)

The NHPA and its implementing regulations (CFR 36, 800) require federal agencies to initiate the section 106 process if an agency determines that the agency's actions are undertakings as defined in Sec. 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. None of the WDM methods described in **Chapter 3** that might be used operationally by WS-Colorado cause major ground disturbance; any physical destruction or damage to property; any alterations of property, wildlife habitat, or landscapes; or involve the sale, lease, or transfer of ownership of any property. In general, such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas in which they are used that could result in effects on the character or use of historic properties. Therefore, the methods that would be used by WS-Colorado under the proposed action do not have the potential to affect historic properties. If an individual activity with the potential to affect historic resources is planned under an alternative selected as a result of a decision on this EA, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

Noise-generating methods such as propane exploders, pyrotechnics, or firearms that are used at or in close proximity to historic or cultural sites for the purposes of hazing or removing nuisance birds, groups of birds, and/or species have the potential for audible effects on the use and enjoyment of a historic property. However, such methods would only be used at a historic site at the request of the owner or manager of the site to resolve a damage or nuisance problem, which means such use would be to benefit the historic property. Another mitigating factor for the noise issue is that virtually all of the methods involved would only have only temporary effects on the audible nature of a site and can be ended at any time to restore the audible qualities of such sites to their original condition with no further adverse effects. Site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary in those types of situations.

1.14.10 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act requires Federal agencies to notify the Secretary of the Department that manages the Federal lands upon the discovery of Native American cultural items on Federal or Tribal lands. Federal projects would discontinue to work until a reasonable effort has been made to protect the items and the proper authority has been notified. All WS-Colorado employees will continue to abide by this Act.

1.14.11 Environmental Justice and Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Environmental Justice has been defined as the pursuit of equal justice and equal 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. A critical goal of Executive Order 12898 is to improve the scientific basis for decision-making by conducting assessments that identify and prioritize environmental health risks and procedures for risk reduction. Environmental Justice is a priority within USDA and WS. USDA plans to implement Executive Order 12898 principally through its compliance with the provisions of NEPA.

WS activities are evaluated for their impact on the human environment and compliance with Executive Order 12898 to ensure Environmental Justice. WS personnel use WDM methods as selectively and environmentally conscientiously as possible. The use of chemicals by WS is regulated by the EPA, CDA, by MOUs with Federal land managing agencies, and by WS Directives. The WS operational activities properly disposes of any excess solid or hazardous waste. WS assistance is provided on a request basis in cooperation with State and local governments and without discrimination based on race, ethnicity, or socioeconomic status. The nature of WS's BDM activities is such that they do not have much, if any, potential to result in disproportionate environmental effects on minority or low-income populations. Therefore, no such adverse or disproportionate environmental impacts to such persons or populations are expected.

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

Children may suffer disproportionately from environmental health and safety risks, including their developmental physical and mental status, for many reasons. Because WS makes it a high priority to identify and assess environmental health and safety risks, WS has considered the impacts that alternatives analyzed in this EA might have on children. All WS bird damage management is conducted using only legally available and approved damage management methods where it is highly unlikely that children would be adversely affected at all, much less in any disproportionate way.

1.14.13 Control Order for Resident Canada Geese at Airports and Military Airfields (50 CFR 21.49)

Pursuant to the MBTA under 50 CFR 21.49, the airport control order authorizes managers at commercial, public, and private airports (and their employees or their agents) to establish and implement management activities when necessary to resolve or prevent threats to public safety from resident Canada geese. Such activities include: indirect and/or operational control strategies such as trapping and relocating, nest and egg destruction, gosling and adult trapping and culling activities, or other legal and nonlethal control strategies. All techniques must be used in accordance with other Federal, State, and local laws, and their use must comply with any labeling restrictions. Management activities involving the take of resident geese may be conducted between April 1 and September 15 and the destruction of nests and eggs may take place between March 1 and June 30.

1.14.14 US Fish and Wildlife Service Resident Canada Goose Mangement FEIS

The USFWS has issued a Final Environmental Impact Statement (FEIS) addressing the need for and potential environmental impacts associated with goose damage management activities titled *Resident Canada Goose Mangement* (USFWS 2005). The FEIS also contains detailed analyses of issues and methods used to manage Canada goose damage. A Record of Decision (ROD) and Final Rule were published by the USFWS on August 10,2006 (Federal Register Vol. 71, Bo. 154: 45964-45993). On June 27, 2007, WS issued a ROD and adopted the USFWS FEIS (Federal Register Vol. 72, No. 123: 35217).

1.14.15 Depredation Order for Resident Canada Geese Nests and Eggs (50 CFR 21.50)

Under 50 CFR 21.50, is regulation addresses the control and management of resident Canada geese. The nest and egg depredation order for resident Canada geese authorizes registered private landowners and managers of public lands (landowners) (and their registered employees or their agents) to destroy resident Canada goose nests and eggs on property under their jurisdiction when necessary to resolve or prevent injury to people, property, agricultural crops, and other interests. Landowners authorized to operate under the depredation order may conduct resident Canada goose nest and egg destruction activities. All persons wishing to operate under the authority of this Depredation Order must register with the USFWS at https://epermits.fws.gov/eRCGR before any nests or eggs are taken. All persons acting under authority of this order should review all the requirements as they appear in federal regulations to ensure compliance.

1.14.16 Depredation Order for Resident Canada Geese at Agricultural Facilities (50 CFR 21.51)

Under 50 CFR 21.51, the USFWS may authorize agricultural producers that are actively engaged in commercial agricultural production to conduct and implement operational damage management activities including lethal and nonlethal strategies on resident Canada geese when the geese are committing depredation to agricultural crops and when necessary to resolve or prevent injury to agricultural crops or other agricultural interests from resident Canada geese. Management activities involving the take of resident geese may be conducted between May 1 and August 31 and the destruction of resident Canada geese nests and eggs may take place between March 1 and June 30.

1.14.17 Public Health Control Order for Resident Canada Geese (50 CFR 21.52)

Under 50 CFR 21.52, authorizes States, Tribes, and the District of Columbia, via the State or Tribe wildlife agency, to conduct resident Canada goose management activities including strategies such as trapping and relocation, nest and egg destruction, gosling and adult trapping and culling activities, or other lethal and nonlethal methods when resident Canada geese are posing a direct threat to human health. A direct threat to human health is one where a Federal, State, Tribal, or local public health agency has determined that resident Canada geese pose a specific, immediate human health threat by creating conditions conducive to the transmission of human and zoonotic pathogens. The State or Tribe may not use this control order for situations in which Canada geese are merely causing a nuisance. Under this section resident Canada geese may be removed from April 1 to August 31.

1.14.18 Depredation Order for Blackbirds, Cowbirds, Grackles, Crows, and Magpies (50 CFR 21.43)

Pursuant to the MBTA under 50 CFR 21.43, a depredation permit is not required to lethally take blackbirds when those species are found committing or about to commit depredations upon agriculture or ornamental crops, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance (Sobeck 2010). Those bird species that can be lethally removed under the black bird depredation order that are addressed in the assessment include American crows, red-winged blackbirds, yellow-headed blackbirds, Brewer's blackbirds, common grackles, and brown-headed cowbirds.

1.14.19 Depredation Order for Muscovy Ducks (50 CFR 21.54)

Muscovy ducks have been released or have escaped from captivity and have formed feral non-migratory populations within the U.S., especially in urban areas. Native to South America, Central America, and Mexico with isolated populations occurring in southern Texas, Muscovy ducks have also been domesticated and are kept for food or pets. The USFWS has issued a Final Rule on the status of Muscovy ducks within the U.S. (75 FR 9316-9322). While Muscovy ducks are afforded protection according to the MBTA at CFR 10.13 (since naturally occurring populations are known to inhabit parts of south Texas), damage and threats of damage associated with this species may be controlled under 50 CFR 21.54. Under this order, Muscovy ducks, nests, and eggs, may be removed or destroyed without a depredation permit from the USFWS at any time in the U.S. except in Hidalgo, Starr, and Zapata counties in Texas (50 FR 9316-9322).

1.14.20 Occupational Safety and Health Act of 1970

The Occupational Safety and Health Act of 1970 and its implementing regulations (29 CFR 1910) on sanitation standards states that, "*Every enclosed workplace shall be so constructed, equipped, and maintained, so far as reasonably practical, as to prevent the entrance or harborage of rodents, insects, and other vermin. A continuing and effective extermination program shall be instituted where their presence is detected*." This standard includes birds that may cause safety and health concerns at workplaces.

1.14.21 Investigational New Animal Drug (INAD)

The Federal Drug Administration can grant permission to use investigational new animal drugs commonly known as INAD (see 21 CFR 511). The sedative drug alpha chloralose was registered with the FDA to capture waterfowl, coots, and pigeons. The use of alpha chloralose by WS was withdrawn in 2018 and is no longer authorized by the FDA to sedate as a nonlethal form of capture.

1.14.22 (6 CCR 1010-2) Colorado Retail Food Establishment Rules and Regulations

3-201.17 (A)(3) states:
(A) If GAME ANIMALS are received for sale or service they shall be:
(3) As allowed by LAW, for wild GAME ANIMALS that are live-caught:

- (a) Under a routine inspection program conducted by a regulatory agency such as the agency that has animal health jurisdiction, and
- (b) Slaughtered and processed according to:
  - (i) LAWS governing MEAT and POULTRY as determined by the agency that has animal health jurisdiction and the agency that conducts the inspection program, and
  - (ii) Requirements which are developed by the agency that has animal health jurisdiction and the agency that conducts the inspection program with consideration of factors such as the need for antemortem and postmortem examinations by an APPROVED veterinarian or veterinarian's designee.

25-4-1601 C.R.S. provides the Colorado Department of Public Health and Environment's authority for the uniform statewide administration, implementation, interpretation, and enforcement of *The Colorado Retail Food Establishment Rules and Regulations.*

1.14.23 Compliance with State Laws

Several Colorado laws regulate WS and BDM. WS complies with these laws as applicable, and consults and cooperates with State agencies as appropriate. These laws are in the CRS.

CRS 25-12-103. Maximum permissible noise levels. Governs noise activities and requires that noise produced is not objectionable due to intermittence, beat frequency, or shrillness. Sound levels of noise radiating from a property line at a distance of twenty-five feet or more in excess of the decibel levels established (A) for the specified time period and zones shall constitute that noise is a public nuisance. It is not applicable to the operation of aircraft or to other activities which are subject to federal law with respect to noise control.

CRS 33-1-102. Defines protected small game birds (all birds hunted in Colorado) and nongame wildlife.

CRS 33-2-105. Endangered species. This provides special protection to State designated T&E species.

CRS 33-3-106. Permit to capture or destroy protected game damaging crops or property; . . . CPW can issue permits to take game and protected birds under this Statute.

CRS 33-6-107{9}. Take of black-billed magpies, common crows, starlings, English or house sparrows, common pigeons... These statutes allow citizens of the state of Colorado to cooperate with and fund WS BDM.

CRS 33-3-106. Procedures for CPW to handle depredations caused by wildlife. These sections of provide information for CPW and private landowners on how to handle wildlife damage on private and leased lands. In essence, these set the time frames for handling wildlife complaints for CPW. CPW will provide landowners with short- and long-term solutions for depredation problems.

1.14.24 WS' Environmental Assessments

Colorado-WS has previously developed an EA that analyzed the need for action to manage damage associated with several bird species (USDA 2013). The EA identified the issues associated with birds and analyzed alternative approaches to meet the specific need identified in those EAs while addressing the identified issues.

Since activities conducted under the previous EAs will be re-evaluated under this EA to address the new need for action and the associated affected environment, the previous EAs that addressed birds will be superseded by this analysis and the outcome of the Decision issued.

1.14.25 Part 139 Airport Certification

The FAA issued the Federal airport certification regulation Title 14, CFR Part 139 in 2004, to establish certification requirements for airports that provide scheduled air carrier operations in aircraft carrying more than 9 passenger seats but less than 31 passenger seats. This regulation provided guidance to airports holding a part 139 airport certification certificate from the FAA and outlines requirements, regulations, and procedures that must be followed to keep this certification.

1.15 What Are the State of Colorado's Authorities and Objectives for Managing Bird Damage?

It is WS's policy to comply with applicable state laws (WS Directive 2.210) and WS' practice to cooperate with states in managing wildlife damage. CPW manages wildlife under its jurisdiction.

1.16 How Does WS-Colorado Work with State, County, and local Governments?

CPW manages wildlife, CDA manages damage to agricultural and rangeland resources from predators, counties and local agencies manage feral domestic animals, and CDPHE manages some threats to human health and safety. These agencies are bound by several State laws that regulate BDM. WS-Colorado complies with these State laws as appropriate, and consults and cooperates with State and local agencies. These laws are in the CRS or Administrative Codes.

WS-Colorado has a Cooperative Service Agreement with CDA and Intergovernmental Agreements with CPW. These documents establish a cooperative relationship between WS-Colorado and CPW and CDA, outline responsibilities and agreements for funding, and set forth objectives and goals for resolving wildlife damage conflicts in Colorado. Recognizing that the wording of these Intergovernmental and Cooperative Services Agreements may change upon renewal, it is not expected that future conditions included in the agreements would have environmental relevance not already evaluated in this EA.

Under the Intergovernmental Agreements with CPW, WS-Colorado provides professional assistance upon request to resolve wildlife and human conflicts related to certain wildlife damage to agriculture, horticulture, animal husbandry, forest and range resources, natural resources, threatened and endangered species, and public health and safety caused by resident and migratory bird species. CPW, as the lead agency, may request assistance from WS-Colorado for any species under their primary responsibility, with WS-Colorado acting as their agent for BDM work. While WS-Colorado is acting as an agent for CPW for WDM work under state agency jurisdiction, CPW is the lead agency at all times. CPW is responsible for issuing any required permits for management actions and can specify the methods to be used.

At other times, when not working as an agent for CPW, WS-Colorado has authority under the Act of 1931 and subsequent amendments allowing for WS-Colorado to enter into agreements with public and private entities. Additionally, CRS 33-3-106 allows property owners or their agents to address bird damage and/or damage caused by wildlife on their property. WS-Colorado therefore may either act as an agent for CPW or may directly act for requesting land/resource owners to address wildlife damage conflicts under legislative authority and state law. The Cooperative Service Agreement with CDA does not specify that WS-Colorado may operate as their agent when requested. However, state law provides for cooperation between CDA and WS-Colorado, and CDA provides funds to WS-Colorado for the management of birds associated with damage. Therefore, WS-Colorado can operate under federal authority as well as the authority of state law to work directly for cooperators.

1.16.1 What MOUs Does WS-Colorado Have with CDA?

Colorado Revised Statutes (CRS) Title 35, Article 40 discusses CDA's responsibilities regarding depredating animal management. It also allows CDA to enter into agreements with other entities to conduct depredating animal management. CDA currently has an MOU with WS-Colorado. This document establishes a cooperative relationship between WS-Colorado and CDA, outlines responsibilities, and sets forth objectives and goals of each agency for resolving wildlife damage in Colorado. CDA also Colorado-WS to operate under commercial pesticide applicators license to properly handle and apply restricted used pesticides in Colorado while concurrently operating under a valid categorical exclusion. Additionally, label instructions, and all other pesticide and wildlife laws and regulations must be adhered to (e.g. possession of a depredation permit from the USFWS and/or CPW to take the protected bird species). Pesticide products are registered annually, and applicator licenses are earned following testing and maintained through completion of continuing education courses and examinations conducted through CDA.

1.16.2 How Does WS-Colorado Work with the Colorado Department of Public Health and Environment (CDPHE)?

Under Amendment 14, the Colorado Department of Public Health and Environment can issue a permit to use prohibited methods for the protection of human health and safety, including issues involving the outbreak of a disease. Individuals or entities interested in applying for this permit, document the type of damage occur, the species involved, and their numbers and submit an application to the state veterinary at the Colorado Department of Public Health and Environment. After a permit has been issued, a detailed trapping plan must be submitted to area and district manager with Colorado Parks and Wildlife officials. Annually following the expiration of the issued permit, permittees must submit a summary report documenting the dates, number of animals per species, and device used to the issuing agent and agency (CDPHE).

1.16.3 How Does WS-Colorado Work with CDOT, Division of Aeronautics?

Under the cooperative service agreement between the Colorado Department of Transportation, Division of Aeronautics and USDA Wildlife Services Colorado (Agreement No. 17-HAC-ZH-00006) wildlife hazard management and immediate assistance in assessing and mitigating potential or realized wildlife hazards to aviation at eligible public-use airports in Colorado will be provided for five years by a USDA biologist. These services include providing technical assistance, conducting site visits, and conducting wildlife damage control activities and wildlife hazard management training to protect human health and safety, as defined within the agreement.

1.17 How Does WS-Colorado Work with Federal Agencies?

1.17.1 How Does WS-Colorado Work with the US Forest Service and the BLM?

USFS and BLM have the responsibility to manage the resources on federal lands for multiple uses including livestock grazing, recreation, and conservation of T & E or species of concern, while recognizing the State's authority to manage wildlife populations. These uses are outlined in LRMPs and RMPs. WS-Colorado conducts BDM activities on USFS and BLM lands in accordance with all applicable laws and regulations. These agencies recognize WS-Colorado's expertise in BDM and relies on WS-Colorado's professional expertise in devising appropriate methodologies for conducting BDM to reduce agricultural losses, prevent damage to other resources, and to protect human health and safety. While the USFWS and BLM can conduct BDM activities to protect resources on public lands, each entity would be responsible for the NEPA associated with such activities.

WS-Colorado coordinates with these land management agencies before performing BDM activities on lands under their jurisdiction. The federal land management agencies USFS and BLM prepare land management plans per the National Forest Management Act (USFS) and FLPMA (BLM) that guide long-range management direction and include action constraints for protecting sensitive resources. At some time either during or prior to the last five years, WS-Colorado been requested to operate on most National Forests and BLM Districts within Colorado. All national forests and BLM Districts may request WS-Colorado assistance with emergency work at any time. For this EA, the USFS and BLM are cooperating agencies and have been involved with this EA to ensure consistency with their land management plans.

1.17.2 What MOUs Does USDA - WS Have with the US Forest Service and BLM?

Memorandum of Understanding between the USDA Wildlife Services And The USDA Forest Service FS Agreement No. 17-SU-11132422-231.

- Documents the cooperation between the USFS and WS for managing indigenous and feral vertebrates causing resource damage on NFS lands, minimizing livestock losses due to predation by avian predators, managing wildlife diseases, managing invasive species, and protecting other wildlife, plants, and habitat from damage as requested by the Forest Service and/or state or Federal wildlife management agencies.

- WS evaluates needs for WDM in cooperation with the USFS, develops and annually updates Annual Animal Damage Management Work Plans (ADM) in cooperation with the USFS and appropriate state and federal agencies, tribes, and others. USFS cooperates with WS to ensure that planned WDM activities do not conflict with other land uses, including human safety zones, and to ensure that work plans are consistent with forest plans. WS notifies the USFS before conducting activities on NFS lands and provides reporting on WDM results.

- WS is responsible for NEPA compliance for wildlife damage invasive species management, and disease management activities when requested by entities other than the USFS, and coordinates with the USFS, relevant state and federal agencies and tribes in completing NEPA compliance; the USFS complies with NEPA for all actions initiated by the USFS.

- WS provides technical assistance and training to the USFS on WDM methodologies when requested.

1.17.3 How Does WS-Colorado Work with the US Fish and Wildlife Service?

When WDM activities may affect federally listed threatened or endangered species, WS-Colorado consults with the US Fish and Wildlife Service (USFWS) to ensure its activities will not jeopardize the continued existence of the listed species. Under Section 7 of the ESA, Federal agencies must consult with the USFWS when any action the agency carries out, funds, or authorizes may affect a listed endangered or threatened species. Effects of WS-Colorado BDM activities on federally listed species in Colorado were evaluated by the USFWS in a Biological Opinion consultation on December 14, 2018. WS-Colorado closely follows operational measures outlined in its ESA consultation documents to minimize the risk of take of listed species. WS-Colorado may also assist the USFWS in protecting ESA-listed species, when requested.

Minimization measures, reasonable and prudent measures, and terms and conditions included in the consultation documents are identified in Appendix A and analyses of the potential impacts of the WS-Colorado activities on threatened and endangered species.

WS has a national Memorandum of Understanding with the US Fish and Wildlife Service, including the following pertinent sections:

- WS and the USFWS recognize that non-target migratory birds might incidentally be killed despite the implementation of all reasonable and practical measures to minimize the likelihood of take during actions covered under depredation permits and depredation orders (WS Directive 2.105).
- During NEPA compliance, WS will evaluate the reasonable range of alternatives, assess and estimate impacts on migratory bird populations, monitor impacts on migratory bird populations, and consider ways to minimize impacts.
- USFWS will provide WS available migratory bird population data, reported take by non-WS entities, and biological information as requested within a reasonable time frame.
- WS provides recommendations to the USFWS on WS Form 37 about the take of migratory birds to alleviate damage for applicants.

1.17.4 How Does WS-Colorado Work with the Federal Aviation Administration?

WS-Colorado works with the Federal Aviation Administration (FAA), when requested, for necessary resolution of wildlife damage manage at airports to support aviation safety.

Memorandum of Understanding between the US Department of Transportation Federal Aviation Administration and the USDA Wildlife Services No. 12-34-71-003-MOU

- This partnership supports the organizations' common mission to collaboratively advance and encourage aviation safety within their respective areas of responsibility and to reduce wildlife hazard risks through education, research, and outreach, including promoting effective communication for ensuring critical safety, security, efficiency and natural resources/environmental compatibility.

- The end goal is to increase wildlife strike reporting and technical and operational assistance and necessary training to the aviation community to ultimately reduce the risk of wildlife hazards and ensure safer operations at airports.

1.18 How Does WS-Colorado Manage Bird Damage at Airports and DoD Facilities?

BDM at airports consists of a combination of methods including habitat management, exclusion, harassment, and lethal management. In Colorado, some of the most commonly struck bird species are horned larks, mourning doves, cliff swallows, and rock pigeons. On average 19% of the reported strikes in Colorado are listed as unknown. For the most part, airport personnel hazed birds from the air operating area, however in some instances individuals or species require lethal removal to protect human health and safety.

Generally bird-aircraft collisions occur during takeoff and landing. These strikes are not only a common occurrence but are also costly in terms of the potential loss of human life and economically. Estimates suggest that wildlife strikes (bird and other wildlife) cost the U.S. civil aviation industry up to $625 million annually (Devault et al. 2018). Seventy-two percent of these strikes occur below 500 ft above ground level, making wildlife hazard mitigation on airport property a high management priority.

When ingested into engines, bird species can cause significant structural damage and lead to catastrophic engine failure. The civil and military aviation communities have acknowledged that the threat to human health and safety from aircraft collisions with wildlife is continuing to increase (Dolbeer 2000, MacKinnon et al. 2001). Collisions between aircraft and wildlife are a concern throughout the world because wildlife strikes threaten passenger safety (Thorpe 1996), result in lost revenue, and repairs to aircraft can be costly (Linnell et al. 1996, Robinson 1996). Aircraft collisions with wildlife can also erode public confidence in the air transportation industry as a whole (Conover et al. 1995).

There are four main strategies to reduce wildlife hazards in airport environments. These include: 1. modifying flight schedules (e.g., military installations), 2. habitat modification and eliminating wildlife attractants (e.g., food, water, and shelter), 3. harassment techniques involving repellents to disperse wildlife, and 4. wildlife population management (DeVault et al. 2018). Successful wildlife damage management activities in these environments necessitates the use of a variety of management actions. At times, hazardous wildlife situations require the removal of individual animals or the reduction of animal populations to protect human health and safety.

Legal Considerations

At an international level, the International Civil Aviation Organization (ICAO) provides guidance and standards for participating nations and 1.) assesses hazards posed by wildlife in the vicinity of airports certified for passenger traffic, 2.) takes all necessary precautions and cations to decrease the number of hazardous bird and mammal populations, and 3.) eliminates or prevents the establishment of wildlife attractants (food, water, shelter) on or near airports. Nations participating in the ICAO, create committees to assess and respond to wildlife hazard activities at their airports.

In accordance with these standards, the FAA mandates that airports in the U.S. initiate formal assessments of wildlife hazards, referred to Wildlife Hazard Assessments (WHAs), when certain triggering events (i.e., damaging wildlife strikes) occur. WHA use a combination of qualitative and quantitative techniques associated with wildlife management to collect data and assess the impact wildlife and wildlife attractants have on human health and safety at airports. From this data, wildlife biologists generate written summaries that guide future management decisions and recommendations. These recommendations are integrated by the airport into a Wildlife Hazard Management Plan (WHMP) that serves as a template for how the airport will approach and implement these recommendations over time. The FAA provides guidance on how to conduct, complete, and write both the WHA and WHMP in the Federal Code of Regulations (Title 14 CFR Part 139.337), Advisory Circulars (ACs), and Certification Alerts (CertAlerts).

To reduce the chances of a catastrophic wildlife-aircraft collision, Wildlife Services has developed an exclusive branch the Airport Wildlife Hazards Program to assist USDA wildlife biologists and specialists working on airports and military installations globally. Regardless of the species being managed, it is imperative that no single method or technique is exclusively relied on. By integrating a variety of methods either sequentially or concurrently WS personnel mitigates wildlife hazards in these environments. In collaboration with scientists and support staff at the National Wildlife Research Center, this program provides valuable guidance and expertise on techniques used to reduce wildlife hazards at airports. Here we will discuss some commonly used tools and techniques used by WS for reducing wildlife hazards at airports.

Federal Aviation Administration Recommendations

The Federal Aviation Administration of the U.S. regulates all aspects of civil aviation including: air traffic management, construction and operation of airports, certification of personnel and aircraft, and commercial space transportation. In 2001 the first CertAlert, information the FAA disseminates providing guidance on Part 139 airport certification and related issues, established minimum fence standards for excluding large mammals such as deer from airport environments. Additionally, Advisor Circulars (ACs) provide guidance for compliance with airworthiness regulations. Generally, ACs are not regulatory but do reflect industry standards or regulations. As research techniques and data becomes available, CertAlerts are periodically updated and/or canceled to reflect scientific advancements.

Three ACs that form part of the basis for airport management in Colorado are AC 150/5200-33B, AC 150/5200-38, and AC 150/5200-36A. AC 150/5200-33B provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near airports and discusses airport development projects affecting aircraft movement near hazardous wildlife attractants. Within this document, wildlife groups are ranked according to their involvement in damaging strikes within the U.S. These rankings are based on 47,212 strikes recorded in the National Wildlife Strike database from 1990 to 2003. In conjunction with Wildlife Hazard Assessments (discussed below) airport operators are able to determine these species relative abundance and use patterns in and around airport environments.

AC 150/2500-38 defines the minimum acceptable standards for conducting and preparing a Wildlife Hazard Site Visit, Wildlife Hazard Assessment, and Wildlife Hazard Management Plan. The FAA also recommends guidance and qualifications for Qualified Airport Wildlife Biologist. The objectives of a Wildlife Hazard Assessment is to provide a baseline of data and background information on wildlife species considered hazardous on or near airports, and the attractants that provide food, water, and shelter. WHA typically take a year to complete and the assessment methodologies should be reproducible. Data collection involves point counts, trapping indices, and vehicle route counts. This data identifies wildlife population trends at the airport and provides information on the locations and seasonal movements of wildlife hazards. It also provides airport managers and personnel an idea of wildlife abundance and how specific movement patterns may impact aviation safety, specifically wildlife strikes. WHAs promote an integrated wildlife damage management techniques to modify the environment (e.g., mowing), exclude wildlife (e.g., fences), harass wildlife away from airfield (e.g., pyrotechnics), remove wildlife (e.g., lethal removal), report strikes, document pilot reported information regarding wildlife, and how potential wildlife hazards or strikes could impact flight routes, traffic patterns, or schedules.

Wildlife Hazard Assessments are required for Part 139 operators when:

1.) An air carrier aircraft experiences multiple wildlife strikes.
2.) An air carrier aircraft experiences substantial damage from striking wildlife.
3.) An air carrier aircraft experiences an engine ingestion of wildlife.
4.) Wildlife of a size, or in numbers, capable of causing ….

- An air carrier aircraft experiences a multiple wildlife strike.
- An air carrier aircraft experiences substantial damage from striking wildlife. As used here… substantial damage means damage or structural failure incurred by an aircraft that adversely affects the structural strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component.
- An air carrier aircraft experiences an engine ingestion of wildlife; or
- Wildlife of a size, or in numbers, capable of causing an event described above is observed to have access to any airport flight pattern or aircraft movement area.

When a WHA is complete, it is submitted by the airport to the FAA for review and approval. The FAA will then use the assessment to determine if the airport should prepare and implement a Wildlife Hazard Management Plan. Wildlife Hazard Management Plans identifies hazardous wildlife and attractants, while suggesting proactive and reactive management techniques, necessary resources and supplies, and training requirements (AC 150/5200-38).

AC 150/5200-36A has two purposes, first it describes the qualifications for wildlife biologists who conduct Wildlife Hazard Assessments (WHA) for airports certified under Title 14, Code of Federal Regulations, Part 139 (14 CFR Part 139), and non-certificated airports funded by a Federal Aviation Administration (FAA) Airport Improvement Program (AIP) or Passenger Facility Charge (PFC)

Program. Second, this AC address the minimum wildlife hazard management curriculum for the initial and recurrent training of airport personnel.

Qualified Airport Wildlife Biologists must:

1. Have the necessary academic coursework from accredited institution and work experience to meet the qualifications of a GS-0486 series wildlife biologist as defined by the U.S. Office of Personnel Management classification standards or be designated as a Certified Wildlife Biologist by The Wildlife Society and,

2. Have taken and passed an airport wildlife hazard management training course acceptable to the FAA Administrator, and,

3. While working under the direct supervision of a qualified airport wildlife biologist, have conducted at least one Wildlife Hazard Assessment acceptable to the FAA Administrator as described in (139.337(c)), and,

4. Have successfully completed at least one of the following within five years of their initial FAA approved airport wildlife hazard management training course, and every five years thereafter:
(i.) An airport wildlife hazard management training course that is acceptable to the FAA Administrator or,
(ii.) Attendance, as a registered participant, at a join Bird Strike Committee-USA/Bird Strike Committee-Canada annual meeting, or
(iii.) Other training acceptable to the FAA Administrator.

What is Part 139?

14 CFR Part 139 requires the FAA to issue airport operating certificates to airports that:

- Serve scheduled and unscheduled air carrier aircraft with more than 30 seats.
- Serve scheduled and unscheduled air carrier operations in aircraft with more than 9 seats but less than 31 seats, and
- The FAA Administrator requires to have a certificate.

This does not apply to airports at which air carrier passengers operations are conducted only because the airport has been designated as an alternative airport.

Airport Operating Certificates serve to ensure safety in air transportation. To obtain a certificate, an airport must agree to certain operational and safety standards and provide for such things as firefighting and rescue equipment. These requirements vary depending on the size of the airport and the type of flights available. The regulation, however, does allow the FAA to issue certain exemptions to airports that serve few passengers yearly and for which some requirements might create a financial hardship.

Habitat Modification

Habitat modification at airports relies on altering the physical environment to reduce its attractiveness to hazardous wildlife species. Grassland communities are the predominate habitat in most airport environments. WHMPs recommend planting herbaceous ground cover(s) at heights from 6 to14 inches that are unpalatable to wildlife. Biologist must consider the most common hazardous species present at the airport when making vegetation recommendation and mowing regimes. For large populations of small birds, it may be beneficial to keep vegetation heights taller, to break up sight lines and reduce habitat use. However, by maintaining taller vegetation heights this may increase the number of invertebrates or increase small mammal and rabbit abundance which may in turn attract coyotes and rabbits. Assessing the relative hazard risk associated with each wildlife species is necessary for determining the most effective habitat modification regime for airports.

As with all airports, the attractiveness and quality of service directly impacts customer satisfaction. While a variety of trees and shrubs may enhance the aesthetics of public areas, such as the terminal and causeways leading to the terminal, landscaping options should be carefully selected as they can serve as an attractant to wildlife. Trees and shrubs provide a variety of roosting and nesting locations and may produce palatable fruits and nuts that attract wildlife. In general, these options should be avoided or used sparingly.

Besides shelter, water is a major attractant for birds and mammals. In airport environments, water sources should be eliminated or made inaccessible to wildlife. When removing large open water sources is impractical, commercially available synthetic floating covers is recommended (Devault et al. 2017). Obviously, habitat modification in airport environments is difficult to implement and is typically expensive. Thus, it is imperative that wildlife biologist and airport planners cooperatively consult with one another during all planning phases of airport construction and/or renovation.

Fencing

While the majority of reported wildlife –aircraft strikes involve birds, collisions with large to medium sized mammals (coyotes, deer, elk, moose) are much more likely to cause damage (Devault 2017). To effectively exclude these mammals from the airport operating areas CertAlert 04-06 recommends installing a 10-12 ft chain length fence with 3-strand barbed-wire outriggers and a 4 ft skirt buried at a 45 ° angle to the outside. However, the FAA does recognize that other fence types such as 8 ft chain link and electrical or tension fences may be suitable in some circumstances, such as at smaller part 139 or general aviation airports. Access points, such as gates, should have a gap at the bottom no larger than 6 in and airport operations staff should regularly examine the perimeter for gaps, holes, washouts that could allow wildlife to access the airfield. As with any technique or system, it is unlikely that any short or long-term solution will completely be mammal or bird proof. This constant struggle pitting mammal adaptability against human ingenuity makes wildlife hazard management challenging.

Translocation

Translocation is the transport and release of wildlife from one location to another (Diehl 1988). In airport environments, translocation allows wildlife biologist to move bird species, such as raptors, away from airport environments where they have a high likelihood of being struck by aircraft. This wildlife management technique is an attractive option for managing strike risks at airports since the hazard is removed in a more socially acceptable way compared to lethal removal. From 2008 to 2011, USDA Wildlife Services translocated over 600 red-tailed hawks from 19 airports across the U.S. Although the translocation of raptor species appears to be a viable solution, the relocation of other species such as waterfowl may be less feasible because of the potential to introduce or spread infectious pathogens or parasites to naïve areas and other susceptible bird populations. Translocation is also a labor-intensive process and the associated costs may not be worth the benefit in some situations where captured birds immediately return to the airport once released. Further research is needed to gain a better understanding of the survival rates of translocated individuals, as well as how these introductions impact already established communities. However, the probability of these animals surviving in these naïve communities is notably greater than them remaining at airports and either being struck by aircraft or having to be lethally removed. From 1990 to 2009 the FAA National Wildlife Database (FAA 2011) found that raptors were involved in 5,724 reported strikes resulting in almost $56 million dollars in economic losses (Dolbeer et al. 2011).

An increase in air traffic (Federal Aviation Administration (FAA) 2016a) along with increases in certain wildlife species, that are commonly involved in bird strikes, (waterfowl, gulls, raptors, blackbirds/starlings, and other species) have contributed greatly to the increase in number of reported strikes (Dolbeer 2015). Collisions between aircraft and wildlife, especially when ingested by engines, can lead to structural damage, catastrophic engine failure, lost revenue, and threaten passenger and air crew safety (Linnell et al. 1996, Robinson 1996, Thorpe 1996, Dolbeer 2013; 2015; Dolbeer et al. 2012). Understandably, aircraft collisions with wildlife serve to erode the public's confidence in the air transportation industry for years to come (Conover et al. 1995).

The FAA has reported a 7.4 increase in reported wildlife-collisions since 1990 (Dolbeer 2015). In 2015, 13,795 strikes were reported; documenting a <1 % increase from 2014 (Dolbeer 2015). Over 95% of these strikes involved migratory birds within the U.S. (Dolbeer 2015). As a result of these population increases, increases in commercial air traffic, and the advent of more efficient and quieter aircraft engines; the Federal Aviation Administration (FAA), U.S. Department of Agriculture (USDA), U.S. Navy, and U.S. Air Force expect the risk of wildlife-aircraft collisions to continue to be a challenge.

In previous decades, wildlife strikes have increased due to wildlife adapting to urban environments, including airports (Dolbeer et al. 2014). Two common bird species that illustrate this point are population proliferations in resident Canada geese and North American snow geese (U.S. Fish and Wildlife Service. 2015). Resident Canada goose populations have increased from 1.0 million to over 3.6 million within the last 25 years (Dolbeer et al. 2014, U.S. Fish and Wildlife Service. 2015). North American snow goose populations have increased from 2.6 million to 5.5 million birds within the last 35 years (U.S. Fish and Wildlife Service. 2015). Similarly, population trends and abundances for 21 species of birds in North America, with a mean body mass of ≥ 4 lbs and involved in at least 10 aircraft/bird collisions (from 1990-2012), found that 81% (17 of 21) experienced populations increases with a net gain of 17 million birds (Dolbeer and Begier 2013). Dolbeer and Eschenfelder (2003) previously documented population increases in 13 of 14 bird species in North America with a mean body mass ≥ 8 lbs from 1970 to the early 1990s. White-tailed deer populations similarly are increasing. In the 1900s white-tailed deer populations were around 350,000 however, by 2010 over 28 million individuals cover the landscape (McCabe 1997, VerCauteren et al. 2011).

Visual Deterrents

Wildlife biologists use a variety of visual deterrents at airports to provoke a behavioral or physiological fear response in bird species that utilize airport environments. The immediate and long-term effectiveness of these methods depends on the habitat, size of the group being dispersed, species, and their integration with other techniques (DeVault et al. 2013). The period of effectiveness for these items also depend on the rate that a species habituates (i.e., becomes accustomed to) to their use.

For birds, vision is a major sensory pathway and is highly developed as far as higher temporal visual resolution, and sensitivity. When considering a visual deterrent, biologists must also consider the biology of the target species. Just because an animal notices the deterrent that does not necessarily mean that the deterrent will stimulate avoidance behaviors.

In practice, visual deterrents rely on innate instinctual antipredator behaviors in birds. Researchers at the National Wildlife Research Center examine these behaviors in multiple species and try to determine specific visual cues from predators such as size, shape, and movement pattern that elicits a fear response similar to that exhibited in a natural setting. Some examples of visual deterrents used in airport environments include: mylar tape, animal effigies, and lasers.

Auditory and Tactile Repellents

Pyrotechnics are considered to be both an auditory and visual deterrent. In airport environments, these noise-making projectiles (e.g., shell crackers, bird whistles, bird bangers, bird screamers) are commonly used to reduce bird hazards. Besides being used at airports, in 1997 the Humane Society of the United States (Hadidian et al. 1997) recognized their use ad an effective and humane scaring method for birds.

This method relies primarily on an explosive charge or other loud noise to haze (i.e., scare) birds. Several manufactures market pyrotechnic cartridges that produce a loud explosive sound or combine explosive sounds with light and smoke. These cartridges can be launched from rifles, shotguns, flare pistols, or custom-made launchers that use blank primers to ignite and launch pyrotechnic cartridges.

Along with visual stimulation, other auditory and tactile repellents are useful in deterring or dispersing birds away from airport environments. Depending on the species, birds detect auditory frequencies ranging from 1 to 3 kilohertz (kHz). Commercially available auditory repellents are marketed in three broad sound categories including: ultrasonic, sonic, or bio-sonic sound. These devices broadcast alarm or distress calls, human synthesized vocalizations, or explosions (e.g. pyrotechnics, propane cannons). The likelihood that bird species will respond to specific audio frequencies depends largely on the ability of the species to detect the sound. Notably, although some auditory repellent devices are marketed as using ultrasonic sound, bird are not capable of detecting sounds within that range. Auditory deterrents are primarily based on the premise that when birds hear natural warnings or distress calls they will quickly leave an area and will not be as likely to habituate since there is an evolutionary cost associated with ignoring distress calls (i.e. potential death). As with all auditory deterrents, environmental factors can impact sound transmission and; factors such as ambient temperature, wind direction, and physical features such as buildings, should be considered prior to using these devices.

Tactile repellents are designed to create pain or discomfort on the skin, bill, or feet of birds. Typically, repellents consist of metal or plastic spikes, electrified wires, sticky materials, grid-wire barriers, compressed air, and chemical compounds to stimulate avoidance behaviors in birds. Barriers made of wires or spikes are used to deter birds from perching or loafing on airport sensors and equipment. Obviously, larger birds such as owls and hawks require a different configuration of spikes and wires to prevent them from perching on objects compared to smaller species such as meadowlarks. However, no single device will deter all species and other methods should be integrated into a wildlife damage management protocol. Additionally, consumers should be aware that while some commercially available auditory and tactile repellents have been rigorously tested by wildlife researchers other products on the market have not been evaluated using scientifically sound protocols.

Chemical Applications/Repellents

Depending on the bird species and situation, chemical repellents can be used or combined with other methods. Chemical repellents are classified by their physiological mode of action and if a target species develops avoidance behaviors following their use. Primary repellents are agents that cause a target species to escape or leave following an initial exposure due to an offensive, unpalatable, or irritating smell or taste. Secondary repellents are not immediately offensive, but following exposure target species experience adverse physiological effects or illness that the animals associate with a taste, color, or visual cue. Following an initial exposure, animals will subsequently avoid these visual cues.

In using chemical repellents, biologists and other professionals must consider 1. how a target species learns, 2. The sensory capabilities of the target species, 3. the behavior they wish to illicit from the species, 4. population turnover rates (e.g., migration, immigration, emigration), and 5. the efficiency of the repellents (DeVault et al. 2017). In general, secondary repellents are regarded as more effective than primary repellents. With secondary repellents animals learn to associate illness or physiological discomfort with secondary repellent visual cues (e.g., color, taste). For example, when golf courses apply a foraging repellent such as anthraquinone to deter Canada goose from feeding on the golf greens; treated areas absorb a range of ultraviolet light that serves as a visual cue that geese associate with illness. Unlike mammal species, birds are less likely to associate taste with illness and base their learning patterns on visual stimuli associated with illness.

Compared to secondary repellents that are derived primarily from synthetic chemical compounds, primary repellents are usually derived from natural products including flavoring ingredients and food. Primary repellents are designed to cause an immediate reflexive withdrawal following exposure to a painful or irritating smell or taste. Because animals naturally limit their exposure to immediate pain or discomfort they are less likely to associate these effects with primary repellents. Therefore, when considering using primary repellents, biologist should consider integrating other deterrent methods to prevent birds from revisiting sites or continuing to sample treated foods.

Other chemical formulations like Avitrol (3-aminopyridine) are considered as toxicants rather than repellents since large doses can be lethal to some species (Mason and Clark 1995). When animals ingest sub-lethal doses, birds exhibit erratic and disorienting behaviors while emitting distress calls. This behavior alarms other birds in the area and causes them to disperse. Often these agents are referred to as "frightening agents" and are used where large populations of birds accumulate.

Local Population/Pack Management

Prior to the removal of an individual or a reduction in local population or pack numbers, biologists' asses the strike risk and hazard level posed by wildlife. This information helps determine the course of action that should be taken to mitigate immediate and future wildlife threats to aviation safety. Species that have a high hazard level (i.e., ≥ 50% of strikes with aircraft result in damage) and that pose a high risk (i.e., the species has been frequently documented, struck, and associated with damage) such as Canada geese may warrant lethal removal (DeVault et al. 2017). Prior to any lethal wildlife removal, biologist consult with federal, state, and local rules and regulations.

After assessing the hazard level, strike risk potential, and proper permits, wildlife biologists consider the local and regional population dynamics of the problematic specie(s). Local surveys are performed within airport environments (according to standardized guidelines) to assess local populations and when available, other sources such as Breeding Bird Surveys and Christmas Bird Counts, are used to develop simple population models (DeVault et al. 2013). These models serve as a predictive tool to analyze the immediate and long-term impacts that lethal or reproductive mitigation activities could have on local or regional populations. Following lethal removal, wildlife population levels and wildlife strikes are monitored to determine the effects of these management actions.

Avian Radar

Following the emergency landing of Flight 1549 on the Hudson river when an Airbus A320-214 struck a population of Canada geese on takeoff; the FAA issued an Advisory Circular on avian radar and how to purchase this technology using federal funding assistance. Avian radar is used to describe marine surveillance radar equipment that is modified for use on airports. These systems usually consist of 3 cm (X-band) or 10 cm (S Band) wavelengths that are broadcast and detected using several antenna configurations (DeVault et al. 2017). The premise behind this technology, is to allow airport personnel to identify and track bird targets in situations where human detection capabilities are limited (e.g. fog, night).

The FAA in collaboration with several research partners including USDA National Wildlife Research Center, Department of Defense, and academia continue to examine the capabilities of this technology and how it can be feasibly integrated into wildlife damage management activities at airports. Currently, research suggests that small mobile marine-style avian radar systems are not able to accurately identify bird to a specie level or categorize birds based on size (DeVault et al. 2017). Other common problems associated with these systems include under-reporting bird abundances and/or bird movements.

One of the first airports to use avian radar in 2010, the Seattle-Tacoma International Airport, has had some success in using 3D-scanning technology to detect wildlife activity around the airport and subsequently focusing wildlife harassment efforts (Washburn 2019). Although this technology is currently being used for situational awareness, it may also prove beneficial in managing flight arrival and departures during increased periods of bird activity (i.e. migration) at other facilities (i.e. military bases). For now, the airport community continues to evaluate this technology and as technological advancements continue to be made, individual airports will revisit this topic.

Colorado Airport System

Across the U.S., certificated part 139 and non-certificated airports, that receive federal funding support, are required by federal regulations to mitigate safety issues associated with wildlife hazards. Given USDA Wildlife Services' history of providing professional wildlife damage management, Colorado has four operational airport projects: Denver International Airport, Buckley Air Force Base, Peterson Air Force/Colorado Springs Airport joint-use facility, and the Air Force Academy at Colorado Springs. Additionally, a state airport wildlife biologist conducts wildlife hazard management on an "as requested" basis at various other airports across the state. **Table 1.13** provides a small synopsis of nine airport facilities across the state and provides a description of the types of flight operations conducted at each location.

Table 1.13. Airport facilities in Colorado listing air carriers, general aviation, civil and military operations (Air Traffic Activity System).

			Itinerant					Local			Total
Facility	YR	Region	Air Carrier	Air Taxi	General Aviation	Military	Total	Civil	Military	Total	
APA	2013	ANM	32	30,947	134,927	2,446	168,352	121,830	2,202	124,032	292,384
APA	2014	ANM	88	33,857	140,133	3,469	177,547	129,090	2,820	131,910	309,457
APA	2015	ANM	93	26,447	133,055	3,293	162,888	147,668	2,726	150,394	313,282
APA	2016	ANM	43	24,979	145,807	3,588	174,417	153,848	3,846	157,694	332,111
APA	2017	ANM	58	26,865	141,529	3,621	172,073	151,920	2,030	153,950	326,023
Sub-Total for APA			314	143,095	695,451	16,417	855,277	704,356	13,624	717,980	1,573,257
ASE	2013	ANM	8,307	9,428	14,266	59	32,060	3,241	27	3,268	35,328
ASE	2014	ANM	8,716	8,926	14,060	115	31,817	3,544	34	3,578	35,395
ASE	2015	ANM	8,986	9,674	15,447	156	34,263	4,850	81	4,931	39,194
ASE	2016	ANM	9,310	10,248	16,407	179	36,144	5,041	155	5,196	41,340
ASE	2017	ANM	9,626	10,865	16,012	144	36,647	5,655	124	5,779	42,426
Sub-Total for ASE			44,945	49,141	76,192	653	170,931	22,331	421	22,752	193,683
BJC	2013	ANM	26	5,279	51,573	868	57,746	55,637	1,234	56,871	114,617
BJC	2014	ANM	82	5,136	53,268	1,293	59,779	53,032	2,681	55,713	115,492
BJC	2015	ANM	8	5,524	54,464	1,183	61,179	62,272	2,018	64,290	125,469
BJC	2016	ANM	108	6,093	64,889	1,270	72,360	67,619	1,737	69,356	141,716
BJC	2017	ANM	11	5,973	66,042	1,087	73,113	90,411	2,243	92,654	165,767
Sub-Total for BJC			235	28,005	290,236	5,701	324,177	328,971	9,913	338,884	663,061
COS	2013	ANM	14,521	13,712	26,431	13,138	67,802	33,900	25,954	59,854	127,656
COS	2014	ANM	13,535	13,830	26,326	14,458	68,149	31,204	31,040	62,244	130,393
COS	2015	ANM	13,921	9,870	26,854	14,109	64,754	29,622	30,927	60,549	125,303
COS	2016	ANM	12,912	12,287	28,224	13,896	67,319	33,083	29,952	63,035	130,354
COS	2017	ANM	14,843	13,290	28,723	13,700	70,556	36,579	28,043	64,622	135,178
Sub-Total for COS			69,732	62,989	136,558	69,301	338,580	164,388	145,916	310,304	648,884
DEN	2013	ANM	420,073	162,719	3,988	80	586,860	0	0	0	586,860
DEN	2014	ANM	422,178	148,436	4,021	526	575,161	0	0	0	575,161
DEN	2015	ANM	424,930	118,147	4,464	107	547,648	0	0	0	547,648
DEN	2016	ANM	445,019	122,982	4,376	143	572,520	0	0	0	572,520
DEN	2017	ANM	461,992	116,305	4,120	69	582,486	0	0	0	582,486
Sub-Total for DEN			2,174,192	668,589	20,969	925	2,864,675	0	0	0	2,864,675
EGE	2013	ANM	3,466	7,845	15,134	3,581	30,026	6,485	523	7,008	37,034
EGE	2014	ANM	3,530	8,396	16,193	3,217	31,336	7,421	942	8,363	39,699

EGE	2015	ANM	3,609	8,709	16,591	2,400	31,309	7,122	1,095	8,217	39,526
EGE	2016	ANM	3,649	8,848	15,811	2,971	31,279	5,830	552	6,382	37,661
EGE	2017	ANM	3,637	8,546	15,762	2,660	30,605	5,246	1,351	6,597	37,202
Sub-Total for EGE			17,891	42,344	79,491	14,829	154,555	32,104	4,463	36,567	191,122
FTG	2013	ANM	0	61	19,677	368	20,106	24,084	406	24,490	44,596
FTG	2014	ANM	9	172	21,569	365	22,115	25,950	1,157	27,107	49,222
FTG	2015	ANM	0	544	24,643	284	25,471	30,766	1,155	31,921	57,392
FTG	2016	ANM	2	117	27,570	479	28,168	35,202	2,315	37,517	65,685
FTG	2017	ANM	0	439	31,685	548	32,672	47,583	1,650	49,233	81,905
Sub-Total for FTG			11	1,333	125,144	2,044	128,532	163,585	6,683	170,268	298,800
GJT	2013	ANM	2,907	13,089	18,791	1,393	36,180	11,569	781	12,350	48,530
GJT	2014	ANM	3,232	12,246	17,604	1,573	34,655	10,373	1,024	11,397	46,052
GJT	2015	ANM	3,069	11,547	17,060	2,251	33,927	7,661	1,575	9,236	43,163
GJT	2016	ANM	2,743	12,113	18,461	1,891	35,208	8,790	1,125	9,915	45,123
GJT	2017	ANM	5,391	9,082	19,091	1,606	35,170	8,459	646	9,105	44,275
Sub-Total for GJT			17,342	58,077	91,007	8,714	175,140	46,852	5,151	52,003	227,143
PUB	2013	ANM	243	4,879	62,482	3,183	70,787	74,204	2,037	76,241	147,028
PUB	2014	ANM	204	3,950	60,013	3,295	67,462	72,255	2,807	75,062	142,524
PUB	2015	ANM	143	3,180	63,295	3,561	70,179	95,016	5,694	100,710	170,889
PUB	2016	ANM	78	4,238	47,505	25,591	77,412	49,996	40,202	90,198	167,610
PUB	2017	ANM	119	4,369	15,693	60,811	80,992	6,220	89,437	95,657	176,649
Sub-Total for CO			2,325,449	1,074,189	1,764,036	215,025	5,378,699	1,760,278	326,348	2,086,626	7,465,325
Sub-Total for ANM			2,325,449	1,074,189	1,764,036	215,025	5,378,699	1,760,278	326,348	2,086,626	7,465,325
Sub-Total for PUB			787	20,616	248,988	96,441	366,832	297,691	140,177	437,868	804,700
Total:			**2,325,449**	**1,074,189**	**1,764,036**	**215,025**	**5,378,699**	**1,760,278**	**326,348**	**2,086,626**	**7,465,325**

1.18.1 What is the History of Assessing Wildlife Hazards to Aviation Operations?

In October of 1960, a turboprop-powered Lockheed Electra crashed into the Boston Harbor following the ingestion of over 200 European starlings in three out of its four engines (DeVault et al. 2016). All sixty-two members on board were killed; and to this date it remains one of the deadliest bird strikes ever recorded. This marked the beginning of wildlife hazard management projects in North America and Europe.

Early on, Canada and Europe lead the field by creating the Bird Strike Committee Canada and Bird Strike Committee Europe (now the International Bird Strike Committee) (DeVault et al. 2016). In the 1970s, British researchers began publishing reports on habitat modification and vegetation management to discourage starling and other species from using airport environments (Brough 1971, DeVault et al. 2016). Additionally, during this time, Blokpoel (1974) a Canadian biologist, published a book outlining bird-strike management.

Two additional bird-induced crashes, a Learjet 24 at DeKalb-Peachtree Airport, Atlanta, Georgia, in 1973, and a DC-10 at John F. Kennedy International Airport, New York, New York, in 1974 led the FAA and International Civil Aviation Organization to recommend land-use restrictions near airports

(DeVault et al. 2016); and other civil authorities quickly followed by developing regulations that required airports experiencing bird strikes to implement habitat management and operational techniques (lethal and nonlethal)(FAA 2004). The FAA and the International Civil Aviation Organization expanded their regulations to include other terrestrial mammals such as deer in 1991 and 2008, respectively (Dolbeer et al. 2013, International Civil Aviation Organization 2009).

In 1991, John F Kennedy International Airport was the first to develop and implement a large scale local bird management regime involving gull rookeries near the airport (Dolbeer et al. 1993). This marked the beginning of aggressive bird management project implementation in the US to prevent bird and other wildlife strikes. This field continued to advance as the FAA and International Civil Aviation Organization developed bird strike databases to track bird strikes throughout the US, Canada, and Europe. This allowed researchers to identify correlations between these events and lead to the conclusion that the most damaging bird strikes, approximately 65% (in the US), occurred at elevations less than 500 ft above ground level and served to reinforce the implementation of wildlife hazard management activities at airports (Cleary and Dolbeer 2005).

As a result of these efforts and others, by federal agencies and private sector biologists, today wildlife hazard management projects at airports in the US and around the world have substantially increased. Of these Wildlife Hazard Management Programs, the United States Department of Agriculture Wildlife Services program alone has assisted more than 5,000 airport staff at 406 airports in 2017 compared to: 2,751 staff at 365 airports in 2009; and only 193 and 42 airports (staff numbers unknown) in 1998 and 1990 respectively (Beiger and Dolbeer 2019, Washburn 2019).

1.18.2 What are Wildlife Hazard Assessments and the regulations behind them?

A year after the January 2009 Miracle on the Hudson plane crash, the National Transportation Safety Board (NTSB) published concerns and recommendations that all airports that were federally certified for passenger traffic should proactively conduct a wildlife hazard assessment to assess the potential for wildlife strikes (NTSB 2010). In 2004, the FAA required that all certified airports must take immediate action to alleviate wildlife hazards whenever they were detected (FAA 2004). Further, these airports must also conduct a Wildlife Hazard Management Assessment (WHA) when wildlife strikes or the potential threat of strikes exists and meets specified criteria relating directly to these strikes (see FAA Recommendations).

WHA must include the "identification of the wildlife species observed and their numbers, locations, local movements, and daily and seasonal occurrences" (FAA 2004). Therefore, the broad objective of a WHA is to identify and quantify wildlife species on and around the airport and develop a plan that prioritizes and alleviates wildlife hazards (i.e, a wildlife hazard management plan, Cleary and Dolbeer 2005, DeVault et al. 2016). The areas of the airport to be examined are defined as the AOA or air operations area, this is the space designated for takeoff, landing, and surface maneuvers of aircraft (FAA 2004). However, other areas that may attract wildlife within a 1 mile radius of a piston-powered aircraft runway and within 2 miles of turbine-powered aircraft runways should also be examined (FAA 2004).

Based on the data collected, airport biologist are then able to: 1) calculate the relative risk posed by wildlife species to aircraft based on season, habitat type, and area of occurrence (AOA, runway safety areas), 2) quantify seasonal abundances of wildlife within the airport environment, 3) prioritize management actions and allocate resources related to the relative strike risk, and 4) quantify the impact of management actions prior to and post application in relation to wildlife strikes/risk (DeVault et al. 2016).

1.18.3 How do Airport Wildlife Biologists use Breeding Bird Survey protocols and statistical sampling in Wildlife Hazard Assessments?

In managing wildlife hazards, wildlife biologists and airport personnel first identify and quantify wildlife species on and around the airport. This information is then used to develop management recommendations and prioritize resource allocations. Biologists quantify avian and other wildlife hazards by using sampling methodologies that accurately detect wildlife species, their abundance, the attractants drawing these species into the environment, and correlations between seasonality and local abundances over time.

To justify management objectives and priorities to stakeholders, other agencies, and the public, survey data collection and analysis methodologies are evaluated and selected based on their ability to yield scientifically sound and accurate results. Wildlife biologists structure these surveys based on: 1) survey objective(s), 2) the presence of wildlife species and local abundances, 3) relevant data needed to meet objective(s), 4) factors that may influence the accuracy of measurements, 5) applicability of measurement methods, and 6) availability of data management and analysis tools (DeVault et al. 2016).

Before a Wildlife Hazard Assessment is conducted, an initial site visit is conducted by wildlife biologists to gain a better understanding of the species involved and potential attractants (Cleary and Dolbeer 2005). Additionally, biologists will review strike records or the FAA wildlife strike database and target these species in their survey efforts. Wildlife surveys include counts of individual birds and populations, numbers of individuals within populations, and species identification. Data are collected using a point-transect approach that is similar to the North American Breeding Bird Survey (BBS; Sauer et al. 2008). Point transects cover a range of habitats, seasons, times of day, temperature, and climatic conditions (i.e. wind, precipitation, humidity, and cloud cover). Additionally, the presence of predators or other disturbances may influence bird behavior during survey counts (DeVault et al. 2016).

During a wildlife survey, wildlife biologists select around 20 observation locations (depending on the size of the facility) using a geographic information system (GIS) throughout the airport environment (e.g. terminal buildings, runways, taxiways). Given that the average size of an airport in the US is 761 hectares (ha), and a minimum sighting distance of 200 meters, a random sample of 20 observations points would cover approximately 261 ha of airport property (DeVault et al. 2013; 2016). These observation points will be used for three daily observation periods: morning (30 minutes before sunrise to 1000 hours), mid-day (1200 to 1500 hours), and evening (1600 hours to 30 minutes after sunset) throughout the year and during times of interest (i.e. unique events).

For each wildlife survey, the start time and location (1 of the 20 observation points) is randomized. Additionally, biologists will spend 3 minute periods at each point during a two-hour period. Within a season, these points will be surveyed at least three times or more, when the probability for detecting a species is >50% per survey (DeVault et al. 2016). Once all of the data has been collected biologists must then perform a detailed analysis.

Using raw survey data, biologists can calculate a species' abundance index, unadjusted for error (DeVault 2016). Although, index abundances calculated from this unadjusted data does not provide a reliable nor scientifically sound estimate of abundance (DeVault et al. 2016, Burnham 1981). Other analytical options incorporate detection histories and examine potential biases in relation to study design and conduct. One approach, the Double Sampling approach estimates population densities using the formula $D=(\bar{x}')/(\bar{x}/\bar{y})$. Where $\bar{x}'$ is the mean number of birds detected during a rapid survey.

Biologists perform rapid survey using the same survey protocols as described above. However, instead of sampling all 20 of the randomly selected observation points, just 6 of these points are used. Rapid surveys involve walking through these points and counting all birds or populations in the area or flushed from the area (DeVault et al. 2016). This data represents the actual number of birds using the area the time of the survey. The mean number of birds recorded per cell is represented by $\bar{x}$ and $\bar{y}$ is the mean number of birds actually present during the rapid survey. This method is intended to enhance the accuracy of bird density estimates in airport environments.

An alternate analysis method, Distance Sampling, uses the distance from the observation point to the bird or population of birds to estimate a detection probability (DeVault et al. 2016). Additional covariates such as habitat are then factored in using a software package. This allows for the calculation of more accurate detection probabilities and density estimates. Distance Sampling relies on several assumptions including: 1) All objects at an observation point are capable of being detected, excluding extenuating circumstances (e.g. noise interference); 2) Objects do not move as a result of observer actions within 5 minutes; and 3) Distance measurements are accurate (i.e., laser range finders, GIS).
Using this method, distance sampling can provide robust results in estimating bird abundance or density estimates (DeVault et al. 2016). However, it should be noted that greater than 60 observations are needed to produce reliable density estimates (Buckland et al. 2001).

1.18.4 How has GIS been incorporated into Wildlife Hazard Assessments?

In 1832, Charles Picquet was the first to visual map an outbreak of cholera showing the magnitude of cases across 48 districts of Paris. This represented the first application of what would later become known as heat mapping (See **Figure 1.6**). Later in 1854, John Snow similarly depicted cholera deaths in London and found that these cases correlated to contaminated water sources. This became the foundation for the study of Epidemiology (the study of the spread of disease) and lead to spatial analysis being used as a problem-solving tool. The invention of a printing technique called photozincograph furthered the field by allowing users to create separate layers from a map but this did not fully represent what GIS was to become; since there was no data to be analyzed.

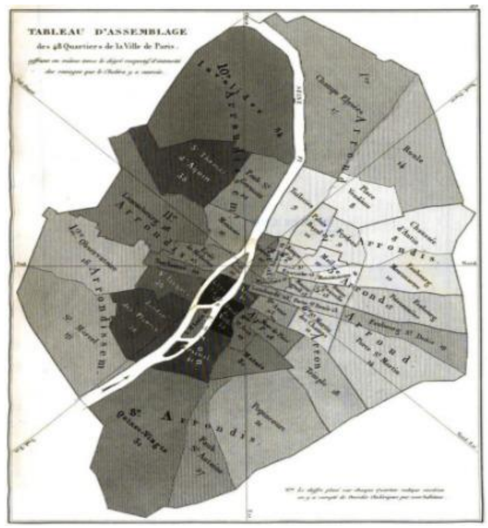

Figure 1.6. Map representing an outbreak of cholera throughout 48 districts of Paris. (https://www.geospatialworld.net/blogs/overview-of-gis-history/)

The first computerized concept of geographic information system (GIS) was researched and developed by Roger Tomlinson in the early 1960s. Tomlinson created a manageable inventory of natural resource data for the Canadian government using automated computing to store and process large amounts of data. He also coined the term GIS. Later, in 1965, Howard Fisher created and established some of the founding map-making software for GIS spatial analysis and visualization at the Harvard Laboratory for Computer Graphics. Jack Dangermound, a member of the Harvard Lab, and his wife Laura later founded the Environmental Systems Research Institute, Inc. (ERSI) in 1969. ERSI became a consulting firm that provided land managers, city planners, and natural resource stewards mapping and spatial analysis tools that could be used to solve complex problems. As technology developed and computers became more powerful, ESRI developed more sophisticated software and integrated their use into the academic community; and in 1981 ERSI released their first commercially available GIS package.

Today, many companies have integrated the use of GIS into their business ventures. However, many of these companies are reluctant to share their data across multiple platforms due to a perceived risk that it might confer an adaptive advantage to a competitor. As the field moves forward, collaborations between entities sharing data reveal previously unrecognized patterns, trends, and relationships that may one day provide relevant answers to previously unanswerable questions.

Currently WS biologists, using cell phones equipped with integrated GIS software, are able to document, visualize, and detect short-term and long-term changes in wildlife species, their abundance, and location throughout the airfield. This technology, in combination with mapped locations of wildlife strikes, provides an easy to understand visual representation of wildlife hazards and subsequent solutions to airport managers, operations support staff, and other cooperators. Additionally, this data allows airport managers and personnel to prioritize and redistribute resources to mitigate wildlife hazards throughout the year. Along with wildlife risk analysis and modeling, this technology will assist WS personnel in evaluating project effectiveness and in developing management strategies (DeVault et al. 2018).

1.18.5 How does Wildlife Services Calculate Wildlife Risk Analysis?

Risk Analysis of Birds at Airports

Bird-aircraft collisions (hereafter "bird strikes") is considered a safety concern and causes losses of human lives (Thorpe 1996; Thorpe 2005) and a growing economic concern for the civil and military industry exceeding $1.2 billion annually (Allan 2000). The management of wildlife at airports to reduce aircraft strikes has evolved over the last 25 years from making management decisions based solely on frequency and total numbers of individuals seen during surveys to using bird strike data and GIS systems to illustrate habitat features that are yielding seasonal patterns and use by hazardous species. In similar fashion, metric models and the data within those models has also evolved to quantify the associated risk to aircraft in regard to wildlife presence and activity on an airfield. By using current survey data, dependent on the quality, and prior bird strike data for an individual airport, a species-specific strike-risk estimate can be used to prioritize management recommendations (DeVault et al 2017).

Survey Methodology

To comply with the International Civil Aviation Organization's standards of recommended management practices the FAA requires airports in the USA for passenger traffic (civilian airports) to conduct a Wildlife Hazard Assessment (WHA). A WHA is a year-long study of a specific airport environment intended to capture population abundance or trends, habitat features, seasonal trends, and any response to management actions. The WHA is conducted prior to making any management recommendations to airport managers that would impact populations of birds utilizing the airfield. When initiating a WHA, the survey design and sampling method is crucial to determining what data is necessary to capture. If this first step is ignored or does not remain consistent throughout the study, time and resources can be wasted and fail to meet the objectives of quantifying the avian hazards that exist on the airfield (Blackwell et al. 2009).

Wildlife surveys are conducted monthly during crepuscular, diurnal and nocturnal times by conducting morning, afternoon, evening, and night surveys for one calendar year. Survey methods, based on the standardized USFWS Breeding Bird Survey, consisted of observing wildlife activity for 3-minute intervals at each of the designated stations that are chosen prior to the assessment to adequately cover the entire airfield and document wildlife species occurrence (**Figure 1.7**).

Wildlife surveys consist of recording spatial coordinates, date, time, species observed, number observed, habitat features, and wildlife activity or behavior (ex. Flying, perching, feeding or vocalizing) using a global positioning unit along with current ArcPad software. Airport Biologists that conduct the surveys use geographic information systems (GIS) to systematically record data and produce a spot-mapping approach to illustrate where presence occurs. Field optics (binoculars, spotting scopes, and thermal imagery) are used to identify wildlife species and count individuals. Other survey data is collected outside of the temporal constraints of the scheduled wildlife surveys to allow further documentation of wildlife activity and are included in the final WHA findings. Nocturnal surveys did not follow the wildlife surveys on the airfield. Instead, nocturnal surveys were conducted by using spotlights or Forward Looking Infra-Red (FLIR) cameras and slowly driving perimeter roads or down runways and taxiways to observe mammalian activity, and to some degree avian activity. Other surveys include general observations, or incidentals, that are recorded on an ad lib basis as well as off-site surveys to ensure that land-use practices on or near the airport can be captured and assessed within the FAA 5-mile airspace as recommended in current version of FAA Advisory Circular 150/5200-33 (FAA 2004).

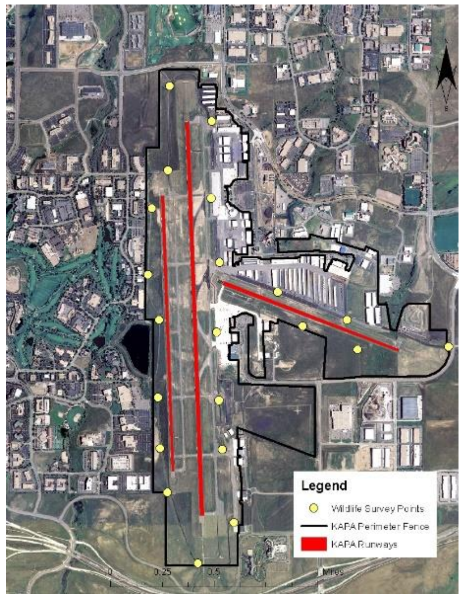

Figure 1.7. Map of designated survey stations on an airport.

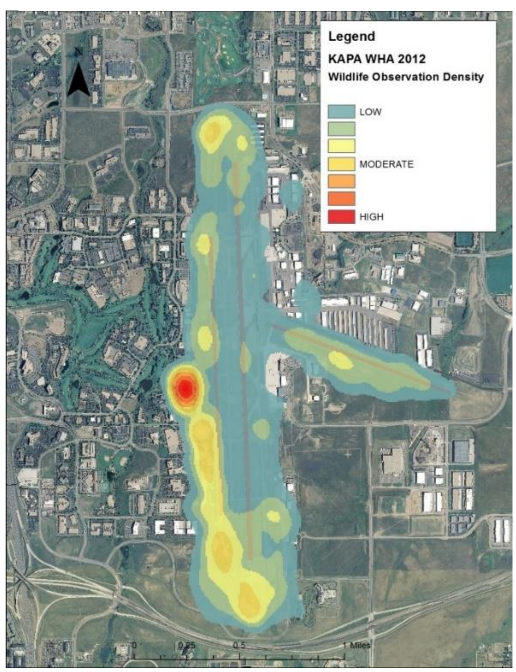

Figure 1.8. Example of Wildlife Observation Density heat map generated from GIS software.

It is understood that when collecting data even using a responsible survey design that there will be bias due to imperfect detection (DeVault 2013). However, we reduce this bias associated with naïve bird count data by carefully standardizing survey methodology (DeVault 2013). Therefore, accurate quantification of avian hazards at airports is essential when conducting a Wildlife Hazard Assessment (WHA). Only when there is quality sampling methodology and data analysis can an airport biologist make responsible management recommendations. Once the data is analyzed at the conclusion of the year-long assessment the objective of determining what management efforts need to be prioritized can be accurately assessed and bird strike risk can begin to be quantified. Based on this WHA, a Wildlife Hazard Management Plan (WHMP) is written by the airport to implement the recommended actions.

Determining Bird Strike Risk

By definition, a risk assessment is the methodology used by insurers for evaluating and assessing the risks associated with an insurance policy. For example, if an individual voluntarily chooses to engage in high risk activities, such as sky diving, the probability that this individual will harm themselves or others is high. How often this person's activities is also factored into a risk assessor's responsibility whether it's one time or on a daily basis. Therefore, insuring an individual would be denied or extremely high premiums offered based on the level of risk that this individual is taking and how often the actions are taken, or frequency. For airports, risk can be calculated in similar fashion, however, even though the bird is seen on the airport frequently does not necessarily indicate that this species is a high risk to aircraft safety or damage (Soldatini et al. 2010). There is no widely accepted formula for estimating strike risk, however, by developing a probabilistic risk metric that is adaptable for each airport to use that can illustrate the likelihood of aircraft damage or effect on flight when the strike occurs, strike data for the airport, and the monetary costs associated with strikes then risk estimation can be made (DeVault et al 2017). It is important to note that risk analysis is the same concept between civilian and military operations, however, civilian aircraft data are secluded from current risk calculations from military operations due to sporadic flight schedules, nature of the airframe design, and aircraft behavior.

It is likely that FAA will soon require airports to adopt a pro-active risk based approach in their Safety Management System (SMS), therefore having an effective method to calculate and prioritize wildlife risks will provide benchmarks for the effectiveness of an airports WHMP (Devault et al. 2018, Dolbeer and Wright 2009). During the past 13 years, the National Wildlife Strike Database has seen improvements in reporting and the number of strike reported has increased 7-fold from 1,850 in 1990 to 13,408 in 2016 and continues to be a useful tool as part of an SMS to enhance safety at airports nationwide (Dolbeer and Wright 2009, Dolbeer et al. 2016).

Although the strike database can provide data for an economical approach into calculating risk, introducing ecological data for further risk analysis into a single metric risk index will yield risk to an aircraft on the basis of the actual presence of birds at airports as well as the likelihood that the species will cause damage if struck (Soldatini 2009, DeVault et al. 2017). The national database further provides us with a means to determine the first step in risk assessment which is a risk value for each species, or relative hazard score (DeVault et al 2011, Dolbeer et al 2000). Strike data is summarized from the database assessing the effects of avian body mass, body density, and group size in addition to percentage of strike that caused damage to determine the relative hazard score of hazardous species or species groups (DeVault et al 2011). These rankings, in turn, are used to reflect species that would most likely cause damage to the aircraft as a result of a bird-aircraft collision. For example, large bodied waterfowl would have a high hazard score (i.e., potentially cause more damage to aircraft if struck) while smaller birds such as passerines would have a relatively low hazard score.

A threshold of 0.96 damaging strikes per 100,000 aircraft movements has been established as a benchmark and anything exceeding that level would require an airport to re-evaluate their WHMP (Dolbeer and Wright 2009). Population size and behavior was not considered in the relative hazard score analysis but could be assumed that large populations of birds are particularly hazardous even within smaller bird species (DeVault et al 2011).

Habitat features and seasonal patterns also influence behavior of individuals or groups of birds and can increase risk. Airports provide suitable habitats for roosting, feeding, and breeding opportunities by providing food, water and cover attractants to wildlife (Barras and Seamans 2002, DeVault and Washburn 2013). This factor fuels the likelihood, or probability, that aircraft would encounter a bird species during take-off or landing.

In a simple risk matrix, **Figure 1.9** shows the relationship between probability and severity where the cells correspond to a certain risk level. Simply put, when you factor in relative hazard scores of a certain species combined with the probability of encountering the species on the airfield, the higher the severity of damage experienced once a strike occurs, thus providing a "proportion of risk" to the aircraft operations at a particular airport.

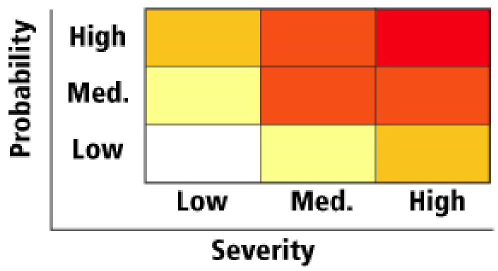

Figure 1.9. Simple Risk Matrix Table illustrating the relationship between levels of probability and severity of an action (Canadian Centre for Occupational Health and Safety https://www.ccohs.ca/oshanswers/hsprograms/risk_assessment.html).

It would not be effective to focus management efforts for certain species that are not found at the airport during certain times of the year. The benefit of this type of risk matrix is for management objectives to be prioritized based on the species hazard as well as the season. In turn, based on this risk matrix airport biologists can provide the airport managers with a strike risk forecast for each season (**Figure 1.8**).

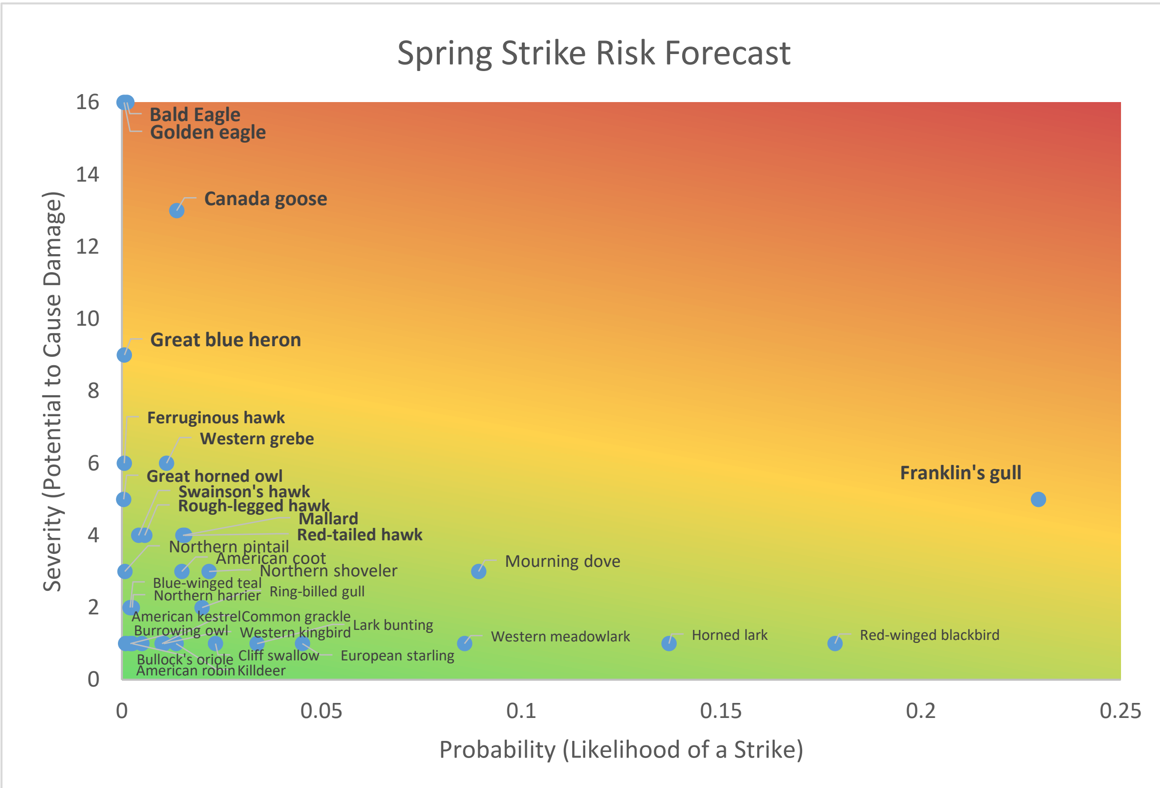

Figure 1.10. Example of a strike risk forecast generated using a probabilistic risk metric for an airport.

1.19 How will BDM impact 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).

These issues are evaluated in the following sections:

- Impacts to threatened and endangered species
- Impacts to unique geographic areas
- Impacts to cultural and historic resources
- Compliance with other environmental laws

1.20 What is the Effectiveness of the National WS Program?

The purpose behind integrated wildlife damage management is to implement methods in the most effective manner while minimizing the potentially harmful effects on people, target and non-target species, and the environment. Defining the effectiveness of any damage management activity or set of activities often occurs in terms of losses or risks potentially reduced or prevented. Inherently, it is difficult to forecast damage that may have been prevented, since the damage has not occurred and therefore must be forecasted.

Effectiveness is based on many factors, with the focus on meeting the desired WDM objectives. These factors can include the types of methods used and the skill of the person using them, with careful implementation of legal restrictions and best implementation practices. Environmental conditions such as weather, terrain, vegetation, and presence of humans, pets, and non-target animals can also be important considerations.

To maximize effectiveness, field personnel must be able to consistently apply the WS Decision Model to assess the damage problem, determine the most advantageous methods or actions, and implement the strategic management actions expeditiously, conscientiously, ethically, and humanely to address the problem and minimize harm to non-target animals, people, property, and the environment. Wildlife management professionals recognize that the most effective approach to resolving any wildlife damage problem is to use an adaptive integrated approach, which may call for the strategic use of several management methods simultaneously or sequentially (Courchamp et al. 2003).

1.20.1 What are the Considerations for Evaluating Project Effectiveness?

WS and professional wildlife managers acknowledge that the damage problem may return after a period of time regardless of the lethal and/or nonlethal strategies applied if the attractant conditions continue to exist at the location where damage occurred, bird densities and/or the availability of transient/juvenile animals are sufficient to reoccupy available habitats, and/or if birds cannot be fully restricted from accessing the problem area due to conditions and size of the damage site. However, effectiveness is determined by the ability to reduce the risk of damage or threats caused by individual/populations of bird species at the time and, if possible, in the future.

The ability of an animal population to sustain a certain level of removal and to eventually return to pre-management levels eventually does not mean management strategies were not effective for addressing the particular event, but that periodic lethal and/or nonlethal management actions taken during a critical time of the year in specific places may be necessary in specific circumstances. The rapid return of local populations to pre-management levels also demonstrates that limited, localized actions taken to resolve a particular damage problem have minimal impacts on the target species' population.

The use of nonlethal methods described in **Chapter 2**, such as harassment or fright methods, typically requires repeated application to discourage those animals from returning, which increases costs, moves birds and/or groups of birds to other areas where they could also cause damage, and is typically temporary if habitat conditions that attracted those birds to damage areas remain unchanged. Therefore, both lethal and some nonlethal methods often result in the return of the same or new individuals to the area, unless the conditions are changed and/or the individuals are physically excluded from the area, such as by fencing.

The common factor when using any wildlife damage management method is that new or the original individual birds return if the attractive conditions continue to exist at the location where damage occurred and bird population densities and/or the availability of transient/juvenile animals are sufficient to reoccupy all available habitats. One of WS-Colorado objectives is to ensure that all BDM actions cumulatively would not cause adverse effects on statewide target bird species popultions or non-target species populations (unless to meet CPW or USFWS management objectives).

Dispersing and relocating problem birds, particularly animals that have learned to take advantage of resources and habitats associated with humans, could move the problem from one area to another, or the relocated animal could return to its original trapping site. Based on an evaluation of the damage situation using the WS Decision Model, the most effective methods should be used individually or in combination based on experience, training, and sound wildlife management principles. The effectiveness of methods are evaluated on a case-by-case basis by the field employee as part of the decision-making process using the WS Decision Model for each BDM action and, where appropriate, field personnel follow-up with the cooperator.

1.20.2 What Role Does Cost-Effectiveness Play in WDM and NEPA?

A common concern expressed by commenters about government-supported bird damage management is whether the value of livestock or game population losses are less than the cost of using at least some public funds to provide bird damage management services. However, this concern indicates a misconception of the purpose of bird damage management, which is not to wait until the value of losses is high, but to prevent, minimize, or stop losses and damage where it is being experienced, the property owner's level of tolerance has been reached, and assistance is requested. Bird damage management would reach its maximum success if it prevented all losses or damage, which would mean the value of losses or damage due to predators would be zero. However, in the real world, it is not reasonable to expect zero loss or damage. Also, wildlife damage management involves not only the direct costs (costs of actual lethal and nonlethal management) but also the considerations of effectiveness, minimization of risk to people, property, and the environment, and social considerations (Shwiff 2004). Additionally, management operations are dependent upon cooperator funding and/or objectives and needs. The cost effectiveness of these methods and the effectiveness of these methods are inseparable.

1.20.3 Does WS Authorizing Legislation Require an Economic Analysis?

No. The statute of 1931, as amended does not incorporate consideration of economic valuations and cost-effectiveness for the BDM project as part of decision-making. In addition to authorizing the BDM services, it provides for entering into agreements for collecting funds from cooperators for the services the agency provides.

1.20.4 Does NEPA and the CEQ Require an Economic Analysis for Informed Decision –making?

Section 102(2)(B) of NEPA requires agencies to:

"[I]dentify and develop methods and procedures...which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations…"

NEPA ensures that federal agencies appropriately integrate values and effects that cannot be quantified from an effects or cost-effectiveness standpoint into decision-making. Such unquantifiable values can include, for example, the value of viewing wildlife, human health and safety, aesthetics, and recreation.

The CEQ regulations at 40 CFR §1502.23 takes a similar position in support of the law:
"If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with section 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision." (Emphasis added)

WS-Colorado has determined that there are important qualitative values that are relevant and important to its decision-making that are considered in this EA, but that those considerations will not be monetized. Estimates of non-monetary cost and benefit values for public projects that are not priced in private markets can be difficult to obtain, and methodologies can only produce implied monetary values that are subjective and require value judgments. Selecting an appropriate discount rate to measure the present monetary value of costs and benefits that will occur in the future is also difficult and subjective, with the level of the discount rate creating dramatically different project benefits.

Cost-effectiveness is not the primary goal of WS or WS-Colorado, instead our goal is to lessen or reduce damage through appropriate management methods. Several factors contribute to the cost-effectiveness of damage management including environmental protection regulations, land management goals, presence of people and pets, and social factors influence bird damage management methods available for use by field employees (using the WS Decision Model) whenever a request for assistance is received. These constraints may increase the cost of implementing Damage Management actions while not necessarily increasing its effectiveness, yet they are a vital part of the WS program (Connolly 1981, Shwiff 2004).

Services that ecosystems provide to resources of value to humans can be considered in qualitative and/or economic terms. The Memorandum entitled "Incorporating Ecosystem Services into Federal Decision Making" issued by the CEQ, the Office of Management and Budget (OMB) and the Office of Science and Technology Policy (OSTP) on October 7, 2015 (https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf) does not require an economic test for the ecological services to be considered valuable.

The Memorandum states:

"[This memorandum] directs agencies to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts. (Consideration of ecosystem services may be accomplished through a range of qualitative and quantitative methods to identify and characterize ecosystem services, affected communities' needs for those services, metrics for changes to those services, and, where appropriate, monetary or nonmonetary values for those services.)…Adoption of an ecosystem-services approach is one way to organize potential

effects of an action within a framework that explicitly recognizes the interconnectedness of environmental, social, and, in some cases, economic considerations, and fosters consideration of both quantified and unquantified information."

Therefore, neither NEPA nor CEQ guidance requires economic analyses for informed decision-making unless relevant to the understanding differences among alternatives.

The qualitative considerations at issue in this EA are evaluated in **Chapter 3** and the agency's decision based on all considerations, including non-quantifiable values, will be explained in the decision document.

1.20.5 What are the Various Factors and Methods for Evaluating Cost-Effectiveness?

When evaluating the cost-effectiveness of wildlife damage management activities and the cost and benefits to society, several issues need to be considered in relation to economics. Since the implementation of wildlife damage management in the 1950s, economists have struggled to quantify the costs and benefits associated with wildlife. Cost associated with wildlife include: predation on livestock, destruction and contamination of crops, transmission of diseases, traffic collisions, and property damage. Several benefits of wildlife include: bird watching, recreational activities, hunting opportunities, food resources, and ecosystem services (Gren et al. 2018). In general, when managing renewable natural resources, economists consider two main questions: 1. What is the optimal size of the population (i.e. the population size that maximizes benefits), and 2. If changes to the current population size could result in benefits to a community or decrease costs (Gren et al. 2018). Wildlife management economic studies calculate direct benefits (e.g., the monetary value of animals/species saved); spillover benefits (e.g., benefits to wildlife populations, or local/regional economies); intangible benefits (e.g., landowner participation); direct economic effects/costs (e.g., losses to resource owners or ESA-listed species); indirect economic effects (e.g., how livestock loss alters producer purchases, additional jobs, etc…); benefits of wildlife to society, the efficiency of the wildlife population being examined, and policy design. Although, determining and accounting for all of the influencing factors involved remains challenging.

In wildlife economics, the size of a population is determined by its associated costs and benefits to society (Gren et al. 2018). Usually, an optimal population size is calculated. At this size, the population offers the best total net benefit to society. To determine this size, economics have to calculate the costs and benefits of game animals and the number of individuals in a society that would be impacted. Some examples of cost associated with recreational hunting would be the market price of game-meat and the value associated with birding/wildlife viewing. Notably, while it is relatively easy to calculate the market price of a pound of venison it is more difficult, and depends on an individual, on how much value they place on birding or viewing wildlife. Birders may estimate the cost based on distance traveled, gas used, or equipment purchased in determining how much the opportunity to view wildlife costs to them.

Some studies have identified values for such non-market goods (e.g. hunting, fishing, and wildlife viewing) by people's stated willingness to pay (WTP) for these opportunities. Ciriacy-Wantrup (1947) first suggested this artificial market concept and used it to interview hunters and recreationists to identify their WTP for a specific recreation area (Mitchell and Carson 1989, Gren et al. 2018). Notably this method does have some limitations since the wording of the questions can influence the quality of answers the responders provide (Shwiff et al. 2013, Gren et al. 2018). Surveyors using these answers can also have difficulty relating the responders' answers to the presence or absence of wildlife in the area. Shaw (1985) found that when people camping were asked about their trip they were likely to have a positive attitude despite the presence or absence of wildlife. Other methods include measuring the benefits to a society from an activity. To do this economists would need to examine records of sales for equipment, transportation, and lodging associated with various activities (i.e., hunting season) (Lindsey et al. 2006, Gren et al. 2018). Of course, other methods would need to be built into this economic model to show how much these effects disperse from local communities throughout a region (Gren et al. 2018).

Costs of wildlife

Costs associated with wildlife and society include: damage to property (including browsing, predation, traffic accidents, and disease transmission. These costs can be estimated or calculated for groups of individuals similar to the benefits as mentioned above. For each of these categories, the cost is calculated in three parts: costs for the actual damage, costs of mitigation, and costs for adaption measures (e.g. Conover et al. 1995, Gren et al. 2018). For example, the costs of Canada geese feeding on agricultural crops include: the actual damage or loss of yield of the crop to farmers, the cost of mitigating the damage (e.g. pyrotechnic equipment and use), and the time spent using mitigation methods to prevent damage. For livestock producers, they may also experience indirect costs associated with bird damage management (for starlings consuming/contaminating livestock feed) such as reduced cattle weight, decreased milk production, and increased veterinary costs associated with disease transmission.

Wildlife-vehicle collisions (i.e., bird strikes) can also generate costs associated with direct and indirect economic effects. These costs relate directly to the loss of human life, personal injury, damage and repairs to aircraft, and hours out of service. Indirect costs can result from losing the confidence of public consumers as a result of a crash, lost jobs associated with a decline in ticket sales, and/or the airline losing service contracts. In airport environments, wildlife biologists and operations staff work with Wildlife Hazard Assessments and implement Wildlife Hazard Management Plans to calculate the probability of wildlife-aircraft collisions and to estimate the likelihood that the strike would result in damage. While these estimates are not currently used in economic models, future economic models could factor in these risk assessments. As economic cost:benefit methodologies improve in relation to bird damage and population estimates, we look forward to incorporating further wildlife economic data into subsequent publications.

Efficient wildlife populations

When analyzing wildlife economics, most authors include sections on the "Benefits of game animals" and "Costs of wildlife," Gren et al. (2018) suggests that a third section should be included that examines the size of the game species population (i.e., if populations are too high or too low) in relation to the costs and benefits for a society. They state that in theory, economic models should be tied to these game animal populations and that when marginal increases in benefits are observed then that should, in an ideal model, relate to slight increases in the game species populations. If these models are designed correctly then when the game species population reaches an optimum size this should maximize the benefits to society minus the costs. However, before incorporating this data into current wildlife economic models researchers need to better understand how environmental factors and human pressures (e.g. hunting) impact animal population dynamics. Researchers would also need an accurate count of how many animals are in these game species populations to begin with prior to making assumptions about yearly population growth. Thus, game species population counts (e.g. aerial surveys, mortality counts, hunter harvest data) would need to be conducted prior to designing a wildlife economic model.

As mentioned in Chapter 3, population growth follows a logistic or S-shaped growth rate with relatively rapid growth at low population levels and low growth at higher levels. However, this approach does not incorporate other factors such as selective hunting pressure (targeting certain age classes), ecological interactions, and other mortality events (e.g., disease outbreaks or climate change). Many of these factors, make developing relevant wildlife economic cost: benefit models theoretically and empirically challenging for researchers.

Wildlife Policies

Wildlife policies should also be considered when developing wildlife management economic models. While external costs are typically resolved by stakeholders, a third party with regulatory power is usually needed to make population management changes (Gren et al. 2018). This responsibility often falls on government or other regulatory agencies that make policies regarding: the distribution of property rights, command and control policy, and wildlife damage compensation and economic incentives for wildlife damage prevention (Gren et al. 2018).

Distribution of property rights

In wildlife population management, private property rights have both the potential to solve wildlife-human conflicts or to create them. Here we will further illustrate this point by providing two polarizing examples. The first example argues that private property rights provide economic incentives for efficiently managing wildlife populations by providing other opportunities to market wildlife. In northern Florida and southern Georgia, the creation of large, approximately 300,000 acres, quail hunting estates serve to protect populations of endangered Red-cockaded woodpeckers (Engstrom and Palmer 2005). While actively managing these contiguous land parcels with regular prescribed burning regimes, private landowners have allowed populations of both bobwhite and Red-cockaded woodpeckers (*Picoides borealis*) to thrive (Engstrom and Palmer 2005). Both of these species benefit from the removal of mid- and over-story hardwood trees that increase herbaceous ground-cover. While most of these private property owners are actively managing their property to provide hunting opportunities for bobwhite quail (economic stability) they are also providing ecological stability for bobwhite quail and red-cockaded woodpeckers through prescribed burning. In addition to providing a stable environment for these species, these private landowners are providing an economic benefit to society by preserving an endangered species, allowing bird watchers more opportunities to view these species, and providing habitat to other threatened or endangered species (e.g., gopher tortoise, gopher snake, wire grass, long-leaf pines).

When wildlife populations, such as deer, are not actively managed by hunting or a lack of natural predators; populations can increase to the point where human/deer conflicts become a concern. In these situations, deer can damage crops, landscaping, interfere with reforestation, and cause vehicle accidents and be economically costly to society.

Command and control policies

Command and control policies are regulations imposed by a government or other regulatory agency. These policies put regulations on property rights. For example, hunting regulations limit the number of deer harvested on lands within the state, when animals can be hunted (e.g., time and dates), where they can be hunted (e.g., game units), and how they can be hunted (e.g., muzzle loader, archery, rifle). Harvesting regulations are commonly implemented when a species needs protection, and gives populations a change to re-establish themselves in an area. In Norway, when a winter moose hunting season was opened, this resulted in a decrease in moose vehicle collisions and helped to restore wildlife habitat.

Regulatory agencies are also responsible for distributing revenue obtained from legislative Acts such as the Pittman-Robertson Act and Dingell-Johnson Act. The Pittman-Robertson Act places an 11% excise tax on firearms and ammunition. This money is distributed by the Secretary of the Interior to states in relation to the area covered by the state and the number of registered hunters. States then use this money to fund research projects, acquire crucial wildlife habitat, conserve threatened and endangered species habitat, and protect existing wildlife populations. These habitat improvements may also benefit non-hunters by stimulating eco-tourism. Similarly, the Dingell-Johnson Act also known as the Federal Aid in Sport Fish Restoration Act places a tax on rods, reels, creels, and fishing lures that authorizes the Secretary of the Interior to provide financial assistance to states for fish restoration and management plans and projects.

Wildlife payment programs and economic incentives for wildlife damage prevention

Economic compensation programs provide pastoralists and farmers with compensation for killed or injured livestock or crops (based on market values) following wildlife depredation. In poverty-stricken areas, these programs are easily implemented by conservationists and regulatory agencies when resource owners suffer economic losses due to wildlife damage or when wildlife damage mitigation methods are considered ineffective, unethical, too expensive, or threaten the existence of a protected species (Gren et al. 2018).

Although there are some benefits to wildlife compensation programs, there can also be several negative consequences. While these programs can have positive outcomes, there can also be several negative consequences to implementing wildlife payment programs. In Kenya, after the implementation of a wildlife payment program for livestock, there was a notable decline in retaliatory lion killings. However, after the programs implementation, farmers were less likely to practice abatement methods to protect their livestock (Gren et al. 2018). Therefore, it is recommended that when implementing such programs, predation compensations should only be provided to producers that still practice abatement methods. Additionally, when the monetary compensation for livestock or crops is set at a high level, this compensation can have a similar effect to subsidies for producers. This encourages others to begin to produce livestock or to farm crops and increases the availability of prey to predators in an area (Gren et al. 2018). This could also indirectly lead to a decrease in the amount of natural food sources for local livestock as grazing pressure increases in response to livestock production.

Public policies can also provide incentives for using abatement methods such as translocation, scare devices, barriers, or changed in livestock husbandry practices to reduce wildlife damage. Several cost: benefit studies have examined the results of such activities for: supplemental feeding to reduce black bear damage to forests, and the lethal removal of predators and other abatement measures to protect sheep. Berger (2006) suggested that livestock damage compensation payments were more efficient than the subsidies related to predator culling in regard to the profitability of the sheep industry. Additionally, wildlife abatement methods by an individual farmer can lead to an increase in predation on adjacent properties. These brief discussions highlight a few of the positive and negative impacts associated with wildlife payments and the economic incentives for wildlife damage prevention.

Overall, additional research is needed for calculating the economics of wildlife damage management. Such advances are needed before conservationists, wildlife managers, and policy makers can confidently use this data to manage animal populations on a landscape. Currently, the scientific literature available for wildlife policy makers (i.e., mainly bird species) is limited by a lack of economic data quantifying the role of hunting and other activities play in regions or areas. For the most part, these studies are limited to mammal game species such as moose, elk, deer, bears, and wolves. In the future, as economic studies investigating the costs and benefits of birding, game bird hunting, and recreation associated with bird species become more readily available, policy and decision makers will have a more complete idea as to how bird damage management influences bird populations and their resulting economic impacts to our society. As Core and Martin (1985: 283) state: "The value of a day or a trip must be converted to the value of the marginal animal. Otherwise, the value estimate – no matter how precise empirically or theoretically – has little management value."

Shwiff et al. (2005) describe the primary types of considerations for conducting economic analyses of WDM:

- **Direct Benefits:** These are typically calculated as the number of individual animals saved from predation, representing a cost savings, in that with predation management a certain number of losses or amounts of costs can be avoided. The dollar value of the species or animals saved represents the direct benefits of the activity and the losses avoided by stakeholders. However, determining the market value for resources and wildlife species saved is difficult, with livestock usually valued using market price, which is typically conservative, and wildlife species using civil values. Number of animals lost in the absence of BDM activities is difficult to determine. Also reported losses are most likely substantially fewer than actual losses, as many losses are not reported to authorities, not all losses are found in the field, and many carcasses found are too consumed or decayed to make a clear determination of cause of death and species responsible.

- **Spillover Benefits (secondary, indirect, or incidental benefits):** These benefits are an unintentional side effect of the primary purpose of the BDM activity, and may be evaluated using multiplier values from the direct benefits. Spillover benefits can include benefits to wildlife populations in the same geographic area. Indirect benefits can include benefits to local and regional economies.

- **Intangible Benefits:** Such benefits include increased cooperation from landowners as a result of the implementation of BDM, such as facilitating landowner participation in other conservation efforts or potentially minimizing amateur efforts to manage bird damage, which may not be as selective or humane as those conducted by trained professionals.

- **Direct Economic Effects/Costs:** These costs reflect the value of losses to the livestock operator and the associated reductions in purchases for directly supporting those livestock as well as the costs of lethal and nonlethal BDM activities for protection of livestock and/or localized wildlife species, such as valued big game species, recently introduced native species, or ESA-listed species.

- **Indirect Economic Effects:** These effects are generated as livestock loss alters producer purchases of supplies from other industries in the region and outside the region, resulting in additional jobs, increased income for the region, and greater tax revenues.

All of these factors are complicated, interrelated, and difficult to delineate and quantify. As different economic studies use different factors, values, and multipliers, they are very troublesome to make comparisons.

The following summarizes the types of economic analyses typically applied to bird damage management, especially associated with livestock contributions to regional economies (discussed in Schuhmann and Schwabe 2000, Shwiff et al. 2005, Rashford and Grant 2010, Loomis 2012, Shwiff et al. 2012):

- **Cost: Benefit Analysis:** Considers measures of costs that include financial costs (out of pocket expenditures such as for exclusion) and opportunity costs (benefits that would not be available to society based on bird damage management actions taken today) and measures of benefits as evaluated by a consumer's (increase in enjoyment/satisfaction) or producer's (increases in profit) willingness-to-pay (WTP) for one more unit of the identified "good," considered either on a personal level or societal level. On a personal level, the "good" is considered to have economic value if the individual person (recognizing that individuals have differing value systems) receive enjoyment/ satisfaction from the "good" and if the "good" is to some degree scarce. Opportunity costs must also be considered – costs/resources spent on a good that cannot then be used for another purpose. On a societal level, many public natural resources, such as wildlife, may not have a direct market value, but provide satisfaction and enjoyment to some (but not all) segments of society. This is a difficult and subjective analysis (despite attempts at its' quantification), as the direct and indirect factors and discount rates included in such analysis must be carefully considered and evaluated accurately for the contribution they play or this type of analysis can substantially misrepresent the actual situation and/or be readily disputed.

- **Willingness to Pay:** Studies have identified the WTP for non-market goods such as wildlife recreation (mostly hunting, fishing, and wildlife viewing) for individual species, and, to a substantially lesser degree, ecosystem services, such as clean drinking water, pollination and pest management for agriculture, and renewal of soil fertility. WTP can also be used to monetize existence or passive values, such as the value of knowing that a species exists somewhere in the wild, even if the individual never spends any money to actually experience it in the wild.

- Methods used to determine or using WTP have included:

  - **Recreational Benefits:** Considering the costs of travel to experience enjoyment of non-market recreational experiences (Travel-Cost Method; TCM), using a demand curve above actual travel costs obtained through surveys with recreationists, reflecting actual behavior. Shwiff et al. (2012) summarize the primary criticisms of TCM: assumptions that visitors' values equal or exceed their travel costs, because travel costs are not an accurate proxy for of the actual value of the good; values must also be assigned to the time individuals spend traveling to the site, including opportunity costs (time spent traveling cannot be spent doing some other activity) since each person values their time differently; human access to conservation sites may be limited (including access to private land) and individuals may not be aware or have a preference toward the species associated with a chosen recreation site; and if individuals are not willing or able to travel to the site to expend funds, then this method confers no value.

- **Existence/ Altruistic/Bequest Benefits** (depending on whether the benefit is enjoyed by the individual now or by other individuals now, or by other individuals in the future): Constructing a hypothetical or simulated market and surveying individuals if they would pay an increase in their trip costs or an increase in their taxes/utility bills/ overall prices for increasing environmental quality, including wildlife populations, recognizing that the higher the dollar amount respondents are asked to pay, the lower the probability that they would actually pay (Contingent Valuation Method; CVM). This includes situations in which individuals are willing to provide donations to environmental groups to protect resources that they care about, but may never experience themselves. Shwiff et al. (2012) summarize the primary criticisms of CVM: the hypothetical nature of the questionnaires, the inability to validate responses, the high costs of conducting this type of survey, and the difficulty of identifying the target audience. Also, public goods such as wildlife do not lend themselves to this type of valuation and this valuation tends to understate the true non-market value.

- **Benefit Transfer to Other Locations:** Extrapolation of WTP results from one area to another, recognizing that the extrapolation may or may not be reasonable or applicable in another area depending on circumstances. Shwiff et al. (2012) summarize the primary criticisms of the benefit transfer method: the reliability of this methods may be inconsistent as this method depends on estimates created using the CVM or TCM methods; wildlife values in one area may be unique and simply transferring the value associated with a species in one location to the same species in another location does not capture local qualities; preferences and willingness to pay for those preferences may not account for all the values and benefits of wildlife conservation projects, including ecosystem services.

- **Regional Economic Analysis:** Shwiff et al. (2012) describes this method as including estimations of secondary benefits and costs associated with the conservation of wildlife species in units of measure that are important to the general public (revenue, costs, and jobs). Increasing wildlife populations (the primary benefit) may have secondary benefits such as increasing consumptive and non-consumptive tourism, which can be estimated using multipliers to account for changes spread through economic sectors. Loomis and Richardson (2001) used WTP estimates obtained from CVM and TCM studies for estimating the value of the wilderness systems in the US. This requires the use of computer models, which can translate conservation efforts into regional impacts on revenue and jobs. However, secondary benefits or costs cannot be incorporated into a cost: benefit analysis because losses in one region may become gains in another region, potentially leading to offsetting effects.

As Schuhmann and Schwabe (2000) conclude:

- "While these methods [CVM and TCM] are widely used, it is important to stress that none of the approaches mentioned is without its flaws. Indeed, there is continual debate on the validity and tractability of each method…"

- "There is little uncertainty that wildlife-human conflicts impose significant costs on society. Yet, as most wildlife managers, hunters, and nature enthusiasts would agree, there is also enormous value associated with these same wildlife resources."

In addition, the Paperwork Reduction Act of 1995 requires agencies to submit requests to collect information from the public to the Office of Management and Budget (OMB) for approval for surveys used for general-purpose statistics or as part of project evaluations or research studies (https://www.whitehouse.gov/sites/default/files/omb/inforeg/pmc_survey_guidance_2006.pdf). Therefore, any surveys conducted for the purposes of determining WTP and related questions must have all survey questions and designs approved by the OMB. Developing a high quality survey requires professional assistance in designing, executing, and documenting their surveys. This requirement makes it very difficult and expensive to conduct public surveys.

1.21 What Are the Results of CPW Economic Studies on Economic Values Regarding Hunting and Wildlife?

Over 80% of Colorado Parks and Wildlife's funding for wildlife is provided by sportsmen and women through hunting, fishing, and recreational shooting. CPW relies on user fees to pay for wildlife damage management and state parks. In Colorado, hunting contributes $919 million, fishing contributes $1.9 billion, and wildlife viewing adds $2.3 billion to the local economy. From FY 15-16 Colorado state parks had over 12 million visitors annually contributing $1 billion to the state economy. In the next 25 years, Colorado's population is projected to grow by more than 2 million people. Colorado offers over 800 watchable wildlife viewing sites along with 40 birding trails. All birding trails include a visitor center and were made possible through grants by Great Outdoors Colorado. These locations allow the public to view hundreds of birds annual, enjoy natural ecosystems, and provide valuable learning opportunities for children.

1.22 What Are the Economic Concerns Commonly Expressed by Public Comments to WS BDM EAs?

Commenters often request economic analyses that incorporate the combination of the economic contributions of resource and agricultural protection projects and the economic contribution of wildlife-related recreation and values of the existence of wildlife on ecosystem services and recreation opportunities.

Aspects of these values are included in this EA in the evaluation of impacts to target and non-target populations, ecosystem services and biodiversity, [sociocultural/wildlife values] and impacts to recreation.

Commenters to WS BDM EAs commonly express concerns about the economic costs of BDM in relation to the economic values being protected, especially values related to agricultural crops and property, and whether the use of public funds are appropriate to support private profits. These are discussed here and several are included in **Chapter 2**, Alternatives Not Considered.

CHAPTER 2: DISCUSSION OF ALTERNATIVES AND ISSUES

2.1 What is included in Chapter 2?

Chapter 2 discuss the alternatives, identifying issues that will receive detailed environmental impacts analysis in **Chapter 3** (Environmental Consequences), issues that have driven the development of Protective Measures, and issues that will not be considered. Pertinent portions of the affected environment are discussed with the issues used to develop Protective Measures in this chapter. Additional information on the affected environment is incorporated into the discussion of the environmental impacts in **Chapter 3**.

A major overarching factor in determining the issues that are included for analysis is that if the BDM conducted by WS-Colorado were discontinued, what types and levels of BDM would most likely be continued by other entities or private entities (to the extent allowed by state and federal laws). Thus, a minimal amount of BDM activities could take place without federal assistance, and, hence, would not trigger NEPA. Currently, only six full-time private Nuisance Wildlife Control Operators are known working in Colorado at this time. Others may become involved if a business opportunity developed. Additionally, there are a number of pest control companies that infrequently perform wildlife damage management activities when requested by their customers with traditional urban rodent or insect pest damage. From a practical perspective, this means that the Federal WS-Colorado program has a limited ability to affect the environmental outcome of BDM in Colorado.

2.2 What Alternatives Are Analyzed In Detail?

The following issues or concerns about BDM have been identified through interagency planning and coordination, and from EAs in Colorado that have preceded this document (WS 2013, 2016). The following alternatives were developed to meet the need for action and scope of the issues as identified with managing damage caused by birds in Colorado.

Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action). This is the Proposed Action as described in **Chapter 2** and is the No Action Alternative as defined by the Council on Environmental Quality (40 CFR 1500-1508) for analysis of ongoing programs or activities. Under this action, WS-Colorado proposes to continue to provide an integrated BDM.

Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only. Under this alternative, WS-Colorado would use only nonlethal methods for Bird Damage Management. Also, WS-Colorado will recommend the use of nonlethal methods.

Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management. Under this alternative, WS-Colorado would not conduct operational BDM activities in Colorado. If requested, WS-Colorado would provide affected resource owners/managers with technical assistance information only. Operational BDM activities would be conducted by other federal and/or state agencies, local governments, Nuisance Wildlife Control Operators (NWCOs), private individuals, or not conducted.

Alternative 4: No Federal WS-Colorado Bird Damage Management. No action by WS-Colorado would include no investigations of migratory bird damage or reports to support the issuance of federal permits by USFWS. Such permits allow the take of migratory birds to alleviate damage. Additionally, no technical assistance or operational assistance would be provided by WS-Colorado.

For all alternatives in which WS-Colorado provides requested services, WS-Colorado uses the WS Decision Model (**Figure 2.5.1.2**; WS Directive 2.201) for evaluating the situation and determining the most effective strategy to address the situation.

2.3 What Are the Descriptions of the Alternatives?

2.3.1 Alternative 1: Continuing the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).

The Proposed Action/No Action alternative which is also the baseline for the analysis in this EA would continue the current implementation of an integrated approach utilizing all applicable and appropriate techniques and methods, as deemed appropriate by the WS Decision Model (Slate et al. 1992, WS Directive 2.201), to reduce damage and threats of damage associated with birds in Colorado. This is the Proposed Action as described in **Chapter 2** and is the No Action Alternative as defined by the Council on Environmental Quality (40 CFR 1500-1508) for analysis of on-going programs or activities. The Proposed Action is to continue the current portion of the WS-Colorado activities that responds to requests for assistance in dealing with damage associated with birds to protect human health and safety, agricultural and natural resources, and property, and conduct disease surveillance projects involving birds as needed. The largest component of BDM in Colorado is to reduce, resolve, and prevent bird damage and to alleviate threats to human health and safety at airports. In order to meet these BDM goals, WS-Colorado consults each year with the USFWS, CPW, CDA, CDOT, DoD, FAA, USFS, and BLM, and would continue to respond to requests for assistance with, technical assistance, or when funding is available, operational damage management.

Under this alternative, WS-Colorado would be able to respond to requests for assistance by: 1) taking no action, if warranted, 2) providing only technical assistance to requests from resource owners or managers on actions they could take to reduce damages associated with birds, or 3) provide technical and direct operational assistance to persons requesting assistance (resource owners or managers). Technical and operational activities conducted by WS-Colorado are primarily funded by entities requesting assistance. The Decision Model described by Slate et al. (1992) and WS Directive 2.201 is a mental exercise in problem solving and is common to most, if not all, professions, including WS. The decision model would be applied to requests for assistance to determine appropriate action to alleviate bird damage to resources.

While following these guidelines, WS-Colorado will respond and provide information to all requests for assistance regarding wildlife and wildlife damage. At a minimum resource, owners and managers will be provided technical assistance regarding the use of appropriate methods and direct damage management assistance may be provided by a professional WS-Colorado specialist or biologist using an Integrated Wildlife Damage Management (IWDM) approach if funding is available. Technical assistance typically consists of providing the requestor with information about the species associated with the damage, a discussion on the extent of the damage, and previous methods used by the cooperator to alleviate damage. Types of technical assistance may include: written communication, telephone conversations, presentations to interest groups (including homeowners and government agencies), and/or site visits to the affected properties. Part of technical assistance would be completing WS Form 37 Migratory Bird Damage Project Reports for the Fish and Wildlife Service to evaluate applications to take birds to alleviate damage. WS-Colorado recognizes that education is an essential component in wildlife damage management because, the main goal is to reach a balance between the needs of wildlife and the needs of human society. An IWDM approach encourages the use of any practical, effective, legal technique or method, used singularly or in combination, to meet the requestor's need in resolving damage associated with birds. Additionally, WS-Colorado frequently provides lectures, courses, demonstrations, and outreach activities to homeowners, producers, local and county officials, research professionals, and other interest groups. Periodically, information is presented at professional meetings and/or conferences so that recent technological advancements can be shared with other wildlife professionals and the public.

Operational damage management would include only those wildlife damage activities that WS' personnel directly conduct or supervise. WS-Colorado may initiate operational damage management assistance only when technical assistance is not effective in alleviating the damage or threat of damage associated with an issue and funding is available. Operational damage management assistance will only proceed once the entity requesting assistance has signed an agreement, work initiation document, or comparable document. An initial site visit is needed to assess the damage, and determine the availability (legal and administrative) of strategies and methods based on legal, biological, humaneness, economic, and social considerations to alleviating the problem. In general, the integrated use of several methods simultaneously or sequentially is the most effective approach to resolve damage. After the implementation of such strategies, WS employees will continue to monitor and evaluate the situation to assess effectiveness. If the strategies implemented were effective, the need for further management actions would end (Slate et al. 1992).

Under this alternative an integrated BDM strategy would be considered to alleviate or prevent damage. When practical and effective, nonlethal methods would be used under the WS Directive 2.101. Nonlethal methods may include but are not limited to, habitat/behavior modification, lure crops, visual deterrents, inactive nest destruction, live trapping, translocation, frightening devices, exclusionary devices, and chemical repellents. Lethal methods used by WS-Colorado, may include live-capture followed by euthanasia, egg addling/removal, the avicide DRC-1339, and/or take by use of firearms. The euthanasia of live-captured birds would occur in accordance with WS Directive 2.505 and will consist of acceptable forms of euthanasia for free ranging birds with conditions in accordance with the AVMA (AVMA 2013). Birds taken as part of operational projects may be donated for human or wild animal consumption at zoos or wildlife rehabilitation centers.

The USFWS would evaluate reports provided by WS-Colorado to assess applications for the take of migratory birds to alleviate damage. Applications for the take of migratory birds must be submitted by the landowner or public land manager. The evaluation considers the damage caused by migratory birds, economic impact of the damage, effective nonlethal methods available and were the methods attempted as well as the biological impact on the species causing damage. After the USFWS concludes its evaluation a permit may be issued, denied or modified.

2.3.2 Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.

Under this alternative, WS-Colorado would only provide nonlethal technical and operational BDM assistance in Colorado. Technical assistance including information, demonstrations, recommendations, and appropriate methods and techniques would be provided to cooperators experiencing damage or threats of damage associated with birds. The implementation of such recommendations, methods, and techniques would be the responsibility of the requester with additional nonlethal operational assistance provided by WS-Colorado if requested. In some instances, WS-Colorado may be able to loan supplies or material, when funding is available, to requestors. As with other proposed action alternatives, a key component of the assistance provided by WS-Colorado will be to educate the requester about wildlife, wildlife damage, and wildlife damage management.

Technical assistance would include information gathered about the species(s) identified by the requestor associated with the damage, extent of damage, history of issue, and previous methods attempted by the cooperator to alleviate the issue. WS-Colorado would then provide nonlethal information, recommendations, and strategies in accordance to the information provided by the cooperator. In general, several management strategies, including those for short and long-term solutions, may be described to the requester to manage damage based on the level of risk, need and practicality of their application. Only methods that are legally available for use by the appropriate individual or entity will be recommend for use. Methods such as the use of DRC-1339 for blackbirds, pigeons, and gulls, would be excluded since these methods are lethal and currently only available for use by WS.

WS-Colorado biologists would stop providing assistance to requestors seeking to obtain a Migratory Bird Depredation Permit (MBDP) from USFWS for lethal take. WS-Colorado would provide a Form 37 recommending nonlethal take only. The USFWS will need to process MBDP lethal requests without WS-Colorado involvement.

Nonlethal methods that may be employed or recommended by WS-Colorado include, trapping and translocation of birds (e.g., raptors), the use of pyrotechnics, husbandry, habitat alteration and/or exclusionary devices such as netting and overhead lines. It should be noted that exclusionary devices are most effective when used in small localized areas to protect high value resources (e.g. aquaculture).

Entities seeking to reduce damage through lethal operational assistance would need to request help from other governmental agencies, private entities, or conduct such activities on their own. Where nonlethal methods are impractical or ineffective, WS would refer resource owners or managers requesting appropriate lethal methods to other government agencies and private entities. In order to use lethal methods for migratory bird damage management, resource owners and managers would be required to apply for a migratory bird depredation permit issued by the USFWS to take birds. A federal permit is not required to take non-native bird species (e.g., starlings, house sparrows, feral pigeons, etc.), state managed bird species, or birds excluded from 50 CFR part 10.

WS-Colorado biologists would complete a Migratory Bird Damage Report (WS Form 37) as part of the permitting process in order to evaluate the damage or threat of damage associated with birds to implement nonlethal take (e.g., capture and relocation). Following review of this permit application from a resource owner or manger, USFWS officials would issue a Migratory Bird Depredation Permit to authorize the nonlethal take of a specific number of birds and species. Under this alternative, the lethal take of migratory birds is prohibited and WS-Colorado would not participate under this nonlethal alternative.

2.3.3 Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.

Under this alternative, WS-Colorado would respond to requests for assistance by: 1) taking no action, if warranted, or 2) providing only technical assistance to requests from resource owners or managers on actions they could take to reduce damages associated with birds or refer requestors to other agencies or NWCOs. Technical assistance would include providing information, demonstrations, recommendations, and appropriate methods and techniques to cooperators. Persons requesting a migratory bird depredation permit would receive technical assistance and a Form 37 Migratory Bird Damage Project Report to be submitted to the USFWS with their permit application. The implementation of such recommendations, methods, and techniques would be the sole responsibility of the requester with no operational assistance by WS-Colorado. This alternative would exclude WS-Colorado from providing nonlethal and lethal operational assistance similar to alternatives 2 and 4. This would effectively preclude the use of certain methods, such as nonlethal and lethal techniques and methods including, live trapping and translocation, and DRC-1339.

WS-Colorado employees would initially gather information about the species(s) identified by the requestor associated with the damage, extent of damage, history of damage, and previous methods attempted by the cooperator to alleviate the issue. WS-Colorado would then provide information, recommendations, and strategies in accordance to the information provided by the cooperator. In general, several management strategies, including those for short and long-term solutions, may be described to the requester to manage damage based on the level of risk, need, and practicality of their application. In such cases, WS-Colorado would have no responsibility for any lethal or nonlethal actions implemented by the requester upon the advice and recommendations from WS-Colorado personnel. The requester is responsible for compliance with the Endangered Species Act and all other Federal, state, and local laws and regulations.

2.3.4 Alternative 4: No Federal WS-Colorado Bird Damage Management.

This alternative would exclude any federal involvement by WS-Colorado to reduce threats to human health and safety, and alleviate damage to agricultural resources, property, and natural resources involving birds. WS-Colorado would not be involved with any aspect of bird damage management within Colorado including technical assistance or operational assistance. All requests for assistance to alleviate damage associated with birds received by WS-Colorado would be referred to the USFWS, CPW, CDA or private entities. This alternative would not prevent other federal, state, and/or local agencies or private entities from conducting BDM activities to alleviate damage and threats to resources in Colorado. Therefore, entities seeking assistance in addressing damage associated with birds would be unable to contact WS-Colorado but instead would only be able to refer the requester back to other entities. The requester would then be able to contact other entities for additional information and assistance, and could take actions to alleviate the damage or conduct such activities on their own. https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/sa_reports/ct_wildlife+damage+management+technical+series.

Table 2.1. Evaluation of whether activities would be performed for each of the Alternatives. Y= Yes, N = No.

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4
A. Nonlethal BDM Technical Assistance.	Y	Y	Y	N
B. Lethal BDM Technical Assistance.	Y	N	Y	N
C. Form 37 Recommendations for Federal Permit.	Y	N	Y	N
D. Operational BDM (Nonlethal).	Y	Y	N	N
E. Lethal Operational BDM.	Y	N	N	N

2.4 What Issues Are Analyzed in Detail in Chapter 3?

In Chapter 3, we discuss issues and concerns regarding potential impacts that might result from the proposed action(s). The issues described below have been identified by WS-Colorado experience, previous EAs, and public comments as they relate to managing damage associated with birds in Colorado. These issues, as they are discussed here in relation to the possible implementation of the alternatives, provide a context for their analysis in **Chapter 3**. The issues analyzed in detail are as follows:

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Populations.
Issue B: Impacts of Bird Damage Management on Non-target Bird Species, Including T & E Species.
Issue C: Impacts of Bid Damage Management Methods on Public and Pet Safety and the Environment.
Issue D: Impacts of Bird Damage Management on Sociocultural Resources.
Issue E: Impacts of Bird Damage Management on Humaneness and Animal Welfare Concerns.

2.4.1 Issue A: Impacts of Bird Damage Management Activities on Target Bird Populations.

A common concern among members of the public, wildlife management agencies, and WS is whether BDM actions adversely affect the viability of target native species populations. The target species selected for analysis in this EA have been identified as species which may be impacted by WS-Colorado BDM activities; especially those species that more than 10/yr would be removed with lethal control measures under the proposed action. Species taken lethally by WS-Colorado with an average of more than ten taken/year included four nonindigenous commensal birds (European starling, feral domestic rock pigeon, house sparrows, and Eurasian collared-dove); one native dove (mourning dove); four blackbird spp. (Red-winged blackbird, Brewer's blackbird, brown headed-cowbirds, and common grackle); one swallow (cliff swallow); four grassland passerines[5] (horned lark, western meadowlark, western kingbird, and lark bunting); three waterfowl (Canada goose, mallard, and blue-winged teal); three corvids (common raven, black-billed magpies, and American crow); five raptors (red-tailed, Swainson's, Ferruginous, American kestrel, and Northern harrier); one shorebird (killdeer); and one gull (ring-billed gull) from FY13 to FY17 (**Table 3.8**).

Additionally, 31 other species were taken, but annual take averaged less than 10 for FY13 to FY17 (**Table 3.8**). No other species were taken by WS-Colorado in BDM from FY13-17, other than those given in **Table 3.8**. This analysis will address impacts to these species as well as others that WS anticipates may be taken. In addition, some concerns have been voiced about potential impacts from WS' harassment and hazing activities on birds (**Table 3.8**). Finally, some species of birds taken or harassed by WS-Colorado are also harvested by hunters, NWCOs, and private individuals and businesses. Where data is available, harvest data will be used with WS-Colorado take to determine cumulative impacts.

The analysis to determine the magnitude of impacts of BDM on the populations of bird species addressed in this EA are based on a measure of the number of individuals lethally removed in relation to that species' population abundance within the state. WS only uses lethal methods as requested by cooperators seeking assistance and permitted by the USFWS, under depredation orders, or if bird species are invasive and are not protected by the federal government or state laws. Any activities conducted by WS personnel and permitted by the USFWS under the alternatives addressed would occur along with other natural processes and human-induced events, such as natural mortality, private damage management activities, mortality from regulated harvest, and anthropogenic alterations of wildlife habitat. Lethal take is monitored by comparing the number of birds lethally removed with overall populations or trends based on publicly available data. Information on bird species populations and trends are derived from several sources including the North American Breeding Bird Survey (BBS), the Partners in Flight Landbird Population database, the Colorado Breeding Bird Atlas Project, the Rocky Mountain Avian Data Center, Christmas Bird Counts published literature, and harvest data. Further information on those sources is provided in **Chapter 3**.

To fully understand the need for BDM, it is important to have background knowledge about the species causing damage and the likelihood that damage will occur. Full life histories of the species discussed here may be located in ornithology reference books. Here, we give a limited background on the bird species found Colorado and covered by this EA, specifically information pertaining to their seasonal movements in Colorado. Species are given in order of WS BDM efforts directed towards them, their subsequent take, and the occurrence and value of damage that the species cause in Colorado. However, species that cause a limited amount of damage may be combined with species that cause more damage where life histories and damage are somewhat similar. Finally, it should be noted that jurisdiction and management of these bird species lies with USFWS and CPW which was discussed in **Chapter 1**. WS-Colorado has the authority to manage damage only caused by birds. It has no authority to manage bird populations in Colorado, the flyway, region or United States, or issue permits for the take of protected bird species.

[5] Categories of birds for this EA in Section 2.13.

2.4.2 Issue B: Impacts of Bird Damage Management on Non-target Bird Species, Including T & E Species.

Of most concern to WS-Colorado, and others, are BDM activities that may potentially impact non-target species, including Threatened and Endangered (T&E), and sensitive bird species (state Species of Concern) that have limited populations. The federal Endangered Species Act (ESA) makes it illegal for any individual to "take" any listed endangered or threatened species or their critical habitat. Take is defined as, "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 USC 1531-1544). Critical habitat is classified as specific areas within a geographic area or areas that are essential for the conservation of a threatened or endangered species. The ESA requires that federal agencies conduct their activities in a way that conserves species. Federal agencies are also required to consult with the USFWS prior to undertaking any action that may impact listed endangered or threatened species or their critical habitat pursuant to Section 7(a)(2) of the ESA. As part of the scoping process to facilitate interagency cooperation, WS consulted with the USFWS pursuant to Section 7 of the ESA during the development of this EA, which is discussed further in **Chapter 3**.

There also may be concerns that WS' activities could result in the disturbance of eagles that may be near or within the vicinity of WS' activities. Under 50 CFR 22.3, the term "disturb," as it relates to the take under the Bald and Golden Eagle Act, has been defined as "to agitate or bother a bald and golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) Injury to an eagle, 2) A decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) Nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." The environmental consequences evaluation conducted in **Chapter 3** of this EA will discuss the potential for WS' activities to disturb eagles as defined by the ESA.

Colorado has 20 bird species or subspecies considered T&E, or sensitive (**Table 2.2**). Some federal and state listed species have the potential of being impacted as a result of a BDM project. Any activity involving a listed species would require a Section 10 or State permit under ESA, Colorado laws, or other allowance to conduct that activity. Additionally, the species likely being impacted, its status throughout its range, and available techniques would be considered. In most all situations, nonlethal techniques would likely be used including live trapping and translocation. In addition, Colorado has documented 79 species considered sensitive species by USFWS (2008) and National Audubon Society (2007) watchlist.

Table 2.2. Federal and State listed avian T&E and candidate species in Colorado and potential of them to be targeted in BDM or the potential impact as a non-target species in BDM.

Species	*Scientific Name*	Status	Locale	BDM Target	Protected by BDM	BDM Non-target
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	FC ST	Southeast	A/S	N P	F
Plains Sharp-tailed Grouse	*Tympanuchus phasianellus jamesii*	SE	Far East	A/S	N P	F
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	SC	Northwest	A/S	N P	F
Greater Sage-Grouse	*Centrocercus canadensis tabida*	FC SC	Northwest	A/S	N P	F
Gunnison's Sage-Grouse	*Centrocercus minimus*	FC SC	Southwest	A/S	N P	F

Bald Eagle	*Haliaeetus leucocephalus*	SC	Statewide	A/S Aq L	0	F R
Ferruginous Hawk	*Buteo regalis*	SC	Statewide	A	0	F R
American Peregrine Falcon	*Falco peregrinus anatum*	SC	Statewide	A L	0	F
Whooping Crane	*Grus americana*	FE SE	Far East	A/S Aq	0	FT
Greater Sandhill Crane	*Grus canadensis tabida*	SC	West	A/S Aq	N	F
Western Snowy Plover	*Charadrius alexandrinus*	SC	Statewide	A/S	N	F M
Piping Plover	*Charadrius melodus*	FT ST	Statewide	A/S	N	F M
Mountain Plover	*Charadrius montanus*	SC	Statewide	A/S	N	F M
Long-billed Curlew	*Numenius americanus*	SC	Statewide	A/S	0	F
Least Tern	*Sterna antillarum*	FE SE	East	A/S Aq	N	F M
Western Yellow-billed Cuckoo	*Coccyzus americanus*	FT SC	West	0	0	0
Burrowing Owl	*Athene cunicularia*	ST	Statewide	A	0	F
Mexican Spotted Owl	*Strix occidentalis lucida*	FT ST	South	0	0	0
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	FE SE	Southwest	0	C	0
Sprague's Pipit	*Anthus spragueii*	FC	Statewide	A/S	0	F

STATUS
F - Federal
S - State
E - Endangered
T - Threatened
C – Candidate/Concern
P – Proposed

BDM Target
A – Airport
Aq – Aquaculture
L – Livestock/Poultry
S – Toxic Spill (*e.g.,* oil)
0 – Not Targeted

BDM to Protect
C – Cowbird Nest Parasitism
N – Egg/Nestling Depredation
P – Predation Adults
0 - none

BDM - Non-target
F –Frightening Devices
M – Mist Nets
R – Raptor Traps
T – Toxicants
0 – No Impact

2.4.3 Issue C: Impacts of Bird Damage Management on Public and Pet Safety and the Environment.

Potentially Impacted Environment

Damage or threats of damage associated with bird species addressed in this EA can occur throughout Colorado. However, WS-Colorado only provides assistance when the appropriate resource owner or manager requests assistance and only when the appropriate paperwork has been signed (cooperative service agreement, work initiation document, or another similar document). Most bird species covered in this EA utilize a variety of habitats in areas where foraging, loafing, roosting, and nesting sites are readily available. Requests for bird damage management occur throughout the State of Colorado since many of the bird species listed herein have broad geographic distributions. **Chapter 3** contains supplemental information analyzing how the environment is impacted by BDM activities while providing BDM assistance on federal, state, county, municipal, and private lands in Colorado. Once a request for assistance has been received under the Proposed Action alternative, or those actions described in the other alternatives, BDM could be conducted on private, state, federal, tribal, and/or municipal lands in Colorado to reduce damages to agriculture, natural resources, property, and human health and safety associated with birds. The analyses in **Chapter 3** are intended to apply to actions taken under the selected alternative that has the potential to occur at any locale at any time within the area analyzed. This EA analyzes the potential impacts of bird damage management and associated activities in Colorado that have been conducted and are currently being conducted under a cooperative service agreement, work initiation document, or other similar documents within WS. WS-Colorado will also briefly discuss the potential impacts of future BDM activities that have the possibility of occurring within the state.

It should be noted that the USFWS **requires** a migratory bird depredation permit for the intentional take of migratory birds. Therefore, the affected environment could include areas in and around public, private, commercial, industrial buildings and facilities where birds may roost, feed, loaf, or nest. Examples of areas where bird damage management activities could occur include: public parks, bridges, urban/suburban woodlots, residential buildings, golf courses, industrial parks, agricultural areas, wetlands, cemeteries, hydro-electric dam structures, reservoirs, electrical substations, landfills, transmission line right-of-ways, military bases, dairies, ranches, livestock operations, grain handling areas, vineyards, orchards, and airports.

Impacts of Chemical Methods

Some individuals have expressed concerns that they believe that chemical BDM methods could adversely affect people and pets from direct exposure or indirectly from birds that have died from chemical use. Under the proposed alternatives in this EA, the avicides that WS could use are DRC-1339, an avicide used to remove damaging feral pigeons, starlings, crows, blackbirds, and gulls. Chemical repellents that could be used under the proposed action include methyl-anthranilate (MA), an artificial grape flavoring used in the food industry that repels many bird species, methiocarb (Mesurol® - Gowan Co., Yuma, AZ) used in eggs to repel corvids from raiding nests of other birds, and polybutene products which are bird repellents that have a tactile, sticky consistency to touch and are applied directly to problem locations to prevent birds such as feral pigeons from perching. Avicides and chemical repellents are regulated under FIFRA and Colorado pesticide laws by EPA and CDA, and applied by WS under their management and in accordance with labeling and WS Directives. WS applicators are certified by the State and must complete a written examination and undergo recurrent training.

Impacts of Use of Firearms and Pyrotechnics

Some people may be concerned that WS's use of firearms and pyrotechnic bird scaring devices could cause injuries to people and indirect harm to pets. WS personnel occasionally use small caliber firearms or air rifles and shotguns to remove feral domestic pigeons and other birds that are causing damage, and would continue to use such firearms in bird damage situations. WS policy has requirements for training, safe use, storage and transportation of firearms as prescribed by the WS Firearms Safety Training Manual (WS Directive 2.615). The required firearms training is conducted annually by certified instructors. Hands-on firearms proficiency is evaluated in the field and candidates must pass a written exam. Therefore, firearms are handled in a safe manner with consideration given to the proper firearm to be utilized, the target density, backstop, and unique field conditions.

WS would also use pyrotechnic cartridges fired from 15 mm pistols and 12 gauge shotguns. Pyrotechnics often emit sparks when launched, creating some potential fire hazard to private property from field use. Prior to the implementation of formalized training standards, other states reported incidents where small fires were started from the use of pyrotechnics in the field. Pyrotechnics storage, transportation, and use are regulated by the Alcohol, Tobacco and Firearms

Bureau, Department of Transportation, and WS policy respectively. WS requires adherence to all federal, state, and local laws. Pyrotechnics on-hand are less than 50 lbs. in total weight of active material; that, along with industry approved packaging of the materials allow WS's pyrotechnics to be classified as Division 1.4 (formally known as Class C), the lowest classification of explosive materials as defined by the Alcohol, Tobacco and Firearms Bureau. Pyrotechnics are stored and transported in approved metal boxes. Training for pyrotechnics field use is also conducted and maintained under the WS Firearms Safety Training Manual guidelines. Pyrotechnics also make loud whistling, screaming or explosion sounds to scare birds and other wildlife. Some pets, primarily dogs afraid of loud noises, may show fear and whimpering from the noise. WS will try to make people aware of bird hazing operations in urban/suburban environment and minimize the time birds are hazed to alleviate impacts on pets or allow pet owners to make alternative plans to care for their pets.

On the other hand, public health and safety may be jeopardized by not having a full array of BDM methods for responding to complaints involving threats to human health and safety such as bird airstrike hazards and a disease outbreak. Many bird species such as raptors, gulls, and starlings represent a major strike risk for aircraft at airports and are commonly struck (Dolbeer 2006). This can result in damage and injuries to people. Additionally, disease, especially the potential for High Path H5N1 Avian Influenza, could be a significant threat to humans. Surveillance of this disease is being conducted in much of the United States in migratory birds to monitor for its presence. WS-Colorado uses several BDM methods to capture target animals, depending on the specifics of these types of situation. Firearms, traps, mist nets, chemical immobilization, or toxicants may be used to take a target bird. BDM methods that may pose a slight public safety risk may be used safely and effectively to eliminate or monitor for a recognized public safety risk.

Impacts of BDM on Water Quality and Wetlands. Two issues arose regarding water quality and wetlands in WS EAs (WS 1999, 2001) that were believed to be impacted by BDM targeting blackbirds at feedlots and other locations with avicides. Some discussion is provided here to ensure the reader that these issues have been considered.

Potential for BDM Chemicals to Runoff site and Affect Aquatic Organisms*.*

Common name DRC 1339 ($C_7H_9CI_2N$, CAS No. 7745-89-3) 3-chloro-p-toluidine hydrochloride (synonyms: 3-chloro-4-methylbenzenamine hydrochloride, or 3-chloro-4 methylaniline hydrochloride). Initially named after a testing code from the Denver Research Center (DRC) as the 1,339th chemical evaluated as a toxicant. This restricted use chemical is used by the U.S. Department of Agriculture (USDA) Wildlife Services (WS) to reduce bird conflicts at livestock facilities and airports, and to reduce damage to crops, livestock, property, and natural resources, including threatened and endangered species, per label allowances.

As a slow acting avicide, it has proven to be an effective tool for addressing starling, pigeon, blackbird, corvid, and gull damage (West et al. 1967, West and Besser 1976, Besser et al. 1967, and DeCino et al. 1966). Following the consumption of a lethal dose, DRC-1339 kills target bird species within 3 to 80 hours (Dawes 2006). Prior to death, DRC-1339 is partially to mostly metabolized (Schafer 1984, Goldade 2017). In treated birds, DRC-1339 causes renal failure that results in weight loss, depression, lethargy, increased thirst and urination, dehydration, articular gout, and eventually culminates in death (Merck 2018). Birds that consume lethal doses may appear asymptomatic (showing no physical signs of distress) for many hours following chemical ingestion. Typically in the hours before death (~4 hours), birds cease to eat or drink and become listless, inactive, and may appear comatose (Dawes 2006). Although acutely toxic to many pest bird species, this chemical appears to pose little risk of secondary poisoning to nontarget animals, including avian scavengers (Cunningham et al. 1979, Schafer 1984, Knittle et al. 1990).

For highly sensitive species, such as starlings (average weight 89 grams), a minimal lethal dose of 0.3 mg/g of bird body weight is needed to cause death (Royall et al. 1967). Other non-sensitive species, such as raptors, house sparrows, and finches require a higher dose to cause death (Eisemann et al. 2003). A house sparrow weighing 29 grams would need to consume a lethal dose of 9 mg/g, a 22 g house finch and a 118 g American kestrel would require more than 5 mg/g and 38 mg/g to cause death, respectively (DeCino et al. 1966, Schafer 1983). Thus, secondary hazards due to DRC-1339 are very low unless the toxic bait is still largely intact in the carcass.

Environmental Fate

In general, DRC-1339 rapidly degrades in the environment following operational application. When exposed to sunlight or ultraviolent radiation DRC-1339 has an average degradation half-life (in soil) of 0.17 days based on soil type (WS 2019). In Texas loam soil DRC-1339 has a half-life of 0.02 days in LAD clay soil (WS 2019). DRC-1339 rapidly and irreversibly binds to soil organic matter suggesting that the volatilization of the chemical from the soil into the atmosphere is not a likely pathway for exposure. Similarly, it appears that DRC-1339 has a low potential for volatilization into the atmosphere from aqueous solutions due to its moderate vapor pressure (1.06 x 10^{-4} torr at 25 ° C) and a high Henry's Law constant value (~1.47 x 10^{-8} atm-m^3-mol^{-1}). Due to its high affinity to soil organic matter it has a low potential for migration into groundwater and surface water sources (WS 2019).

In water, DRC-1339 is highly soluble, resistant to hydrolysis, sensitive to light, and has a half-life ranging from 6.5 to 41 hours depending on season. Depending on the season applied, DRC-1339 will degrade more rapidly in summer months than in winter (USEPA 2011). DRC-1339 is not expected to bioconcentrate in aquatic environments. In field trials, bluegill fish exposed to DRC-1339 have an average bioconcentration factor of 33x (edible tissues), 150x (in non-edible tissues), and 88x (whole fish) (Spanggord et al. 1996, USEPA 2018).

Aquatic Effects Analysis

Due to concerns raised during interagency discussions regarding DRC-1339 having adverse effects on aquatic organisms, we have included a more detailed analysis of these potential impacts following use of the product. Under current BDM activities, WS-Colorado would use DRC-1339 in accordance with EPA-approved label directions regarding application and vigilance for use around threatened and endangered species. Available acute and chronic toxicity data are summarized for all major terrestrial and aquatic taxa below (**Table 2.4, 2.5**). Information contained in these tables, was gathered from online databases and searches from relevant peer reviewed and published literature (WS 2019).

Table 2.4. Acute aquatic invertebrate toxicity for DRC-1339 technical.

Test species	Test	Results	Reference
Cladoceran (*Daphnia magna*)	EC_{50}	0.07 mg/L	USEPA 2011a
	LC_{50}	1.6 mg/L	Marking and Chandler 1981
Caddisfly (*Isonychia* sp.)	LC_{50}	6.5 mg/L	Marking and Chandler 1981
Mayfly (*Hydropscyche* sp.)	LC_{50}	12 mg/L	Marking and Chandler 1981
White River Crayfish (*Procambarus acutus*	LC_{50}	15 mg/L	Marking and Chandler 1981
River Horn Snail (*Oxytrema catenaria*)	LC_{50}	6.7 mg/L	Marking and Chandler 1981
Glass Shrimp (*Palaemetus kadiakensis*)	LC_{50}	6.1 mg/L	Marking and Chandler 1981

Panaeid Shrimp (*Panaeus* sp.)	LC_{50}	10.8 mg/L	Walker et al. 1979
Blue Crab (*Callinectes sapidus*)	LC_{50}	16.0 mg/L	Walker et al. 1979
Asiatic Clam (*Corbicula manilensis*)	LC_{50}	18.0 mg/L	Marking and Chandler 1981

Table 2.5. Acute oral median lethality and subacute dietary DRC-1339 toxicity studies for mammals and birds.

Test species	Test	Results	Reference
Mammals			
Brown Rat (Laboratory)	LD_{50}	302 mg/kg	USEPA 2018a
North American Deermouse	ALD	1,800 mg/kg	Schafer and Bowles 1985
Brown Rat (white lab)	LD_{50}	1,170-1,770 mg/kg	Ford 1967
Domestic Dog ^	LD_{50}	>100 mg/kg	Ford 1967
Domestic Sheep	LD_{50}	>200 mg/kg	Ford 1967
Birds			
Mallard	LD_{50}	105 mg/kg	USEPA 1995
	LC_{50}	322 mg/kg (98% a.i.)	
Chachalaca (*Ortalis* sp.)	LD_{50}	42.1 mg/kg	Eisemann et al. 2003
Northern Bobwhite	LD_{50}	2.9 mg/kg	USEPA 1995
	LC_{50}	14.1 mg/kg (98% a.i.)	
Ring-necked Pheasant	LD_{50}	10 mg/kg	Eisemann et al. 2003
Domestic Turkey	LD_{50}	10.26 mg/kg	Eisemann et al. 2003
Rock pigeon	LD_{50}	17.7 mg/kg	Eisemann et al. 2003
Mourning Dove	LD_{50}	3.2 mg/kg	Eisemann et al. 2003
Herring Gull	LD_{50}	4.6 mg/kg	Eisemann et al. 2003
Cooper's Hawk	LD_{50}	562 mg/kg	Eisemann et al. 2003
Barn Owl	LD_{50}	4.2 mg/kg	Eisemann et al. 2003
Scrub-Jay (*Aphelocoma* sp.)**	LD_{50}	1.8 mg/kg	Eisemann et al. 2003
American Crow	LD_{50}	1.33 mg/kg	Eisemann et al. 2003
Common Raven	LD_{50}	2.9 mg/kg	Eisemann et al. 2003
European Starling	LD_{50}	3.2 mg/kg	Eisemann et al. 2003
House Sparrow	LD_{50}	375 mg/kg	Eisemann et al. 2003
Red-winged Blackbird	LD_{50}	2.4 mg/kg	Eisemann et al. 2003

*ALD – Acute Lethal Dose estimated LD_{50} when unable to calculate ^ Emetic at doses of 10, 50 and 100 mg/kg a.i. = active ingredient
** Species split into 4 species (Island (*Aphelocoma insularis*), California, Florida (*A. coerulescens*), and Woodhouse's (*A. woodhouseii*) Scrub-Jays) since Schafer et al. (1983), the data used in Eisemann et al. 2003 (likely California or Woodhouse's, or both, knowing where birds captured).

Moderately toxic to fish, DRC-1339 has a 96-hour median lethality concentration (LC_{50}) for bluegill (11 ppm), rainbow trout (9.7 ppm), and southern leopard frog (*Rana sphenocephala*) tadpoles (44 mg/L) (Marking and Chandler 1981). Aquatic invertebrates are also moderately sensitive to DRC-1339 depending on the species (**Table 2.4**). The 48-hour median effective concentration (EC_{50}) for aquatic invertebrates exposed to DRC-1339 is 0.07 ppm for freshwater cladoceran (USEPA 2011). Marine invertebrates appear to be more tolerant to DRC-1339 with 96 hour LC_{50} values of 10.8 and 106.0 ppm for penaeid shrimp and blue crabs, respectively (Walker et al. 1979, WS 2019) (**Table 2.4**).

Indirect Effects of Carcasses from Control Actions on Aquatic Environments

Available toxicity data for the technical a.i. (active ingredient) and formulation demonstrate comparable toxicity based on mammalian data (**Table 2.5**). Formulation toxicity is expected to be similar to the technical a.i. because 97% of the a.i. is in the formulated product. The rate of metabolism and degradation in non-target species after ingestion is unknown but is assumed to be similar to the three major degredates identified from environmental studies including carbon dioxide, 3-hydroxy-p-toluidine, and N-acetyl-3-chloro-p-toluidine. Carbon dioxide and N-acetyl-3-chloro-p-toluidine were measured in an aerobic soil metabolism study and 3-hyroxy-p-toluidine was the primary degradate in an aqueous photolysis study (USEPA 2011).

Concerns have been specifically raised concerning the risk of environmental contamination from application of DRC-1339 and toxicity exposure to aquatic organisms from carcasses of birds killed with DRC-1339. Aquatic exposure from proposed DRC-1339 applications is expected to be low based on the method of application, proposed use pattern and mitigation measures to protect aquatic resources. The current use restrictions for the Bird Control and LNF labels require a 50-foot "No-treatment" application buffer from manmade and natural water bodies that will reduce the potential for DRC-1339 to enter water bodies from runoff. Drift is not a potential pathway for exposure since applications are made as a bait and only broadcast in limited applications. No applications are allowed on either label using aerial application equipment, further reducing the potential for any off-site transport.

A very conservative estimate of aquatic residues was made using the maximum application rate from the Bird Control label (0.1 lb. a.i./acre) and assuming that all of the material would be deposited into a static water body. The maximum application rate for the LNFD label is 0.083 lb. a.i. per acre. The water body dimensions evaluated in this assessment were one acre in area and one to six feet deep. The maximum instantaneous DRC-1339 residues from this estimate ranged from 0.006 to 0.035 mg a.i./L. These are conservative estimates of exposure since it assumes all material from a treatment area would be deposited into a water body, assumes no DRC-1339 degradation and does not account for the mitigating effects of the "No treatment" application buffer. The aquatic residue values can be compared to the aquatic effects data for DRC-1339 to determine whether there is any potential for risk under the proposed exposure scenario.

Indirect Effects of Carcasses from DRC-1339 Applications on Aquatic Environments

The risk to aquatic organisms from the use of DRC-1339 is minimal due to the method of application, label requirements for removal of unused bait and carcasses, and "No treatment" buffers adjacent to aquatic habitats. A comparison of the available data investigating acute aquatic residues in static water bodies show a wide margin of safety for aquatic organisms (**Figure 2.1**). Chronic effects of exposure to DRC-1339 for aquatic organisms is not available, but the methods of application and short half-life in the environment would suggest that chronic risk would be negligible.

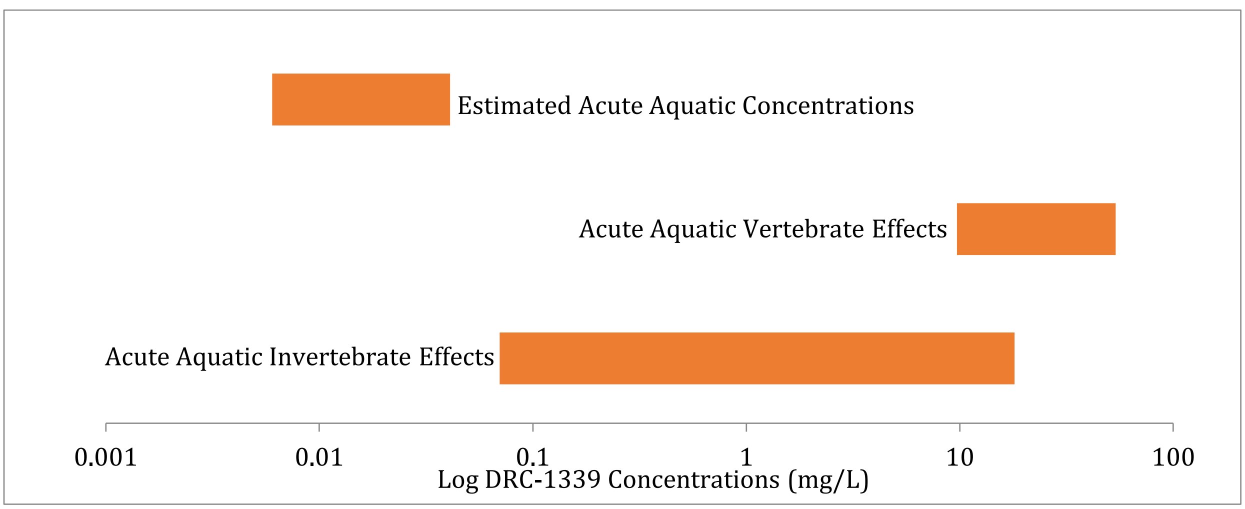

Figure 2.1. Aquatic risk characterization for DRC-1339.

Potential to Cause Accelerated Eutrophication of Wetland Areas

A concern has been raised that carcasses of birds killed by DRC-1339 might significantly increase nutrients in cattail marsh roosting areas, resulting in accelerated eutrophication. Eutrophication is an ecosystem's response to the addition of artificial or natural nutrients, mainly phosphates, to an aquatic system. The increased key nutrients, phosphorous (P), potassium (K), nitrogen (N), and carbon (C), increase plant production, which leads to increased decomposition of organic material that often reduces or depletes oxygen content in the water (WS 2019). Less oxygen can reduce or eliminate certain species and the increased biomass can reduce the size of wetlands. The delayed mode of action of DRC-1339 is such that most birds would not become lethargic and die until they were in their nighttime roosts. If birds died in nighttime roosts, they would be an additional source of nutrients introduced into an aquatic system. To make a comparison, blackbirds and starlings deposit large quantities of fecal material into nighttime roost sites and would continue to roost and deposit fecal material into cattail marsh roosts for the entire winter roosting period. Therefore, this analysis looks at a comparison between the amount of nutrients that would be deposited by bird carcasses and the amount of nutrients from the bird droppings that would continue to be deposited into the winter wetland roost.

Most DRC-1339 blackbird projects are conducted by WS from October to March. From FY11 to FY15, the most starlings taken by a WS state in a single project was an estimated 152,000 in FY12 in Washington (WS 2019). The most red-winged blackbirds and brown-headed cowbirds taken in one project, respectively, was 67,000 in Texas and 65,000 in Louisiana, both in FY11(WS 2019). Of these species, red-winged blackbirds are the most likely species to be found roosting above wetlands, typically cattail marshes (Yasukawa and Searcy 2019), whereas starlings (Cabe 1993) and brown-headed cowbirds (Lowther 1993) prefer evergreen thickets and trees, but can sometimes be found in cattails. However, in order to assess the risk of wetland eutrophication from bird carcasses, we assumed all birds die and fall into a wetland.

The average weight of starlings, red-winged blackbirds, and brown-headed cowbirds (assuming equal male/female ratios) is 87 g (Blem 1981), 49 g (Hayes and Caslick 1984), and 42 g (Lowther 1993), respectively (**Table 2.6**). The lean dry weight (excluding the weight of water and fat) of starlings is about 38% of the whole weight (calculated from data in Blem 1981). No data was found for red-winged blackbirds or brown-headed cowbirds. Using the 38% value for all three species, gives a lean dry weight of 33 g for starlings, 19 g for red-winged blackbirds, and 16 g for brown-headed cowbirds (**Table 2.6**). The amount of P, K, and N was estimated to be 1.3%, 0.7%, and 14%, respectively, of the lean dry mass. With these assumptions, **Table 2.6** estimates the weights for birds and nutrients of concern added to a wetland.

On the other hand, nightly droppings into the wetland would continue if birds were not taken with DRC-1339. Fecal output, feces, urates and urine, is highly variable depending on the species and the extent of wetland water conservation needed by that species (e.g., arid vs. wet habitats). Daily fecal output varied significantly for starlings depending on the type of food eaten (animal *vs* plant matter (poultry pellets) or 3.5 g/day *vs* 14.7 g/day) (Taitt 1973); animal matter is typically selected if available, but starlings commonly feed on the pelletized grain at confined animal feeding operations. For this analysis, we will assume a starling's fecal output is an average from these two food sources, about 9 g/day, which would be appropriate for the winter months when most control actions occur. Starlings tend to rely more on plant matter intake than animal matter (fewer invertebrates are available in frozen ground and snow) during the winter months when most control actions occur. Additionally, we will consider the nightly fecal output to be half the daily output, about 4.5 g/starling, since that is the portion that would go into the wetland and use the same percentages for red-winged blackbirds and brown-headed cowbirds (**Table 2.6**). The dry matter of excreta was found to be an average of 0.73 g for females and male red-winged blackbirds (Hayes and Caslick 1984). This would be about 29% of their nightly output. Using this same percentage for dry fecal matter nightly output, starlings and cowbirds would excrete 1.31 g and 0.64 g. The amount of P, K, and N was estimated to be 1.3%, 0.7%, and 14% of the lean dry mass (Hayes and Caslick 1984, Chilgren 1977, 1985). Table 8 provides estimates of weights of carcasses and nutrients added to wetlands. Considering the estimated weights provided in **Table 2.6**, it would take less than a month of roosting for droppings to surpass the weights from bird carcasses in all categories except N, which would take about 39 days. Assuming that birds are on their nightly winter roosts for close to six months of the year (mid-October to mid-April) and that control actions, which occur mostly from mid-November to mid-March (Sept.-April), likely prevent about half the droppings or 3 months (90 nights) accumulation, the dry waste from carcasses would be less than the dry weight of droppings added to the wetland had the control action not occurred. This means that accelerated eutrophication would not be expected to occur from bird damage management activities.

Table 2.6. Amount of nutrients from bird carcasses and nightly fecal output potentially deposited into wetlands from birds managed with DRC-1339.

Test Species	European Starling		Red-winged Blackbird		Brown-headed Cowbird	
Nutrient	Bird	Feces	Bird	Feces	Bird	Feces
	Statistics for Individual Birds or Nightly Fecal Output (grams)					
Ave. Wt. (male & female)/50% for	87	4.5[1]	49	2.5	42	2.2
Total Dry Weight (50% for feces/night)	33[2]	1.31	19	0.73[3]	16	0.64
Dry Weight Phosphorous (1.3%/1.5%)	0.429[4]	0.020	0.247	0.011[3]	0.208	0.010
Dry Weight Potassium (0.7%/1.4%))	0.231[4]	0.018	0.133	0.010[3]	0.133	0.009
Dry Weight Nitrogen (14%/9.2%)	4.62	0.121	2.66	0.067[3]	2.24	0.059
	Statistics for Maximum Single Project Take FY11-FY15 (kilograms)					
Highest WS Project Take (FY11-FY15)	152,000		67,000		65,000	
Project Weight of Birds/Wet Excreta	13,224	686	3,283	168	2,730	143
Project Dry Weight of Birds/Excreta	5,016	199	1,273	49	1,040	42
Total Dry Weight Phosphorous	65	3.0	16	0.75	13	0.65
Total Dry Weight Potassium	35	2.7	8.9	0.68	8.6	0.59
Total Dry Weight Nitrogen	702	18	178	4.5	146	3.8

[1] from Taitt 1973 [2] from Blem 1981 [3] from Hayes and Caslick 1984 [4] from Chilgren 1977, 1985/Murphy and King 1982

Safety of Consuming Donated Canada Goose or Other Wild Bird Meat

In 2010, 6.4 million households were classified as having low food security (Horak et al. 2014). In some cases, food intake levels were reduced based on the limited availability of food resources (Horak et al. 2014). To assist with this desperity soup kitchens, food pantries, and shelters provide nutritious meals to people in need, when resources are available. Often, the demand for food assistance in these communities greatly outweighes the amount of food donated to these entities. To better meet the needs of soup kitchens and food banks, several organizations have established a link between wild game hunters and providers to supply protein to people in need. Wild game has become a sought-after resource for protein rich meals. Each year more than 10,000,000 meals from wild game are provided nation wide. Nationally, WS donates more than 60 tons of wild game (geese, deer, feral hogs, goats, and ducks) to a variety of charitable organizations each year (Horak et al. 2014). Although infrequent, there is a concern that donated wild game may contain lead or other contaminants. This issue is further evaluated in **Chapter 3**.

2.4.4 Issue D: Impacts of Bird Damage Management on Sociocultural Issues.

Throughout history, humans have been fascinated by wildlife. This attraction eventually led to the domestication of animals, and has since then provided our society with economic, recreational, and aesthetic benefits. Aesthetics is a branch of philosophy that explores the nature of beauty, or the appreciation of beauty. Therefore, as an observer, each person may have a subjective range of appreciation for what constitutes as beautiful. Among the American public, people often voice a variety of opinions in regard to bird damage management due to a range of philosophical, aesthetic, and personal attitudes. These values and opinions typically result in a variety of decisions on how to ideally mange conflicts/problems between humans and wildlife.

In today's society, people commonly keep indoor or outdoor pets and in some instances, people may consider individual wild animals as "pets." Although wild bird and feral domestic bird species may readily adapt to living in urban/suburban areas and habituate to humans, these animals may be associated with damage to resources and/or pose a threat to human health and safety. In such cases, the people not experiencing damage associated with the wild or feral domestic bird species may be neutral, supportive, or strongly opposed to any capture and translocation efforts, **hazing, habitat alteration** or lethal removal. Some members of the public may encourage agencies to teach the community tolerance for damage and threats caused by wildlife. On the other hand, people directly impacted by the associated damage may be in favor of capture and translocation efforts, hazing, habitat alteration or lethal removal in order to alleviate the damage or threats to protected resources. Regardless of the situation, integrated wildlife management remains a challenging task of balancing conflicts between human society and wildlife populations while meeting the fundamental needs of all parties involved.

Some bird damage is derived from feeding wildlife. This is especially true when the public feeds feral or wild waterfowl or pigeons and other birds in urban or suburban areas. While the feeding of birds is not healthy for the birds, a few members of society receive joy or a sense of purpose from feeding or "caring" for wildlife. These people have deep beliefs and strong convictions that the animals need their assistance. Some of these individuals have no intention to stop feeding regardless of educational outreach by local or state agencies, federal agencies or NGOs. These individuals can make implementation of BDM difficult for government agencies that will need to conduct extraordinary outreach with the public, media and elected officials. The feeding of wildlife is prohibited by state statute and ordinances in some local jurisdictions.

Hunting also provides people of all socio-economic levels, social standing, or land ownership the opportunity to hunt or fish as long as it is done legally and responsibly (LePelch 2014). Once an essential part of providing food and shelter, today these activities are primarily a part of vocational activities, subsistence hunting, or insuring that people know where their food comes from, where it has been living, what it has been consuming, and assuring the health and safety of the meat as it is prepared for human consumption.

2.4.5 Issue E: Impacts of Bird Damage Management on Humaneness and Animal Welfare Concerns.

The issue of humaneness and animal welfare as it relates to the lethal removal or capturing wildlife is an important and complex concept that can be interpreted in a variety of ways. Schmidt (1989) indicated that vertebrate pest 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.*" Suffering is described as a "*. . . highly unpleasant emotional response usually associated with pain and distress.*" However, suffering "*. . . can occur without pain . . .*" and "*. . .*

pain can occur without suffering . . ." (American Veterinary Medical Association 1986). Because suffering carries with it the implication of a time frame, a case could be made for "*. . . little or no suffering where death comes immediately . . .*" (California Department of Fish and Game 1989), such as with shooting. Defining pain as a component of humaneness and animal welfare in BDM methods used by WS appears to be a greater challenge than that of suffering. Pain obviously occurs in animals. Altered physiology and behavior can be indicators of pain, and identifying the causes that elicit pain responses in humans would "*. . . probably be causes for pain in other animals . . .*" (American Veterinary Medical Association 1986). However, pain experienced by individual animals probably ranges from little or no pain to significant pain (California Department of Fish and Game 1989). Pain and suffering, as it relates to damage management methods, has both a professional and lay point of arbitration. Wildlife managers and the public would be better served to recognize the complexity of defining suffering since "*. . . neither medical nor veterinary curricula explicitly address suffering or its relief*" (California Department of Fish and Game 1989).

The American Veterinary Medical Association states, "*... 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 accepted methods of euthanasia to be used when killing all animals, including wild and feral animals. The American Veterinary Medical Association states, "*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 use terms such as killing, collecting or harvesting, recognizing that a distress-free death may not be possible.*" (Beaver et al. 2001). Leary et al. (2013) recognized the lack of control managers have over free ranging wildlife and the best possible methods under the circumstances must be applied for euthanasia or humane killing.

2.5 What Alternatives Are Not Considered?

Several alternatives were considered but not analyzed in detail. A list of these alternatives is provided; however, they were found to be either cost prohibitive or impractical and as such received no further analysis.

2.5.1 Compensation for Bird Damage Losses.

This would require WS-Colorado to establish and implement a system to document and reimburse people negatively impacted by bird damage. Under this alternative, WS-Colorado would continue to provide technical assistance to resource owners or managers requesting assistance with managing bird damage. When a damaging event was reported to WS-Colorado, a WS specialist would need to conduct a site visit to determine the number and species of bird involved, the extent of the damage, and the value of the resource being damaged. The dispersal of compensation to impacted resource owners and managers would: 1) Require large disbursements of money and labor to investigate and validate all damage claims, and to determine and administer the appropriate amount of compensation, 2) Reimbursements made to resource owners and managers would likely be below full market value, 3) Provide little incentive to resource owners and managers to alleviate bird damage through cultural and or management practices; and 4) Not be practical to reducing threats to human health and safety (e.g., airport environments).

2.5.2 Short Term and Long-Term Population Suppression.

Many of the problems associated with BDM occur in urban/suburban areas where overabundant bird populations occur. In many of these locations, population regulation through hunting, translocation, or habitat modification has become unfeasible and/or ineffective. Under this alternative, WS-Colorado would initially decrease the population of a bird species associated with damage to a manageable level (as determined by the local wildlife population agency with input from the resource owner/manager) and follow up with the use of reproductive inhibitors to maintain the population at tolerable levels. As scientific based research continues to expand our knowledge in the field of wildlife management, new techniques, tools, and concepts begin to become more readily available for public use. With society's growing interest in the use of nonlethal techniques to manage wildlife damage, researchers have begun investigating novel reproductive inhibitors for a variety of wildlife species. Because reproductive inhibitors reduce birth rates within a treated population, this nonlethal method is perceived by the public as being a more humane alternative to conventional population control methods. However, it should be noted that reproductive inhibitors as a tool for managing bird populations is limited by the size of the population, age of reproduction, breeding season, accessibility to populations prior to breeding, longevity of contraceptive methods, methods of dosage delivery, social structure of target species, non-target species in the area, persistence in the environment, and other factors. For example, if a species is easily accessible year-round then it is less critical to identify a contraceptive that is long lasting.

Reproductive inhibition in avian populations can be accomplished through permanent physical sterilization (e.g., castration, vasectomy, and tubal ligation), egg addling (e.g., shaking or oiling), or reversible procedures such as the use of contraceptives (e.g., hormone implantation, immuno-contraception, or oral contraception) that have specific physiological targets. Physiological targets, in one or both sexes, may include reproductive hormones (e.g., steroid and nonsteroidal), reproductive function (e.g., spermatogenesis, egg production), and cholesterol synthesis.

Whether fertility control is biologically and economically feasible as compared to lethal methods depends on population numbers, age structures, sex ratios, birth and mortality rates, and population recruitment. Population models used to determine the efficacy of contraception as a management tool have found that contraception alone can reduce a population as effectively as lethal control (Hone 1992, Barlow et al. 1997, Dolbeer 1998). However, contraception can have a larger effect on population reduction in species that have low reproductive potential and mortality rates (Dolbeer 1998). In the 1960s, declining Canada goose populations in urban areas within the U.S. were augmented through re-introduction activities. From 1966 to 2001, Canada goose populations (where such introductions occurred) experienced a high rate of growth. In these areas, Canada geese established non-migratory populations due to the availability of year-round food supplies and a lack of predation (Forbes 1993, Ankney 1996, Gosser and Convoer 1999, Fagerstone et al. 2006). Yoder et al. (2006) constructed a population growth model for Canada geese evaluating a 50% reduction in eggs hatched and estimated (that without lethal removal) a founding population of 140 birds (without the use of a reproductive inhibitor) would increase to approximately 3,400 birds within 10 years. However, with the use of a reproductive inhibitor the same population would increase to approximately 1,200 geese within the same 10-year time frame. Therefore, Yoder et al. (2006) recommended a yearly contraception project combined with a lethal removal component should be implemented once every 3 years to maintain Canada geese populations at a tolerable population size.

While some products may be biologically feasible, reproductive inhibitors also need to be economically practical. The development, production, and registration associated with investigating a novel reproductive contraceptive typically takes 5-10 years and for every 10 chemical compounds tested only one will prove effective. Costs for registering new chemical compounds can exceed $1 million. Furthermore, the oral delivery of such chemicals, at the proper dosages, depends wholly upon a practical delivery system. A major limiting factor in wild free-ranging animal populations is inadequate bait consumption and subsequent disparities in chemical dosages among animals.

Contrary to the commonly held belief that many bird species are monogamous, paternity analyses using molecular techniques have shown that very few bird species are truly monogamous (Moore et al. 2012, Griffith et al. 2002). Many of the species believed to be exclusive to one mate exhibit alternative reproductive strategies. Among many "socially monogamous" species, females and males regularly copulate with individuals outside of a "monogamous pair" resulting in extra-pair fertilizations (EPF) (Griffith et al. 2002, Moore et al. 2012). The reported frequency of goose EPF (percentage of clutches with at least one EPF chick) varies from 0 to 13% (Griffith et al. 2002, Moore et al. 2012). Interspecific brood parasitism (IBP), where a female deposits an egg in the nest of another nesting female who subsequently provides all parental care is also well documented (Yom-Tov 2001, Moore et al. 2012). Moore et al. 2012 found EPF and IBP rates of 14 and 26%, respectively from nests in urban areas (21.7% EPF, 21.7% IBP) and rural areas (5.3% EPF, 31.6% IBP) although urban sites had a fourfold higher rate of EPF. One factor that may contribute to IBP in urban resident Canada goose populations is their relatedness. In this study, the genetic relatedness values indicated sibling or mother-offspring relationships between the female birds depositing and caring for parasitic offspring (Moore et al. 2012). Overtime, this female philopatry (tendency of females to return or use similar natal breeding areas) may allow females to be more tolerant of the presence of related females in higher density urban nesting sites and contribute to unnaturally high resident goose densities (Moore et al. 2012).

Considering the likelihood of EPF, male Canada geese could be sterilized to prevent the production of young (Converse and Kennely 1994). However, this method is only effective if the female does not form a bond with a different male or engage in EPF. The ability to identify and capture breeding resident Canada goose pairs for male vasectomizations becomes increasingly difficult depending on site-specific bird densities and time of year. The sterilization of one male Canada goose cost approximately $100 per bird. Regardless of the amount of birds sterilized at an urban site, the resident goose population in that area would not immediately be reduced since leg-band data indicates Canada geese can live up to 30 years (on average 10-24 years) (Moore et al. 2012).

Currently, no reproductive inhibitors are commercially available for use managing multiple bird species populations over large geographic areas. Given the high labor costs associated with live-capturing and performing sterilization procedures on birds, and the lack of available chemical reproductive inhibitors to manage several bird populations, this is not warranted as a suitable alternative, at this time. If a reproductive inhibitor becomes available in the future that meets with our project objectives, this alternative will be re-evaluated as a method available under the alternatives.

2.5.3 Use of Bird-Proof Feeders in Lieu of Lethal Management at Dairies and Cattle Feeding Facilities.

Another alternative to reducing economic losses from starling depredations at livestock feeding operations is to store all feed in "bird-proof" buildings, containers, or feeders. Although this is an effective alternative to lethal management at dairies and cattle feeding facilities, it can be one of the most expensive alternatives and relies on constant and consistent diligence toward bird exclusion. Wright (1973) and Feare and Swannack (1978) found that feeding livestock in bird-proof buildings reduced feed losses to starlings and improved animal weight gain. To alleviate the restrictive properties of conventional screens or doors Feare and Swannack (1978) found that enclosing cattle feeding areas with industrial polyvinyl chloride plastic (PVC) strips allowed livestock, farming equipment, and personnel unrestricted movement while excluding starlings. If producers are unable to supplemental feed their livestock in such restrictive enclosures, bird-proof livestock feeders can reduce feed losses. Bird-proof feeders are offered in both automatic and self-feeding options. Flip top self-feeders protect livestock feed from birds as well as the elements. To access the feed, livestock must use their nose to push the lid of the feeder up, thus restricting access to starling depredation events. Producers using these systems must remain vigilant because the flip-tops frequently become bent, dislodged, or lost. Automatic, electric, or magnetic feeders may also be used in outdoor environments. Although the initial investment is more expensive than other available management options, automatic feeders dispense small amounts of feed to individual cows throughout the day. This limits the amount of time starlings have access and feed on dispensed grain. In many cases, livestock producers tolerate some bird damage throughout the year and only request assistance from WS-Colorado when the damage becomes and economic burden. This damage threshold varies among cooperators, damage situations, and their amount of disposable capital for damage management. For these reasons, WS-Colorado did not carry this alternative forward for further analysis.

2.5.4 WS-Colorado Would Implement Lethal Bird Damage Management Only.

Under this alternative, WS would not conduct any nonlethal operational management of birds for BDM purposes in the state, but would only conduct lethal BDM. WS Directive 2.101 states that WS must consider the use of nonlethal methods before lethal methods. This alternative was eliminated from further analysis because many situations can be resolved effectively through nonlethal or a combination of lethal and nonlethal means. For example, for blackbird roosts in urban areas, WS has used nonlethal methods (e.g., habitat alteration and hazing) exclusively as an effective means to resolving damage. Lethal BDM does not interface with the overall concept of IWDM, where multiple methods can be used to achieve a desired cumulative effect. Restricting that portion of the project to lethal methods only, would likely not be socially acceptable to various stakeholders. In addition, some BDM projects would be ineffective and inefficient in solving damage if lethal BDM was the only option.

2.5.5 Only Live Trapping and Translocation would be Employed Rather Than Lethal Take.

Under this alternative, all requests for assistance would be addressed using live-capture methods or the recommendation of live-capture methods. Birds causing damage to resources or associated with damage would be live-captured using live-traps, cannon nets, rocket nets, bow nets, net guns, mist nets, or hand capture. All live-captured birds by WS-Colorado would then be translocated. Translocation may be appropriate in some situations, as research suggests, this method is effective for some bird species within narrow circumstances and the act of translocation does not result in death to the individual from intra-species strife. Under current knowledge, raptors are not known to be vectors of disease to other wildlife. Any decisions on translocation of wildlife by WS are coordinated with CPW or USFWS and consultation with the appropriate land management agency(ies) or manager(s) associated with proposed release sites. Moreover, relocated animals are easily stressed and have the potential to transmit disease pathogens into healthy populations or have low survival rates. WS considers translocation for some species and conducts such, but does not relocate all damaging species. Species that often cause damage problems (*e.g.,* Canada geese and grackles) are relatively abundant or are non-native or invasive (*e.g.,* starlings). The translocation of such species is not necessary for the maintenance of viable populations. Translocation may also result in future depredations if the relocated animal encounters protected resources. In some cases, if damage from the relocated animal occurs, this would require payment of liability claims.

In general, translocation is not a feasible option for dealing with certain species of birds causing damage (e.g. urban crow or turkey vulture roosts). In such cases, hundreds or thousands of birds would need to be live-captured and translocated to alternative areas, which most likely would result in bird damage occurring at a new location. In New York, Canada geese that were translocated 150 km (93 miles) from their initial capture site were harvested at a (23%) higher rate during hunting season than geese that were not translocated (6.6%) (Holevinski et al. 2006). Following the translocation of 177 Canada geese 25% (44 geese) returned to their original capture site less than 10 months following their release (Holevinski et al. 2006).

Public proposals to trap and translocate geese are generally viewed as a humane alternative to the capture and processing of birds to provide food for needy families. Public acceptance of trapping and translocating, resident Canada geese for example, is largely based on the belief that it is a nonlethal technique. However, the translocation of groups or individuals of an overabundant species is considered a biologically unsound management practice due to several factors including: the biological carrying capacity of an area, habitat degradation, historical population trends, and human health and safety. In Colorado, the relocation of thousands of resident Canada geese is not a viable solution in managing goose conflicts on a large scale in part due to a lack of available release sites. Property owners, managers, and communities are often opposed to accepting individuals or groups of individual birds of an already overabundant species that will likely continue to cause conflict or damage in the new location. In other states, resident Canada geese have been translocated as part of a damage management plan to wildlife refuges and state wildlife areas. These areas provide hunters the opportunity to harvest larger numbers of birds while alleviating Canada goose conflicts in urban and suburban areas.

From the 1970s to 1990s Colorado Parks and Wildlife routinely trapped and translocated resident Canada geese to rural areas of Colorado and other states (Gammonley 2019). These operations were site-specific and covered under the authority of the USFWS. The purpose behind these efforts were largely related to establishing new local populations of resident Canada geese following their drastic declines. By the mid-1990s, there were no suitable areas remaining for the translocation of resident Canada geese (Gammonley 2019). Furthermore, the trapping and translocation of these animals was proven to be costly and inefficient in addressing site-specific human-goose conflicts. Consequently, by the late 1990s, CPW suspended resident Canada goose translocation efforts (Gammonley 2019).

Table 2.3. Number of Canada geese translocated as part of a study in New York and the fate of the birds >60 days after their release in a new location (Swift et al. 2009).

Numbers of geese relocated and neck-banded in this study, and fate of birds observed >60 days after release.[1]

Year	No. moved	No. neck-banded	No. shot first year	No. shot other years	No. seen back in Rockland	No. last seen alive elsewhere	No. seen >60 days after release
2004	206	191	82 (43%)	12 (6%)	18 (9%)	8 (4%)	120 (59%)
2005	385	314	121 (39%)	16 (5%)	20 (6%)	11 (4%)	168 (54%)
Total	591	505	203 (40%)	28 (6%)	38 (8%)	19 (4%)	288 (57%)

[1] Numbers of geese moved included goslings and recaptures that we did not neckband as part of this study; all other columns include only birds neck-banded for this study.

Swift et al. (2009) conducted a study in New York to determine: 1.) the fate of translocated geese, especially if they returned to the capture area; and 2.) if the removal of the geese reduced the numbers observed in select areas in subsequent years. They found that of 505 geese captured and that were neck-banded and translocated approximately 40% (n=203) were killed by hunters during the first hunting season (**Table 2.3;** Swift et al. 2009). Only 8% were seen again at the original capture site (Rockland) and 4% were seen alive at a site other than the capture site. In the years that followed the translocation of resident Canada geese from these sites declined by 62% in three years following removal efforts and declined by 15% in the surrounding County (Swift et al. 2009). From 2002-2004, a mean of 1,906 birds were counted following translocation efforts in 2006-2008 a mean number of 1,623 birds were counted. During this time, Canada goose population estimates at a state and flyway level remained stable or increased (Swift et al. 2009). Little evidence was found to suggest that new geese moved into these capture sites to replace the birds that were removed (Swift et al. 2009).

The effectiveness of resident Canada goose translocations are likely enhanced by incorporating egg treatment activities. By limiting the local reproductive rates of resident Canada geese, this should slow the rate of population recovery, providing that immigration is low (Swift et al. 2009). In the past, other studies have suggested that translocating resident Canada geese is ineffective due to a strong homing instinct and site fidelity that result in them returning to their former nesting areas (Smith et al. 1999, Preusser et al. 2008). Return rates of 22 – 42% have been reported for adult Canada geese translocated from Minnesota to Oklahoma (Swift et al. 2009). Several factors likely play a role in rate of return of translocated Canada geese including: hunter harvest rates, distance between sites, and topography. Swift et al. (2009) believe their low return rate was likely influenced by these factors.

The most effective strategy for alleviating resident Canada goose conflicts is an integrated wildlife damage management plan to reduce the overall local population of geese. This involves limiting resident goose reproduction, and discouraging and/or limiting the number of birds in sensitive areas. Throughout the year an integrated goose plan may include: hazing with radio controlled boats, lasers, or pyrotechnics; limiting reproductive success through egg oiling or addling; and reducing resident goose populations. However, it should be noted that hazing and egg oiling/addling activities are costly, have temporary impacts, and dispersed geese remain within 2 miles of the locations hazed from (Holevinski et al. 2007, Preusser et al. 2008, Seamans et al. 2009).

The translocation of individual animals or groups of animals are often suggested without consideration for species abundance as a whole (Craven et al. 1998). Under WS Directive 2.501 the translocation of wildlife is discouraged due to the potential for disease transmission, stress associated with translocation, poor survival rates, and potential complications arising from placing naïve animals in new locations/habitats.

2.5.6 The use of Biological Control Rather Than BDM.

For centuries, humans have approached the management of overabundant vertebrate populations from two independent perspectives. The majority of this text examines the use of conventional wildlife damage management tools such as exclusion by barriers, frightening devices (lights, pyrotechnics, lasers), hazing, habitat management, chemical repellents, trapping, and lethal removal. An alternative perspective to managing overabundant vertebrate populations is the use of biological control methods. Biological control, by definition, is the intentional alternation of an organism's environment to increase mortality, reduce natality, or cause a significant dispersal from an affected area (Howard 1967). The impacts and effectiveness of using biological controls (such as introducing avian predators to control bird populations) is highly variable and dependent on the unique ecological and interspecific relationship between predators and their prey as well as other environmental, biological, and procedural interactions. Howard (1967) stated that the combined predation pressure by native hawks, owls, snakes, and carnivores usually led to greater seasonal and annual densities of vertebrate prey species than if these predators were not present. Instead, he suggests that prey species populations over large geographic areas are largely dependent on the suitability of the habitat and by other self-limiting factors such as intraspecific stressors (competition for food, mates, territories, climatic conditions, or disease). Furthermore, avian predators are largely opportunistic and not host-specific.

The introduction of alien predators into naïve ecosystems is not only dangerous but may be catastrophic for endemic wildlife populations. During the 1930s, on the Frisian island of Terschelling 102 weasels and 9 ermine were introduced to control water voles girdling young trees (Howard 1967). Within 3 years all of the weasels died. Within 5 years, all of the water voles on the island were exterminated along with the majority of the rabbit population. Ermine populations on the island rapidly increased and began feeding on sparrows, starlings, terns, shelducks, curlews, domestic poultry (ducks, turkeys, chickens) and other species of wading birds. Eventually, ermine population on the island had to be lethally removed. While biological control has been successful in the control of certain invertebrate pests and disease pathogens, it has never been definitively effective against vertebrate pests.

2.5.7 WS would refer requests for assistance to Private Nuisance Wildlife Control Operators (NWCOs).

When the public experiences damage or threats of damage associated with birds they always have the option of contacting a private wildlife control agent and/or other private entities to alleviate damage. Additionally, WS-Colorado could refer persons requesting assistance to Nuisance Wildlife Control Operators and/or other private entities if Alternative 1 or Alternative 2 are implemented. WS Directive 3.101 provides guidance on interfacing and establishing cooperative relationships with private businesses. After receiving a request for assistance, WS under Alternative 1 or Alternative 2 would be able to inform requesters of other service providers that might be able to provide assistance. WS-Colorado did not carry this alternative forward for further analysis.

2.6 What Issues Are Not Considered?

The following issues are not considered in detail because they are outside of the scope of this EA. The environmental consequences of these issues were found to have the least impact under the current program alternative. Even though these issues are not analyzed in this EA, some of these issues are still considered in determining Protective Measures to reduce potential impacts. Below, are the issues that were sufficiently discussed and show little or no change. Subsequently, these will not be addressed in this EA, except where protective measures are developed to minimize impacts of these issues.

2.6.1 Concerns that the Proposed Action May Be "Highly Controversial" and Its Effects May Be "Highly Uncertain," Both of Which Would Require that an EIS Be Prepared.

The failure of any particular special interest group to agree with every act of a Federal agency does not create controversy, and NEPA does not require the courts to resolve disagreements among various scientists as to the methodology used by an agency to carry out its mission (*Marsh vs. Oregon Natural Resource Council*, 490 U.S. 360, 378 (1989)[6]).

Another concern commonly expressed in comments on prior EAs involves the degree to which the potential impacts are "highly uncertain or involve unique or unknown risks" (40 CFR 1508.27 (b)(5)). Commenters have suggested that uncertainty in any aspect of our analyses, including risks, requires the preparation of an EIS, based on the CEQ regulations at 40 CFR 1508.27 (b)(5). However, this

[6] Court cases not cited in Literature Cited section.

regulation states that such uncertainty or unique or unknown risks "should be considered" (40 CFR 1508.27 (b)). The existence of any level of uncertainty, or unique or unknown risks, do not in themselves require a determination of significant impact. The degree of uncertainty and the level of any unique or unknown risk must be evaluated. Throughout the analyses in **Chapter 3** of this EA, WS-Colorado uses the best available data and information from wildlife agencies having jurisdiction by law (CPW and USFWS; 40 CFR 1508.15), as well as the scientific literature, especially peer-reviewed scientific literature, to inform its decision-making. Where there is uncertainty, we consider this in our analysis and in our assessment of significant impact. If either of these factors would result in significant impacts, our analysis in **Chapter 3** will reflect that. Our analyses are in compliance with the CEQ regulations at 40 CFR 1508.27(b)(5).

2.6.2 Concerns that Lethally Removing Wildlife Represents "Irreparable Harm."

Public comments have raised the concern that the lethal removal of any wildlife represents irreparable harm. Although an individual bird or multiple birds in a specific area may be lethally removed by WS BDM activities, this does not in any way irreparably harm the continued existence of these species. Wildlife populations experience mortality from a variety of causes, including human harvest and depredation control, and have evolved reproductive capabilities to withstand considerable mortality by replacing lost individuals (See Other Causes of Mortality in **Chapter** 3). Colorado's historic and current populations of big game animals, game birds, furbearers and unprotected birds, which annually sustain harvests of thousands of animals as part of the existing human environment, are obvious testimony to the fact that the lethal removal of wildlife does not cause irreparable harm. Populations of some of these species are in fact much higher today than they were several decades ago (e.g., Snow geese, Canada geese), in spite of liberal hunting seasons and the lethal removal of hundreds or thousands of these animals annually. The legislated mission of USFWS and CPW is to preserve, protect, and perpetuate all the wildlife in the United States and Colorado. Therefore, USFWS and CPW would be expected to regulate lethal removal of protected wildlife species in the state to avoid irreparable harm. Our analysis, herein **Chapter 3**, shows that the native species WS takes in BDM will continue to sustain viable populations. Thus, losses due to human-caused mortality are not "irreparable."

2.6.3 Impacts on Global Climate Change/Greenhouse Gas Emissions.

Global climate change is an important topic, which needs to be considered. However, we believe that it does not warrant consideration as an "Issue" for comparative analysis. We have considered the topic of global climate change, and our analysis is provided below.

The State of the Climate in 2012 report indicates that since 1976, annual average global temperatures have been warmer than the long-term average (Blunden and Ardnt 2014). Average global surface temperatures in 2012 were among the top ten warmest years on record with the largest average temperature differences in the United States, Canada, southern Europe, western Russia and the Russian Far East (Osborne and Lindsey 2013). Impacts of this change will vary throughout the United States, but some areas will experience air and water temperature increases, alterations in precipitation and increased severe weather events. The distribution and abundance of a plant or animal species is often dictated by temperature and precipitation. According to the EPA (2013), as temperatures continue to increase, the habitat ranges of many species are moving 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).

WS-Colorado recognizes that climate change is an ongoing concern and may result in changes in species range and abundance. Climate change may also impact agricultural practices. The combination of these two factors over time may lead to changes in the scope and nature of wildlife-human conflicts in Colorado. Because these types of changes are an ongoing process, this EA has developed a dynamic system including mitigations and standard operating procedures that allow the agencies to monitor for and adjust to impacts of ongoing changes in the affected environment. WS-Colorado would monitor activities conducted under this analysis in context of the issues analyzed in detail to determine if the need for action and associated impacts remain within parameters established and analyzed in this EA. If substantive changes in the potential environmental impacts of our BDM activities warranting analytical revisions are identified, WS-Colorado would supplement the analysis and/or modify the project actions in accordance with applicable local, state, and federal regulations including the NEPA. Established Protective Measures also include reporting all take to the USFWS, CPW, and CDA annually as appropriate for review of project-specific and cumulative impacts on wildlife populations. Coordination with agencies that have management authority for the long-term well-being of native wildlife populations and review of available data on wildlife population size and population trends enables the project to check for adverse cumulative impacts on wildlife populations, including actions by WS-Colorado that could jeopardize the long-term viability of WS-Colorado actions on wildlife populations. Monitoring would include review of federally-listed T&E species and consultation with the USFWS, as appropriate, to avoid adverse impact on T&E species. As with any changes in need for action, WS-Colorado would supplement the analysis and/or modify project actions in accordance with applicable local, state, and federal regulations including NEPA, as needed, to address substantive changes in wildlife populations and associated impacts of the BDM. In this way, we believe the proposed action accounts for is responsive to ongoing changes in the cumulative impacts of actions conducted in Colorado in accordance with the NEPA.

The CEQ has advised federal agencies to consider whether analysis of the direct and indirect greenhouse gas (GHG) emissions from their proposed actions may provide meaningful information to decision makers and the public (CEQ 2014). Based on their review of the available science, CEQ advised agencies that if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO_2- equivalent GHG emissions on an annual basis the agencies should consider that a quantitative and qualitative assessment may be meaningful to decision makers and the public (CEQ 2014). USDA-APHIS has assessed the potential GHG impacts from the national WS program and current and proposed actions are in context with this guidance.

The average home produces 9.26 metric tons (MTs) of carbon dioxide equivalents (CDE; includes CO_2, NO_2, CO, and SO_x) annually (EPA 2017). Nationwide, WS has 170 district and State Offices and this includes district offices (as of 2013) with only one staff person. Using the average home data from the EPA (2017), we estimate that WS produces approximately 1,574 MT of CDEs annually. Each State Office would likely produce fewer CDEs annually than the average home because little electricity is used at night and on weekends, so this estimate is likely to be conservative.

WS vehicles are used for a multitude of wildlife management projects, including current Colorado BDM activities. WS cannot predict the fuel efficiency of each all-terrain vehicle (ATV) used in the field nor can it predict how often an ATV would be used. However, if a conservative estimate of 20 miles per gallon is used and consideration is given to total mileage being substantially less than the mileage calculated for normal vehicular use, the effects of ATVs on air quality would be negligible. WS also cannot predict the fuel efficiency of each vehicle in the national program. The Federal Highway Administration (FHWA 2017) estimated average fuel consumption per light duty vehicle at 475 gallons per year in 2015. WS owned or leased 1,665 vehicles in 2013. The EPA (2017) uses 0.989 as the ratio of CDEs to total greenhouse gas emissions for passenger vehicles, and the EPA and United

States Department of Transportation use the conversion factor of 8,887 grams of CO_2 [per gallon of gasoline (75 Fed. Reg. 88, 25330). Using these data, vehicle use by all WS programs nationwide might contribute approximately 7,109 metric tons (MT) of CDEs each year.[3]

Nationwide, WS either owns or lease ten different types of helicopters; their average fuel consumption is 24.88 gallons per hour. Helicopters with this average fuel consumption emit approximately 0.24 MT/hour of CO_2 emissions (Conklin and de Decker 2017).[7] WS also owns or leases six different types of fixed wing aircraft. Average CO_2 emissions from these types of aircraft is 0.11 MT/hour (Conklin and de Decker 2017). Nationwide, WS flew 10,426 hours (helicopter and fixed wing combined) of agency-owned aircraft in FY 2013 and flew an additional 4,225 hours under contract aircraft. If all 14,651 flight hours were attributed to fixed-winged planes, the estimated CO_2 emissions would be 1,612 MT/year. If all flight hours were attributed to helicopters, the estimated CO_2 emissions would be 3,516 MT/year.

Combining vehicle, aircraft, and office use for FY 2013, the range of CDEs produced by WS is estimated to be between 10,295 and 12,199 MT per year, which is well below the CEQ's suggested reference point of 25,000 MT/year (CEQ 2014). These are cumulative data for WS nationwide. WS-Colorado produces only a small portion of these emissions, and the WS-Colorado BDM activities analyzed in this EA produce an even smaller portion.

WS understands that climate change is an important issue. The WS program will continue to participate in ongoing federal efforts to reduce greenhouse gas emissions associated with program activities including compliance with Executive Order 1369 – planning for federal sustainability in the next decade.

Given the information above, none of the alternatives considered in anticipated to result in substantial changes that would impact national WS greenhouse gas emissions. WS-Colorado BDM activities under the proposed action would have a negligible effect on atmospheric conditions, including the global climate. Therefore, this issue will not be considered for comparative analysis.

Impacts on the Natural Environment Not Considered

In addition, the proposed action does not include construction or discharge of pollutants into waterways and therefore, would not impact water quality or require compliance with related regulations or Executive Orders. The proposed action would cause minimal or no ground disturbance and therefore, would impact soils and vegetation insignificantly. WS uses very little fossil fuels and contributes negligible greenhouse gases that could impact global warming.

2.6.4 Resources Not Evaluated in Detail and Why?

In addition, the following environmental resources are not evaluated in detail in this EA because the agency has found that these resources are not adversely impacted by the national WS program and WS-Colorado operations, based on previous BDM EAs prepared in the Western United States and in Colorado. They will not be discussed further in this EA.

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[7] (8.89×10^{-3} MT/gallon of gasoline) x (475 gallons/vehicle) x (1/0.989) x (1,655 vehicles) = 7,109 MT of CDEs

[6] Less than one percent each of NO_x, CO, SO_x, and other trace components are emitted from aircraft engine emissions (FAA 2005).

- **Floodplains (E.O. 11988):** WS-Colorado operations do not involve construction of infrastructure and would not impact the ability of floodplains to function for flood abatement, wildlife habitat, navigation, or other functions.

- **Visual quality:** WS-Colorado operations do not change the visual quality of public sites or areas. Although, physical structures may be recommended as part of technical assistance, they are not constructed by WS-Colorado and therefore are not under the agency's jurisdiction.

- **General soils (lead contamination from the use of lead ammunition):** WS-Colorado operations do not directly involve placing any materials into the soils or cause major soil disturbance. Soil disturbance is minimized because vehicles are used on existing roads and trails to the extent practicable and there is no construction proposed or major ground disturbance. Setting live traps involves only minor surface disturbance, and equipment is set primarily in previously disturbed areas.

- **Minerals and geology:** WS-Colorado operations do not involve any contact with minerals or change in the underlying geology of an area.

- **Prime and unique farmlands and other unique areas (concerning wilderness and other special management areas):** WS-Colorado operations do not involve permanently converting the land use of any kind of farmlands or other unique areas.

- **Air quality:** WS-Colorado's emissions are from routine use of trucks, airplanes, and very limited use of harassment devices using explosives, and therefore constitute a *de minimis* contribution to criteria pollutants regulated under the Clean Air Act.

- **Vegetation (including timber and range plant communities):** WS-Colorado operations do not change any vegetation communities or even small areas of plants.

- **Environmental effects of the loss of individual animals:** Under the current and proposed alternatives, an individual bird or group of birds in a specific area may be removed through WS-Colorado BDM activities. All WS-Colorado BDM activities are conducted under the authorization of and in compliance with Federal and state laws and in coordination with CPW, CDA, and/or the USFWS, as appropriate. Although we recognize that some individuals might find this loss distressing, the loss of an individual animal does not significantly impact the environment. The possible exception is endangered species, for which the loss of a single animal may be significant to the population. In these cases, such impacts are considered under Issue B: impacts on populations of non-target species. Humaneness and ethics are under Issue C: Impacts of BDM on Public and Pet Safety and the Environment, and this analysis does apply to each individual animal taken, whether lethally or nonlethally.

2.6.5 WS-Colorado's Impact on Biodiversity.

This issue concerns the impacts on the ecosystem due to the removal of bird species during BDM. This issue addresses complex interrelationships among trophic levels, habitat, biodiversity, and wildlife populations. These are inherently indirect and cumulative impacts. The analysis of this issue is limited to the larger picture of the ecosystem effects, as opposed to effects on any particular species' population; however, impacts on wildlife populations are included in this analysis to the extent that they may affect the ecosystem. Effects on species' populations are analyzed under issues A and B, described above.

No WS wildlife management project is conducted to eradicate a native wildlife population. WS operates in accordance with international, federal, and state laws and regulations enacted to ensure species viability. Any reduction of a local population or group would be temporary because immigration from adjacent areas or reproduction would soon replace the animals removed. WS operates on a relatively small percentage of the land area in Colorado and WS take is a small proportion of the total population of the species analyzed in **Chapter 3**.

2.6.6 Wildlife Damage Should Be an Accepted Loss -- A Threshold of Loss Should Be Reached Before Providing BDM Services.

WS is aware of concerns that federal WDM should not be allowed until economic losses become unacceptable. Although some loss of resources to wildlife can be expected and tolerated, WS has the legal direction to respond to requests for WDM, and it is Program policy to assist each requester to minimize losses. WS uses the Decision Model discussed in later in this chapter to determine an appropriate strategy.

In a ruling for Southern Utah Wilderness Alliance, et al. vs. Hugh Thompson, Forest Supervisor for the Dixie NF, et al., the United States District Court of Utah upheld the determination that a WDM program may be established based on threatened damage. In part, the court found that a forest supervisor need only show that damage (from predators) is threatened to establish a need for WDM (Civil No. 92-C-0052A January 20, 1993). Thus, there is precedent for conducting BDM when damage has not yet occurred but is only threatened.

2.6.7 Wildlife Damage Management Should Be Fee Based and Not a Taxpayer Expense.

WS is aware of concerns that WDM should not be provided at the expense of the taxpayer or that it should be fee based. WS was established by Congress as the agency responsible for providing WDM to the people of the United States. Funding for WS BDM comes from a variety of sources in addition to Federal appropriations. Such non-Federal sources include local government funds (state, county or city), producer associations, and individual private citizens which are all applied toward project operations. Federal, state, and local officials have decided that WDM needs to be conducted and have allocated funds for these activities. Additionally, WDM is an appropriate sphere of activity for government projects, since wildlife management is a government responsibility. A commonly voiced argument for publicly funded WDM is that the public should bear the responsibility for damage to private property caused by "publicly-owned" wildlife.

WS-Colorado is not involved in establishing or approving national policies regarding supporting private livestock operations, or agricultural production but, provides federal leadership in resolving wildlife-human conflicts and supporting coexistence of wildlife and humans. It is publicly accountable for the work that is requested by public and private entities and landowners, state and federal governments, tribes, and the public, and all activities are performed according to applicable laws and its mission and policies.

WS-Colorado is aware of beliefs that federal wildlife damage management should not be allowed until economic losses become "unacceptable," and that livestock losses should be considered as a cost of doing business by producers. WS-Colorado receives requests for assistance when the operator has reached their tolerance level for damage or worries about safety and health, as well as in circumstances where the threat of damage is foreseeable and preventable. This tolerance level differs among different people and entities, and at different times. Although some losses can be expected and tolerated by agriculture producers and resource owners, WS-Colorado is authorized to respond to requests for assistance with wildlife damage management problems, and it is agency policy to respond to each requester to resolve losses, threats and damage to some reasonable degree, including providing technical assistance and advice. The WS Decision Model (WS Directive 2.201) is used in the field to determine an appropriate strategy on a case-by-case basis. The WS authorizing legislation does not require an economic analysis at any scale of operation.

This issue is appropriately addressed through political processes at the state and federal levels.

2.6.8 Compensation for Losses or Damage Should Replace WS-Colorado Bird Damage Management.

Wildlife is typically managed by the state, regardless of land ownership. Some states have established programs to partially accept monetary responsibility for some types of wildlife damage. However, there is currently no system in place to equitably distribute the costs of wildlife damage between all consumptive and non-consumptive user groups. It is under these circumstances where a particular state or county may provide for compensation for wildlife damage (for example, Bruscino and Cleveland 2004).

WS has no legal authority or jurisdiction to provide financial compensation for losses.
The Agricultural Act of 2014, (aka the 2014 Farm Bill) has provisions for the federal government to provide indemnity payments to eligible producers on farms that have incurred livestock death losses in excess of the normal mortality. These losses will be, as determined by the Secretary of Agriculture, due to attacks by animals reintroduced into the wild by the Federal Government or protected by Federal law (such as animals protected under the Migratory Bird Protection Act or the Endangered Species Act). Payments are equal to 75% of the average fair market value of the applicable livestock on the day before the date of death. The Secretary of Agriculture or designee makes that determination. None of the avian predators considered in this EA are eligible under this statute.

This issue is appropriately addressed through political processes at the state and federal levels.

2.6.9 No Federal Funds Should Be Used to Support State Bird Damage Management Needs for Protection T&E and Species of Management Concern.

CPW and BLM has identified limited circumstances for which BDM for protection of native game species of greater sage-grouse, Gunnison sage-grouse, especially related to raven/crow predation, would meet department objectives. CPW conducts administrative removals of offending animals itself, it can hire WS-Colorado, it can use commercial wildlife damage management companies, or it can certify, train, and use volunteer agents. WS' policy and objective is to consider and respond appropriately to all requests for BDM assistance. WS-Colorado ultimately decides when it is appropriate to enter into agreements with CPW and BLM to assist with meeting state game management objectives.

This issue is appropriately addressed through the political process at the state and Congressional levels.

2.6.10 Lethal Starling and Blackbird Control Is Ineffective Because 50-60% Die Annually.

Because natural mortality in blackbird populations is 50 - 65% per year some persons argue that this shows lethal BDM actions are futile. However, the rate of natural mortality has little or no relationship to the effectiveness of lethal BDM because natural mortality generally occurs randomly throughout a population and throughout the course of a year. Natural mortality is too gradual in individual concentrations of depredating birds to adequately reduce the damage that such concentrations are causing. It is probable that mortality caused by BDM actions is not "additive" to natural mortality but merely displaces it, otherwise known as "compensatory" mortality (see **Chapter** 3). In any event, it is apparent that the rate of mortality from BDM is well below the extent of any natural fluctuations in overall annual mortality and is, therefore, insignificant to regional populations. The objective of lethal BDM in the alternatives analyzed in this EA is not to necessarily add to overall blackbird or starling mortality, which would be futile under current funding limitations, but to redirect mortality to a segment of the population that is causing damage in order to realize benefits during the current production season. The resiliency of these bird populations does not mean individual BDM actions are not successful in reducing damage, but that periodic and recurring BDM actions are necessary in many situations.

2.6.11 Impacts from the Use of Lead Ammunition in Firearms.

Under Alternative 1, birds causing damage or posing threats could be lethally removed with firearms. Questions often arise regarding the deposition of lead ammunition into the environment from ammunition used in firearms. In 1876, H. S. Calvert reported the risk of lead exposure to wildlife following the ingestion of lead shot or bullet fragments. Since that time, professional journals have published scientific literature examining the ingestion of lead by wildlife, lead toxicity to wildlife, and levels of lead accumulations in the environment and tissues resulting from lead shot (Tranel and Kimmel 2008). To address this problem, the USFWS requires that non-toxic shot be used to lethally remove birds under depredation permits issued pursuant to the MBTA and under 50 CFR 21.43 Depredation Order for blackbirds, grackles, cowbirds, magpies, and crows. WS-Colorado uses nontoxic shot (*e.g.,* steel and bismuth) bullets, and pellets for ground-based shooting in accordance with 50 CFR 20.21(j). All migratory birds lethally removed under depredation permits issued by the USFWS and in areas where there is a potential risk to T&E or sensitive species such as Bald eagles are taken using nontoxic shot. Furthermore, nontoxic shot is used in areas frequented by waterfowl and upland game bird species since their feeding behaviors makes them particularly susceptible to shot ingestion.

For more than 100 years, professional journals have published literature examining the impacts of lead shot ingestion on wildlife including decreased survival, behavioral changes, poor body condition, and impaired reproduction (Tranel and Kimmel 2009). However, outside of the ban of lead ammunition for waterfowl hunting in 1991, attempts to reduce the use of lead for hunting and in fishing tackle have occurred so recently that data on the effectiveness of these alternatives are currently unavailable. Since other entities and individuals are allowed to lethally remove bird species within Colorado through regulated hunting seasons, the issuance of depredation permits, under depredation/control orders or without the need to obtain a depredation permit, WS' assistance with removing birds would not be additive to the environmental status quo of lead deposited into the environment. Programs developed to encourage hunters and fishermen to voluntarily switch to non-lead ammunition can be challenging due to a lack of understanding of the cost, availability, performance, and suitability of non-lead alternative use. Further research is needed on technical, social, and economic factors influencing the use of non-toxic lead alternatives before broad scale policy decisions can be finalized. Additionally, Haig et al. (2014) reminds us that there are a variety of factors that influence wild bird population mortality within North America, including window strikes, vehicle strikes, airplane strikes, and predation by domestic cats (Loss et al. 2013; 2014).

2.6.12 Impacts of Dispersing a Bird Roost on People in Urban/Suburban Areas.

In urban areas, WS often works with the community or municipal leaders to address bird damage involving large bird roosts that would likely affect a variety of stakeholders. To successfully implement bird frightening projects in urban or suburban areas, WS works with numerous agencies, organizations, and individuals to develop effective collaborations. In dealing with the dispersal of birds from a roosting location, WS makes a concerted effort to explain the reasons for attempting to disperse birds while providing opportunities for public involvement.

WS often consults not only with the resource owner, where a roost is located, but also with community leaders to allow for community-based decision-making on the best management approach. In such cases, funding is provided by the municipality where the roost is located, which allows activities to occur within city limits where bird roosts occur. This allows roosts that disperse to other areas to be addressed effectively and often, before roosts become well established. Unfortunately, when a bird roost is dispersed in an urban area there is a chance that the birds will continue to create problems at a new roosting site. In such cases, a continuous frightening project will help disperse the birds more easily with each successive dispersal event. When frightening projects are properly conducted, habituation is an uncommon occurrence.

Depending on the species, personnel and equipment should be staged at a bird roost location at least 1 ½ hours before dark and continue until dark or 1 ½ hours prior to sunrise. As soon as the firs birds are viewed in the afternoon, personnel should begin to use pyrotechnics, lasers, or other methods to frighten the birds away from the roost. Birds are much easier to disperse when they are flying, once they are perched it is harder to frighten large groups of birds from the relative safety of their peers. On the first day of a bird-roost frightening project, personnel should surround the site and create a cacophony of sound around the roost. When using firearms or pyrotechnics, personnel should ration their ammunition so that they do not run out before dark or before the roost is completely dispersed. Following the first round of pyrotechnics, birds will attempt to re-enter the roost site. Birds may mill and circle ¼ mile from the area and circle until dark. Once darkness falls, the birds will return to the site despite the frightening method used (Booth 1994).

By the second and third nights of operation, project personnel will need to adapt their dispersal techniques to compensate for variable behavioral responses by the educated population. Mobile units should be prepared to follow large populations and continue to haze them until they are beyond city limits. Roosts are typically completely dispersed by the fourth or fifth night. Another issue often raised is that the dispersal of birds from a roost location to alleviate damage or conflicts at one site could result in new damage or conflicts at a new roost site. While the original complainant may see resolution to the bird problem when the roost is dispersed, the recipient of the bird roost may see the bird problem as imposed on them. Thus, overall, there is no resolution to the original bird problem (Mott and Timbrook 1988). Bird roosts usually are dispersed using a combination of harassment methods including pyrotechnics, propane cannons, effigies, and electronic distress calls (Booth 1994, Avery et al. 2008, Chipman et al. 2008). A similar conflict can develop when habitat alteration is used to disperse bird roosts. This concern would be heightened in large metropolitan areas where the likelihood of birds dispersed from a roost finding a new roost location and not the probability of individuals not coming into conflict would be very low. WS has developed alternatives to minimize the potential of dispersing bird roosts in urban/suburban areas by evaluating a management option to alter the habitat when birds are not present (e.g. summer months) or depopulate a bird roost.

An effigy, in general terms, is a replica or some other three-dimensional representation of, in this case, a bird species causing damage. The presence of an effigy elicits a desired behavioral response, avoidance of an area or flight, from the remaining birds in the roost. The effectiveness of effigies in deterring roosting birds is related to the presentation, movement, and context of the mount. Recent advancements have found that avian responses to objects is a critical part of foraging, populationing, predator detection, and special orientation in relation to avoiding static or moving structures (DeVault et al. 2013).

2.7 How Do WS-Colorado Personnel Select a BDM Strategy Using the WS Decision Model?

The Decision Model is not a written documented process for each incident, but rather a mental problem-solving process. This process is similar to adaptive management strategies used by all wildlife management professionals when addressing a wildlife damage problem, including biologists who work for some of the lead and cooperating agencies for this EA. To use an analogy, it is also similar to assessment processes used by fire departments when they arrive on a scene to determine the most effective and safe strategy for resolving the situation.

In general, the thought process and procedures of the Decision Model include the following steps.

(1.) **Receive Request for Assistance:** WS-Colorado only provides assistance after receiving a request for assistance. WS does not respond to public bid notices.

(2) **Assess Problem:** First, WS-Colorado makes a determination as to whether the assistance request is within the authority of WS-Colorado. If an assistance request is determined to be within the authority of WS-Colorado, WS-employees will 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 be include the current economic loss or current threat to human health and 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 is complete, a WS' employee will conduct an evaluation of available management methods. The employee will evaluate the methods available in the context of their legal and administrative availability and acceptability based on legal, safety, biological, humaneness, environmental, social, and cultural factors.

(4) **Formulate Management Strategy:** A WS' employee will formulate a management strategy using those methods that the employee determines to be practical and effective for use, considering additional factors essential to formulating each management strategy, such as available expertise, willingness of the resource owner, legal constraints on available methods, costs and effectiveness. In many cases, the methods included in a strategy work in concert to produce the best results; this is the advantage of using an integrated strategy instead of a list of methods.

(5) **Provide Assistance:** After formulating a management strategy, a WS employee could provide technical and/or operational assistance to the requester (see WS Directive 2.101).

(6) **Monitor and Evaluate Results of Management Actions:** When providing operational assistance, it is necessary to monitor the effectiveness of the management strategy. The cooperator primarily monitors the effectiveness of these strategies and is assisted by WS-Colorado employees when appropriate. Continual monitoring is essential in determining whether additional techniques or assistance is required to resolve the problem or if modification of the strategy is necessary.

(7) **End of Project:** After providing technical assistance, a project normally ends after the WS employee provides recommendation and/or advice to the requester. An operational assistance project normally would end when WS' personnel stop or reduce the damage or threat of damage to an acceptable level to the requester or to the extent possible. Some damage situations may require continuing or intermittent assistance from WS-Colorado and may have no well-defined termination point, as work must be repeated periodically to maintain damage at a low level, such as safety operations at airports.

2.8 What Are the Integrated Wildlife Damage Management Strategies that WS-Colorado Employs?

The mission of WS is to provide Federal leadership in managing damage associated with wildlife. WS recognizes that wildlife is an important public resource greatly valued by the American public. Wildlife, by its very nature, is a highly mobile and dynamic resource that can damage agriculture, natural resources, property, and human health and safety. The WS-Colorado program professionally assists entities and other resource owners/managers in alleviating human-wildlife conflicts.

2.8.1 Technical Assistance.

Technical assistance provided by WS-Colorado consists of personnel providing verbal or written advice, recommendations, information, demonstrations or trainings, on available and appropriate WDM methods. Verbal consultation and/or site visits are used to determine the extent of damage, identification of the species involved, and the history and nature of the problem. Following verbal communication and/or a site visit, WS may provide technical assistance recommending habitat modification, cultural practices to reduce the likelihood of wildlife damage, behavior modification of species involved, or ways to reduce specific wildlife populations to alleviate damage to resources. Generally, short and long-term strategies to alleviate damage are given to the requestor; these strategies are recommended based on the level of risk, need, and the practicality of their application by the requestor. In some cases, WS may not recommend damage control actions if requestors are satisfied with an explanation of biology, behavior, and population ecology of the species associated with the resource damage. USDA-APHIS NEPA implementing regulations categorically exclude technical assistance from the regulations categorically exclude technical assistance from the requirement to prepare and EA or EIS (7 CFR 372.5 (c), 60 Fed. Reg. 6,000 – 6,003, 1995). However, it is discussed in this EA because it is an important component of the IWDM approach to resolving bird damage problems.

In resolving BDM issues, WS-Colorado personnel may suggest the use of nonlethal, lethal, or a combination of techniques in resolving wildlife damage conflicts. Nonlethal recommendations may include, but are not limited to, habitat modification and manipulation, frightening devices, behavioral modifications, exclusion devices, physical barriers, visual repellents, live capture, translocation, livestock guarding animals, and animal husbandry. Lethal methods that may be recommended during technical assistance may include traps and other capture devices, shooting, removal or destruction of eggs and/or nests, and chemical toxicants. In making BDM recommendations, WS employees take into account environmental factors and relevant laws and regulations. When appropriate, WS recommends that regulatory agencies issue permits to allow resource owners to alleviate wildlife damage issues. Recipients of technical assistance are responsible for implementing the recommended control actions. The WS-Colorado program does not control the actions, if any, taken by others.

2.8.2 Operational Damage Management Assistance.

Operational BDM assistance is given when technical assistance alone is not sufficient to resolve a problem. WS personnel conduct operational BDM, when the resource owner's efforts, such as habitat modification, exclusion, hazing or husbandry practices, are ineffective. WS-Colorado provides these services on a cost-reimbursable basis. Usually, funding is provided by resource owners, private businesses, or local, state, or Federal agencies. WS personnel consider practical methods for resolving damage problems and take action by implementing the most strategically appropriate methods. Damage management assistance may be include harassment, wire grid installation, egg and nest removal, shooting to supplement harassment, capture and translocation, and capture and euthanasia.

2.8.3 Education and Outreach.

Education and outreach are essential elements of the WS-Colorado's BDM activities. Finding an ecological balance among species, let alone multiple species including humans, is extremely challenging since nature is continuously in a state of flux. WS-Colorado routinely disseminates information to resource owners and managers that request technical assistance, and provides lectures and demonstrations to the public. Furthermore, WS-Colorado frequently collaborates with other local, state, and federal agencies in educational and public outreach events. WS-Colorado employees regularly attend and present at professional meetings and conferences so that other WS personnel, wildlife professionals, and the public are periodically updated on recent developments in wildlife damage management technology, scientific research, laws and regulations, and agency policies and guidelines.

2.8.4 Community Based Decision Making.

Technical assistance provided by Wildlife Services to resource owners for decision-making.

WS-Colorado follows the "co-managerial approach" to solve bird damage or conflicts associated with bird species as described by Decker and Chase (1997). This approach recognizes the need, value, and difficulty of adapting wildlife management issues to meet local situations. It requires that the participants establish guidelines upfront regarding operational procedures, oversight, accountability, goals, and an evaluation processes for the eventual outcome. During these discussions, WS may provide decision-making bodies, representing local stakeholders, educational information and professional expertise on wildlife management protocols, wildlife damage management issues and solutions, training for community participants, and guidance on community management plans, and monitoring activities. This management model is effective when local community stakeholders desire to participate in solving their human-wildlife conflicts through management implementation, cost sharing, and accountability regardless of the outcome.

Local decision makers, including community leaders, private resource owners/managers, and public property owners/managers are responsible for deciding which effective methods should be used to resolve human-wildlife conflicts.

Community decision makers

The President or the President's or Board's appointee will serve as the local decision maker for communities with a homeowner or civic association. The President and Board are popularly elected residents of the local community who oversee the interests and business of the local community. This person would be responsible representing the community's professional interests and for communicating pertinent information back to the community for discussion and decision making. In business communities, identifying a decision maker becomes complicated because the lease may not indicate whether the business must manage wildlife damage themselves, seek approval to manage wildlife from the property owner or manager, or from a governing board. In such cases, WS would provide technical assistance to the local community or local business community decision maker(s) and recommendations to reduce damage. If local community decision maker(s) requested additional operational damage management, WS would conduct these activities if: they were in line with WS recommendation, a written agreement was signed (e.g., Cooperative Service Agreement and work initiation document), and funding was provided.

Private property decision makers

When a private property owner requests BDM assistance, the decision maker is the requesting individual. WS would first provide technical assistance and recommendation(s) to reduce damage. Operational damage manage would be provided by WS if a written agreement was signed (e.g., Cooperative Service Agreement and work initiation document), assistance was requested, funding was provided, and the request was in line with WS' recommendations.

If multiple resource owners of a local community are not governed by a civic association or if a resource is shared by the community WS will provide technical assistance to the self or locally appointed decision maker. If requested, operational damage management activities would be supplied if a written agreement was signed (e.g., Cooperative Service Agreement and work initiation document), funding was provided and the request was in line with WS recommendations. However, a minimum of 67% of the affected resource owners must agree to operational damage management actions. If WS is working cooperatively with a state agency (e.g. CPW, CDA) then the minimum percentage of resource owners agreeing to operational management may be higher because of state agency policy or practice. Affected resource owners, for example, would include property that is adjacent to water bodies where Canada geese or urban ducks primarily live. Resource owners who disagree with operational management actions may request WS to not conduct this action on their property and WS will honor this request.

Public property decision makers

For local, state, or federal property the decision maker is the same as the official responsible for, or authorized, in managing the property in the public's interests, goals, and legal mandates. When requested, WS will provide technical assistance and recommendations to this person. Operational management actions would be provided by WS if requested, agreements (cooperative service agreements and work initiation documents) are signed, funding is provided, and if these actions align with WS recommendations.

2.9 Bird Damage Management Methods Available for Preventing, Reducing, and Alleviating Damage and Threats Associated with Birds in Colorado.

Wildlife Services has been conducting Wildlife Damage Management (WDM) in the United States for more than 100 years. WS-Colorado has modified WDM activities to reflect societal values and minimize impacts to people, wildlife, and the environment. These efforts have involved research and development of new field methods and the implementation of effective strategies to resolve wildlife damage. WS-Colorado personnel use a wide range of methods in Bird Damage Management (BDM) and strategies are based on applied IWDM principles. Some techniques suggested for use by resource owners, by other entities or individuals, to stop bird damage may not be considered by WS if they are biologically unsound, legally questionable, or ineffective such as ultrasonic devices to repel birds and the use of illegal chemicals.

2.9.1 Nonlethal Methods That May Be Used.

Resource Management. Resource management includes a variety of practices that may be used by agriculture producers and other resource owners to reduce their exposure to potential wildlife depredation losses. Implementation of these practices is appropriate when the potential for depredation can be reduced without significantly increasing the cost of production or diminishing the resource owner's ability to achieve land management and production goals. WS-Colorado may provide technical assistance for agricultural producers and resource owners to alleviate the damage themselves. Changes in resource management are usually not conducted operationally by WS-Colorado, but WS-Colorado could assist producers in implementing changes to reduce problems.

Animal Husbandry. This category includes modifications in the level of care and attention given to livestock, shifts in the timing of breeding and births, selection of less vulnerable livestock species to be produced, and the introduction of human custodians to protect livestock. The level of attention given to livestock may range from daily to seasonally. Generally, when the frequency and intensity of livestock handling increases, so does the degree of protection especially during calving and lambing when young livestock are vulnerable to species such as common ravens and golden eagles. The use of human custodians, such as sheep herders or range riders, can significantly reduce damage levels, but can be very costly.

The risk of predation to poultry and small livestock, primarily newborns, can be reduced when operations monitor their livestock during hours when predatory birds are most active. The risk of predation is usually greatest with immature livestock, and this risk can be reduced by holding pregnant females in pens or sheds to protect newborns and by keeping these animals in pens or sheds during the first 2 weeks of life. The risk of predation to livestock diminishes with age and as they increase in size. For example, Common ravens can kill calves within a short time following birth. Keeping cows gathered during calving can reduce the opportunity for this, if custodians are present to scare away the birds. Shifting breeding schedules can also reduce the risk of predation by altering the timing of births to coincide with the greatest availability of natural food items for predators or to avoid seasonal concentrations of migrating predators such as ravens. Similarly, Golden eagles or Bald eagles may depredate new born lambs. The risk may be ameliorated by holding ewes and their lambs near sheds or away from nesting eagle territories and near developed areas of the ranch. For sheep or goats on range mitigating eagle predation, this may be more difficult.

Altering animal husbandry to reduce wildlife damage has many limitations. Gathering herds may not be a viable option when livestock are spread throughout several isolated pastures and where grazing conditions require livestock to scatter. Hiring extra herders, building secure holding pens, and adjusting the timing of births is usually expensive or incompatible with market conditions. The timing of births may be related to weather or seasonal marketing of livestock. The expense associated with a change in husbandry practice may exceed the savings. WS encourages resource owners to use these strategies where they may be beneficial, but does not conduct these techniques operationally.

Guard Animals. Guard animals are used in WDM to protect a variety of resources and can provide significant protection at times. Guard animals (i.e., dogs, burros, and llamas) have proven successful in many sheep and goat operations. The effectiveness of guarding animals may not be sufficient in areas where there is a high density of wildlife to be deterred, where the resource, such as sheep foraging on open range, is widely scattered, or where the guard animal to resource ratios are less than recommended. Also, pairing an inappropriate or ineffective guard animal with livestock will have unsatisfactory results. WS-Colorado often recommends the use of guard animals, but has not had an operational guard animal project.

Several breeds of dogs such as the Great Pyrenees and Komondor have been used to protect sheep and goats. Border collies and other dogs can sometimes be very effective for Canada goose damage reduction at parks and golf courses. However, the supply and longevity of proven guard dogs is generally quite limited. Resource owners typically must purchase and rear their own guarding dog. Therefore, a 4 to 8-month lag-time is necessary to raise a guarding dog before it becomes an effective deterrent to wildlife such as geese. Since 25% to 30% of dogs are unsuccessful, the first dog raised as a protector may not be useful. Guard dogs may be ineffective for a number of reasons, but usually because they kill the livestock they are protecting, fail to bond with the livestock, or because they do not stay with the livestock or resource they are intended to guard. Furthermore, guard dogs can harass and kill non-target wildlife while protecting resources (Timm and Schmidt 1989).

Crop Selection/Scheduling. In areas where damage to crops from wildlife is expected, different crops can be planted that are less attractive to the wildlife causing damage or crops can be planted at an earlier or later date to avoid damage. This practice depends on the species causing damage (*e.g.,* resident vs. migrant), the availability of alternate food sources, and the market for alternative crops. Research has been conducted on damage resistant crop varieties with little success.

Lure Crops. If depredations are not avoided by careful crop selection or a modified planting schedule, lure crops can sometimes be used to mitigate the potential loss (Cummings et al. 1987). Lure crops are planted or left for consumption by wildlife as an alternate food source. To improve the efficacy of this technique, it is recommended that frightening devices should be used in nearby non-lure crop fields and wildlife should not be disturbed in the lure crop fields. This approach provides relief for critical crops by sacrificing less important or specifically planted fields. Establishing lure crops is sometimes expensive, requires considerable time and planning to implement, and may attract other unwanted species to the area. Lure crops have been used successfully to reduce damage by cranes and geese in the Middle Rio Grande Valley of New Mexico for many years (WS 2009).

Habitat Management. Localized habitat management is often an integral part of WDM. The type, quality, and quantity of habitat are directly related to the wildlife produced or attracted to an area. Habitat can be managed to not produce or attract certain wildlife species. For example, vegetation can be planted that is unpalatable to certain wildlife species or trees and shrubs can be pruned or cleared to make an area unattractive for roosting birds. Ponds or other water sources can be eliminated to reduce certain wildlife species. Habitat management is typically aimed at eliminating nesting, roosting, loafing, or feeding sites used by particular species. Limitations of habitat management as a method of reducing wildlife damage are determined by the characteristics of the

species involved, the nature of the damage, economic feasibility, and other factors. Legal constraints may also exist which preclude altering particular habitats. Most habitat management recommended by WS is aimed at reducing wildlife aircraft strike hazards at airports, eliminating bird winter roosts, or managing field rodent populations at airports so as not to attract raptors.
Change in the architectural design of a building or a public space can often help to avoid potential wildlife damage. For example, selecting species of trees and shrubs that are not attractive to wildlife can reduce the likelihood of potential wildlife damage to parks, public spaces, or residential areas. Similarly, incorporating spaces or open areas into landscape designs that expose wildlife can significantly reduce potential problems. Modifying public spaces to remove the potential for wildlife conflicts is often impractical because of economics or the presence of other nearby habitat features that attract wildlife. Some forms of habitat management may also be incompatible with the aesthetic or recreational features of the site.

Birds use trees and poles for roosting, perching and nesting, and the removal or modification of these items will often reduce the attractiveness of the area. Large winter bird roosts can be greatly reduced at roost sites by removing all the trees or selectively thinning the stand or branches in used trees. Roosts often will re-form at traditional sites, and substantial habitat alteration is the only way to permanently stop such activity. Poles can also be used to attract raptors to sites where reductions in rodent populations are desired.

Habitat management does have the potential to have an effect on all T&E species if present in an area, especially where a T&E species is present that uses the habitat to be modified. If WS determines habitat management would be appropriate to reduce wildlife damage or the threat of damage at a site, such as an airport where wetlands often should be removed, WS will ensure that the cooperator is aware for the need to address T&E species impacts. Habitat management instigated by WS will only be conducted following a consultation with USFWS on a site-specific basis where T&E species are present. Any efforts to mitigate identified effects will be the responsibility of the landowner, but must be agreed upon before WS will commence WDM activities. This will ensure that WS habitat management activities will not have an adverse impact on T&E species and their habitat.

Prey-base Control with Insecticides and Rodenticides is conducted primarily at airports to reduce the attractiveness of an area to predators including raptors such as Red-tailed hawks, American kestrels, and Great blue herons. All pesticides used by WS-Colorado are registered for use by EPA and CDA and are not expected to have more than a minimal effect on non-target species. A reduction in insects at an airfield in Texas was shown to reduce the number of bird strikes as well as bird abundance (M. Bodenchuk, WS, TX pers. comm. 2010). Similarly, insecticides were used at JFK International Airport to reduce the abundance of ants and beetles consumed by laughing gulls attracted to the airport to feed (WS 2012, Bernhardt et al. 2010, Kutschbach-Brohl et al. 2010).

Modification of Human Behavior. WS often tries to alter human behavior to resolve potential conflicts between humans and wildlife. For example, WS may talk with residents of an area to eliminate the feeding of wildlife that occurs in parks, recreational sites, or residential areas to reduce damage by certain species of wildlife, such as Rock Pigeons, Canada Geese, and gulls. This includes inadvertent feeding allowed by improper disposal of garbage or leaving pet food outdoors where wildlife can feed on it, especially near fast food restaurants. Many wildlife species adapt well to human settlements and activities, but their proximity to humans may result in damage to structures or threats to public health and safety. Eliminating wildlife feeding and handling can reduce potential problems, but many people who are not directly affected by problems caused by wildlife enjoy wild animals and engage in activities that encourage their presence. It is difficult to consistently enforce no-feeding regulations and to effectively educate all people concerning the potential liabilities of feeding wildlife.

Remote Controlled Systems (i.e. boats, hovercraft). Remote control systems (i.e. Goosinator) are marketed as a predatory decoy that can be used on a variety of surfaces (land, water, snow, and ice). These remote control decoys (like others such as remote control boats) are used to chase or harass Canada geese away from an area. Hazing or persistent harassment is often recommended as a strategy for deterring Canada geese as part of an integrated management program.

2.9.2 Physical Exclusion That May Be Used.

Physical exclusion methods restrict the access of birds to resources. These methods can provide effective prevention of bird damage in many situations. Bird proof barriers can be effective but are often cost-prohibitive, particularly because of the aerial mobility of birds which requires overhead barriers as well as peripheral fencing or netting. Exclusion adequate to stop bird movements can also restrict movements of livestock, people, and other wildlife (Fuller-Perrine and Tobin 1993). Exclusionary devices are often costlier than the value of the resource being protected, especially for large areas, and therefore, are uneconomical and not used often. In addition, some exclusionary devices are labor intensive which can further reduce their cost-effectiveness. Exclusionary devices can potentially injure, maim, and kill non-target wildlife, particularly birds. Netting can entangle birds and needs to be checked frequently to release birds that have been trapped. Wire grids can inadvertently injure or kill non-target wildlife species, including T&E species, from impact at high speeds.

Fencing. Fences are widely used to prevent damage from wildlife. Exclusionary fences constructed of woven wire or multiple strands of electrified wire can be effective in keeping wading birds from some areas such as an aquaculture facility or molting Canada Geese out of crop fields. The size of the wire grid must be small enough and the height of the fence high enough to keep the birds from entering the area. For ponds, fencing at least 3 feet high should be erected in water 2 to 3 feet deep. If fences are built in shallow water, birds can easily feed on the pond side of the fence. Raceway fences should be high enough to prevent feeding from the wall. Occasionally, blackbirds will cling to fencing or screening near the water and feed on small fish. A slippery surface created by draping plastic over the fence or screen can be used to eliminate this problem. Electric fences or wires have also been used with limited success. This type of exclusion can make routine work around ponds and hatcheries difficult or impossible. Fencing does have limitations. Even an electrified fence is not always bird-proof and the expense of the fencing can often exceed the benefit. In addition, if large areas are fenced, the wildlife being excluded has to be removed from the enclosed area to make it useful.

Overhead Barriers. Overhead barriers such as netting and wire grids are mostly used to prevent access to areas such as gardens, fish ponds and raceways, dwellings, and livestock and poultry pens. Selection of a barrier system depends on the bird species being excluded, expected duration of damage, size of the area or facility to be excluded, compatibility of the barrier with other operations (*e.g.,* feeding, cleaning, harvesting, etc.), possible damage from severe weather, and the effect of on-site aesthetics. The barrier system also depends on the resource being protected and its value. Overhead barrier systems can initially be very costly and expensive to maintain.

Netting consists of placing plastic or wire nets around or over resources in a small area, likely to be damaged or that have a high value. Netting is typically used to protect areas such as poultry pens, fish ponds and raceways, and high value crops. Complete enclosure of ponds and raceways to exclude all fish-eating birds requires 1.5- to 2-inch mesh netting secured to frames or supported by overhead wires. Gates and other openings must also be covered. Some hatchery operators use mesh panels placed directly on raceways to effectively exclude predatory birds. Small mesh netting or wire with less than 1-inch openings, secured to wood or pipe frames, prevents feeding through the panels. Because the panels may interfere with feeding, cleaning, or harvesting, they are most appropriate for seasonal or temporary protection. It is also used to prevent wildlife access to settling ponds that contain poisons which could kill them. Small mesh can also be used in ponds to prevent fish from entering shallow water where they would be easy prey for wading birds. Complete enclosure of areas with netting can be very effective at reducing damage by excluding all problem species, but can be costly.

Ponds, raceways, buildings, and other areas can be protected with overhead wires or braided or monofilament lines suspended horizontally in one direction or in a crossing pattern. Monofilament wires can effectively deter gull use of specific areas where they are causing a nuisance (Blokpoel 1976, Blokpoel and Tessier 1984, Belant and Ickes 1996). The WS program in Washington has effectively utilized steel wires to deter gulls from preying on salmon fingerlings, including T&E species, at the base of dams. Spacing between wires or lines should be based on the species and habits of the birds causing damage. Where the wire grids need to be suspended up high to allow for maintenance, perimeter fencing or wire around ponds and raceways provides some protection from wading birds and is most effective for herons. Partial enclosures, such as overhead lines, cost less but may not exclude all bird species such as terns. Additionally, some areas in need of protection are too large to be protected with netting or overhead wires.

Other Exclusionary Methods. Entrance barricades of various kinds are used to exclude several bird species such as starlings, pigeons, and House Sparrows from dwellings, storage areas, gardens, or other areas. Heavy plastic strips hung vertically in open doorways have been successful in some situations in excluding birds from buildings used for indoor feeding or housing of livestock (Johnson and Glahn 1994). Plastic strips, however, can prevent or substantially hinder the filling of feed troughs or feed platforms at livestock feeding facilities. Such strips can also be covered up when the feed is poured into the trough by the feed truck. They are not practical for open-air feedlot operations that are not housed in buildings. Metal flashing or hardware cloth may be used to prevent entry of wildlife into buildings or roosting areas. Floating plastic balls called Euro-Matic Bird Balls™ have successfully been used at airports and settling ponds to keep birds from landing on ponds. Porcupine wire such as Nixalite™ and Catclaw™ is a mechanical repellent method that can be used to exclude pigeons and other birds from ledges and other roosting surfaces (Williams and Corrigan 1994). The sharp points inflict temporary discomfort on the birds as they try to land which deters them from roosting. Drawbacks of this method are that some pigeons will build nests on top of porcupine wire and it can be expensive to implement when large areas are involved. Electric shock bird control systems are available from commercial sources and, although expensive, can be effective in deterring pigeons and other birds from roosting on ledges, window sills and other similar portions of structures (Williams and Corrigan 1994). There are many more examples of these types of exclusionary devices to keep wildlife from entering or landing on areas where they are unwanted.

2.9.3 Frightening Devices Or Deterrents That May Be Used.

Frightening devices are used to repel wildlife from an area where they are a damage risk (i.e., airport, crops) or at risk of being contaminated (*e.g.,* oil spill, settling ponds). The success of frightening methods depends on an animal's fear of, and subsequent aversion to, offensive stimuli (Shivik and Martin 2000). A persistent effort is usually required to effectively apply frightening techniques and the techniques must be sufficiently varied to prolong their effectiveness. Over time, animals often habituate to commonly used scare tactics and ignore them (Pfeifer and Goos 1982, Conover 1982, Shirota et al. 1983, Schmidt and Johnson 1983, Mott 1985, Dolbeer et al. 1986, Graves and Andelt 1987, Avery et al. 1988, Tobin et al. 1988, Bomford 1990, Seamans et al. 2013). In addition, in many cases birds frightened from one location become a problem at another. Scaring devices, for the most part, are directed at specific target species by specialists working in the field. However, several of these devices, such as scarecrows and propane exploders can be automated and work without the presence of an operator.

Harassment and other scaring devices and techniques to frighten birds are probably the oldest methods of combating wildlife damage. These devices may be either auditory or visual and generally only provide short-term relief from damage. However, a number of sophisticated techniques have been developed to scare or harass birds from an area. The use of noise-making devices is the most popular and commonly used. Other methods include harassment with visual stimuli (*e.g.,* scarecrows, human effigies, balloons, Mylar® tape, and wind socks), vehicles, lasers, people, falcons, or dogs. These are used to frighten mammals or birds from the immediate vicinity of the damage prone area. As with other WDM efforts, these techniques tend to be more effective when used collectively in a varied regime rather than individually. However, the continued success of these methods frequently requires reinforcement by limited shooting (see Shooting). These techniques are generally only practical for small areas. Finally, it must be noted that sound-scare devices can also scare livestock when they are used in their vicinity.

Visual scaring techniques such as use of Mylar® tape (highly reflective surface produces flashes of light that startles birds), eye-spot balloons (the large eyes supposedly give birds a visual cue that a large predator is present), flags, effigies (scarecrows), sometimes are effective in reducing bird damage. Mylar tape has produced mixed results in its effectiveness to frighten birds (Dolbeer et al. 1986, Tobin et al. 1988). Birds quickly learn to ignore visual and other scaring devices if the birds' fear of the methods is not reinforced with shooting or other tactics.

Electronic distress sounds and alarm calls of various animals have been used singly and in conjunction with other scaring devices to successfully scare or harass animals. Many of these sounds are available on compact discs and tapes. Distress calls are broadcast to the target animals from either fixed or mobile equipment in the immediate or surrounding area of the problem. Animals react differently to distress calls; their use depends on the species and the problem. Calls may be played for short (*e.g.,* few second) bursts, for longer periods, or even continually, depending on the severity of damage and relative effectiveness of different treatment or "playing" times. Some artificially created sounds also repel wildlife in the same manner as recorded "natural" distress calls.

Propane exploders operate on propane gas and designed to produce loud explosions at controllable intervals. They are strategically located (i.e., elevated above the vegetation, if possible) in areas of high wildlife use to frighten wildlife from the problem site. Because animals are known to habituate to sounds, exploders must be moved frequently and used in conjunction with other scare devices. Exploders can be left in an area after dispersal is complete to discourage animals from returning.

Pyrotechnics, shell-crackers and scare cartridges are commonly used to repel wildlife. Shell-crackers are 12-gauge shotgun shells containing firecrackers that are projected up to 75 yards in the air before exploding. They can be used to frighten birds or mammals, and are most often used to prevent crop depredation by birds or to discourage birds from undesirable roost locations. The shells should be fired so they explode in front of, or underneath, populations of birds attempting to enter crop fields or roosts, or the air operating area at an airport. The purpose is to produce an explosion between the birds and their objective. Birds already in a crop field can be frightened from the field; however, it is extremely difficult to disperse birds that have already settled in a roost.

Noise, whistle, racket and rocket bombs are fired from 15-millimeter flare pistols. They are used similarly to shell-crackers but are projected for shorter distances. Noise bombs (also called bird bombs) are firecrackers that travel about 25 yards before exploding. Whistle bombs are similar to noise bombs, but whistle in flight rather than exploding. They produce a noticeable response because of the trail of smoke and fire, as well as the whistling sound. Racket bombs make a screaming noise in flight and do not explode. Rocket bombs are similar to noise bombs but may travel up to 150 yards before exploding.

A variety of other pyrotechnic devices, including firecrackers, rockets, and Roman candles, are used for dispersing wildlife. Firecrackers can be inserted in slow-burning fuse ropes to control the timing of each explosion. The interval between explosions is determined by the rate at which the rope burns and the spacing between firecrackers.

Lights, such as strobe, barricade, and revolving units, are used with mixed results to frighten waterfowl. Brilliant lights, similar to those used on aircraft, are most effective in frightening night-feeding birds. These extremely bright-flashing lights have a blinding effect, causing confusion that reduces the bird's ability to see. Flashing amber barricade lights, like those used at construction sites, and revolving or moving lights may also frighten birds when these units are placed on raceway walls, fish pond banks, or ingress corridors. However, most birds rapidly become accustomed to such lights and their long-term effectiveness is questionable. In general, the type of light, the number of units, and their location are determined by the size of the area to be protected and by the power source available.

Lasers (the term of "laser" is an acronym for Light Amplification by Simulated Emission of Radiation) to alter bird behavior was first introduced nearly 35 years ago (Lustick 1973), but are a relatively new technique used to frighten and disperse birds from their roosts. The laser received very little attention, until recently, when it had been tested by NWRC. Results have shown that several bird species, such as Double-crested Cormorants, Canada Geese, other waterfowl, gulls, vultures, and American Crows have all exhibited avoidance of laser beams during field trails (Glahn et al. 2000, Blackwell et al. 2002). The repellent or dispersal effect of a laser is due to the intense and coherent mono-wavelength light that, when targeted at birds, can have substantial effects on behavior and may illicit changes in physiological processes (Cummings 2016). Best results are achieved under low-light conditions (i.e., sunset through dawn) and by targeting structures or trees in proximity to roosting birds, thereby reflecting the beam. Lasers are directional by the user and therefore, will have little effect on non-target species.

Water spray devices from rotating sprinklers placed at strategic locations in or around ponds or raceways will repel certain birds. However, individual animals may become accustomed to the spray and feed among the sprinklers. Best results are obtained when high water pressure is used and the sprinklers are operated with an on-off cycle. The sudden startup noise also helps frighten birds from an area.

Physical harassment with radio controlled airplanes is effective in several situations for dispersing damage-causing birds. This tool is effective in removing raptors from areas that are not accessible by other means. Radio controlled airplanes allow for up close and personal harassment of birds, while combining visual (*e.g.,* eyespots painted on the wings) and auditory (*e.g.,* engine noise and whistles attached to the aircraft) scare devices. Disadvantages of method are birds in large populations do not respond well to the plane, much training is required to become efficient, a good working relationship is required by the operator and air traffic controllers at airports where they are most commonly used, weather conditions may restrict the usefulness of the plane, and the planes require frequent mechanical up-keep.

Avitrol® (Avitrol Corporation, Tulsa, OK), 4-aminopyridine, is primarily used as a chemical frightening agent (repellent) for blackbirds in corn and sunflower fields and can be effective in a single dose when mixed with untreated baits. However, Avitrol is not completely a frightening agent because most birds that consume the bait die (Johnson and Glahn 1994). Avitrol comes pre-formulated with treated baits mixed with untreated baits (1:99) and applied to crop fields for birds to ingest. After ingesting the bait, the bird becomes ill, flies erratically, emits distress calls, and then dies. This behavior is intended to frighten the remaining blackbirds from the treated fields. NWRC research and producers have had mixed and inconsistent results with the technique's effectiveness. As a result, this formulation of Avitrol has not been used widely. Avitrol is more often used as a toxicant for other species of birds such as pigeons and it will be discussed further under chemical toxicants. Avitrol is a restricted-use pesticide that can only be sold to certified applicators. It is available in several bait formulations with only a small portion of the individual grains carrying the chemical. It can be used during anytime of the year, but is used most often during fall and winter just prior to harvest of a crop. Any granivorous bird associated with the target species could be affected by Avitrol. Avitrol is water soluble, but laboratory studies demonstrated that Avitrol is strongly absorbed onto soil colloids and has moderately low mobility. Biodegradation is expected to be slow in soil and water, with a half-life ranging from three to 22 months. However, Avitrol may form covalent bonds with humic materials, which may serve to reduce its bioavailability in aqueous media, is non-accumulative in tissues, and is rapidly metabolized by many species (Schafer 1991). Avitrol is acutely toxic to avian and mammalian species; however, blackbirds are more sensitive to the chemical with little evidence of chronic toxicity for many species. Laboratory studies with predator and scavenger species have shown minimal potential for secondary poisoning, and during field use only magpies and crows appeared to have been affected (Schafer 1991). However, a laboratory study by Schafer et al. (1974) showed that magpies exposed to two to 3.2 times the published LD_{50} (Lethal Dose required to kill 50% of the test subjects of a given species) in contaminated prey for 20 days were not adversely affected and three American Kestrels were fed contaminated blackbirds for seven to 45 days were not adversely affected. Therefore, no probable risk is expected, based on low concentrations and low hazards quotient value for non-target indicator species tested on this compound. No probable risk is expected for pets and the public, based on low concentrations and low hazards quotient value for non-target indicator species tested on this compound.

Live Trap and Translocation. Translocation may be appropriate in some situations (i.e., if the problem species' population is at very low levels, a suitable relocation site is known, and the additional dollars required for relocation can be obtained.) However, those species that often cause damage problems (*e.g.,* blackbirds, Canada Geese) are relatively abundant and relocation is not necessary for the maintenance of viable populations. Relocation may also result in future depredations if the relocated animal encounters protected resources again and, in some cases, could require payment of damage compensation claims. Any decisions on relocation of wildlife are coordinated with USFWS or CPW, and, in many instances, State laws require consultation with appropriate land management agencies/manager before relocating wildlife to these lands. Finally, some state agencies require veterinary examinations and disease tests prior to relocation.

The American Veterinary Medical Association, The National Association of State Public Health Veterinarians, and the Council of State and Territorial Epidemiologists all oppose the relocation of mammals because of the risk of disease transmission (Centers for Disease Control 1990). Although relocation is not necessarily precluded in all cases, it would in many cases be logistically impractical and biologically unwise. Relocation to other areas following live capture would not generally be effective or cost –effective because problem bird species are highly mobile and can easily return to damage sites from long distances, habitats in other areas are generally already occupied, and relocation would most likely result in bird damage problems at the new location. Relocation of wildlife is also discouraged by WS policy (WS Directive 2.501) because of stress to the relocated animal, poor survival rates, and difficulties in adapting to new locations or habitats. However, there may be exceptions for relocating certain bird species. Relocation of damaging birds might be a viable solution and acceptable to the public when the birds were considered to have high value such as migratory waterfowl, raptors, or T&E species. In these cases, WS would consult with the USFWS or CPW to coordinate capture, transportation, and selection of suitable relocation sites.

Chemical Repellents. Chemical repellents are nonlethal chemical formulations used to discourage or disrupt particular behaviors of wildlife. There are three main types of chemical repellents: olfactory, taste, and tactile. Olfactory repellents must be inhaled to be effective. These are normally liquids, gases or granules, and require application to areas or surfaces needing protecting. Taste repellents are compounds (i.e., liquids, dusts, granules) that are normally applied to trees, shrubs and other materials that are likely to be ingested or gnawed by the target species. Tactile repellents are normally thick, liquid-based substances which are applied to areas or surfaces to discourage travel of wildlife by irritating the feet or making the area undesirable for travel. Most repellents are ineffective or short-lived in reducing or eliminating damage caused by wildlife, therefore, are not used very often by WS.

Effective and practical chemical repellents should be nonhazardous to wildlife; nontoxic to plants, seeds, and humans; resistant to weathering; easily applied; reasonably priced; and capable of providing good repellent qualities. The reaction of different animals to a single chemical formulation varies and this variation in repellency may be different from one habitat to the next. Development of chemical repellents is expensive and cost prohibitive in many situations. Chemical repellents are strictly regulated, and suitable repellents are not available for many wildlife species or wildlife damage situations. Chemical repellents are commercially available for birds and include active ingredients such as methyl anthranilate which is grape soda flavoring (i.e., Rejex-it®), anthraquinone (Flight Control®Plus, Avipel®), methiocarb (i.e., Mesurol), or polybutenes (i.e., Tanglefoot® - Tanglefoot Co., Grand Rapids, MI). These compounds are relatively nontoxic to the environment with the amount of active ingredient used in the different formulations, especially following label instructions (some problems have been brought forth regarding anthraquinone, but it should be relatively safe if used according to label). The active ingredients in many repellents are listed on the EPA's 25b exempt list and, as such, are considered to have relatively low risk to the environment. Registration requirements for these chemicals are reduced because they are relatively nontoxic. Most repellents have only "Caution" on the labels because they are relatively nontoxic. These can typically be purchased by the public. An exception is methiocarb which is discussed below. Applied in accordance with label directions, none of the other repellents discussed are expected to have an effect on non-target species.

Methyl anthranilate (MA), an artificial grape flavoring used in foods and soft drinks for human consumption, could be used or recommended by WS as a bird repellent. MA has been shown to be an effective repellent for many bird species, including waterfowl (Dolbeer et al. 1993). It is equivalent in birds as capsaicin (hot peppers) is to mammals. It is registered under the brand name Rejex-it® (Natural Forces LLC, Davidson, NC) for applications to turf or to surface water areas used by unwanted birds. The material has been shown to be nontoxic to bees (LD_{50} > 25 micrograms/bee[8]),

[8] An LD_{50} is the dosage in milligrams of material per kilogram of body weight, or, in this case in micrograms per individual bee, required to cause death in 50% of a test population of a species.

nontoxic to rats in an inhalation study (LC_{50} > 2.8 mg/L[9]), and of relatively low toxicity to fish and other invertebrates. MA is a naturally occurring chemical in concord grapes and the blossoms of several species of flowers which is used as a food additive and perfume ingredient (Dolbeer et al. 1991). It has been listed as "Generally Recognized as Safe" by the FDA (Dolbeer et al. 1991). Water surface and turf applications of MA are generally considered expensive. For example, the least intensive application rate required by label directions is 20 lbs. of product (8 lbs. active ingredient) per acre of surface water at a cost of about $64/lb. with retreatment required every 3-4 weeks; a golf course in Rio Rancho, New Mexico estimated that treating four watercourse areas would cost in excess of $25,000 per treatment for material alone (WS 2009). MA completely degrades in about 3 days when applied to water which indicates the repellent effect is short-lived. Cost of treating turf areas would be similar on a per acre basis.

Another, potentially more cost-effective, MA application is with the use of a fog-producing machine (Vogt 1997). The fog drifts over the area to be treated and is irritating to the birds while being nonirritating to any humans that might be exposed. Fogging applications must generally be repeated 3-5 times after the initial treatment before the birds abandon a treatment site. Applied at a rate of about .25 lb./ acre of water surface, the cost is considerably less than when using the turf or water treatment methods. However, WS would ensure that these methods were currently registered for use in Colorado as these or any chemical registration could be canceled.

Methiocarb is a chemical repellent used for nonlethal taste aversion and was first registered as a molluscicide, but found to have avian repellent properties. Mesurol®, the trade name, is registered with EPA (EPA Reg. No. 56228-33) as an aversive-conditioning egg treatment to reduce predation from Common Ravens, Chihuahuan Ravens, and American Crows on the eggs of T&E species or other wildlife species determined to be in need of special protection. Mesurol is registered for WS use only. The active ingredient is methiocarb which is a carbamate pesticide which acts as a cholinesterase inhibitor. Species which feed upon treated eggs may show signs of toxicity (*e.g.,* regurgitation, lethargy, or temporary immobilization). Occasionally, birds may die after feeding upon treated eggs, but most birds exposed to treated eggs survive. Avery et al. (1994) examined the potential of using eggs injected with 30mg of methiocarb to condition common ravens from preying on eggs of endangered California Least Terns. Results showed that proper deployment of treated eggs can be a useful, nonlethal method for reducing raven predation at Least Tern colonies. Avery and Decker (1994) evaluated whether predation might be reduced through food avoidance learning. They used captive Fish Crows to examine avoidance response from methiocarb (18mg/egg) and methyl anthranilate (100mg/egg). Their study showed that some crows displayed persistence to the 5-day exposure and that successful application may require an extended period of training for target predators to acquire an avoidance response. During the spring of 2001, WS conducted a field test on the Sterling Wildlife Management Area in Idaho, where Mesurol treated eggs were exposed to Black-billed Magpies to evaluate aversive conditioning to eggs of waterfowl and upland game birds. The number of magpies feeding on treated eggs decreased after a period. However, their feeding behavior switched to pecking holes in eggs, possibly trying to detect treated eggs before consuming them. This behavior may suggest that at least some magpies experienced the ill effects of Mesurol, but the *"tasting"* of eggs may result in increased predation (Maycock and Graves 2001).

[9] An LC_{50} is the dosage in milligrams of material per liter of air required to cause death in 50% of a test population of a species through inhalation.

2.9.4 Capture Or Live Take Methods That May Be Used.

Several methods are available to capture or take offending animals. The appropriateness and efficacy of any technique will depend on a variety of factors.

Foot-hold traps are versatile and widely used by WS for capturing many species. These traps can be utilized to live-capture a variety of animals but are most often used by WS to capture mammals. Birds are rarely targeted with foot-hold traps, except padded jaw foot-hold pole traps (discussed below). Traps are effectively used in both terrestrial and shallow aquatic environments. Traps placed in the travel lanes of the targeted animal, using location to determine trap placement rather than attractants, are known as *"blind sets."* Three advantages of the foot-hold trap are: 1) they can be set under a wide variety of conditions, 2) non-target captures can be released or relocated, and 3) pan-tension devices can be used to reduce the probability of capturing smaller non-target animals (Turkowski et al. 1984, Phillips et al. 1996). Disadvantages of using foot-hold traps include: 1) the difficulty of keeping them in operation during rain, snow, or freezing weather, 2) the lack of selectivity where non-target species are of a similar or heavier weight as the target species, and 3) the additional time and labor necessary over other methods to keep them functional.

Cage traps come in a variety of styles for WDM to target different species. The most commonly known cage traps used in the current WS-Colorado program are box traps. Box traps are usually rectangular, made from wood or heavy gauge wire mesh. These traps are used to capture animals alive and can often be used where many lethal or more dangerous tools would be too hazardous. Box traps are well suited for use in residential areas.

Cage traps usually work best when baited with foods attractive to the target animal. They are used to capture birds ranging in size from sparrows to vultures. Cage traps do have a few drawbacks. Some individual target animals avoid cage traps. Some non-target animals become "trap happy" and purposely get captured to eat the bait, making the trap unavailable to catch target animals. These behaviors can make a cage trap less effective. Cage traps must be checked frequently to ensure that captured animals are not subjected to extreme environmental conditions. For example, an animal may die quickly if the cage trap is placed in direct summertime sunlight. Another potential problem with the use of cage traps is that some animals fight to escape and injure themselves in the process. WS Protective Measures when conducting bird trapping operations is to ensure that an adequate supply of food and water is in the trap to sustain decoy and captured birds for several days. Active traps are checked regularly to replenish bait and water and to remove captured birds. Non-target species are released during trap checks. USFWS BOs had no concerns with impacts to T&E species from the use of these traps.

Decoy traps, modeled after the Australian crow or funnel trap, are used to capture several species of birds, including crows, starlings, pigeons, sparrows, magpies, gulls, and vultures. They are large screen enclosures with the access modified to suit the target species. A few live birds are maintained in the baited trap to attract birds of the same species and, as such, act as decoys. Non-target species are mostly released unharmed (as discussed above birds can injure themselves lethally or birds may be killed by a predator that gains access into the trap).

Nest box traps are used for a variety of damage situations to capture birds (DeHaven and Guarino 1969, Knittle and Guarino 1976). Traps are made of nylon netting, hardware cloth, and wood, and come in many different sizes and designs, depending on the species of birds being captured. The entrances of traps also vary greatly from swinging-door, one-way door, funnel entrance, to tip-top sliding doors. Traps can be baited with grains or other feed, but mainly need to appear to be ideal nesting sites to attract the target birds.

Clover, funnel, and pigeon traps are enclosure traps made of nylon netting or hardware cloth and come in many different sizes and designs, depending on the species of birds being captured. The entrance of the traps also varies greatly from swinging-door, one-way door, funnel entrance, to tip-top sliding doors. Traps are baited with grains or other feed which attract the target birds. WS standard procedure when conducting trapping operations is to ensure that an adequate supply of food and water is in the trap to sustain captured birds for several days. Active traps are checked daily, every other day, or as appropriate, to replenish bait and water and to remove captured birds.

Cannon and rocket nets are normally used for larger birds such as waterfowl, but can be used to capture a wide variety of avian species. Cannons use mortar projectiles to propel a net up and over birds which have been baited to a particular site. Birds are taken from the net and disposed of appropriately.

Net guns have occasionally been used by WS to catch target waterfowl. These shoot from a "rifle with prongs," go about 20 yards, and wrap around the target animal.

Mist nets are very fine mesh netting used to capture several species of birds. Birds cannot see the netting when it is in place because the mesh is very fine and overlapping "pockets" in the net assure birds will become entangled. They typically become entangled after striking the net. Net mesh size determines the birds that can be caught (Day et al. 1980). These nets can be used for capturing small-sized birds such as House Sparrows and finches entrapped in warehouses and other structures. They can also be used to capture some larger birds such as blackbirds and starlings when they are going to a roost or feeding area. Mist nets are monitored closely, typically watched from a discreet location. Mist nets when used outdoors are often monitored at least hourly to ensure that any captured non-target species, especially T&E species, can be released quickly and unharmed. Mist nets are more often used in buildings to catch birds such as sparrows and finches, but have been used recently by WS to capture birds to be sampled for disease and released.

Bow nets are small circular net traps used for capturing birds and small mammals. The nets are hinged and spring loaded so that when the trap is set it resembles a half moon. The net is set over a food source and triggered by an observer using a pull cord.

Hand nets are used to catch birds and small mammals in confined areas such as homes and businesses. These nets resemble fishing dip nets with the exception that they are larger and have long handles. A variant on the hand net is a round throw-net with weights at the edges of the net, similar to that used for fishing. This net is also used for capturing birds in urban areas.

Drive traps/Corral traps are used to herd some animals into pens where they are captured. Drive traps have been used for species such as Canada geese, domestic waterfowl, jackrabbits (Lepus spp.), and ungulates. A drive-trap consists typically of wire panels that are erected into a 15 ft^2 to 100 ft^2 pen, depending on the number of geese or other target species, with two wings made of 2-3 ft. high plastic fencing extending 60-200 ft. in a 'V' from the pen. Target species are herded to the pen at each site with people on foot or in boats, depending on the target species and the existing conditions. WS-Colorado uses the standard "drive-trap" (Day 1980) to capture Canada geese or domestic waterfowl, primarily along the I-25 corridor in urban and suburban areas, during the molt when they are flightless (June 10th – July 20th) for relocation, donation, or euthanasia.

Raptor traps come in a variety of styles such as the bal-chatri, Swedish goshawk trap, and purse traps. These have been used by WS at airports to capture raptors to remove them from the airfield. Most raptors captured in these have been banded and relocated. Raptor traps are also used to remove birds from areas around nesting T&E shorebirds. Disposition of captured raptors is determined after consultation with the local USFWS office.

Padded-jaw pole traps are modified No. 0 or 1 coil spring foot-hold traps used to capture specific target birds such as raptors, magpies and crows. These are placed on top of poles or typical roosting spots frequented by targeted birds. These traps are monitored frequently and non-target species can be released unharmed. Target species can be relocated or euthanized, mostly depending on the species to be captured and the desires of CPW and USFWS.

Glue boards are a non-toxic device used to live-capture (i.e. routinely monitored) and hold animals until they can be removed. These devices have several advantages in that they are non-toxic, non-contaminating, have a high capture rate, and do not require a license to use and would be used inside buildings in situations where capturing individuals is difficult. Target species can be relocated or euthanized, depending on the species captured and other mitigating factors (suitable habitat, permission from other agencies).

Paintball guns are considered a high intensity hazing activity conducted in an attempt to change the behaviors of wildlife. The goal of using a paintball projectile to haze wildlife is to allow the animal to associate a negative stimulus (being hit by a paintball) with human interactions. When using a gas pressurized system, the user should make every attempt to minimize the chance of permanent injury or harm to the animal. Recommendations include: keeping the gas pressure that would be appropriate for the use on humans, projectiles should be fired at distances that will prevent the penetration of skin, shot placement is important and the face should be avoided, and animals should be aware of where the negative stimuli is emanating from (i.e. human).

2.9.5 Lethal Methods That May Be Used

Snap traps are modified rat snap traps used to remove individual woodpeckers, starlings, and other cavity use birds. The trap treadle is baited with peanut butter or other taste attractants and attached near the damage area, such as on the exterior wall of a home that is being damaged by a species such as a woodpecker. These traps pose no imminent danger to pets or the public.

Shooting is used selectively for target species, but may be relatively expensive because of the staff hours sometimes required. Nevertheless, shooting is an essential WDM method. Removal of feral pigeons may be achieved by night shooting with an air rifle and be quite effective in a short period. Shooting can also be a good method to target individual birds. However, shooting is mostly ineffective for populationing birds.

Lethal reinforcement through shooting is often necessary to ensure the continued success in bird scaring and harassment efforts (see the discussion on shooting under Frightening Devices). This is especially important where predatory birds are drawn by birthing activities, aquiculture facilities, sanitary landfills, and other locations where food is available. In situations where the feeding instinct is strong, most birds quickly adapt to scaring and harassment efforts unless the WDM activities are periodically supplemented by shooting.

The risk of lead poisoning to birds was analyzed previously in Chapter 2. WS personnel use non-toxic shot as listed in 50 CFR 20.21 (j) to take migratory birds using shotguns. WS uses steel or other non-toxic shot to take birds with firearms. Also, as required by USFWS policy and permits.

Egg, nest, and hatchling removal and destruction can be a means of maintaining populations of a damaging avian species at a static level. Nesting populations of Canada Geese and gulls, especially if located near airports, may pose a threat to public health and safety, as well as equipment. Pigeons and starlings can also cause extensive damage to public facilities. Egg and nest destruction is used mainly to control or limit the growth of a nesting population in a specific area through limiting reproduction of offspring or removal of nest to other locations. Egg and nest destruction is practiced by manual removal of the eggs or nest.

Some species frequently attack people to guard their nests. In Colorado, species that will actually strike people are Canada geese and western kingbirds. This causes concern when the nest is located near a door or exit to a residential house or business. Of greatest concern is the threat to elderly people or bicyclist who may fall in response to the attack. Where these are creating a significant nuisance, WS may remove the nest, eggs, or hatchlings.

Egg addling or oiling is the practice of destroying the embryo prior to hatching. Egg addling is conducted by vigorously shaking an egg numerous times which causes detachment of the embryo from the egg sac. Egg oiling (a liquid spray) does not allow an egg to breathe or get oxygen, which prohibits the embryo from developing. Eggs are oiled and addled so that birds do not re-nest at least for an extended period; for example, Canada Geese will set on eggs an average of 14.2 days beyond the expected hatch date for addled eggs. Egg destruction can be accomplished in several different ways, but the most commonly used methods are manually gathering eggs and breaking them. This method is practical only during a relatively short time interval and requires skill to properly identify the eggs and hatchlings of target species. Some species may persist in nesting and the laying of eggs, making this method ineffective.

Chemical immobilizing and euthanizing drugs are important tools for managing wildlife. Under certain circumstances, WS personnel are involved in the capture of animals where the safety of the animal, personnel, or the public are compromised and chemical immobilization provides a good solution to reduce these risks. For example, chemical immobilization has often been used to capture aggressive Canada Geese in residential areas where public safety is at risk. It is also used to take nuisance waterfowl that cannot be easily captured with other methods. WS employees that use immobilizing drugs are certified to use these following the guidelines established in the WS Field Operational Manual under "Use of Immobilization and Euthanasia Drugs." These are typically used in urban, recreational, and residential areas where the safe removal of a problem animal is most easily accomplished with a drug delivery system, hand-fed baits. Immobilization is usually followed by relocation when appropriate (i.e., mainly waterfowl) or euthanasia. Euthanasia is usually performed with drugs such as Beuthanasia-D® or Fatal-Plus® which contain forms of sodium phenobarbital. Euthanized animals are disposed of by incineration or deep burial to avoid secondary hazards. Drugs are monitored closely and stored in locked boxes or cabinets according to WS policies, and Department of Justice, Drug Enforcement Administration or FDA guidelines. Most drugs fall under restricted-use categories and must be used under the appropriate license from the U.S. Department of Justice, Drug Enforcement Administration which WS does hold.

Euthanasia can be accomplished with several methods. Several drugs and methods are available to euthanize captured animals. Euthanasia methods include registered drugs such as Beuthanasia-D®, Fatal Plus®, cervical dislocation, decapitation, a shot to the brain, or asphyxiation with CO or CO_2.

These methods are completely target species -specific and animals euthanized with drugs are buried or incinerated.

Carbon Dioxide (CO2). Although not a registered pesticide, CO2 is a chemical method. Carbon dioxide is sometimes used to euthanize birds which are captured in live traps. Live birds are placed in a container such as a plastic five-gallon bucket or chamber which is then sealed. CO2 gas is released into the bucket or chamber and birds quickly die after inhaling the gas. This method is approved as a euthanizing agent by the American Veterinary Medical Association (Beaver et al. 2001). CO2 gas is a by-product of animal respiration, is common in the atmosphere, and is required by plants for photosynthesis. It is used to carbonate beverages for human consumption and is also the gas released by dry ice. The use of CO2 by WS for euthanasia purposes is exceedingly minor and inconsequential to the amounts used for other purposes by society. Euthanasia conducted by WS would be done in accordance with WS Directive
2.505.

Chemical pesticides have been developed to reduce or prevent wildlife damage and are widely used because of their efficiency. Although some pesticides are fairly group specific to certain species (*e.g.,* birds vs. mammals), pesticides are typically not species specific and their use may be hazardous unless used with care by knowledgeable personnel. The proper placement, size, type of bait, and time of year are keys to selectivity and successful use of pesticides for WDM. When a pesticide is used according to its EPA registered label, it poses minimal risk to people, the environment, and non-target species. Neither EPA nor CDA would register a chemical that had not undergone rigorous environmental testing to determine its potential effects on humans and the environment including risks to non-target species. Since the tests required by EPA to register a chemical, development of appropriate pesticides is expensive, and the path to a suitable end product is filled with legal and administrative hurdles. Few private companies are inclined to undertake such a venture. Most pesticides are aimed at a specific target species, yet suitable pesticides are not available for most animals. Available delivery systems make the use of pesticides unsuitable in many wildlife damage situations. This section describes the pesticides used by WS in BDM.

DRC-1339 (EPA. Reg. Nos. 56228-29 and 56228-63), 3-chloro-4-methylbenenamine hydrochloride, is an avian pesticide registered with EPA. For more than 30 years, DRC-1339 has proven to be an effective method of starling, blackbird, gull, crow, raven, magpie, and pigeon damage management (West et al. 1967, West and Besser 1976, DeCino et al. 1966). DRC-1339 is a slow acting avicide that is rapidly metabolized into nontoxic metabolites and excreted after ingestion. This chemical is one of the most extensively studied and evaluated pesticides ever developed. Because of its rapid metabolism, DRC-1339 poses little risk of secondary poisoning to non-target animals, including avian scavengers (Cunningham et al. 1979, Schafer 1984, Knittle et al. 1990). This compound is also unique because of its relatively high toxicity to many pest birds, but low-to-moderate toxicity to most raptors with almost no toxicity to mammals (DeCino et al. 1966, Palmore 1978, Schafer 1981). For example, starlings, a highly sensitive species, require a dose of only 0.3 mg/ bird to cause death (Royall et al. 1967); many other bird species such as raptors, House Sparrows, and eagles are classified as non-sensitive requiring a much higher dose (Oral LD_{50}s doses for Golden Eagles = 450 mg, Northern Harrier = 45 mg, and House Sparrow = 99 mg), usually at least a 10-fold increase in dose over sensitive species. Numerous studies have shown that DRC-1339 poses minimal risk of primary poisoning to non-target and T&E species. Secondary poisoning has not been observed with DRC-1339 treated baits. During research studies, carcasses of birds which died from DRC-1339 were fed to raptors and scavenger mammals for 30 to 200 days with no symptoms of secondary poisoning observed (Cunningham et al. 1979). This can be attributed to relatively low toxicity to species that might scavenge on birds killed by DRC-1339 and its tendency to be almost completely metabolized in target birds leaving little residue for scavengers to ingest. Secondary hazards of DRC-1339 are almost non-existent. DRC-1339 acts in a humane manner producing a quiet, painless death. Prior to the application of DRC-1339, pre-baiting is required to monitor for non-target species that may consume the bait. If non-target species are observed, then the use of DRC-1339 would be postponed or not applied. Research studies and field observations suggest that DRC-1339 treatments kill about 75% of the blackbirds and starlings at treated feedlots (Besser et al. 1968). The inherent safety features of DRC-1339 help avoid negative impacts to T&E species as well as preclude hazards to most species other than the target species listed.

DRC-1339 is unstable in the environment and degrades rapidly when exposed to sunlight, heat, or ultra violet radiation. DRC-1339 is highly soluble in water but does not hydrolyze and degradation occurs rapidly in water. DRC-1339 tightly binds to soil and has low mobility. The half-life is about 25 hours, which means it is nearly 100% broken down within a week, and identified metabolites (i.e., degradation chemicals) have low toxicity. Aquatic and invertebrate toxicity is low.

DRC-1339 concentrate is used effectively under five EPA registered labels to reduce damage by specific bird species. Hard-boiled eggs and meat baits are injected with DRC-1339 and used to reduce raven, crow, and magpie damage for the protection of newborn livestock, the young or eggs of threatened, endangered, or sensitive species, human health and safety, and silage and fodder bags. It is also registered for application on grain, poultry pellets, raisins, and cull French fries to reduce damage caused by blackbirds and starlings at livestock and poultry feedlots. A similar label allows DRC-1339 to be used at blackbird and starling staging areas associated with nighttime roosts with similar baits. Another label allows DRC-1339 to be used on whole kernel corn to reduce health, nuisance, or economic problems caused by pigeons in and around structures in non-crop areas. A fifth label allows the use of DRC-1339 on bread cube baits to reduce damage caused by several species of gulls that, during their breeding season, prey on other colonially nesting bird species, or damage property and crops. The specified gull species can be managed to reduce damage or damage threats on their breeding grounds or several other areas including airports and landfills and for T&E species and human health and safety protection.

DRC-1339 is the primary and almost exclusive toxicant used at dairies, feedlots and CAFOs to treat starlings, pigeons and other target birds. The birds are pre-baited for a couple days up to two weeks with the same bait that will be treated with DRC-1339 and applied later. The baits usually are placed in trays and inside barns or other buildings containing livestock but out of reach of the livestock where the birds feed. The trays may be placed on elevated platforms inside the buildings or on the floor in isles where livestock are excluded. Trays containing pre-bait and treated bait may be placed on the ground adjacent to bunkers where starlings, pigeons and othe birds feed with the livestock. The feed locations are monitored for non-target species. If non-target species are observed feeding on pre-bait or treated bait then the damage management program is discontinued or modified.

The use of DRC-1339 as per label instructions will have little effect on non-target species in Colorado. DRC-1339 baits cannot be used in areas where potential consumption of treated baits by T&E species could occur. Observation of sites to be treated with or without prebaiting is necessary to determine the presence of non-target species. DRC-1339 baits cannot be used directly in water or areas where runoff is likely.

Avitrol® (Avitrol Corp., Tulsa, OK), 4-aminopyridine, discussed as a chemical frightening agent (repellent) for blackbirds and starlings above, is often used as a toxicant at a 1 treated:9 untreated ratio for pigeons, House Sparrows, and other commensal birds (the ratio can be reduced to 1:5 for House Sparrows). Avitrol treated baits are placed in an area where the targeted birds are feeding and most all birds that consume treated baits normally die (Johnson and Glahn 1994). Birds display abnormal flying behavior after ingesting treated baits and emit distress vocalization (pigeons do not). This chemical is not normally used at airports because the abnormal flying behavior could cause affected birds to fly into the path of aircraft. Avitrol is a restricted use pesticide that can only be sold to certified applicators and is available in several bait formulations with only a small portion of the individual grains carrying the chemical. Any granivorous bird associated with the target species could be affected by Avitrol which none of the T&E species in the United States are. Blackbirds and corvids are slightly more sensitive to the chemical than other species of mammals and birds. In addition, chronic toxicity has not been demonstrated (Schafer 1991). Laboratory studies with predator and scavenger species have shown minimal potential for secondary poisoning. However, in a field study, magpies and crows may have been affected secondarily (Schafer 1991). A laboratory study showed, though, that magpies which fed for 20 days on birds killed with 2 to 3.2 times the lethal dose of active ingredient were not affected (Schafer et al. 1974). Similarly, American Kestrels that fed on blackbirds for 7 to 45 days which had died from a lethal dose of Avitrol were not adversely affected (Schafer 1991). Therefore, no probable secondary risk is expected with use of this compound, even for pets and the public. Avitrol is water soluble, but laboratory studies demonstrated that Avitrol is strongly absorbed onto soil colloids and has moderately low mobility. Biodegradation is expected to be slow in soil and water, with a half-life ranging from 3 to 22 months. Avitrol may form covalent bonds with humic materials, which may serve to reduce its bioavailability in aqueous media. Avitrol is non-accumulative in tissues and rapidly metabolized by many species (Schafer 1991). Colorado WS has not used Avitrol in the last 5 FYs (FY07 – FY14) for urban bird damage situations. Use of Avitrol by WS is not likely to have an adverse effect on T&E species, especially because it will be used according to label restrictions and primarily in urban environments by WS.

Chemosterilants and Contraception. Contraceptive measures can be grouped into four categories: surgical sterilization, oral contraception, hormone implantation, and immunocontraception (i.e., the use of contraceptive vaccines). These techniques require that each individual animal receive either single, multiple, or possibly daily treatment to successfully prevent conception. The use of oral contraception, hormone implantation, or immunocontraception is subject to approval by Federal and State regulatory agencies. Surgical sterilization and hormone implantation are generally impractical because it requires that each animal be captured, sterilization conducted by licensed veterinarians, and, thus, would be extremely labor intensive and expensive. As alternative methods of delivering sterility are developed, sterilization may prove to be a more practical tool in some circumstances (DeLiberto et al. 1998). Reduction of local populations could conceivably be achieved through natural mortality combined with reduced fecundity. No animals would necessarily be killed directly with this sterilization, however, and sterilized animals could continue to cause damage. Thus, sometimes culling the population to the desired level and then implementing a sterilization project would be the optimal solution to overabundant bird populations. Populations of dispersing animals would probably be unaffected. Potential environmental concerns with chemical sterilization would still need to be addressed, including safety of genetically engineered vaccines to humans and other wildlife. Several formulations of drugs have been and are being tested by NWRC and other researchers including nicarbazin, diazacon, and immunocontraceptives. These would have to be registered for use in Colorado before WS would use them. The only EPA approved contraceptive available is OvoControl™ for pigeons. The active ingredient in OvoControl™ is nicarbazin which was developed by WS NWRC researchers. Nicarbazin, a drug approved by FDA for use to control coccidiosis in chickens for the last 45 years, reduces the hatchability of eggs. This reduction only occurs while the bait is being consumed and, thus, primary and secondary hazards to other bird species and mammals are minimized or nullified. Following label directions further minimizes non-target hazards. In Colorado, the use of this bait would have no effect on T&E or sensitive species, people, pets, or the environment. WS has not used OvoControl™, but could if registered with CDA.

2.10 How Does WS-Colorado Conduct Bird Damage Management Monitoring?

WS-Colorado, in coordination with USFWS when appropriate, monitor the results and impact of its BDM. The impacts discussed in this EA are regularly monitored and evaluated in two ways:

1.) WS-Colorado determines if any additional information that arises subsequent to the NEPA decision from this EA would trigger the need for additional NEPA analysis. WS-Colorado reviews implementation results and the related NEPA documents, as needed, to ensure that the need for action, issues identified alternatives, regulatory framework, and environmental consequences are consistent with those identified in this EA.

2.) WS-Colorado monitors impacts on target and non-target bird species populations through its MIS database. The MIS information is used to assess the localized and cumulative impacts of WS-Colorado activities on specific bird species and non-target wildlife populations. WS-Colorado provides detailed information on animal removal, as appropriate, to USFWS to assist with managing species and resources under their jurisdiction.

2.11 How does WS-Colorado Handle Carcass Disposal?

Carcass retrieval after damage management activities is often necessary for zoonotic disease management, ecological, environmental, scientific, or public sensitivity concerns. All bird remains whether whole or in part, will be disposed of in a manner consistent with Federal, state, county, and local regulations and WS Directive 2.210. If chemical euthanasia is performed, WS personnel will comply with procedures outlined in the WS Field Operations Manual for the Use of Immobilization and Euthanizing Drugs and WS Directive 2.430, Controlled Chemical Immobilization and Euthanizing Agents. Animals euthanized with drugs that may pose secondary hazards to scavengers must be disposed of according to Federal, state, county, and local regulations, drug label instructions, or when lacking such guidelines, by deep burial, incineration, or taken to a landfill approved for such disposal. (WS Directive 2.515)

Field Disposal and Burial. All wildlife carcass disposals will be made in a manner which demonstrates WS' recognition of public sensitivity to the viewing of wildlife carcasses. Carcasses will be discarded or buried on the property where they were removed or recovered, or deposited on another cooperator's property if approved by the respective property owner. Otherwise, carcasses may be composted following appropriate Federal, state, and local laws.

Landfill Sites. Wildlife carcasses or parts may be disposed of at public or private landfills that allow carcass disposal. Carcasses will be placed in dark plastic bags or other wrapping. WS will not deposit carcasses at roadside or commercial business refuse dumpsters unless prior approval has been obtained from the dumpster owner or lessee.

Incineration and Field Burning. WS may incinerate carcasses in approved facilities that comply with Federal, state, and local regulations. Open burning should be avoided due to potential fire hazards except when this method is required by regulation and can be conducted safely.

Donation, Salvage, Sale, or Transfer. When possible, WS will make every effort to donate, salvage, or transfer wildlife carcasses to the public when authorized by the federal depredation permit and the State Director, in compliance with existing cooperative service agreements or similar document, Memoranda of Understanding, and all applicable Federal, state, and local laws and regulations. Refer to WS Directive 2.510, Fur, Other Animal Pars, and Edible Meat, for guidelines.

2.12 What is the Process for Verifying Losses and Damage?

Damage associated with birds can be in the form of a threat of damage, and/or damage that has or is currently occurring. Threats of damage associated with birds may be the presence of Black-billed magpies surrounding livestock lambing or calving areas, or areas where birds are known to commonly strike aircraft, and there is ample reason to expect damage. Damage reported to WS-Colorado, such as resource damage, predation or injury, is recorded in the WS MIS database as "reported" damage. If employees are able to verify that the damage occurred, it is recorded in MIS as "verified" damage (defined as resource or production losses examined by a WS-Colorado employee during a site visit and determined to have been caused by a specific predator species). Confirmation of the species that caused the damage and the extent of the problem are important steps toward establishing the need for implementing the BDM activities, and the methodologies that will be most effective to resolve the problem.

2.13 Basic Bird Species Information.

Bird species that cause damage, especially to particular resources, do not fall into regularly designated groups of birds. For this document, bird species are classified in the following guilds: blackbirds (blackbirds, cowbirds, and grackles and not the entire family Icteridae which also includes meadowlarks and orioles), introduced/invasive commensal birds (feral or Rock Pigeons[10], Eurasian Collared-Dove, European Starlings (hereafter referred to as starlings for brevity), House Sparrows, feral poultry (emus, chickens, peafowl, and guineas), corvids (jays, magpies, crows, and ravens), raptors (hawks, eagles, harriers, accipiters, vultures, owls, and shrikes), larids (gulls and terns), shorebirds (plovers, sandpipers, and allies), wading birds (herons, egrets, ibis, and storks), waterbirds (loons, grebes, cormorants, pelicans, and kingfishers), grassland species (meadowlarks, Lark Buntings, kingbirds, Horned Larks, pipits, Dickcissels, Bobolinks, longspurs, orioles, and goldfinches), native doves and pigeons, aerialists (swifts, nightjars, and swallows), woodpeckers, gallinaceous birds (pheasant, prairie-chicken, turkey, and quail), frugivorous birds (robins, waxwings, and finches), and other miscellaneous birds such as hummingbirds and wrens that are infrequently involved in BDM. Several of these species would likely fit into more than one category, however for our purposes, species are placed in groups based primarily on damage (*e.g.*, grassland passerines species frequently occur on airports with prairie grassland ecosystems).

2.13.1 Introduced/Invasive Commensal Birds.

Invasive or non-native species are primarily spread through intentional or unintentional human activities. Within the U.S., ten species of birds have been inadvertently or purposefully introduced from other countries. These species can have drastic impacts on native species populations, ecosystem health, spread disease pathogens, and cause economic disparity (National Invasive Species Council 2001, 2008). These species compete with native wildlife for natural resource and cause billions of dollars in damage annually within the U.S. (Pimentel et al. 2005). For decades, breeding populations of feral pigeons, starlings, and house sparrows (all introduced from Europe) have been found in Colorado.

Other species have only recently become established in United States, but have rapidly expanded their population (Eurasian Collared-Dove) or have become established locally in small numbers

[10] Rock Pigeons in North America were actually from domestic stocks brought to the United States by early settlers and escaped (Johnston 1992). Therefore, they are truly feral domestic pigeons with less genetic variability than wild Rock Pigeons, the species they are derived from, and are referred to as feral or domestic pigeons or Rock Pigeons in this EA. This is similar to the most common domestic ducks which were derived from wild Mallards and Muscovy Ducks (both wild and feral populations exist in Colorado of these two species).

(domestic species such as feral waterfowl and other poultry). WS-Colorado's BDM goal for invasive species may be eradication, especially for those species that cause significant damage to resources such as the European Starling. It should be noted that a few introduced species have not received the status of "invasive species" primarily because they do not meet the definition of the National Invasive Species Council (2001) such as Ring-necked Pheasants.

European Starlings *(Sturnus vulgaris)*. First introduced into North America in the 19th century, starlings have established both resident and migratory populations in Colorado. Migrant populations can cover distances of 1,000 -1,500 km at speeds of 60-80 km/hr to escape inclement weather and reach food sources (Feare 1984). These black, stocky birds with triangular wings, short tails, and long pointed bills are often seen strutting around cities on lawns and in parking lots. Adult birds molt once per year, appearing glossy black with iridescent pink, green, and amber feathers in the spring to molted black with white spots in the winter. Starlings are aggressive cavity nesters and will out compete native birds, such as Eastern bluebirds, for suitable breeding habitat. Nests are generally located in old woodpecker cavities, natural hollows, birdhouses, crevices, and under building eaves. In the winter, these gregarious birds form large mixed species roosts consisting of thousands of birds. Large populations converge in early August and disband in April. Depending on the region, migration patterns vary from year to year with spring migrations occurring in mid-February to late March and fall migration from September to early December (Kessel 1953, Dolbeer 1982, Linz et al. 2007).

Yearly, large aggregations of starlings converge on cattle feedlots and dairies consuming an estimated $84 per 1,000 birds (Linz et al. 2007). Livestock operations additionally experience economic damage from the potential spread of livestock diseases and fecal contamination of livestock feed associated with starlings. Large populations of starling in urban/suburban areas pose a substantial threat to human health and safety because of the likelihood if struck, to cause a catastrophic crash resulting in the loss of aircraft and lives.

European starlings are classified as an invasive species by the U.S. Fish and Wildlife Service and a Migratory Depredation Permit is not required to lethally remove this species. Breeding Bird Survey, Partners in Flight, and the Rocky Mountain Conservancy data suggests that the estimated population of European starlings for Colorado is 1.31 million (**Table 3.10**). These populations are bolstered by northern state migrants during winter months. BDM methods to control starlings are discussed in Johnson and Glahn (1994), **Chapter 1.**

Feral Pigeons *(Columba livia domestica)* ***and Collared-Doves*** *(Streptopelia decaocoto)*. Other invasive species have also established breeding populations within Colorado. In the early 17th century colonists unintentionally introduced domestic pigeons to North America. Escaped domestic pigeons quickly turned feral and established breeding populations throughout the U.S (Johnston 1992). Introduced domestic feral pigeon populations differ from native populations in that humans have selectively bred specific genetic attributes. Due to frequent private collection escapes, feral pigeon populations exhibit a variety of colors ranging from white to bluish-gray with black bars on the wings. Adult birds typically weigh 8.4 – 13.4 oz with a wing span of 20-26 inches. In this EA this species may interchangeably be referred to rock doves or feral pigeons.

Eurasian collared-doves were first introduced into North America in the 1970s when a private collection of 50 individuals escaped from the Bahamas (Romagosa 2012). Today, non-migratory breeding populations have become established in nearly every state within the contiguous U.S. This medium sized dove 4.4 – 8.5 oz with a wing span of 19-22 inches can readily be distinguished by its light gray to buff coloration and a black half-collar edged in white. Collared-doves breed close to human habitats in a variety of habitats but frequently can be seen in urban areas (i.e., backyard bird feeders), near wooded streams, and in agricultural fields. The African collared-dove (*Streptopelia roesogrisea*) formerly ringed turtle-dove (*Streptopelia risoria*) which is similar in appearance to the Eurasian collared-dove has also been observed in Colorado. Although similar in appearance, African collared-doves are larger in size, have a different song, longer tail, darker primaries and slightly darker gray plumage. Typically, this species is not associated with damage in Colorado and rarely establishes self-sustaining populations in the wild.

Feral pigeons and collared-doves are associated with a variety of damage within the state. WS-Colorado uses several BDM methods to manage these species with an emphasis placed on mitigating feral pigeon damage to agriculture, property, and human health and safety (Williams and Corrigan 1994, Linz et al. 2007). Their species medium size, populationing behavior, and abundance make them prime candidates for Colorado BDM. Resource owners and managers typically request bird damage assistance from WS-Colorado when feral pigeons impact livestock operations as mentioned above, damage property with corrosive bird fecal dropping, or pose a risk to human health and safety (e.g., spread diseases such as psittacosis).

In 2003, for the first time, the BBS in Colorado recorded 3 Eurasian collared-doves in 118 counts. BBS counts have continued to document their presence with 142 being documented for 99 counts in 2009 (Sauer et al. 2017). The first recorded bird damage incident associated with this species was recorded in FY2009 and WS-Colorado anticipates that incidents will continue to increase as their populations become further established within the state.

House Sparrows *(Passer domesticus).* Through several intentional or accidental introductions, the house sparrow has become one of many invasive species that has thrived after its introduction into the New World. Often referred to as English sparrows in older laws and regulations, this species is uniquely adapted to living in close association with humans; making it a well-known and commonly recognized bird. Primary habitat for this species includes a variety of human environments, including agricultural croplands, livestock operations, residential and urban areas, and infrastructure such as bridge abutments. House sparrows are compact medium-sized (15 -17 cm; 27-29 g) birds with a full chest and a large, round head. Sexes of this species exhibit a strong sexual dimorphism with males exhibiting dark gray crowns running from the top their bill to just above the nape of the neck, chestnut flanking along the sides of the head, with a brown upper back and mantle. Females of this species, have buffy eye-stripes, unstreaked breasts, and brown upper bodies and heads streaked with dark stripes running along their mantle. Primarily grainivorous, house sparrows feed almost exclusively on cereal grains and seeds. In urban areas, this opportunistic and adaptable species will feed on refuse from trash bins and parking lots.

House sparrows are classified as an invasive species by the U.S. Fish and Wildlife Service and a Migratory Depredation Permit is not required to lethally remove this species. The estimated breeding population of house sparrows in Colorado using BBS data from 2006 to 2010 (Sauer et al. 2017) is 1.4 million using population parameters from RMBO (2007), about the same as it was in the 1990s (Bird Conservancy of the Rockies 2017). In all probability, it is likely that House sparrow populations in Colorado will continue to decline due to a lack of suitable nesting habitat. Each year quality nesting habitat is lost due to the deterioration of buildings, human population expansion along the plains, and death of vegetation due to a lack of irrigation. The take of this invasive species is not considered to have an impact on the human environment and may actually be beneficial. BDM methods for House sparrows are discussed in Fitzwater (1994).

Feral Poultry and Waterfowl. Feral poultry and waterfowl are defined as domestic livestock including: domestic ducks, geese, mute swans, chickens, peafowl, and guineas that have either accidentally or intentionally been released into the wild. Feral ducks and geese are commonly seen in urban and suburban parks throughout Colorado. From FY13 to FY17, WS-Colorado reviewed 0 requests for feral poultry and waterfowl bird damage assistance. Historically, BDM incidents associated with these species includes: damage to turf, landscaping, and other property, the closure of swimming areas due to high coliform bacterial counts, and threat of disease transmission. In some cases, other agencies may request assistance in removing feral domestic waterfowl to protect native wild populations from hybridizing with these species. Occasionally WS-Colorado receives requests for BDM assistance during breeding season when feral waterfowl species, much like their native counterparts, aggressively defend their nests and threaten human health and safety. BDM incidents involving feral poultry are rare and are typically more of a nuisance to homeowners in urban areas. There are no known breeding populations of feral poultry in Colorado. Population estimates for feral waterfowl are unavailable due to the hybridization of domestic waterfowl with native populations.

Exotic Birds. Established breeding populations of Feral exotic birds are notably absent from Colorado. Variable climatic conditions and harsh winters make the likelihood of tropical bird species improbable. Occasionally, Eurasian upland gamebird species (e.g., chukar) have escaped captivity or been intentionally released but these species are not considered an invasive species and are not associated with damage. The primary concern of biologists within Colorado is that, if left unchecked, populations of exotic birds will adversely impact native species populations through competition for resources.

2.13.2 Native Pigeons and Doves.

Three species of doves and pigeons are native to Colorado including: mourning doves (*Zenaida macoura*), band-tailed pigeons (*Patagopemas fasciata*) and white-winged doves (*Zenaida asiatica*). Although rare, Inca doves and mommon ground-doves occasionally visit Colorado; however, sightings of these species are considered vagrant or accidental. Native species have robust bodies with small heads, long, rounded tails, and pointed wings. Band-tailed pigeons are the largest pigeon found in North America weighing 7.9 – 18.2 oz with a wingspan of 25 in. White-winged and mourning doves are slightly smaller weighing 4.0-6.6 oz. with wingspans from 15 – 22 in. All powerful fliers; Mourning doves fly close to the ground near cover between feeding and roosting areas, while pigeons fly at higher altitudes.

Mourning doves are the most abundant species in Colorado and occupy a range of open and semi-open habitat including woodlands, forest edge, prairie, grassland, farms, cities, and suburbs. White-winged doves have adapted to similarly living in a variety of habitats including urban and suburban environments, desserts, streamside woodlands, and forest interiors. While Band-tailed pigeons prefer to live in habitats dominated by ponderosa pine (*Pinus ponderosa*), pinyon-juniper (*Pinus delis*; *Junipers spp.*), or oak (*Quercus spp*.) forest.

Native doves and pigeons are predominately associated with threats to human health & safety due to their body mass, populationing behavior, and abundance. On some occasions, WS-Colorado will respond to grain crop damage associated with mourning and white-winged doves and band-tailed pigeons in response to fruit crop damage. Native Mourning and White-winged doves, along with band-tailed pigeons are protected under the Migratory Bird Treaty Act and have established hunting seasons with bag limits.

2.13.3 Blackbirds.

Depending on the time of year, six species of blackbirds (red-winged, yellow-headed, and Brewer's blackbirds, common and great-tailed grackles, and brown-headed cowbirds) are commonly found in Colorado (**Table 3.24**). Additionally, rusty blackbirds and bronzed cowbirds have been documented in Colorado. Eleven species of blackbirds are found in North and South America. Named after the mainly black body of adult males, these medium sized (2.3 oz) birds are commonly named after the color of their wing epaulets (i.e., shoulder patches). Depending on the species, blackbirds are attracted to a variety of habitats including: open grasslands, dry upland areas, prairies, livestock operations, old fields, and wetlands. Brewer's blackbirds are commonly found in urban areas such as airports, fallow croplands, and livestock operations. Common and great-tailed grackles live in open areas surrounded by scattered trees such as in residential neighborhoods and marshlands. Red-winged and yellow-headed blackbirds, are attracted to agricultural croplands and roost in marshy wetland areas dominated by cattails. Rusty blackbirds are most common in wet woodlands where they predominately feed on invertebrates. This species is rarely seen in Colorado and may either form single species populations or form mixed species populations with other blackbird species and common grackles (Avery 1994).

Red-winged, yellow-headed, and Brewer's blackbirds, common and great-tailed grackles, and brown-headed cowbirds occur year-round in Colorado. Populations of these species form large population in early August through April in more northerly latitudes (e.g., Canada) to migrate south for the winter. During winter migration, Colorado blackbird populations are dramatically bolstered by the influx of these species. Breeding populations of these species are listed here from most to least abundant: red-winged blackbirds, common grackles, Brewer's blackbird, yellow-headed blackbird, great-tailed grackle, and brown-headed cowbird. For the most part, blackbird spp. are classified as migratory nongame birds, and can be taken under a USFWS Depredation Order when concentrated in a manner that constitutes a health hazard except for the rusty blackbird, an Audubon Watchlist species (Butcher et al. 2007). The rusty blackbird was removed from the Order (FR 75(231):75153-75156, Dec. 2, 2010) because the species population has declined significantly over the last 40 years. Rusty blackbirds nest in the boreal forests of Canada. Throughout its range, populations have declined to an estimated population of only 2 million individuals (National Audubon Society (NAS) 2011). A small percentage of rusty blackbirds migrate through Colorado to their wintering grounds in the southeast.

Property owners frequently request assistance in alleviating nuisance noise complaints associated with winter roosts, damage to building and property associated with bird fecal accumulations, and the potential spread of zoonotic disease. Brewer's blackbirds, in particular, will aggressively defend their nests and will often attack people when they feel threatened.

Finally, cowbird species such as the (brown-headed and bronzed), are parasitic nesters depositing eggs in the nests of susceptible host birds. Over 220 host species have been reported as being parasitized by brown-headed cowbirds with144 of these species having reared cowbird young. Cowbird hosts ranged in size from a third of an ounce such as brown creepers, kinglets, and gnatcatchers to 5 ounces such as meadowlarks.

Although nest parasitism activities likely have contributed to the decline of several song bird populations such as the Golden-cheeked warbler and Audubon's oriole, it is unclear how large of a role these activities have on native bird species within the state of Colorado (Ladd and Gass 1999, Flood 1990).

2.13.4 Swallows, Swifts, and Nighthawk spp.

During breeding season, twelve bird species classified in the swallows, swifts, and nighthawk group occur in Colorado. Six species of swallows the tree swallow (*Tachycineta bicolor*), violet-green swallow (*Tachycineta thalassina*), Northern rough-winged swallow (*Stelgidopteryx serripennis*), bank swallow (*Riparia riparia*), cliff swallow (*Petrochelidon pyrrhonota*), and barn swallow (*Hirundo rustica*); three species of swifts the black swift (*Cypseloides niger*), chimney swift (*Chaetura pelagica*), and white-throated swift (*Aeronautes saxatalis*); and other associated species such as the common nighthawk (*Chordeiles minor*), common poorwill (*Phalaenoptilus nuttallii*), and purple martin (*Progne subis*). Swallows and swifts are graceful, acrobatic, aerialists with long-pointed wings. Among these species, WS-Colorado receives the most requests for BDM assistance in response to cliff and barn swallows. These colonial nesting species build mud nests under the eaves of buildings and bridges causing damage from falling debri and bird fecal droppings. Continual clean-up costs during nesting season can prove economically burdensome to resource owners/managers. Additionally, parasites (insects such as mites and fleas) associated with nests can pose a threat to human health and safety due to disease transmission. Other swallow and swift species, nest in the cavities of rocks, banks, and trees. Like all swifts, chimney swifts are aerial specialists, feeding on insects while on the wing and skimming the surface of water to drink.

Common nighthawks arrive in Colorado in late May or early June. This species appears throughout Colorado and may in a variety of habitats including open pinyon juniper and ponderosa pine woodlands, scrub oak, sage-brush, and short-prairie grasslands. As aerial insectivores, like most of the birds in this group, this species primarily threatens human health and safety near airports. Due to their larger body size (1.9 to 3.5 oz) it is more likely to cause damage to aircraft during a bird strike. Swallows, swifts, and nighthawks are migratory nongame birds and protected by USFWS and CPW. The Black Swift is an Audubon Watchlist species (NAS 2007).

2.13.5 Grassland Species (Larks, Longspurs, Sparrow spp.).

Western meadowlarks, lark buntings, kingbirds, phoebes, flycatchers, horned larks, pipits, dickcissels, bobolinks, emberizidae sparrows, longspurs, snow buntings, orioles, rosy finches, and goldfinches are often found in grasslands or semi-open country throughout Colorado. Some species in groups such as flycatchers are actually woodland species, but for ease, are included here. Western meadowlarks are similar in size and appearance to starlings except they are light brown with black V's on their breasts and yellow underparts. Dickcissels are somewhat smaller versions of meadowlarks. Kingbirds, phoebes, and flycatchers are smaller birds that are often found in semi-open grassland areas utilizing perches where they hawk for insects. Horned larks, pipits, lark buntings, longspurs, snow buntings, white-crowned and savannah sparrows are slender, sparrow sized ground-dwellers. Orioles are similar to blackbirds in size and shape, but have bold orange or yellow with black colors. These species tend to stay near edge or riparian areas adjacent to grasslands and forage on primarily insects and usually are not a damage problem. American tree sparrows, small brown and gray birds, also tend to stay near brushy areas at the edge of fields. Goldfinches are small birds with stout short beaks with black wings and yellow or green bodies (have breeding and winter plumages). They feed on weed seeds in grasslands or edge areas. Many of these species such as meadowlarks, horned larks, and goldfinches form loose-knit populations in winter; and are attracted to short grass habitats and agricultural fields where seeds and insects are abundant. Grassland birds tend to stay near the ground; however, meadowlarks and kingbirds will use perches such as telephone wires. Orioles and goldfinches typically stay near edge areas. These species are often abundant at airports where they are struck by aircraft. Although small, their populationing behavior of up to several hundred (Horned Larks, buntings, and longspurs), increase the risk of damaging strikes with aircraft.

2.13.6 Waterfowl (Geese, Ducks, Crane spp.).

Waterfowl primarily refers to ducks, geese, swans, cranes, moorhens, and coots because these species are mostly managed as migratory game birds which frequent wetland areas. Ducks can be further subdivided into surface feeders and divers. Nine species of surface feeding ducks, 10 species of diving ducks, 5 geese, 1 crane, and a coot can be regularly found in Colorado. Most are only common seasonally, with many migrating through or wintering in Colorado. Of all of the species of waterfowl, 16 have been found in BBS surveys from 2006 to 2010 (Sauer et al. 2017). The most common year-round residents are the Canada geese, mallard ducks, gadwall ducks, American wigeons, northern shoveler ducks, green-winged teal ducks, lesser scaups, and the common mergansers. Several species such as the snow goose and lesser scaup are abundant during migration or winter migrating into Colorado from northern breeding areas. Ducks, geese, and swans are aquatic birds with webbed feet, long necks, narrow pointed wings, and short legs. Cranes are tall birds with long legs, beak, and neck, and non-webbed feet. Coots and moorhens have short tails, stubby, rounded wings, lobed toes, and short beaks. In addition to those given, Colorado has also documented 15 other swans, ducks, and geese, and common moorhen and purple gallinule in Colorado which are only infrequently found or accidental. Finally, several feral or escaped waterfowl can be found in Colorado which was discussed above.

Several BDM methods are used to manage damage caused by waterfowl and are specifically discussed in Cleary (1994). Waterfowl are populationing from late summer through winter causing associated damage problems and BDM efforts can be focused on dispersing these birds from damage situations such as crop fields and airports (Booth 1994, Godin 1994).

While waterfowl, cranes, and coots are attracted to wetland habitats; ducks, geese, cranes, and coots are attracted to field crops such as wheat. Geese, swans, and to a lesser extent, wigeons and coots, frequent grass and winter wheat fields. Other species, especially the divers, are attracted to open water where they feed on fish and submerged aquatic vegetation and some can be a problem at aquaculture facilities. Canada geese and mallards can be a nuisance in urban areas at parks and in residential areas where they cause property damage and fecal contamination of water and lawns. Additionally, nesting Canada geese can be very aggressive and injure people nearing their nests. Waterfowl are particularly hazardous to aircraft because of their size and weight, populationing behavior, and relative abundance. From CY13 to CY17, 33 strikes involving waterfowl occurred in Colorado with 9 of these being damaging strikes. Waterfowl, cranes, and coots are protected as migratory game birds by federal and state laws, but most can be hunted during the fall and winter. Hunting dramatically increases the effectiveness of hazing techniques. Permits are needed to take waterfowl, but hunters, with appropriate licensing, can take waterfowl during open seasons. Whooping Cranes are federally listed as endangered with a small population that migrates from Wood Buffalo National Park in Canada through the Central Plains States east of Colorado to Aransas National Wildlife Refuge in Texas. Although, rarely seen in Colorado this species in particular is avoided, but could potentially be hazed from an airport with the appropriate permit (this would be beneficial for the cranes because they could be struck by aircraft). One other species, the greater subspecies of Sandhill Crane is a state listed species of concern.

2.13.7 Corvids (Ravens, Crows, Magpies).

Corvids are well-known, boisterous birds that include crows, jays, magpies, and ravens. Crows and ravens are black, medium sized birds that are slightly iridescent in sunlight. Magpies are black and white birds that appear medium-sized because of their relatively long tail. Jays, with the exception of the gray jay, have blue in varying amounts contrasted with gray, black, or white. Clark's nutcrackers and gray jays are white, black, and gray. Ravens, crows, magpies, and Western scrub-jays are common in open areas close to dense or scattered trees, or brushy or riparian habitats. The other jays are more common in coniferous or deciduous forests with some open areas. These opportunistic feeders consume a wide variety of items including fruits, nuts, small animals, insects, refuse, and carrion. Activities such as plowing are very attractive to ravens, crows, and magpies because it readily exposes food items. Most corvids form populations during the winter. These winter magpie and crow roosts can become a noise nuisance and threaten human health and safety from fecal accumulations. Populationing non-breeding ravens and ravens are often associated with livestock BDM incidents. All of these species, but especially populationing birds, can cause damage to crops such as sprouting agricultural crops and livestock damage. Ravens and magpies will kill livestock, primarily newborn calves and lambs, lambing ewes, or calving cows while animals are temporary incapacitated. Crows and ravens can additionally threaten human health and safety by striking aircraft. Corvids are migratory nongame birds, but the crow is hunted in many states including Colorado. Crows and magpies can be taken without a permit when found doing damage, but USFWS Migratory Bird Depredation permits are required to take the other species.

Corvids are represented by 10 species that breed in Colorado, and are regular occurring species. The most abundant species are the Pinyon jay with 342,629, black-billed magpie with 161,585, Clarke's nutcracker with 380,225, and Steller's jay with 374,753 (Bird Conservancy of the Rockies 2017). Less abundant species include the American crow with a breeding population of 26,430, gray jay 311,421, common raven 114,531, blue jay 23,185 on the western part of its range, and Chihuahuan raven 9,857 on the northern part of its range. Ravens are usually associated with livestock and wildlife depredations, typically pecking the eyes or other soft tissue of newborn livestock causing them to die or potentially depredating eggs and nestlings of the Gunnison Sage-grouse. All are protected species, with the exception that magpies and crows can be taken under a USFWS Depredation Order when found or about to commit damage or are a safety concern, and crows can be hunted in some states during established seasons.

Corvid populations have been negatively and positively affected by habitat changes depending on the species, and possibly West Nile virus which affected this group more than other species of birds. Of these species, WS-Colorado has the highest impact on the Common raven and American crow (discussed in **Chapter 3**), species increasing despite control efforts. Several BDM methods are used to manage damage caused by corvids and are specifically discussed for American crows (Johnson 1994), magpies (Hall 1994), and Western scrub-jays (Clark and Hygnstrom 1994). Several corvids population from late summer through winter causing associated damage problems and BDM efforts can be focused on dispersing these birds from damage situations such as crop fields and airports (Booth 1994, Godin 1994).

2.13.8 Raptors (Hawks, Eagles, Falcons, Ospreys, Shrikes, and Owls).

Raptors are predatory birds or scavengers that possess hooked beaks and talons to capture and feed on prey. Shrikes are also included in this category due to their carnivorous behavior. Birds within this group range in size from the shrike (2.2 oz) and American kestrel falcon (4.1 oz) to larger individuals such as the Golden eagle (7.2 lbs) and Turkey vulture (3.3 lbs). Typical hunting styles for these species include: soaring (eagles, vultures, red-tailed hawks), low-flying ambush (harriers), dense forest ambush (accipiters), hovering (American kestrel falcon, rough-legged hawk), or perching (buteos or broad-winged hawks, owls). Most raptor species can readily be observed in open spaces with abundant small mammal populations and an abundance of perching structures. Raptor BDM incidents are usually associated with livestock depredation events (e.g., poultry, lambs, calves) or human health and safety concerns due to birds protecting a nest or posing a strike risk to aircraft at airports. Eagles, red-tailed hawks, great-horned owls, and, to a lesser extent, other raptor species will attack and feed on livestock (newborn lambs, calves, poultry). Other species, such as turkey vultures will form large roosts in neighborhoods and can be an odor nuisance or cause property damage to structures. Cooper's hawks occasionally chase prey, including birds, into warehouses and then become trapped themselves. Although rarely seen in Colorado, kite species (swallow-tailed kite, Mississippi kite) are known to aggressively defend their nests and have been known to strike people near nests, often drawing blood. Finally, as mentioned above, raptor represent substantial strike hazards to aircraft due to their larger sizes and hunting strategies over open spaces such as airfields.

Colorado has 1 species of vulture, 2 eagles, 14 hawks, 5 owls, and 2 shrikes that regularly occur and have the potential to be involved in BDM projects. Additionally, 7 species of owls are found regularly within the state although they are not likely to be involved in BDM. Lastly, 10 species of raptors, 8 hawks, and 2 owls occur rarely and, as a result, are not likely to be the focus of a BDM project. Almost all work tasks associated with raptors were associated with human health and safety at airports. Raptors in Colorado caused an average of 258 strikes/year (97 falcons, 87 hawks, 66 owls, 1 osprey and 1 eagle) at Colorado airports and airbases from CY2013 to CY2017 (**Table 1.10**). Of these strikes, 93.4% (241/258) were damaging strikes. BDM methods used to manage damage caused by raptors are described in hawks and owls (Hygnstrom and Craven 1994), eagles (O'Gara 1994), and Mississippi kites (Andelt 1994). Unfortunately, hazing efforts are not as effective for removing raptor species form airports and other methods including live trapping and translocation must be used (Godin 1994).

The Migratory Bird Treaty Act provides protection for all raptor species in the U.S. Eagles are specifically protected under the Bald and Golden Eagle Act and a permit is required to haze/harass or translocate them (Wildlife Services only 21.33 airports). WS-Colorado personnel only haze eagles, when necessary, at airport or livestock facilities where they pose a threat to human health and safety or are depredating livestock. Before any bald or golden eagle activities take place, the USFWS requires (in Region 6) personnel to apply for and recieve a Bald and Golden Eagle Depredation Permit. Other lethal take of raptors at airports are conducted under a Migratory Bird Depredation Permit 21.41 (lethal take of non-ealge raptors etc). CPW has identified the following species as bird of conservation concern: bald eagle (State Concern), burrowing owl (State Threatened), and ferruginous hawk (State Concern). WS-Colorado recognizes this and will conduct BDM activities according to state, Federal, and local rules and regulations.

2.13.9 Larids (Gulls and Terns).

Larids are gulls (e.g., California, Franklin's, Herring, Thayer's, and ring-billed) terns (e.g., least tern, caspian tern), jaegers (e.g., long-tailed jaeger, pomarine jaeger), and skimmers (e.g., black skimmer). Gulls are closely related to terns, and distantly to skimmers. These medium to large robust birds, are usually gray to white with long pointed wings, a stout slightly-hooked bill, and square tail. As generalist, gulls readily feed on refuse from dumpsters and landfills, earthworms, insects, and carrion. Attracted to lakes, sandy beaches, flat-roofed buildings, parking lots, and airports, gulls are considered a large strike hazard due to their size, abundance, populationing behavior, and tendency to congregate at airports.

As a group, gulls caused 27% of the strikes at civil airports in the United States from 1990 to 2004 where the species was identified (4,582 out of 16, 727) with most strikes (89% occurred at less than 500 feet above ground) occurring at or near the airport (Dolbeer 2006). However, relatively few gulls, 17 were struck in Colorado from CY13 to CY 17 making up 1.73% of all bird strikes (FAA 2018). The main species involved in these strikes were: Franklin's gulls (3), ring-billed gulls (5), and unidentified gulls (9). Gulls are also a problem at landfills where they may carry off refuse, potentially hazardous waste, to nearby residential areas (landfills are often cited by the Health Department for not having adequate bird control measures). Finally, gull fecal material, such as on a rooftop, can build-up to the point of causing damage. Although some gull species may become year-round residents (many juveniles and non-breeders may stay during the nesting season), few local breeding populations have become established. Gull species primarily migrate through the state although during colder winters these species may migrate farther south. BDM methods for gulls are discussed in Solman (1994).

Similar to gulls, terns are smaller and slimmer with long narrow wings, forked tails, and pointed beaks. These piscivorous (fish eating) birds, dive into the water while hunting prey. Five species of gulls and 5 species of terns can be found in Colorado regularly (**Table 1.2**) with the Ring-billed and California Gulls being most numerous. The Franklin's and Bonaparte's gulls can be numerous during migration. In addition, 23 other species of larids, including 16 gulls, 3 terns, 3 jaegers, and the black skimmer have been recorded in Colorado (**Table 1.2, 1.3**) some with more frequent occurrence such as the Lesser black-backed gull which is expanding its range. Unlike gulls, jaeger and skimmer species are rarities in Colorado, typically associated with coastal areas. Tern and gull species are primarily associated with damage at aquaculture facilities. BDM methods to protect aquaculture facilities from fish-eating birds including larids are discussed in Gorenzel et al. (1994); several of these methods generally apply to protection of other resources.

Larids are protected as migratory birds under the Migratory Bird Treaty Act by USFWS, and are classified as migratory nongame birds by CPW. The least tern is a federally listed endangered species. Of the species that breed in the BBS survey area (9 of the 10 found in Colorado), the Franklin's gull is the only one with a significant downward trend from 1966 to 2009, decreasing at rates of 5.0%/year (Sauer et al. 2011). On the other hand, the ring-billed gull has significantly increased at 3.3%/year from 1966 to 2009.

2.13.10 Shorebirds (Avocets, Stilts, Plovers, Sandpipers, Phalaropes).

Colorado regularly hosts 34 species of shorebirds including avocets, stilts, plovers, sandpipers, and phalaropes with an additional 8 species being documented once or infrequently (**Table 1.2, 1.3**). Most only migrate through Colorado with only 6 species being seen regularly on BBS routes from 2006 to 2010 (Sauer et al. 2017). Additionally, 7 species of shorebirds, and possibly one thought to be extinct, are accidental in Colorado. Avocets and stilts are sleek and graceful waders with long slender beaks, and spindly legs. Plovers are compact birds with short beaks; they dart across mudflats, will stop abruptly, and race off again. Sandpipers vary much more, but typically have medium to long legs and beaks, and populations fly seemingly erratic, but in unison. Phalaropes are similar to plovers with semi-webbed feet, but spin like tops in the water when they are feeding; phalaropes are somewhat unique in that the female is the more colorful and larger than the male. Most shorebirds are attracted to open, shallow water and mudflats. A few can be seen around agricultural fields and airport operating areas, especially fallow or short grass fields, after rains. They feed on invertebrates, typically probing mudflats with their beaks. Shorebirds are commonly hit by aircraft on or around airports where they are abundant (Dolbeer 2006). These species are medium in size and most exhibit populationing behavior making them a threat to aviation. Aviation safety is again the primary concern with these species and BDM methods used to reduce their hazards at airports are discussed in Godin (1994), Booth (1994). Most of WS-Colorado's BDM activities involving shorebirds is related to disease monitoring. Shorebirds are protected as migratory nongame birds. The Eskimo curlew, which migrated through the plains states from arctic breeding grounds was listed as endangered, but is likely extinct. The Piping plover, listed as threatened, has mostly been known to migrate through Colorado; recently, Piping plovers have begun breeding in the Arkansas River Basin. The mountain plover is a proposed threatened species. Additionally, USFWS (2008a) lists the snowy plover, upland sandpiper, and long-billed curlew as birds of conservation concern and Audubon's Watchlist (Butcher et al. 2007) also lists the American golden-plover, marbled godwit, sanderling, semipalmated sandpiper, Western sandpiper, white-rumped sandpiper, stilt sandpiper, buff-breasted sandpiper, Hudsonian godwit, and red knot. Shorebirds mostly pose threats to aircraft. BDM methods used to haze birds from airports are discussed in (Booth 1994, Godin 1994).

2.13.11 Wading Birds (Herons, Egrets, Ibis, and Bitterns).

In Colorado, 8 species of wading birds are regularly found with 9 others being occasionally to accidentally observed throughout the state (**Table 1.2, 1.3**). The largest species, the Great-blue heron, is fairly common year-round, except during colder winters. White-faced ibises, American bitterns, snowy egrets, Great egrets, and black-crowned night-herons similarly occur throughout nesting season. Cattle egrets and green herons are less common and sporadic. In general, wading birds are medium-sized and have long legs, beaks, and necks for stalking and hunting prey. Wetlands and open areas provide a variety of prey options to these species such as rodents, amphibians, insects, and crayfish. Most of these species communally nest in rookeries which can pose an odor and noise nuisance in residential areas. Additionally, where these nesting areas are used year after year, the trees often die from fecal contamination. Requests for BDM involving wading bird species usually involve depredation events at aquaculture facilities and human health and safety concerns due to bird strikes because of their size and slower flight speeds (Dorr and Taylor 2003, Dolbeer et al. 2012).

Wading birds are protected as migratory nongame birds. BDM methods for use at aquaculture facilities are discussed in Gorenzel et al. (1994). These species are managed as migratory nongame birds by USFWS and CPW and can only be taken with a USFWS permit. It should be noted that the American bittern is a bird of conservation concern (USFWS 2008).

2.13.12 Loons, Grebes, Pelicans, Cormorants, and Kingfishers (Waterbirds).

Colorado commonly has one species of loon, pelican, cormorant, and kingfisher, and 5 species of grebes that are regularly found in the state at some time during the year. None of these species is particularly abundant locally in Colorado, except the double-crested cormorant. Nine other species are seen occasionally, well out of their normal range, and are considered accidental or vagrant migrants.

Loons are large (3.5 – 18 lbs) waterbirds with thick bills and necks, and webbed feet; they submerge directly underwater to feed on fish, crustaceans, and aquatic plants. Grebes are smaller, around1.6 lbs, with narrow beaks, long thin necks, and lobed toes; they dive forward to submerge under water and feed on fish. Both species are rarely seen in flight and live in close association to wetlands with abundant fish, invertebrates, and aquatic vegetation. Pelicans, by far the largest waterbird (14 lbs) discussed here, are white or brown waterbirds with a massive bill and throat pouch. These aquatic soaring birds primarily feed on small schooling fish and nest in colonies on the ground.

Cormorants are large (2.6-5.5 lbs), black birds with a stocky bodies, long neck, hooked bill, and reddish-orange facial skin and throat pouch. Anhingas, similar to cormorants in appearance, are rarely found in Colorado. These two species can be differentiated by their tails and bills. When compared to cormorants, anhingas have longer and wider tails and more pointed bills. Both cormorants and the anhingas dive from the water's surface to catch fish. After diving, both species spend long periods of time drying their outstretched wings, since they are not fully waterproof. Another species discussed here, the belted kingfisher is a stocky medium sized bird (4.0 to 6.3 oz) with slate blue wings. Similar to other species in this group, kingfishers dive from the air to ambush fish or invertebrates just under the surface of the water. Attracted to open waters well stocked with aquatic prey, this species is often seen prominently perched on trees, wires, or other elevated structures.

BDM requests for assistance involving this group of birds are primarily associated with fish depredation incidents at aquaculture facilities. Additionally, local regulatory agencies may contact WS-Colorado to protect native fish hatcheries experiencing depredation. Applicable BDM methods used to protect aquaculture are discussed in Gorenzel et al. (1994). Most of these species do not represent a significant hazard to aircraft because of their solitary nature and propensity to live near water. Although, pelicans and cormorants, can be extremely hazardous, due to their larger size, slow flight, and populationing behavior. Loons, pelicans, and cormorants have been struck by aircraft, though infrequently, and have the potential to cause severe damage. From CY13 to CY 17, aircraft in Colorado struck 1 American white pelican, 2 Western grebes, and 1 unidentified grebe.

2.13.13 Woodpeckers.

Nine species of woodpeckers regularly occur in Colorado. An additional 3 species have also been documented in the state. Woodpeckers are familiar birds because of their drumming and cavity building behavior. They are relatively small birds with short legs, two forward - two back, sharp clawed toes for climbing trees, stiff tail feathers for support, and a sharp, stout beak for drilling. These characteristics enable them to climb trees while probing for insects or making cavities. Found near or in wooded areas, their undulating flight is a characteristic trait. Usually territorial, these birds are often found alone or in pairs. Woodpeckers are primarily attracted to areas with mature trees, open space, free access to water, and an abundance of food sources. Primarily insectivorous, though they also eat fruits and nuts, these species damage structures such as buildings and telephone poles while foraging for food. Since woodpeckers are fairly territorial, damage occurs uniformly at low levels throughout orchards rather than focused in a particular area. Woodpeckers are protected as migratory nongame birds. Of the species that regularly occur in Colorado, Lewis's woodpecker is a bird of conservation concern (USFWS 2008a) and red-headed woodpeckers and Williamson's sapsuckers are on the Audubon Watchlist (NAS 2007). Northern flickers and downy woodpeckers were associated with the majority of BDM incidents in Colorado. BDM methods for woodpeckers are discussed in Marsh (1994).

2.13.14 Gallinaceous Birds (Quail, Sage-grouse, pheasants).

Colorado has 13 species of gallinaceous birds. The most likely to be involved in BDM incidents include populations of ring-necked pheasant (65,105), scaled quail (20,741), Northern bobwhite (14,000), and wild turkey (14,000) (population numbers from RMBO 2007 and Rocky Mountain Avian Data

Center 2018). Gallinaceous birds are primarily ground-dwellers with short, rounded wings and short strong bills. Flight is usually very brief for these species, as they prefer to walk. Males are characteristically colorful and perform elaborate courting displays. Pheasants and quail can be found in several habitats ranging from riparian woodlands to agricultural fields, but primarily open areas with brushy cover. Quail are usually found close to permanent water. Turkeys live in close association with wooded regions. Another gallinaceous bird, the prairie-chicken, is found in short- and long-grass prairie habitats interspersed with agricultural areas. All are primarily grain and seed eaters. These species are hazardous to aircraft when found on or around airports. Gallinaceous birds are protected as resident game birds by CPW and most have hunting seasons. Most of these species are non-migratory and not protected by federal laws, except the Gunnison's and Greater sage-grouse and Lesser prairie-chicken are listed as federal candidates. The two populations of Sharp-tailed grouse are listed as State endangered and a species of concern and scaled quail are listed on the Audubon Watchlist (NAS 2007).

2.13.15 Frugivorous Birds.

Several fruit and seed eating birds the most notable of these, are found throughout Colorado including: American robins, Northern mockingbirds, Cedar waxwings, Northern cardinals, and house, purple, and Cassin's finches can be seen throughout Colorado. All of these mid-sized small birds, often form large populations. Robins are one of the most readily identified species in this group with its red-breast and slate-black or grayish back. Northern mockingbirds are gray and white with flashes of white in their wings; they are highly territorial and do not form populations. Waxwings are brownish and have crests, black masks, short tails with yellow tips; they get their name from wax-like red tips on the wing feathers of adults. Finches are small brownish sparrow-sized birds; males have a bright red forehead, breast, and rump. These species are attracted to trees that have fruits or nuts, grains, and areas with an abundance of insects. Earthworms are a major attractant for robins. Most prefer brushy to open areas with scattered trees, and sometimes dense forests. Robins use dense trees or thickets for roosting. Grapes and other fruits can be significantly damaged by these species. Other than agricultural damage, robins and House finches can form nightly roosts in residential areas causing some nuisance problems. Northern cardinals often see their reflection in windows and incessantly attack the window, becoming a nuisance or sometimes damaging screens. These aggressive nesters, often attack people that come near active nests. House finches typically build nests in structures and become nuisances due to the accumulation of fecal droppings. These two species are especially a problem at the entrance to residences and businesses. American robins and a few other species can be a problem at airports during migration, especially when they are populations, though often they are loose-knit. Species in this group are considered migratory nongame birds and protected by USFWS and CPW. Clark and Hygnstrom (1994) discuss methods specifically to address House finch damages. The only species of concern among this group is the Cassin's Finch which is listed as a bird of conservation concern (USFWS 2008a).

2.13.16 Other Birds.

Although other species of birds listed in **Table 1.3** have the potential to cause damage, these species are rarely associated with BDM in Colorado. Species that are likely to be involved in BDM include grosbeaks (human health and safety at airports) or other resources and white-breasted nuthatches (property damage - cavity nesting) though these requests will likely be infrequent. Few of these listed species will ever cause damage, though they may rarely be responsible for a request for assistance (*e.g.,* injured bird picked up to be taken to a rehabilitator).

2.14 Protective Measures.

Protective measures are standardized instructions intended to avoid unwanted results. WS and WS-Colorado incorporate numerous protective measures into our management strategies when conducting BDM in order to prevent or reduce, negative impacts that otherwise might result from an action. Relevant protective measures would be incorporated into all Alternatives analyzed herein, except the no federal BDM alternative (Alternative 4). Most protective measures are instituted to abate specific issue, but some are more general and relate to overall activities. Some of these measures are recommended or required by regulatory agencies (e.g., EPA), and these are listed where appropriate. Additionally, specific measures to protect resources such as T&E species which are managed by WS-Colorado's cooperating agencies (USFWS and CPW) are included in the lists below.

2.14.1 General Protective Measures Used by WS-Colorado in Bird Damage Management.

- WS complies with all applicable laws and regulations that pertain to working on federally managed lands.
- WS coordinates with Tribal officials for work on Tribal lands to identify and resolve any issues of concern with BDM.
- The use of BDM methods such as live traps conform to applicable rules and regulations administered by the State, as well as WS Directives.
- WS personnel adhere to all label requirements for toxicants and pesticides. EPA approved labels provide information on preventing exposure to people, pets, and T&E species, along with environmental considerations that must be followed. WS personnel abide by these restrictions.
- The WS Decision Model (Slate et al. 1992) is consistently used by WS employees when determining appropriate WDM methods. This Model is designed to identify effective wildlife damage management strategies as well as their impacts.
- Non-target animals captured in traps would be released unless it is determined that the animal would not survive and/or that the animal cannot be released safely.
- All personnel who will be using chemicals (e.g. chemicals) will be trained and certified to use such substances or would be supervised by a trained or certified individual.
- All personnel who use firearms will be trained in accordance with WS' Directives.
- Damage management activities will be conducted in a professional and safe manner.
- Management actions would be directed toward specific birds or groups of birds posing a threat to human safety, causing agricultural damage, damage to property, natural resources, or posing a threat to human health and safety. WS will only use non-toxic shot as listed in 50 CFR 20.21 (j) to take migratory birds when using shotguns.
- The take of migratory birds will only occur when authorized by the USFWS, when applicable, and only at authorized levels.

2.14.2 What Protective Measures are incorporated into BDM techniques?

The following is a summary of the Protective Measures used by WS that are specific to the issues listed in **Chapter 2** of this document.

2.14.2.1 Issue A: Impact on Target Bird Species Populations.

- BDM is directed toward localized populations or individual offending animals, depending on the species and magnitude of the problem, and not an attempt to eradicate any native wildlife population in a large area or region. In the case of invasive species, the goal may be to eradicate them (this is rarely feasible for established populations).
- WS Specialists use specific trap types, lures, and placements that are most conducive for capturing the target animal.
- WS BDM lethal removal is monitored. Both "Total Harvest" and estimated population numbers of key species are used to assess cumulative effects of harvest. WS BDM is designed to maintain the level of harvest below that which would impact the viability of populations of native species (see **Chapter** 3) as determined by WS in consult with USFWS and CPW, as appropriate. WS provides data on total take of target animal numbers to other agencies (i.e., USFWS, CPW) as required.
- WS currently has agreements for BDM on less than 5% of the land area in Colorado. This could be increased several-fold, but target bird take would be monitored to ensure that harvest remains below a level that would impact viability of a species.
- WS will relocate birds, as appropriate, primarily for less abundant species such as Golden Eagles and other raptors. Nonnative species will not be relocated, but can be transferred to various facilities at the direction of USFWS or CPW.
- Canada goose round ups would occur in early morning hours when temperatures are cooler and birds remain in flocks prior to foraging.

2.14.2.2 Issue B: Impacts on Non-Target Species Populations, Including T&E Species.

- WS personnel are highly experienced and trained to select the most appropriate BDM method(s) for taking problem birds with little impact on non-target species.
- WS personnel work with research scientists such as NWRC to continually improve and refine the selectivity of management devices, thereby reducing non-target take.
- Non-target animals captured in traps or with any other BDM method are released at the capture site unless it is determined by WS personnel that the animal is not capable of self-maintenance.
- The presence of non-target species would be monitored before using DRC-1339 to reduce the risk of mortality of non-target species' populations.
- WS consults with the USFWS to determine the potential risks to federally listed threatened and endangered species in accordance with the ESA.
- When conducting removal operations via shooting, identification of the target would occur prior to application.
- As appropriate, suppressed firearms will be used to minimize noise impacts.
- WS-Colorado personnel would use bait, trap placements, and capture devices that are strategically placed at locations likely to capture target animals and minimize the potential of non-target animal take.
- Carcasses of birds retrieved after BDM activities would be disposed of in accordance with WS Directive 2.515.
- WS-Colorado would retrieve dead birds to the extent possible, following the use of bait treated with DRC-1339.
- WS personnel will adhere to the following Protective Measures to protect listed T&E and sensitive species. Several are method specific with consideration for a wide variety of T&E species while others are specific to certain species. Included below are Protective Measures incorporated into WDM in general, for specific methods, and for specific species or groups of species. Additionally, WS abides by the Reasonable and

Prudent Alternatives and Measures, or Terms and Conditions for incidental take statements already in place for species that have been covered in a BO and for any newly issued BO.

- When working in an area that has T&E or sensitive species or has the potential for T&E species to be exposed to BDM methods, WS personnel will know how to identify the target and T&E species (*e.g.,* vs. juvenile Bald Eagle), and apply BDM methods accordingly. However, BDM in Colorado has little potential to impact T&E species.
- WS personnel using 4-wheel ATVs will use roads and existing trails as possible to conduct field work.

Method Specific Measures for T&E Species

- WS projects involving habitat management where a T&E species could be affected will be discussed with USFWS prior to implementation. If WS recommends habitat management, the cooperator will be informed that they will need to consult with USFWS and obtain the necessary permits prior to receiving assistance from WS.
- Netting placed by WS personnel will be monitored frequently for ensnared birds or other wildlife.
- Cage traps will be placed in areas where animals will not be exposed to extreme environmental conditions and checked frequently enough to release non-target T&E species alive when used where T&E species could potentially be.
- Mist nets will be used in areas not conducive to capturing T&E species and checked frequently enough to release of entrapped non-target species.
- Raptor and pole traps, several styles of traps modified to capture raptors uninjured and most frequently used at airports so raptors can be relocated, will be monitored frequently to ensure that non-targets can be released without injury.
- Quick-kill traps, primarily snap traps used for woodpeckers, will not be used where T&E species would be exposed. Trap placement can nullify exposure to T&E species.
- WS personnel will retrieve the carcasses of animals shot with lead bullets as possible and dispose of them according to WS Policy.
- WS personnel adhere to all label requirements for toxicants. EPA labels have a section on T&E species and environmental considerations that must be followed for use and WS personnel will abide by these. These restrictions invariably preclude exposure to T&E species.

Piping Plover and Least Tern Protective Measures

- WS will avoid the use of frightening devices where one of these T&E species is seen. There is a minimal chance that these species could be accidentally caught in mist nets or noose mats used to capture shorebirds for disease monitoring. These devices are monitored closely and species taken in them are released unharmed. Where these methods are used with the potential to take T&E species, WS has consulted locally with USFWS under Section 7 of the ESA. WS Protective Measures to avoid impacts include ensuring WS personnel are trained in plover and tern species identification, not working in areas known to be inhabited by these T&E species, monitoring mist nets and traps frequently, and pulling equipment if either species is seen in the vicinity of the trapping operations.

T&E and Sensitive Plant Species Protective Measures

- WS personnel will not collect plants while afield.
- WS personnel will wash vehicles regularly to ensure WS does not spread invasive plant seeds.
- WS who use ATVs and horses will follow established roads and trails. Minimal travel is expected off-trails, but WS personnel will avoid travelling the same areas repeatedly so that new trails are not created.

2.14.2.3 Issue C - Impacts on Public Health and Safety.

- Damage management activities would be conducted professionally and in the safest manner possible. Damage management activities would be conducted away from areas of high human activity. If this were not possible, then activities would be conducted during periods when human activity was low (*e.g*., early morning) whenever possible.
- The use of firearms would occur during times when public activity and access to the control areas was restricted, when possible. Personnel involved in the use of firearms would be fully trained in the proper and safe application of this method.
- All personnel employing chemical methods would be properly trained and certified in the use of those chemicals. All chemicals used by WS would be securely stored and properly monitored to ensure the safety of the public. WS' use of chemicals and training requirements for those chemicals are outlined in WS Directive 2.401 and WS Directive 2.430.
- All chemical methods used by WS or recommended by WS would be registered with the FDA, the EPA, and/or the CDA, when applicable.
- Carcasses of birds retrieved after damage management activities would be disposed of in accordance with WS Directive 2.515.
- WS-Colorado personnel do not collect sick or dying animals (due to natural causes unless they are a part of a research project) and make note of any abnormal behavior in these populations. In areas where animals are exhibiting signs of anticholinesterase toxicity, these animals will be lethally removed according to AVMA guidelines and buried or incinerated, if necessary during roundup activities. In some cases, other authorities (i.e. agency, organization, landowner, or manager) may be advised of the situation and the fate of these birds would be determined by said authorities' active protocols.
- WS-Colorado would conduct damage management activities at times when human activity is limitied (e.g. early morning, night) and where human activites are minimal (e.g. areas closed to the public) to minimize stress on the birds and some members of the public.
- WS-Colorado would bury or incinerate Canada geese living in areas potentially polluted by mining operations, smelting, or where glycol ponding occurs.

2.14.2.4 Issue D – Impacts of BDM on Sociocultural Issues.

- Management actions to reduce or prevent damage caused by birds would be directed toward specific individuals identified as responsible for the damage, identified as posing a threat to human safety, or identified as posing a threat of damage.
- All methods or techniques applied to resolve damage or threats to human safety would be agreed upon with the resource owner and/or manager by entering into a work initiation document, MOU, or comparable document prior to the implementation of those methods.

- Preference would be given to nonlethal methods, when practical and effective under WS Directive 2.101.
- Damage management activities would be conducted professionally and in the safest manner possible. These activities would be conducted away from areas of high human activity. When this is not possible, damage management activities would be conducted during periods when human activity is low (e.g. early morning) whenever possible.
- In public park or open space locations, where Canada goose roundups would occur, WS-Colorado would leave10-20 geese per park for public enjoyment. WS-Colorado understands that many members of the public enjoy watching wildlife and the presence of these beautiful birds enhances the aesthetics of many public parks and open space.
- In other locations where Canada goose roundups would occur (e.g. golf courses, airports, wildlife refuges, private properties), the final decision as to the number of Canada geese that remain would be determined by the property owner, manager, or community official(s) (See *Community Decision Making*).

2.14.2.5 Issue E - Impacts of BDM on Humaneness and Animal Welfare Concerns.

- WS-Colorado will consult with Native American tribes prior to conducting BDM on tribal lands.

Humaneness and Ethical Perspectives

- Personnel would be trained in the latest and most humane devices/methods for removing problem birds.
- WS' personnel would be present during the use of most live-capture methods (*e.g*., mist nets, cannon nets, rocket nets) to ensure birds captured were addressed in a timely manner to minimize the stress of being restrained.
- WS' use of euthanasia methods would comply with WS Directive 2.505.
- The NWRC would continue to conduct research to improve the selectivity and humaneness of wildlife damage management devices used by personnel in the field.
- Preference would be given to nonlethal methods when practical and effective under WS Directive 2.101.

CHAPTER 3: ENVIRONMENTAL CONSEQUENCES

3.0 Overview

Chapter 3 provides a comprehensive comparative analysis of the direct, indirect, and cumulative impacts of the proposed action and alternative(s) on the quality of the human environment. In this chapter, we discuss information pertinent to making an informed selection among the alternatives identified and described in **Chapter 2**. In evaluating the alternatives. A selection should be made based on the need for action identified in **Chapter 1**, the goals outlined in **Chapter 1**, and the issues described in **Chapter 2**. Specifically, this **Chapter** analyzes the environmental consequences of each of the alternatives as those alternatives relate to the issues identified in **Chapter 2**. It also analyzes the cumulative environmental consequences of Alternatives 1, 2, 3, and 4 as they relate to the issues identified in **Chapter 2**.

The Proposed Action/No Action alternative (Alternative 1) serves as the baseline for the analysis. Alternatives 2, 3, and 4 are compared to the baseline (Alternative 1) to determine if the extent of actual or potential impacts would be greater than, less than, or equal to this baseline. The analysis herein, are based on direct, indirect, and cumulative impacts and takes into consideration laws and regulations, directives, and the procedures of local, state, and federal governments, WS-Colorado, CPW, CDA, CDOT, CDPHE, USFWS, FAA, DoD, BLM, and USFS. **Direct impacts** are those that result due to an action that took place at a particular location during a specific period of time. **Indirect impacts** are those that are a result of an action that are seen or experienced later in time or are farther removed in distance. Such impacts may include changes in population densities, ecosystems, and land use. **Cumulative impacts** are defined by CEQ (40 CFR 1508.7) as "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." These actions may result from singularly minor, but collectively significant, actions that accumulate over time. Here we have included all known and foreseeable actions that may contribute to cumulative impacts.

As discussed in **Chapter 2**, there are five issues to be analyzed in detail. For each of the four alternatives, each issue will be discussed and analyzed. The issues are:

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Species.
Issue B: Impacts of BDM on Non-Target Bird Species, Including T & E Species.
Issue C: Impacts of BDM Methods on Public and Pet Safety and the Environment.
Issue D: Impacts of BDM on Sociocultural Resources.
Issue E: Impacts of BDM on Humaneness and Animal Welfare Concerns of Methods.

3.1 The Analysis: How are Bird Estimates Determined?

In this EA, we will evaluate the magnitude of BDM actions (nonlethal, lethal, and/or a combination of methods) based on a measure of the number of individuals lethally removed in relation to the species' abundance in the state, region, Bird Conservation Region(s) (BCRs), or flyway. Magnitude may be determined either quantitatively or qualitatively. Quantitative measures are based on population estimates, while qualitative measures are based on population trends when available. Lethal removal is monitored by comparing the number of birds removed compared to overall populations or trends.

WS-Colorado only uses lethal methods at the request of the cooperator seeking assistance. The removal of birds by WS-Colorado, other government agencies, landowners or managers, and businesses, occurs either without a permit if the species are non-native, during hunting seasons, under depredation orders, or through the issuance of depredation permits by the USFWS pursuant to the Migratory Bird Treaty Act when required. Any action performed by WS-Colorado, and permitted by the USFWS under the alternatives, would occur along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, human-induced mortality from anthropogenic resources (i.e. buildings and windows), mortality from regulated hunter harvest, and human-induced alterations of wildlife habitat.

In this analysis, bird populations are monitored using trend data derived from numerous sources including the Breeding Bird Survey (BBS), the Christmas Bird Count (CBC), Partners in Flight Landbird Population Estimates Database version 2.0, the Bird Conservancy of the Rockies Rocky Mountain Avian Data Center database, the Colorado Breeding Bird Atlas Project, published literature, and harvest data (when available). Further information on these sources is provided below. Here WS-Colorado compares the number of birds for each species lethally removed (when an average of 10 or more are removed per year) to the total estimated breeding bird population within the state. This provided the best available quantification of these impacts. Bird populations are quite mobile and wide ranging and may only reside in Colorado for a limited amount of time during migration.

WS-Colorado's BDM activities are conducted year-round and may include both resident and migratory bird populations. During the winter months, bird populations may be bolstered by individuals immigrating from more northerly breeding grounds (e.g., red-winged blackbirds). When migrating bird population are present and cause damage BDM activities will be conducted. For example, within Colorado we have both resident (year-round populations) and migratory (winter or pass through from northern breeding grounds) populations of Canada geese. Other species, such as cliff swallows, only nest in Colorado during the summer months and migrate to more southern locations during the late summer to fall. While species, such as Franklin's gulls merely pass through our state from their northern breeding areas to southern wintering grounds, returning to pass through again in the spring. And finally, some species such as rough-legged hawks may only winter within our state. WS-Colorado's BDM activities may involve species from all of these groups. For our analysis herein, we will be relying on demography and population estimate information gathered from scientific literature and databases, the U.S. Fish and Wildlife Service, harvest data, and the Cornell Lab of Ornithology's Birds of North America database which has an extensive reference for life history information on over 760 species of birds.

In evaluating the impact to such populations, we have incorporated demographic data related to the reproductive success of each species (fledgling rate, clutch size, number of broods each year, and % of breeding females) and combined it with the breeding estimates to gain a better understanding of the number of birds that could be occupying or migrating through our region. We attempt to factor in that data using our Impact Analysis tables below for each species. Further information will be provided in more detail for each species analyzed, including the sources of our data and any shortcomings we have found related to our analysis.

3.1.1 Bird Conservation Regions

Bird Conservation Regions (BCRs) are ecologically distinct areas in North America that are comprised of comparable bird communities, habitats, and resource management issues. WS-Colorado conducts BDM for species that are either residents in Colorado or primarily come from the western Central and eastern Pacific Flyways. For the purposes of this EA, when applicable, we will include data from BCRs 10, 16, 18 (**Figure 3.1**). Migratory bird estimates will be used for the Central and Pacific flyways, when available, to estimate populations of waterfowl species that could be potentially lethally removed by WS-Colorado BDM activities.

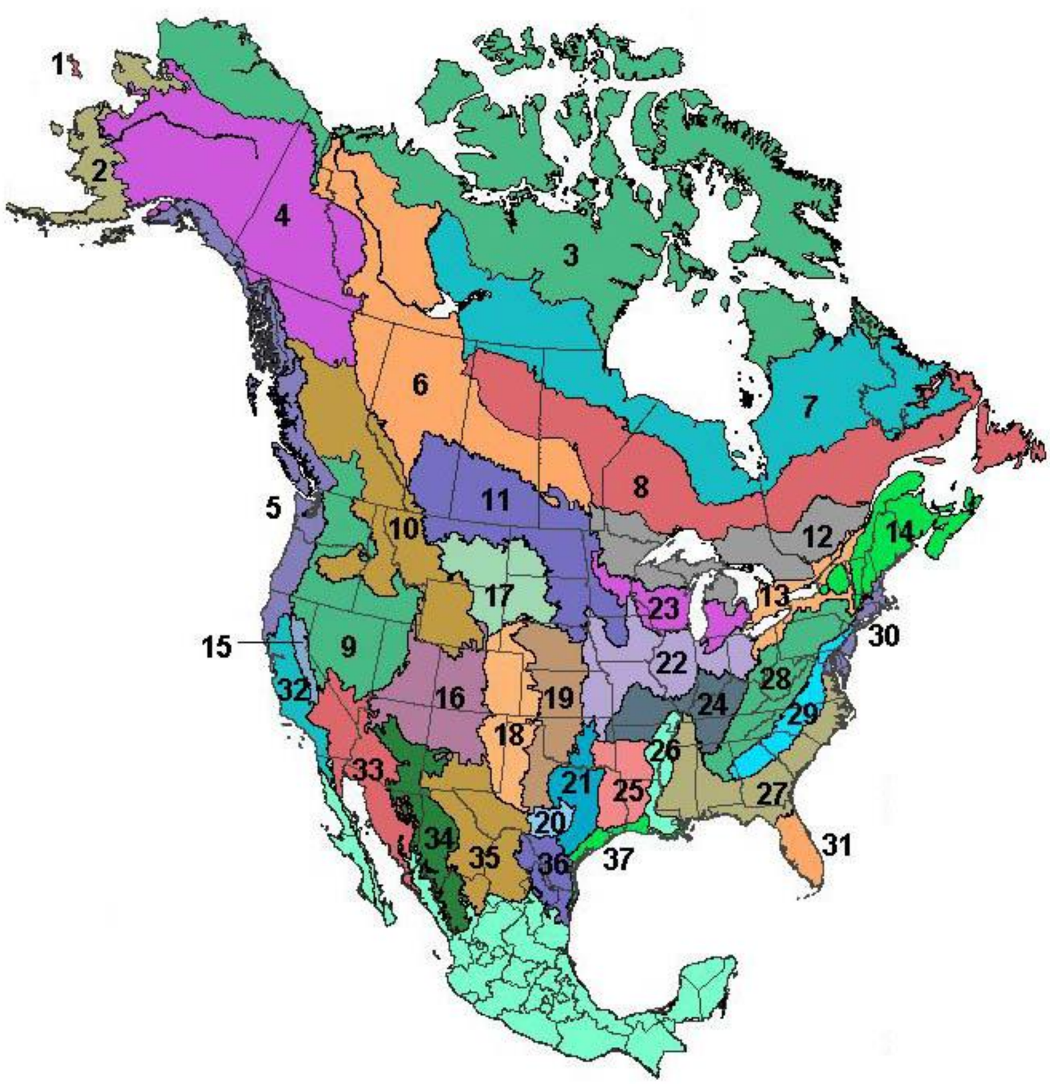


Figure 3.1. Bird Conservation Regions Map of North America (NABCI).

3.1.2 Breeding Bird Survey

To monitor land bird populations, we are utilizing data obtained from the Breeding Bird Survey (BBS). The U.S. Geological Survey, Patuxent Wildlife Research Center coordinated the first BBS in 1966. Since its initiation, it remains the largest inventory of North American land bird data available. Each year data is collected from over 3,700 roadside survey routes primarily covering the continental United States and southern Canada (Sauer et al. 2011). These routes are surveyed each May and June by experienced birders. Observers operating under recognized guidelines, count birds at survey points located along roadways for a set duration of time along a pre-determined route. Routes are ~ 24.5 miles long and are surveyed once per year with the observer stopping every 0.5 mile along the route. The number of birds observed and heard vocalizing within 0.25 miles of each of the survey point, are recorded during a 3-minute sampling period per point.

The primary objectives of the BBS are to generate an estimate of population changes, or an index, for land birds. Here the term **index** is defined as a number that has a proportional relationship to a population estimate. Populations of birds tend to fluctuate, especially locally, because of variable local habitat and climatic conditions. Estimates of population trends from BBS data are derived primarily from route-regression analysis (Geissler and Sauer 1990) and are dependent upon a variety of assumptions (Link and Sauer 1998). Current population trend estimates from BBS data are derived from hierarchical model analysis (Link and Sauer 2002, Sauer and Link 2011) and are dependent upon a variety of assumptions (Link and Sauer 1998). The statistical significance of a trend for a given species is also determined using BBS data (Sauer et al. 2014).

Statistical significances of a trend for a given species are reflected in the calculated *P*-value (i.e., the probability of obtaining the observed data or more extreme data given that a hypothesis of no change is true) for a particular geographic area and are best calculated over a number of years and larger geographic areas. BBS trends are available for 1966 to 2009 and 1999 to 2009, or can be analyzed for any set of years desired (Sauer et al. 2011). Older BBS data (*e.g.,* Sauer et al. 2008) detail the level of significance of a trend estimate. New BBS data does not give the exact level of significance for a trend but instead indicates whether the level of significance is $P<0.05$ or $P>0.05$. BBS data is summarized for Colorado, the Central or Pacific Flyways (the northern limit of the BBS is in central Alberta, British Columbia, and Saskatchewan, and southern limit Mexico), or survey-wide for species breeding in the BBS survey area.

3.1.3 Partners in Flight Landbird Estimates

In general, BBS data are used to monitor trends in land bird populations. However, it is possible to use BBS data to develop broad bird estimates (Rich et al. 2004, Blancher et al. 2013). Using relevant abundances derived from the BBS conducted between 1998 and 2007, the Partners in Flight Science Committee (2013) extrapolated estimates for many bird species in North America as part of the Partners in Flight Landbird Estimate database version 2.0 (PIF database). The Partners in Flight system involves extrapolating the number of birds in 50 quarter-mile circles (total area/route = $10mi^2$) surveyed during the BBS to an area of interest. The model used by Rich et al. (2004), and updated by the Partners in Flight Committee (2013), makes assumptions on the detectability of birds, which can vary for each species. Some species of birds, that are more conspicuous (visual and auditory), are more likely to be detected during bird surveys when compared to bird species that are more secretive or that do not vocalize often. Information on the detectability of a species are incorporated into the model to create a detectability factor, which may be combined with relative abundance data from the BBS to yield an estimate (Rich et al. 2004, Blancher et al. 2013). Raw data are available for individual routes (using count data for specific years) or for a particular geographic area such as a state or Biological Conservation Regions (by combining data from all routes by a single year or multiple years) (US NABCI Committee 2016). If a species has been increasing or declining in the last 20 years, other short-term estimate data obtained from the Bird Conservancy of the Rockies – Rocky Mountain Avian Data Center may provide a more updated snapshot of a species' numbers within Colorado. Species estimates for land birds from RMADC (2019) were derived using the Integrated Monitoring in Bird Conservation Regions (IMBCR) protocol.

Additionally, species' estimate data obtained from the Partners in Flight (PIF) database involves extrapolating the number of birds detected within 50 quarter-mile circles (total area/route = 9.82 mi^2) to estimate a population size (Rich et al. 2004, RMBO 2007). This model makes several assumptions on the detectability of birds, which varies for each species. For example, some large species such as ravens, or species that vocalize frequently such as mourning doves and American crows, are much more easily detected during bird surveys than species that are small or inconspicuous such as owls and vultures or those that do not vocalize often or loudly during surveys such as herons and shorebirds. Furthermore, observers are more likely to see or hear breeding males since they are more visible during surveys while females may be overlooked or are undetectable on nests (e.g., red-winged blackbirds). Given the detectability of a bird species, the PIF version 2 calculates the BBS population estimate using the (BBS Average, Distance, Time, Pair and Bias adjustments, plus the area of regions included in the BBS).

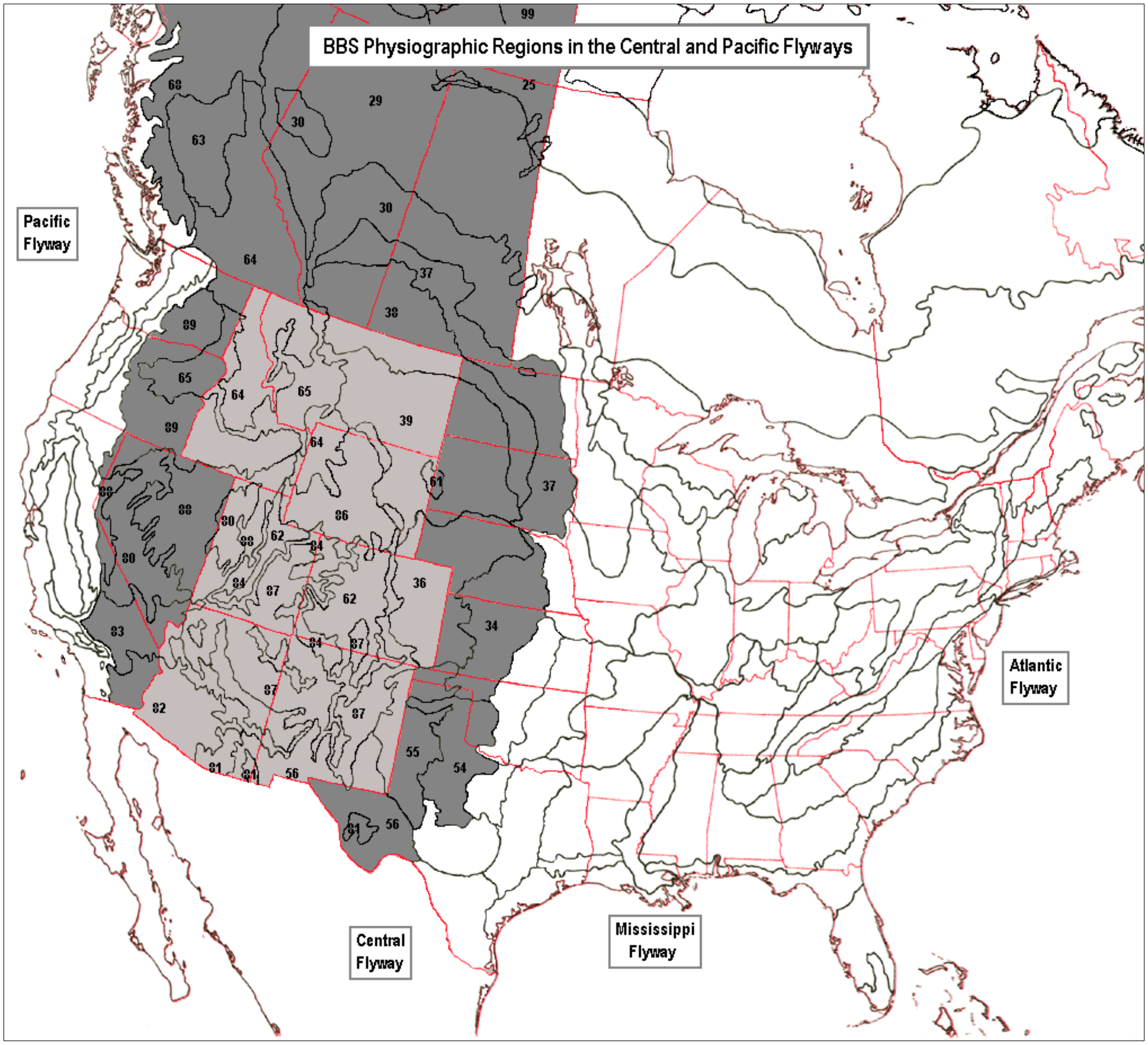


Figure 3.2. BBS physiographic regions in the Central and Pacific Flyways (shaded light gray) that encompass the population of birds that could be impacted by BDM in Colorado, especially those during migration and winter. The shaded area includes BBS regions 34, 36, 37, 38, 39, 54, 55, 56, 61, 62, 63, 64, 65, 80, 81, 82, 83, 84, 86, 87, 88, 89 and that portion of region 30 in Canada excluding Manitoba. This area excludes the eastern portion of the Central Flyway (eastern Great Plains), western portion of the Pacific Flyway (coast and coastal mountains), and birds from the Canadian boreal forest and Arctic tundra (BBS regions 25, 29, 68, and 99) which are mostly north of the BBS boundary limit.

Since some bird species populations have likely changed from 1998-2007, new estimates using current RMADC data will be used when available for bird species impact analysis. For this EA, we used information gathered from a variety of sources including the Bird Conservancy of the Rockies with their built-in parameters to estimate bird species populations involved in BDM from 2013 to

2017 based on our 5 fiscal year (FY) period of time (FY13 to FY17). The majority of the species included in this analysis are estimated at a statewide level, since BDM activities involve local populations at a specific period of time.

For other migratory bird populations that do not nest within Colorado, estimates are based on Central and Pacific flyway data or other Rocky Mountain States within the discussed BCRs. Relative abundance data (2013-2017) averaged from PIF databases will be used to estimate populations that are lethally removed at numbers greater than or equal to an average of 10 individuals per year by WS-Colorado BDM.

3.1.3.1 Inherent Problems Associated with BBS data

In the beginning, Partner's In Flight (PIF) had several objectives including: 1.) identifying the vulnerability for all 448 species of landbirds present in the U.S. and Canada, 2.) being able to provide current estimates for each species, and 3.) provide a starting point for estimating species populations in states, provinces, territories, and Bird Conservation Regions (Rich et al. 2004, Thogmartin et al. 2006). PIF used the methods described by Rosenberg and Blancher (2005) to derive species estimates from available survey data. Unfortunately, a database of information is only as good as the data collected and the parameters that guided the volunteers collecting it. In the past, most large-scale surveys collected indices of species size rather than unbiased estimates of a species population (Thogmartin et al. 2006).

In this case, an index is a statistic (e.g., point count or measure of relative abundance) that is assumed to be correlated to a quantity of interest (e.g., population size or density). Understandably, an important part of wildlife statistics is being able to identify and correlate the number of animals counted (detection rate) and translating that into a population estimate for a sample site (Nichols et al. 2000, Buckland et al. 2001, Thogmartin et al. 2006). For bird surveys, the available count locations, along roadsides, are not able to detect all of the birds within a region due to a number of variables (Bibby et al. 2000). While these factors were largely ignored in the past, modern analyses of BBS indices are attempting to address these shortcomings by: controlling site-specific differences in detection using observable covariates (e.g., observer effects, and among-observer effects (Link and Sauer 1998). To date, there are no analyses that control for point counts only being taken along roadsides or the limitations of species detectability among habitat types or behavior. Notably, each of these issues could potentially lead to inappropriate decisions being made during conservation planning based on misleading and inaccurate species estimates.

Two of these issues, the placement of the routes and roadside effects, are critical in determining if habitats are being sampled appropriately by the BBS. The BBS is limited by infrequently surveyed routes and large roadless areas in both the U.S. and Canada (O'Connor et al. 2000, Thogmartin et al. 2006). The lack of sampling in roadless areas such as mountain tops, western riparian areas, and wetlands leads to under or over-sampling of habitat types. These areas are notably poorly represented in the BBS (Robbins et al. 1986, Thogmartin et al. 2006). Additionally, because the BBS is conducted along roadsides, the influence of the roads themselves on bird behavior or the presence of absence of bird species remains unclear. While some bird species may be attracted to roads others may be repelled by them and introduce bias in BBS data (Forman and Deblinger 2000, Rotenberry and Knick 1995).

Other bias can be introduced through the assumptions that birds are present but are not counted during BBS and are corrected for using one or more adjustment factors (Thogmartin et al. 2006). Link and Sauer (1998:261) suggested that BBS sampling cannot guarantee either a census or a known fixed area of sampling. Thogmartin et al. (2006) suggest several adjustment factors that help address some of these issues. The first adjustment, is a "pair" adjustment it multiplies the average number of birds per route in older datasets (1990s) by two. This accounts for the assumption that only males are vocalizing early during the first BBS stop and that the males are often part of a breeding pair. However, this adjustment factor does not account for unpaired "floater" birds. Furthermore, other species such as nocturnal or crepuscular species, temporary migrants, early and late season breeders, or species that quietly vocalize are poorly counted during BBS surveys (O'Connor et al. 2000, Thogmartin et al. 2006). The relationship between BBS results comparing overly conspicuous species to these other groups are generally unknown. But it is thought that some species may be underestimated or overestimated especially for species where both species vocalize.

The second adjustment factor attempts to address species-specific detection probabilities assigned for individual species. This transforms the index of relative abundance into a density estimate using one of five detection-distance categories: 80, 125, 200, 400, and 800 m. Obviously, several factors can influence this adjustment including: habitat, calling rate, song volume, time of year, species behavior, and observer skill (O'Connor et al. 2000, Thompson 2002, Thogmartin et al. 2006). Although the BBS protocol has attempted to standardize conditions for counts, detection distances are not likely to be constant (Rosenstock et al. 2002, Norvell et al. 2003). This variation in detection distance may lead to over- or under- estimating population sizes. For example, a 200 m detection distance quadruples the population estimate for a species compared to a species with a detection distance of 400 m (Thogmartin et al. 2006).

The third adjustment factor, time of day, is estimated based on polynomial fit to stop count tallies, where the first BBS stop represents the earliest count and the 50th stop represents the last. In theory, this serves to smooth out the pattern in the counts based on the species. However, ill-fitting polynomials especially for species whose peak abundance occurs early during counts (e.g., nocturnal species) or later during the counts are not properly measured. Species of birds like vultures, have behaviors that make them not likely to be detected by BBS (Avery 2004). For instance, vultures do not leave their roosting sites until late afternoon. BBS routes are designed to end at 10 a.m. In the future, changes to BBS protocol should be designed specifically to detect vultures and other bird species that are not readily detectable by the current BBS protocol.

The dynamic nature of bird populations demands that population estimates incorporate temporal components that reflect population change. The uncertainty of these parameters and adjustments make comparisons between and among species BBS data problematic and further complicates determining whether a species has reached a particular conservation target. However, while the scientific community recognizes the short comings of the BBS, we also applaud the original authors Blancher and Rosenberg for their progress in taking on the monumental task of estimating population sizes of landbirds for North America. As conservationists and wildlife managers continue into the future, adjustment corrections will continue to be made and survey methods will be improved upon to utilize this valuable dataset to the best of our ability.

3.1.3.2 Adjustment Corrections

The Partners in Flight Science Committee made several updates to the current 2.0 version of the PIF Population Estimates Database (Blancher et al. 2013). This update addresses some of the recommendations made by Thogmartin et al. (2006), however, further work is needed to address the limitations of these bird population estimates as outlined by Thogmartin et al. (2016), Confer et al. (2008), Thogmartin (2010), and Matsuoka et al. (2012).

Some of the changes made since the original estimates (version 2004) that try to address the inherent problems associated with PIF databases and impact this analysis include:

- The original PIF Estimates (2004) relied on the 1990-1999 BBS count data that was stratified by geo-political regions in the U.S. and Canada. This data was used to estimate the average density of birds in particular regions. The current version of the PIF database updates the Time of Day Adjustments to use the stop by stop BBS count data from 1997 to 2005. This served to increase the sample size and allowed them to estimate a more precise adjustment factor.
- Another data update includes incorporating more up to date information on several range-wide population estimates based on species-specific surveys and knowledge.
- As far as analytical changes, the detection distance categories were reviewed and modified for several species based on published data (e.g., Hamel et al. 2009), and comparisons with datasets from Colorado, California, Ontario, and boreal Canada. This change was intended to increase the reliability of the PIF's Population Size assessment scores (PS score). Three new distance categories were added: 50 m, 100 m, and 300 m to provide smaller increments between distance categories and to make the data more uniform among comparison datasets.
- Pair Adjustments changed from the original estimates that included a multiple of 2 for all species to the use of one of five Pair Adjustment categories (1.0, 1.25, 1.5, 1.75, and 2.0). The original assumption was that on average across BBS routes during the peak time of detection no more than one individual out of a breeding pair would be detected. However, we now know that the detection of both individuals in a pair differs among species and depends largely on how birds are detected on BBS routes (e.g., by sight or song, singly vs. groups). The new Pair Adjustments are used to adjust for time of day and peak detection for example: if a bird is detected at dawn (BBS stop 1) then the Pair Adjustment would equal 2 based on the assumption that largely males are detected by song.
- If the proportion of birds detected singly at individual BBS stops >90% then the Pair Adjustment =2; otherwise the Pair Adjustment was assumed to be lower.
- If the proportion of sexes detected in five separate point counts are skewed toward one sex, a greater Pair Adjustment=2 is needed.
- Additionally, higher Pair Adjustments are needed when a species is breeding or birds are likely to be feeding older nestlings or fledglings at the time of the BBS.
- And finally, if a higher portion of large counts indicates that birds of both sexes are being detected, and all of the above variables are equal, a lower Pair Adjustment would be assigned.

<u>Time of Day Adjustments</u>

The time of day adjustments attempt to account for changes in the detectability of a species as time passes in the morning on BBS routes. Besides increasing the sample size, these adjustments along with the single 6 factor polynomial regression was replaced with a stepwise polynomial regression using the Akaike Information Criterion (AIC).

<u>Extrapolations to un-sampled Range</u>

In regions where BBS information was not available, average counts were assumed to be the same as those seen in adjacent regions in the same BCR. In this update, adjustments were based on the relative proportion of breeding range in the source and adjacent regions, so that population estimates were not incorrectly assumed to be the same in regions with no breeding range. Range information indicating whether suitable habitat was located in the adjacent range was based on NatureServe digital maps (Ridgely et al. 2005).

3.1.4 The Bird Conservancy of the Rockies.

For the last 10 years, the Bird Conservancy of the Rockies in cooperation with the U.S. Forest Service, U.S. Bureau of Land Management, U.S. National Park Service, Colorado Parks and Wildlife, and other agencies developed and conducted landbird monitoring for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program. The IMBCR sampling protocol monitors bird species populations and trends from local management units, to states, and BCRs. This allows users to estimate species densities, population sizes, and occupancy rates for individual strata layers. From 2013 to 2017 data were combined and analyzed for 30 to 39 strata for the annual integrated monitoring report. When we examine the results for each sampling year, in 2017 field technicians completed 250 of 241 surveys, with 3,062 point counts, in 250 grid cells from May 15 – July 16, and documented 206 bird species including 39 priority species. In 2016, field technicians successfully conducted 279 of 279 surveys, with 3,402 point counts, in 279 grid cells, from May 9 – July 14, and documented 201 bird species including 39 priority species. In 2015, field technicians completed 349 of 350 surveys, with 4,066 point counts, in 349 grid cells, from May 12 – July 20, and documented 208 species including 41 priority species. In 2014, field technicians completed 349 of 350 surveys, with 4,066 point counts, in 349 survey sampling units, from May 12 – July 20 documenting 208 species including 41 priority species. Finally, in 2013 field technicians completed 331 of 333 surveys, with 4,006 point counts, in 333 sampling units, from May 13 – July 22 documenting 213 species including 64 priority species. Using the IMBCR protocol survey points are arranged in a 4 x 4 grid of 16 points, with 250 m spacing between the points (**Figure 3.3**). At each point location, a field technician conducts a 6-minute point count at ≥6 survey points within each sampling unit beginning one-half hour before local sunrise and ending no later than 5 hours after sunrise. The grids are selected using a spatially balance sampling algorithm. In general, these grids are selected randomly without regard to habitat type, except for those partially or fully within riparian corridors (**Figure 3.4**). For our analysis, we used the following filters for our queries with the RMADC: Study Design: IMBCR, Super Stratum: CO, and Species. When analyzing this data, the percent coefficient of variation of estimates (C.V.) less than 50% represents a robust density estimate. Species with a C.V. value between 50 – 100% represent marginal density estimates and those with C.V. values above 100% represent poor density estimates.

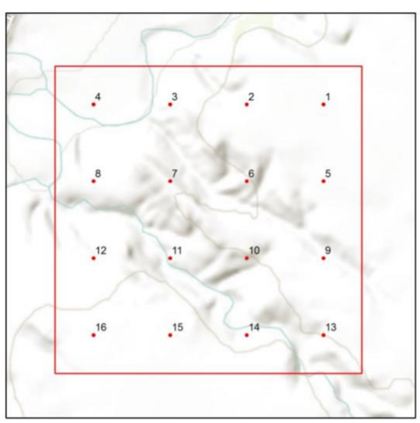


Figure 3.3. Example of a 1 km^2 sampling unit using the IMBCR design from the Bird Conservancy of the Rockies.

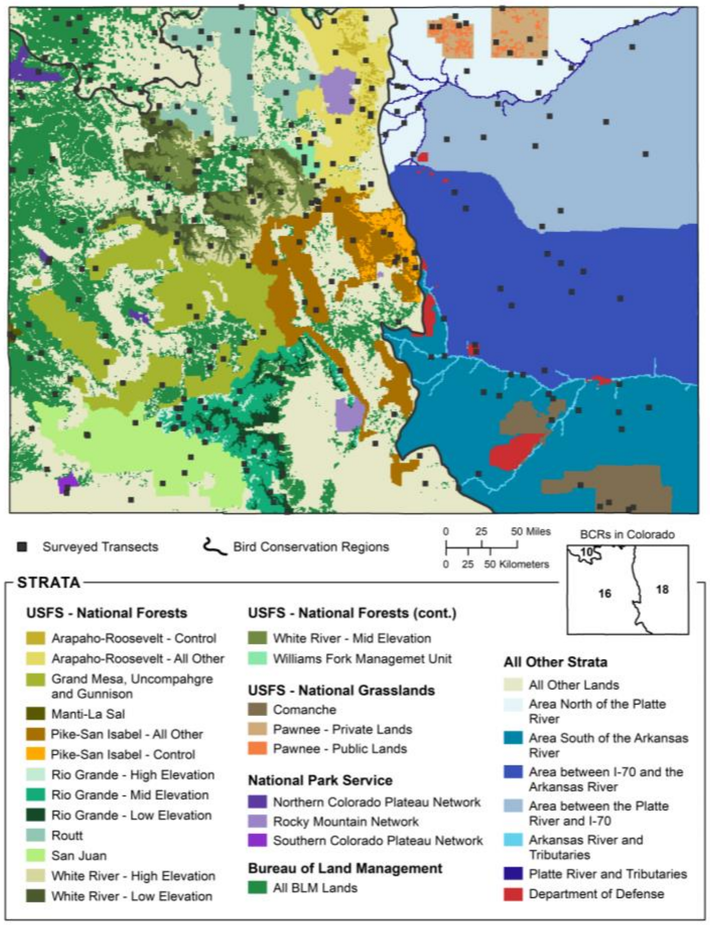


Figure 3.4. Bird Conservancy of the Rockies IMBCR survey locations in Colorado for 2017. (Bird Conservancy of the Rockies, 2017).

3.1.4.1 Breeding Bird Survey (BBS) data vs. The Bird Conservancy of the Rockies (IMBCR) data.

At present, the magnitude of the differences between the BBS and IMBCR protocols and the extent that these differences influence bird species estimates are unclear. Janousek et al. (2015) examined differences between these protocols and their resulting bird species estimates found that overall 94% (104/111) of the species analyzed exhibited variances in their 4-year population trend estimates. Of those examined, 49 species (45%) had trend estimates that occurred in the same direction (e.g., positive or negative) but at a different magnitude of change. Additionally, 39 species (35%) had conflicts between their 4-year trend estimates (e.g., one positive and one negative estimate). Finally, for 16 species (14%) the relative abundance of these species changed temporally in only one monitoring program (e.g. one positive and one with no trend). Despite these differences the authors were not able to determine which of the two monitoring programs produced estimates closest to the truth. Ultimately, inherent differences in survey programs and various life history traits of individual species lead to the inconsistencies seen within this study's species comparison.

As stated previously, the BBS program's goal is to monitor long-term population trends of landbird species and it inherently acknowledges detection biases as discussed previously. For evaluating short-term bird species population trends, BBS data may be less useful unless detection biases are explicitly accounted for. In contrast, IMBCR protocols correct for detection limitations in their annual estimates that are compiled and analyzed across multiple spatial strata. This type of data provides a manager with more information about short-term changes in local populations. Short-term bird population changes are useful in determining the impact(s) of land management practices or how species respond to landscape changes (Janousek et al. 2015).

3.1.5 The Colorado Breeding Bird Atlas Project.

In 1987, the Colorado Field Ornithologists appointed a committee to facilitate and direct a Breeding Bird Atlas in Colorado. The Colorado Breeding Bird Atlases (I 1987-1995; II 2007-2012) provide wildlife professionals, birders and educators, information on bird distribution, habitat use, and breeding phenology of Colorado's avifauna. Volunteers survey habitat types within priority blocks and record species, location, date, and category of breeding behavior observed for all species under a standard methodology. All unusual sightings are verified and all occurrences are consolidated and geographically displayed by species.

3.1.6 Christmas Bird Count.

From December 14th through January 5th each year thousands of volunteers under the guidance of the National Audubon Society conduct the Christmas Bird Count (CBC). This long-running wildlife census asses the number of birds that frequent locations in winter months. Here we use the term **census** to describe the less restrictive sense of the word, as an estimate of population size or density. Participants count the number of birds observed within a 15-mile diameter circle around a central point (177 mi^2). CBC data does not provide a population estimate, but the count can be used as an indicator of trends in the population of a bird species overtime. Researchers, conservation biologists, wildlife agencies, and other interested individuals 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).

3.1.7 Potential Biological Removal for Local Populations.

To estimate bird species populations wildlife managers and conservationists must constantly analyze bird mortality and breeding success in relation to ecological, social, and competitive forces. This proves challenging as bird populations are in a constant state of flux and rarely remain stable or static from year to year. In new environments, bird populations typically have an S-shaped (sigmoid) growth pattern where bird populations grow slowly at first, rapidly accelerate, and then decline. Population declines toward the end of this growth pattern, are a result of negative feedback from lower reproduction and survival success. Finally, this growth curve levels off to reach a carrying capacity, or the maximum number of individuals that the environment can support.

During the acceleration phase, the rate of change in the number of individuals in relation to time dN/dt is the product of the instantaneous growth rate r and the population size N at time t $(dN/dt = rN)$. For example, in 1890, 120 European starlings were introduced into the U.S. and in a time span of 50 years this population increased by one million-fold (Gill 1995:509). In general, small-bodied bird species with large brood sizes and high reproductive rates have an annual growth potential of 50 to 100% in successful years whereas, large-bodied species (e.g., Canada geese) with lower reproductive rates have annual growth potentials of 10 to 30% (Gill 1995). This growth enables smaller bird species to rebound more quickly to short-term obstacles.

Natural Factors that Limit Bird Populations

Of course, these populations are not reproducing inside of a vacuum and therefore other natural ecological factors further manipulate these trends. Ecological factors include: habitat, climate, food supply, and disease (including parasites); and some social behavior(s) can further complicate access to food and habitat availability. In 2019, Rosenberg (et al.) indicated a net loss of 29% (2.9 billion) of North American bird populations since 1970. Grassland bird species exhibited the largest decline with more than 700 million breeding individuals lost (Rosenberg et al. 2019). All forest breeding biomes similarly experienced population declines with and overall reduction of more than 1 billion birds (Rosenberg et al. 2019). Introduced (invasive species, non-native to North America) species, those not protected by the Migratory Bird Treaty Act, exhibited a net loss of 63% across 10 species (Rosenberg et al. 2019). Interestingly, wetland biomes showed an overall net gain in bird populations (13%). Waterfowl species (e.g. ducks, geese) within these areas increased by 56% (Rosenberg et al. 2019).

Steep declines seen in North American bird populations, mirror those seen globally (Rosenberg et al. 2019). These declines are the result of habitat loss, unregulated toxic pesticide use (e.g. breeding and wintering areas), competition with introduced species, urbanization and agricultural intensification, and predation by introduced species (domestic cats) (Rosenberg et al. 2019). As we move forward, targeted research identifying the scope of these declines will be needed to inform and educate conservation actions and societal and legislative policy changes. Ultimately, the US Fish and Wildlife Service and Congress hold the authority for implementing these changes, as it relates to bird populations within the United States.

Habitat

Of these, habitat availability is one of the most influential. For some species, such as woodpeckers, shortages of dead trees, branches, and soft wood can limit population densities when there is a lack of nesting sites. In Europe, this is can be seen in European pied flycatcher and white-backed woodpecker population declines as a result of the routine removal of dead trees and branches in managed forests (Gill 1995). Migratory bird populations are also vulnerable to habitat alterations on their winter range. For example, the number of Greater whitethroats that return to breed in Britain from their wintering grounds in Africa reflect winter survival rates (Batten and Marchant 1977, Gill 1995). One year this species' population dropped by 77% due to drought conditions south of the Sahara (Gill 1995). However, in the subsequent years, when drought conditions subsided this species' population rebounded to previous levels. In this case, annual habitat alterations (either negatively or positively) impacted both food availability and warbler energy requirements and led to noticeable changes in warbler populations.

Human activities can also impact bird populations favorably by creating new habitat or to their detriment by destroying it. While some species benefit from human interference many do not. The clearing of forested habitat for human developments likely benefits open grassland and open-woodland bird species while more specialized forest dwelling species disappear. This can be seen throughout Colorado on airports nestled within urban sprawl. Despite, or perhaps because of, a lack of surrounding grassland habitat a number of prairie species are attracted to the open prairie grassland environments and utilize these areas as loafing and foraging sites. Other wildlife species (such as coyotes and geese) also adapt to using airports and other areas such as golf course as travel corridors, opportunistic feeding sites, and refuges within cities.

Food and Climate

The lack of food sources due to climatic conditions also influences bird populations. During harsh winters, groups of songbirds, waterfowl, and waders can experience mortality rates anywhere from 2 – 10 times the normal rate (Gills 1995). Most of these mortalities are due to a lack of food resources resulting in starvation. Widespread food shortages can also lead to large mass dispersals (i.e., irruptions) of some species. One of the most notable mass dispersals occurred from 1945 to 1946 when over 14,000 Snowy owls were counted in southeastern Canada and New England. This dispersal was supposedly attributed to a lack of lemmings in their artic and subarctic habitat. Because these birds had dispersed from their natural habitat, many died from starvation or were killed.

Disease and Parasites

Diseases and parasites can also cause short-term population declines. In the early 1800s, Captain Cook accidently introduced mosquitoes carrying bird pox and malaria onto the Hawaiian Islands (Gill 1995). Subsequently, susceptible lowland populations of Hawaiian honeycreepers were decimated by these introductions. This is just one of many such vector or pathogen introductions that have led to population declines in susceptible species. Parasite infections can also influence breeding success. High levels of intestinal parasites can decrease adult survival due to reductions in weight gain, reduced secondary sex traits like aggressive behavior, and increase vulnerability to predation from an overall lack in fitness.

Social Forces

In some populations of birds, social forces may play a subtle role in food and habitat availability. Territorial individuals may exclude others from prime foraging locations or force them to occupy secondary habitats where the risk of mortality is greatest. The occupancy of available habitat is typically colonized in three stages. First, areas with the greatest available resources are taken. Once those prime areas are inhabited, surplus individual move into suboptimal habitat and wait for vacancies within the prime habitat. Finally, following a lack of suboptimal habitat, remaining birds or "floaters" travel between habitats and wait for opportunistic vacancies. Floaters may either live singly or form populations and will quickly replace other individuals within an established territory once those individuals die or are removed.

Additive and Compensatory Mortality

Animal mortality is influenced by many factors including disease, malnutrition, predation, and severe weather. A given population of 100 individuals could potentially experience a lack of food in combination with an outbreak of disease that could result in the removal of 40 individuals from a population. Additionally, predators could also opportunistically remove 40 individuals. Overall these factors (starvation, disease, and predation) could have an *additive* impact resulting in 80 animals being removed from the population. However, it should be noted that populations rarely experience such a high level of mortality due to these factors and the removal of some individuals from the population lessens these stressors impacts on the remaining individuals. Such density dependent factors can also have a *compensatory* effect. When predators remove some animals from the population, more food resources are left and fewer-individuals die from malnutrition or disease. By contrast, severe weather can have either an *additive* or *compensatory* effect on a population. If a snow or ice storm proceeded the failure of a food crop this would have a compensatory effect on the population by increasing the survival rates within the remaining population. If, however, the snow or ice storm led to the deaths of a fixed number within the original population regardless of disease or predation, this would be an additive effect.

In general, hunting is thought to have a compensatory effect on game species populations (Bolen and Robinson 2003). When individuals are removed through hunting, this promotes higher reproductive rates and/or increases the life expectancy of the remaining individuals. Wagner et al. (1985) summarized this in mathematical terms in that the total annual mortality increases by a smaller percentage than is measured by the actual percentage of individuals removed by hunting alone. Or a (the crude annual mortality rate) = m (the mortality rate from hunting) + n (the natural mortality rate) – mn. So, for example, in a population with a natural annual mortality rate of n=70%, the additional m = 20% mortality from hunting would not increase the total mortality to 90% but only from 70% to 76%. In other words, it merely removes some of the animals from the population that would naturally die (**Table 3.1**) (Bolen and Robinson 2003).

3.1.7.1 Logistical Growth of Bird Populations.

In analyzing bird population growth and mortality we must also consider how humans exploit these populations for their own purposes. Regardless of the motivation, humans remove birds from wild populations through subsistence or harvest, for consumption, recreation, pets, live scientific or personal collection, to reduce crop damage, or prevent predation on game animals (Runge et al. 2004). Wildlife managers and conservation biologist often struggle to quantify how these activities impact bird populations due to a lack of data. To understand these impacts managers must first identify: minimum population size estimates, estimated harvest levels, and understand population dynamics of a species (Runge et al. 2004).

As mentioned previously, hunter harvest is thought to have a compensatory effect on game species populations. For some species, having at least a cursory idea as to the minimum estimated population size helps wildlife managers guard against: taking no action when human activities are negatively influencing bird populations; and/or implementing unnecessary restrictions when human activities are found to be sustainable (Runge et al. 2004). Of course, accurately estimating bird populations is rarely obtainable for large geographic areas, without funding, abundant human effort, skilled observers, and relevant protocols. Thus, abundance estimates are typically based on the number of individual birds physically counted or at the lower end of an adjusted population scale when calculating population impacts.

When analyzing game species populations in relation to hunter harvest, data is needed as to the total number of animals removed or the known harvest rate relative to a population size (Runge et al. 2004). To understand how this harvest data influences a current population, biologist must understand basic population dynamics. This includes: age, sex, survival and reproductive rates, complete life history models (i.e., tables), and how these factors are influenced by environmental parameters, harvest rates, and species-specific life parameters (Runge et al. 2004). If all of this data is not available at the time of the analysis, a simplified population dynamic model can be used and updated as more information becomes available.

In theory, if all of this information was accurate, readily available, and stayed constant (e.g. harvest rates, and environmental parameters) wildlife conservationists and managers would be able to precisely calculate population growth using: $N_{t+1} = N_t + r_{max} N_t(1 - N_t/K) - h_t N_t$. Where N_t is the population size at t time, h_t is the harvest rate for the same time, r_{max} is the maximum growth rate, and K is the carrying capacity. Once the equilibrium population size for a specific fixed harvest rate is reached the annual harvest will also be constant and is represented by the equation: $H_{eq}(h) = hN_{eq} = (r_{max}Kh - Kh^2)/ (r_{max})$.

Let us imagine that the harvest rate (h_t) is fixed for an indefinite period of time ($h_t = h$) relative to the population size. Under these conditions the population size will continue to grow until it reaches an equilibrium value $N_{eq}(h) = K (r_{max} - h) / (r_{max})$, if the maximum grow rate r_{max} of the population is not too large (**Figure 3.5**). However, if the fixed harvest rate is less than the maximum growth rate (r_{max}) this will produce an equilibrium population size and annual harvest greater than zero. Any harvest rate less than the maximum growth rate (r_{max}) would be sustainable. For the logistic growth model, the maximum sustainable harvest rate is $h^* = r_{max}/2$, which would produce an equilibrium population size of $N^* = K/2$, and an annual harvest of $H^* = r_{max}K/4$ (Runge et al. 2004).

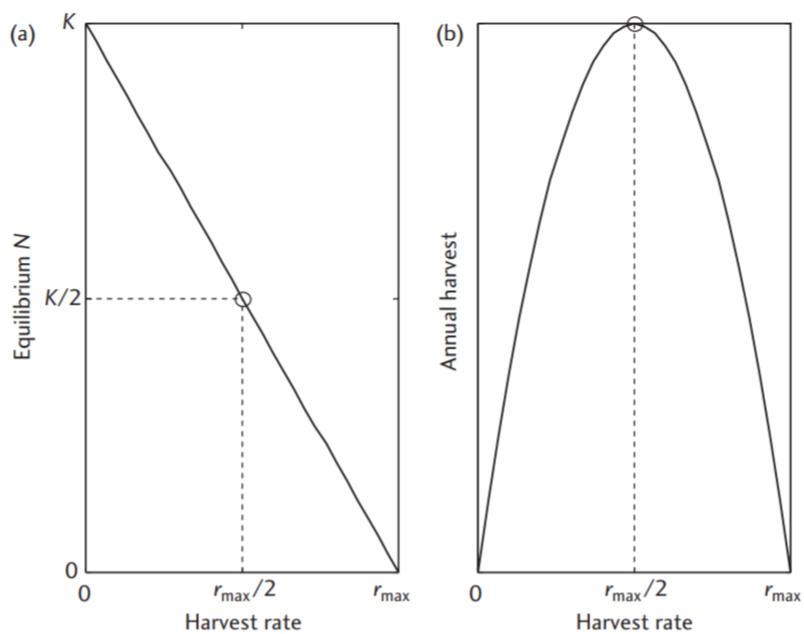


Figure 3.5. Maximum sustained harvest from a logistic growth model. (a.) Equilibrium population size at a fixed harvest rate. (b.) Annual sustained harvest from a fixed harvest rate. The maximum sustained yield would be achieved at point $r_{max}/2$ where the model reaches a balanced population size of half the carrying capacity of the species population (K/2). If the harvest rate were greater than or equal to the maximum growth rate the population would gradually decline to zero (Runge et al. 2004:306).

Despite knowing how to use these models theoretically, their implementation into the current population analysis is complicated. Real population dynamics are more complex than those built into the logistical growth model discussed above. Life-history parameters such as sex, age, reproductive status, percentage of breeding females, percentage of males that breed, and mortality rates related to environmental and human factors are largely unaccounted for. Additionally, the population size calculated by $N_{t+1} = N_t + r_{max} N_t(1 - N_t/K) - h_t N_t$ may differ depending on individual factors related to a species (i.e., density, crowding, predators, competition) (Runge et al. 2004). These calculations also do not take into account that wildlife populations are in a constant state of flux due to random and unpredictable fluctuations in the environment (e.g., disease, climate, adverse weather conditions); and finally, wildlife conservationist and managers have limited control over human exploitation levels nor do we have an accurate count as to how many birds within several populations are adversely impacted. These uncertainties make calculating bird species population impact analyses challenging.

Table 3.1. Estimated sources of annual avian mortality associated with human activity in North America (USFWS 2018).

Mortality Source	Median/Avg. Estimated	Citation
Collisions - Glass	599,000,000	Loss et al. 2014a
Collisions - Communication towers	6,600,000	Longcore et al. 2012
Collisions - Electrical lines	25,500,000	Loss et al. 2014c
Collisions - Vehicles	214,500,000	Loss et al. 2014b
Collisions -Land-based Turbines	234,012	Loss et al. 2014b
Electrocutions	5,600,000	Loss et al. 2014c
Poison	72,000,000	Loss et al. 2013a
Free-roaming/Domestic cats	2,400,000,000	Loss et al. 2013a
Oil Pits	750,000	Trail 2006
Total	**3,324,184,012**	
Total Except Cats	**2,019,218,024**	
Industry Only	**709,684,012**	

3.1.7.2 Life Tables.

Life tables are a systematic way to describe mortality as it affects various age groups in a population. As age-specific survivorship and age-specific fecundity changes within age cohorts, life tables allow us to project population growth and future trends related to these factors. This data allows ornithologists and other wildlife professionals to follow the life history patterns of species and the annual progress of a cohort of eggs, nestlings, or fledglings until the last individual dies. Although life tables are based here on female bird statistics, because they are more reliably measured than those of males, this data is notably subject to error although it is more realistic than associating eggs to males or more specifically males to fertilized eggs.

The proportion of a cohort that survives each year in a population is defined as the annual survivorship (S_x). The probability of an individual surviving to a particular age (L_x) is the product of the subsequent annual survival rates. The number of young produced each year by breeding females in a cohort is defined as age-specific fecundity (B_x). Here fecundity is defined as the number of young successfully raised and serves as an indicator of a female's reproductive success. Therefore, the product of L_x B_x represents an individual's expected annual fecundity at a specific age that is influenced by the chance of dying before reaching that age (i.e., annual mortality rate). The sum values of L_x B_x add up to a net reproductive rate (R_0) or the expected rate of recruitment of new individuals into a population. The larger the R_0 rate the greater likelihood that a population will continue to grow, the lower the R_0 indicate that populations are declining. For example, if and R_0 = 1.5, the population will increase by 50% in one generation.

Annual Survival and Mortality

Annual survival rates are a main component in developing life tables and change conspicuously with age following the first year of life. For our analysis here, if the breeding percentage of females in a population is not available in the literature we calculated that percentage using life tables and known mortality rates provided in scientific literature. See **Table 3.2** for a life table example (e.g. European starlings) and how we calculated the percentage of breeding females in a population. For populations that list a range of adult mortality (e.g., 33 – 77%) we used the mean annual mortality rate to calculate survival.

Table 3.2. European Starling Life Table Example. The mean annual survival rate for adults is 50% in New England which falls within the reported range of 33% -77% from other studies (Flux and Flux 1981).

Year	# Females rounded to nearest whole integer	# Females	% Breeding each year (annual survival)
1	100	100.00	-
2	50	50.00	0.500
3	25	25.00	0.500
4	13	12.50	0.500
5	6	6.25	0.500
6	3	3.13	0.500
7	2	1.56	0.500
8	1	1.49	0.500
9	1	0.75	0.500
10	0	0.37	0.500
11	0	0.19	0.500
12	0	0.09	0.500
13	0	0.05	0.500
14	0	0.02	0.500
15	0	0.01	0.500
16	0	0.01	0.500
Total Females	199		
Total Females Breeding	99		
% Females Breeding	0.497487437		

In general, the survival rates of adult birds vary from as little as 30% per year (e.g., song sparrows) to over 95% (e.g., bald eagles). As a rule, the larger the species the greater the survival rate. Most species die because of predation, disease, starvation, inclement weather, or collisions with objects. During a bird's first year of age, the chance of them surviving fledging to breeding age is about half that of an adult bird. The longer a species nesting period, the greater the chance that the fledglings will survive since they will be more physically developed than shorter nesting period species. Once birds reach adulthood, their chances of survival generally remain relatively constant (**Table 3.3**).

When examining adult survival rates between males and females, males generally survive for longer periods of time as compared to females. This leads some species to have male-biased sex ratios. The factors associated with greater female mortality remains unclear but these results may lend support to the long-held belief that females have a higher cost associated with reproduction than compared to males (Gill 1995).

Table 3.3. Estimated annual survival of adult birds by group. Annual survival rates are given below for fowl, small land birds, ducks, raptors, herons, gulls, waders, and seabirds. This table was adapted from Gill 1995.

Bird Group	Annual Survival per year
Fowl	20% - 50%
Small land birds	30% - 65%
Ducks	40% - 60%
Herons	60% - 80%
Gulls	60% - 80%
Waders	60% - 80%
Seabirds	80% - 95%

Potential Biological Removal

Biologists and conservationists developed the Potential Biological Removal (PBR) model to estimate incidental or allowable take on dynamic and often poorly understood species (Wade 1998). In 1994, this model was detailed in amendments to the Marine Mammal Protection Act (MMPA) as "*the maximum number of animals…that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population*" (16 USC 1362). The formula for PBR is: $PBR = 1/2 r_{max} N_{min} F_R$. Here r_{max} represents the maximum population growth rate at low population densities, N_{min} is the minimum population estimate, and F_R is a recovery factor between 0.1 and 1.0 (Runge et al. 2004). Based on this model, the maximum harvest that can potentially be removed from a population can be determined that will allow the same population to meet or at least maintain its optimum sustainable population size (Wade 1998).

Similarly, this model can be rearranged to determine the maximum sustained yield by using a controlled harvest rate. This formula is expressed as: $h = PBR/ N_{min} = 1/2\ r_{max}$. In using this formula, the minimum population size estimate is not set at a number greater than the optimum harvest rate (h^*). When the population status of a species is unknown or poorly understood or when a depleted population is being managed to allow it to quickly recover to an optimum level, the recovery factor F_R is typically set at 0.1 for an endangered species or 0.5 for a threatened species (Runge et al. 2004). When a F_R is set at a number above 1.0, the management objects are to maintain the species population at a level less than its carrying capacity (Runge et al. 2009).

The PBR model can also be used to set manageable harvest target limits. When used in this way, a maximum productivity level is calculated for a population and is compared to the actual harvest take. This allows a population to reach and maintain a level above the maximum productivity level (Runge et al. 2004). Slate et al. (1998) states that this model tends to overestimate a species' population growth rate and annual production and thus, it inherently produces a conservative estimate of sustainable harvest.

Runge et al. (2009) further adapted this formula to include not only incidental take of a dwindling species, but also for sport harvest and regulated take of wildlife. This formula is described as the prescribed take level (PTL): $PTL_t = F_0 \ x \ r_{max}/2 \ x \ N_t$. Where F_0 represents the management objective and both r_{max} and N_t values are poorly understood. Given the best available data, both factors would ultimately reflect the attitude of the decision makers in how comfortable they are at choosing values from an uncertain population distribution. If values are selected from the lower limits of the population distribution, this might indicate that the decision makers are fearful of extirpating a species. If these values are chosen from the upper limits of the population distribution, such as in situations when a wildlife population is causing damage, the decision makers might be willing to risk a greater harvest take.

Ultimately, the value chosen by the decision makers for F_0 reflects the long-term population size goals in relation to the population size carrying capacity (Runge et al. 2009). Any F_0 value between 0 and 2 (i.e., a harvest rate set between 0 and the maximum population growth rate) produces a suitable harvest regime. To hold a population at half of its carrying capacity and still maintain a maximum sustainable harvest yield, managers would place the F_0 value at 1. To reduce a population to a small fraction of its carrying capacity managers would place the F_0 at 2, so that the harvest rate would be close to the maximum population growth rate.

Prescribed Take Level

Similarly, the prescribed take level (PTL) framework uses demographic data (e.g. survival and recruitment) to calculate an estimated maximum annual growth rate (r_{max}) (Runge et al. 2009, Zimmerman et al. 2019). Using this formula, a biologically sustainable take rate can be estimated based on density-dependent growth under a discrete logistic model ($r_{max}/2$) (Runge et al. 2004, 2009; Johnston et al 2012, Zimmerman et al. 2019). By multiplying the estimated take rate by a population size (N) and a management objective (F_0) this gives an annual allowable take (i.e. PTL) for a population (Runge et al. 2009, Johnson et al. 2012).

$$PTL = F_0 \text{ x } r_{max}/2 \text{ x } N$$

Here, the management objective expresses the long-term management goals relative to the carrying capacity of a species. The management objective (F_0) can range from 0 to 2. A $F_0 = 1$, represents the maximum sustainable yield for a population and will keep the population at a 0.5 carrying capacity. A $F_0 = 0$ or near to 0 will keep the population close to if not at carrying capacity and allow very little take; and an $F_0 = 2$ or near 2, allows large levels of take while still holding the population at a small portion of the carrying capacity. Where managers are concerned about a species it is recommended that a $F_0<1$ should be used, whereas an $F_0 > 1$ should be considered for species with populations that are over-abundant or nuisance species (Runge et al. 2009, Zimmerman et al. 2019).

Zimmerman et al. (2019), differs from that of Runge et al. (2009) in that the underlying density dependence form takes on a discrete logistic non-linear model. They calculated θ as a function of r_{max} using the regression model fit by Johnson et al (2012:1119):

$$\text{Log}(\theta) = 1.129 - 1.824 \times r_{max} + e$$

In this case, e is an approximated Normal $(0, \sigma^2)$ and $\sigma^2 = 0.942$ (standard deviation of a population). Zimmerman et al. (2019), incorporated the uncertainty of knowing the population they were calculating between θ and r_{max} by assuming the fixed parameter values of (1.129 and 1.824) and sampling from the error distribution for σ^2 during simulations.

Similarly, the r_{max}, was defined as the expected growth rate under average environmental conditions, in the absence of take and Alee effects, and when density dependence did not limit survival or recruitment (Runge et al. 2004, Zimmerman et al. 2019). In estimating r_{max}, it is difficult to determine whether observed population growth is really density independent. In this application of the PTL framework, the authors avoided this uncertainty by using an upper confidence bounds of an estimated r_{max} obtained from the demographic modeling of field data (Runge et al. 2009) or allometric relationship estimates from captive animals (Johnson et al. 2012).

Slade's formulate (Slade et al. 1998) was used as seen in Runge et al. (2009) to estimate r_{max} from demography data describing age at first breeding, age of senescence, adult survival, fledglings per breeding adult, and fledgling survival rates (Zimmerman et al. 2019). Given the probability of a breeding-age individual breeding they calculated the estimated fledglings per adult. Then survival to the age of first breeding was calculated as the product of the first-year and subadult survival raised to the power of age at first breeding minus 1 (Runge et al. 2009, Zimmerman et al. 2019).

Similar to Runge et al. (2009) N was estimated as model-based adjustments of Breeding Bird Survey indices estimated at the Bird Conservation Regions scale within selected states (Sauer et al. 2003, Zimmerman et al. 2019). Uncertainty in take levels was also incorporated into the model through Monte Carlo simulations where demographic rates, θ, and population size were smapled from the statistical distributions described by Runge et al. (2004) (Zimmerman et al. 2019).

A 100,000 replicates were run for each parameter and the aforementioned demographic rates from the statistical distributions for each parameter; and θ and r_{max} values were determined for each replicate. The median and standard deviation were transformed to the log normal scale and sampled population size estimates generated from BBS data were transformed from the log normal distribution to eliminate the possibility of sample values < 0 (Zimmerman et al. 2019). The authors specified a management objective of $F_0 = 1$ to maximize sustained yield (Zimmerman et al. 2019) and calculated an allowable take value for each iteration by multiplying the sampled N by the calculated take rate estimated from the theta-logistic model ($[\theta \times r_{max}]/ [\theta + 1]$) (Zimmerman et al. 2019). Results were summarized as medians and 95% quantiles of the distribution of take from 100,000 iterations of the Monte Carlo simulations (Zimmerman et al. 2019).

With an intrinsic growth rate of r_{max}=0.11, 95% CI=0.02-0.19, Zimmerman et al. (2019) and colleagues found similar values to that of Runge et al. (2009) which was expected since both used the same demographic parameters. However, Zimmerman et al. (2019) calculated a slightly higher take rate ($h_{\max}$ = 0.07, 95% CI=0.01-0.15) than Runge et al. (2009) because they accounted for the nonlinearity in density dependence by using a theta-logistic model (θ >1) with high uncertainty (θ=2.56, 95% CI=0.37-17.44).

While trying to implement an estimated allowable take level across regions or BCRs would likely impede the reduction of nuisance wildlife conflicts in some areas and allowing the maximum allowable take on a small local scale may reduce species' populations to a level that may result in local declines; Zimmerman et al. (2019) suggest another option. They suggest that there are four things to consider before implementing an allowable take on a wildlife species across space including: "the biological characteristics of the population, the legal standards for conservation implied in the relevant statues, administrative efficiency, and other objectives expressed by stakeholders."

In general, wildlife managers only apply lethal management techniques as a last resort following the failure of nonlethal methods. The increasing availability of bird population monitoring programs such as the BBS, combined with available statistical modeling that are capable of incorporating detection components from these programs, makes using the PTL framework an appealing option in estimating allowable wildlife take.

3.2 Analysis of Methods.

WS-Colorado personnel utilize a variety of methods in to alleviate, reduce, and/or manage bird damage. These methods involve three main strategies: resource management (e.g., habitat modification and cultural practices such as deterring feeding, guarding animals, and carcass removal), physical exclusion (e.g, netting, conventional fencing), and wildlife management (e.g., hazing, culling, disease sampling, trapping, shooting, DRC-1339, hand capture, and effigies). Other methods or tactics are used for various species (e.g., 15 mm pyrotechnics), and others are species-specific (e.g., Swedish goshawk traps for raptors). Operational management activities are conducted on private or public lands only where signed Work Initiation Documents and agreements have been executed. These agreements may and work initiation documents will list the intended target species and methods to be used.

Table 3.4. Methods used by Wildlife Services-Colorado to capture or lethally removed bird species causing damage or to reinforce hazing, including non-target bird take, FY2013-2017.

		Target		Non-target	
Method	**Removed**	**Dispersed freed**	**Translocated**	**Removed**	**Released**
Alpha chloralose[B]	51	-	-	-	-
Dog	-	2,167	-	-	-
DRC-1339 (feedlot)[A]	204,115	-	-	-	-
DRC-1339 (pigeon)	2,025	-	-	-	-
DRC-1339 (staging)	3,200	-	-	-	-
Electronic hazing	-	2,365	-	-	-
Firearm	48,683	1,458,292	-	-	-
Hand caught	1	80	10	-	-
Lasers	-	650	-	-	-
Nets, dip	-	219	-	-	-
Net gun/rocket net	-	1	308	-	-
Nets, mist	-	-	470	-	-
Pyrotechnics	-	40,311	-	-	-
Pneumatics	9,984	1,758	-	-	-
Traps, Bal-chartri	-	-	17	-	-
Trap, body grip	2	-	-	-	-
Traps, cage, corral	588	808	1	-	31
Traps, decoy	3,340	-	-	-	-
Traps, pole	-	-	-	-	1
Traps, raptor, other	-	-	2	-	-
Traps, Swedish	7	-	1,015	-	-
Vehicles	-	35,314	-	-	-
TOTAL	**271,996**	**1,541,965**	**1,823**	**4**	**32**

A. DRC-1339 is a registered toxicant used under three different pesticide registrations in Colorado by Wildlife Services-Colorado.
B. Alpha chloralose is no longer approved for sedating birds and is included here as part of previously used methods.

Table 3.5. Components used by Wildlife Services-Colorado to capture or lethally removed bird species causing damage or to reinforce hazing, FY2013-2017.

Component	Fiscal Years	Quantity	UOM
Alpha chloralose tablets[B] (20 mg, 40 mg, 60mg)	FY13-17	78	each
DRC-1339 (feedlot)[A]	FY13-17	5,997	grams
DRC-1339 (pigeon)	FY13-17	61	grams
DRC-1339 (staging)	FY13-17	146	grams
Pyrotechnics	FY13-17	5,168	each

A. DRC-1339 is a registered toxicant used under three different pesticide registrations in Colorado by Wildlife Services-Colorado.
B. Alpha chloralose is no longer approved for sedating birds and is included here as part of previously used methods.

Nonlethal Methods

Nonlethal methods have the potential to cause adverse effects to non-targets primarily though physical exclusion, frightening devices or deterrents (**Chapter 2**). From FY2013 to FY 2017, WS-Colorado used a variety of nonlethal methods to disperse birds including: 2,167 dog, 2,365 electronic hazing, 1,458,292 firearms, 650 lasers, 40,311 pyrotechnics, 1,758 pneumatics, and 35,314 vehicles (**Table 3.4**). Any exclusionary device erected to prevent access to a resource by a target species could also potentially exclude non-target species; therefore adversely impacting that species. The use of frightening devices or deterrents may also disperse non-target species from the immediate area where they are employed. However, the potential impacts to non-targets, like the impacts to target species, are expected to be temporary. WS-Colorado would not employ or recommend these methods be employed over large geographic areas or at such an intensity that essential resources would be unavailable and that long term adverse impacts to non-target populations would occur.

Lethal Methods

In cases where shooting were selected as an appropriate method, identification of an individual target would occur prior to application, eliminating risks to non-targets. Additionally, suppressed firearms would be used when appropriate to minimize noise impacts to non-targets. WS-Colorado's recommendation shooting be used would not increase risks to non-targets. Shooting would essentially be selective for target species and the unintentional lethal removal of non-targets would not likely increase based on WS' recommendation of the method. Non-target species captured during the implementation of nonlethal capture methods can be released prior to euthanasia which occurs subsequent to live-capture. Therefore, no adverse effects to non-targets would occur from the use of euthanasia methods by WS. Similarly, WS' recommendation of euthanasia methods would not increase risks to non-targets because these methods are selective for target species and the unintentional euthanasia of non-targets would not likely increase based on WS' recommendation of the method.

3.3 Environmental Consequences and Cumulative Impacts of Issues Analyzed In Detail for each Alternative.

3.3.1 Alternative 1: Continuing the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Populations.

The Proposed Action/No Action alternative would continue the current implementation of an integrated approach utilizing nonlethal and lethal techniques, as deemed appropriate using the WS Decision Model (Slate et al. 1992, WS Directive 2.201), to reduce damage and threats associated with birds in Colorado.

The impacts of an issue on target bird species arises from the use of nonlethal and lethal methods to address the need for reducing damage and threats. However, the primary concern would be from the use of lethal methods to address damage. The lethal removal of birds would be monitored by comparing the number of each species of bird lethally removed with the species' overall populations and/or population trend(s) to assure the magnitude of removal is maintained below the level that would cause adverse impacts to the viability of the species' populations. In this case, the viability of a species' population is the ability of a species to persist and to avoid extinction. The potential impacts on the populations of target bird species from the implementation of the proposed action are analyzed for each species below.

As stated in **Chapter 1**, 503 species of birds have been identified within Colorado with sightings occurring regularly, during migration, or as accidental occurrences (**Table 1.1, 1.2, 1.3, 1.4**). Of these species, 199 species have the potential to be involved in WS-Colorado BDM (**Table 1.1**). Although, most of these species will rarely be targeted unless they occur within airport environments and threaten human health and safety as a result of a bird strike. During FY 13-17, WS-Colorado removed 54,399; dispersed 308,393; and translocated 364 birds on average per year encompassing 41 species of birds (**Table 3.4**). WS-Colorado recorded BDM work tasks involving: Agriculture 216, Property 257, Human Health & Safety 3,607, and Natural Resources 15 (**Table 1.5, 1.6**). On average, WS-Colorado responded to 216 BDM incidents valued at $908,780/fiscal year. Agricultural BDM included: 169 Livestock incidents valued at $799,123; 15 Crop incidents valued at $ 25,957; and 33 Aquaculture incidents valued at $83,700 (**Table 1.5**). Human Health & Safety BDM included: 257 Property incidents valued at $138,438; 15 Natural Resource incidents valued at $6,241; and 3,607 Human Health & Safety incidents (mainly at airports with an untold monetary value associated with preserving human life; **Table 1.6**).

Within these 5 fiscal years, 5 non-target birds representing 2 bird species (common raven and black-billed magpie) were lethally removed (**Table 3.4**). An additional 32 non-target birds representing 6 species were captured and released unharmed (**Table 3.4**). Total non-target birds lethally removed or captured and released was 6 per year which is 0.0003% of the total target and non-target take from FY2013-17. No threatened or endangered species were taken. Six bald eagles and one golden eagle were captured and relocated from an airport under federal permits issued by the Fish and Wildlife Service. An additional 991 bald eagles and 134 golden eagles were hazed at airports. The dispersal of these bald and golden eagles from the airports saved the eagles' lives because eagles at an airport generally die from bird strikes with aircraft (Washburn et al. 2015). An additional 2 peregrine falcons were dispersed from an airport. No eagles or peregrine falcons were killed by damage management actions by WS-Colorado during the 5-year period FY2013-2017.

Of the birds taken, a majority of the birds were taken at three airports (17%) or feedlots or dairies (74%) by WS-Colorado damage management activities. Birds were dispersed primarily at 3 airports or air bases with 86% percent of dispersals. Birds taken at feedlots and dairies were comprised of European starlings (99%), red-winged blackbirds (1%) and pigeons (<1%). A total of 1,138 birds were captured and sampled for disease surveillance (e.g., avian influenza), the captures were often conducted with Colorado Parks and Wildlife and the Fish and Wildlife Services (national wildlife refuge programs) as part of those agencies bird banding and monitoring activities from FY2013-2017. These birds were released alive after samples were taken.

A variety of methods are used by WS-Colorado personnel to remove, disperse and translocate bird species in relation to BDM (**Table 3.4**). These methods involve three main strategies: resource management (e.g., habitat modifications and cultural practices such as deterring feeding, guard animals, and carcass removal), physical exclusion (e.g., netting, conventional fencing), and wildlife management (e.g., hazing, culling, disease sampling, trapping, shooting, DRC-1339, hand capture, and effigies). These methods are exceptionally target specific with non-target birds rarely being taken or captured. Methods more likely to capture non-target birds include use of cage or corral traps. Over the 5-year period, WS-Colorado captured 32 non-target birds out of 271,996 total target birds taken. Birds captured with these methods are released unharmed.

WS-Colorado has used immobilization drugs such as alpha chloralose to capture some bird species in the past (Note that this is no longer an approved method). Some methods or tactics are used for many different bird species (e.g., 15mm pyrotechnics), and others are specific to individual species (e.g., Swedish goshawk traps for raptors). M-44's are not intended to take birds to alleviate damage but may take a few birds (e.g. ravens) unintentionally. WS-Colorado conducts direct control activities involving take on private lands only where signed *Work Initiation Documents* have been executed. WS-Colorado conducts direct control activities on municipal, county or other government lands only if *Work Initiation Documents* or Work Plans are in place covering the public land. These agreements and work plans list the intended target animals and the methods to be used.

Table 3.6. Wildlife Damage Management actions (hazing, removal, relocation, and disease sampling) recorded by WS-Colorado during federal Fiscal Years (FY) 2013- 17 (Fiscal Year term October 1 to September 30) in Colorado.

Resource Category					
Avian Species	**Agriculture**	**Property**	**Human Health & Safety**	**Natural Resources**	**Total***
Brewer's Blackbird	1,168		39		**1,207**
Feral (Rock) Pigeons	2,429	1,455	54,197		**58,081**
European Starlings	95,317	2,104	5,926		**103,347**
Red-winged Blackbirds	4,570		42,917		**47,487**
Yellow-headed Blackbirds			41		**41**
American Avocets			117		**117**
Mountain Bluebirds			250		**250**
Western Bluebirds			69		**69**
Lark Buntings			2,659		**2,659**
American Coots			39		**39**
Brown-headed Cowbirds			13		**13**
Double-crested Cormorants	3		13	1	**17**
Sandhill Cranes			10,702		**10,702**
American Crows	1	4	414		**419**
Long-billed Curlews			1		**1**
Eurasian-collared Doves	185	122	1,953		**2,260**
Mourning Doves		58	4,125		**4,183**
Long-billed Dowitchers			16		**16**
Bufflehead Ducks			22		**22**
Canvasback Ducks			48	9	**57**
Snowy Egrets			1		**1**
Gadwalls Ducks	92		298	36	**426**
Common Goldeneye Ducks			22		**22**
Mallard Ducks	323		2,514	246	**3,083**
Northern Pintail Ducks	4		2,867	8	**2,879**
Redhead Ducks			261	4	**265**

Ring-necked Ducks			135		**135**
Ruddy Ducks		3	9		**12**
Lesser Scaup Ducks			82		**82**
Northern Shovelers Ducks	15	5	223	17	**260**
Blue-winged Teal Ducks	19		1,113	11	**1,143**
Cinnamon Teal Ducks	26		7	26	**59**
Green-winged Teal Ducks	1		839	1	**841**
Common Merganser Ducks	1		4	1	**6**
Hooded Merganser Ducks			1		**1**
American Wigeons	18		24	3	**45**
Wood Ducks			27		**27**
Bald Eagles		1	235		**236**
Golden Eagles	2		60		**62**
Cattle Egrets			1		**1**
American Kestrel Falcons			346		**346**
Belted Kingfishers	6				**6**
Peregrine Falcons					
Prairie Falcons			67		**67**
House Finches			1,865		**1,865**
Northern Flickers		97	77		**174**
Canada Geese	7	5,434	10,696	20	**16,157**
Lesser Snow Geese			253		**253**
Western Grebes			10		**10**
Common Grackles		79	465		**544**
California Gulls	2		1,695	2	**1,699**
Franklin's Gulls	2		70	1	**73**
Herring Gulls	2		2		**4**
Ring-billed Gulls	6		2,586	1	**2,593**
Cooper's Hawks			4		**4**
Ferruginous Hawks		8	357		**365**
Northern Harrier Hawks		18	262		**280**
Red-shouldered Hawks			2		**2**
Red-tailed Hawks		5	329		**334**
Rough-legged Hawks			172		**172**
Sharp-shinned Hawks		1	14		**15**
Swainson's Hawks		1	274		**275**

Great-blue Herons	11		72	5	**88**
White-faced Ibises			52		**52**
Black-crowned Night Herons	7		6	1	**14**
Killdeer		1	410		**411**
Eastern Kingbirds			16		**16**
Western Kingbirds		17	1,236		**1,253**
Belted Kingfishers			1	1	**2**
Horned Larks		955	15,602		**16,557**
Black-billed Magpies		1	475		**476**
Western Meadowlarks		65	1,931		**1,996**
Nighthawks			1		**1**
White-breasted Nuthatchs		14			**14**
Burrowing Owls			6		**6**
Common Barn Owls			19		**19**
Great Horned Owls			92		**92**
Short-eared Owls			3		**3**
Snowy Owls			1		**1**
American White Pelicans	3		149	2	**154**
Ospreys			1		**1**
Wilson's Phalaropes			67		**67**
Quail			34		**34**
Common Ravens	4		271		**275**
American Robins			639		**639**
Northern Shrikes			2		**2**
Shrikes (others)			42		**42**
Loggerhead Shrikes			1		**1**
House Sparrows		3	744		**747**
Barn Swallows		1	514		**515**
Cliff Swallows		5	12,707		**12,712**
Turkey Vultures		1	335		**336**
Willets			68		**68**
Downy Woodpeckers		5			**5**
Greater Yellow-legs			25		**25**
TOTALS	**104,224**	**10,463**	**187,352**	**396**	**302,419**

*Totals are tabulated from submitted BDM incidents for the designated fiscal years.

Table 3.8. Bird species taken or hazed by Wildlife Services-Colorado while conducting bird damage management activities from FY2013-2017.

	Target Species			Non-Target Species	
Species	**Average Removed**	**Average Relocated per year**	**Average Dispersed**	**Average Removed**	**Average Released Unharmed**
European starlings	41,210	-	2,546	-	-
Feral pigeons	4,816	-	26274	-	-
Red-winged blackbirds	2,420	-	39,496	-	-
Mourning doves	1,776	-	15,697	-	0.2
Horned larks	1,193	-	28,211	-	-
Cliff swallows	1,044	-	10,050	-	-
Western meadowlarks	464	-	3,758	-	-
Canada geese	314	-	119,003	-	-
Eurasian collared-dove	255	-	1,055	-	0.2
Western kingbirds	124	-	1,416	-	-
Mallard ducks	108	-	6,045	-	-
Red-tailed hawks	105	102	1,375	-	-
Common grackles	75	-	137	-	-
Lark buntings	64	-	1,817	-	-
House sparrows	45	-	226	-	-
Ring-billed gulls	29	-	804	-	-
Killdeer	26	-	272	-	-
Northern harrier hawks	17	2	350	-	-
Common ravens	17	-	91	0.8	-
American crows	12	60	72	-	-
Swainson's hawks	15	2	238	-	-
American kestrel	14	1	220	-	-
Brown-headed cowbird	10	-	3	-	-
Black-billed magpies	12	-	110	0.2	2.8
Blue-winged teal ducks	10	7	237	-	-
Ferruginous hawks	10	5	191	-	-
Rough-legged hawks	9	10	269	-	-
California gulls	7	-	358	-	-
Turkey vultures	9	-	81	-	-
Green-winged teal ducks	5	1	177	-	-
Barn swallows	5	-	137	-	-
Northern shoveler ducks	6	3	49	-	-

Northern flickers	8	-	30	-	-
Great horned owls	4	74	10	-	-
Gadwall ducks	1	41	54	-	-
Northern pintail ducks	1	-	572	-	-
White-faced ibises	-	-	6	-	-
American robins	-	15	68	-	-
Willets	1	-	9	-	-
American avocet	-	-	14	-	-
American coots	-	-	13	-	-
Lesser snow geese	1	-	50	-	-
American white pelican	-	-	29	-	-
Brewer's blackbirds	131	-	8	-	-
Yellow-headed blackbirds	-	-	8	-	-
Sandhill cranes	1	-	2,133	-	-
Prairie falcon	-	2	3	-	-
Mountain bluebirds	-	-	96	-	-
Western bluebirds	-	-	54	-	-
Canvasback ducks	-	-	7	-	-
Redhead ducks	-	1	56	-	1.4
Ruddy ducks	-	-	-	-	0.4
Ring-necked ducks	-	-	77	-	-
Cinnamon teal ducks	-	3	7	-	-
Bald eagles	-	1	194	-	-
Wilson's phalarophe	-	-	11	-	-
Loggerhead shrikes	-	-	7	-	-
Quail	-	-	-	-	1.2
Total	**54,374**	**330**	**264,281**	**1**	**6**

Introduced/Invasive Commensal Birds

Colorado hosts several species of introduced birds and most are considered invasive species. The goal of BDM for these species may be eradication from the "wild," but this would be difficult for the overabundant species such as starlings and rock doves (feral pigeons). WS-Colorado took 4 invasive species (starlings, feral pigeons, Eurasian collared-doves, and house sparrows) from FY2013 to FY2017 (**Table 3.9**) with the take of Eurasian collared-doves expected to increase as their population expand across the state. These species are most commonly involved in damage associated with agriculture and human health and safety (e.g. airports). The lethal removal of invasive bird species associated with bird damage management activities is considered to have no significant impact on the human environment; since these species are not native components of Colorado ecosystems.

Table 3.9. Introduced/Invasive Commensal species hazed (scared with frightening devices or other nonlethal method) and lethally removed (firearms, DRC-1339, trap, handcaught) from damage situations from FY2013 to FY2017 by WS-Colorado. *Colorado Breeding estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Introduced Commensal Birds						
WS Bird Damage Management Activities					**State Populations (Calendar Year)**	
Fiscal Year (FY)	**Avian Species**	**Removed**	**Dispersed**	**Released**	**Breeding Estimates (Colorado)***	**% taken by WS-CO**
2017	**European Starling**	40,942	1,088	0	1,303,862	3.1%
2016		17,266	1,096	0	1,163,685	1.5%
2015		10,413	6,705	0	1,381,823	0.8%
2014		53,977	1,400	0	1,001,788	5.4%
2013		83,452	2,440	0	1,133,724	7.4%
Average		**41,210**	**2,546**	**0**	**1,196,976**	**3.4%**
2017	**Feral (Rock) Pigeon**	4,468	13,339	0	87,277	5.1%
2016		4,192	9,488	0	30,468	13.8%
2015		5,097	23,410	0	34,925	14.6%
2014		3,916	60,215	0	48,751	8.0%
2013		6,405	24,920	189	66,349	9.7%
Average		**4,816**	**26,274**	**38**	**53,554**	**9.0%**
2017	**House Sparrow**	81	899	0	1,539,038	0.0%
2016		57	124	48	2,048,721	0.0%
2015		12	40	0	2,108,521	0.0%
2014		12	0	84	1,575,468	0.0%
2013		62	66	179	1,458,029	0.0%
Average		**45**	**226**	**62**	**1,745,955**	**0.0%**
2017	**Eurasian Collared Doves**	59	288	0	366,511	0.0%
2016		240	853	0	400,148	0.1%
2015		346	43	0	234,862	0.1%
2014		160	1,593	15	221,049	0.1%
2013		469	2,500	0	137,765	0.3%
Average		**255**	**1,055**	**3**	**272,067**	**0.1%**

European Starlings. Following their introduction in the 1800s, this invasive species rapidly colonized North America. Today, roughly 200 million European starlings are widely distributed across North America (Cabe 1993). The broad diet and aggressive nesting behavior of European starlings has led to intensive competition for nesting cavities with native bird species and has negatively impacted many of these species (Cabe 1993).

Direct Impacts. The Rocky Mountain Avian Data center (RMADC) using the Integrated Monitoring in Bird Conservation Regions (IMBCR) protocol estimates European starling populations to be approximately 1.3 million (**Table 3.10**). As stated previously, for our analysis we will be relying on demography and population estimate information gathered from scientific literature as well as the Cornell Lab of Ornithology's Birds of North America database which has an extensive reference for life history information on over 760 species of birds. Adult European starlings have an annual mortality between 33 – 77% (Flux and Flux 1981). Here we used a median 55% adult survival rate to calculate the percentage of breeding females in the population, as explained previously using life tables. On average, the majority of female starlings breed in their second year of age, raising two broods per season, with an average clutch size of 4.45 eggs (Cabe 1993, Tinbergen 1981). Typically, adult males outnumber adult females 2:1 in starling populations (Kessel 1957).

The estimated fledgling success (portion of total eggs laid that produce young that leave the nest) has been documented as 76.1% (Kessel 1957). Using these parameters, an average breeding population of starlings 1,196,976 with 44.4% breeding females would produce 1,201,037 offspring. From Fiscal Year (FY) 2013 to 2017 WS-Colorado lethally removed on average 41,210 birds per year and 1 nest that were associated with 103,347 work tasks for BDM assistance. These work tasks were associated with agriculture 95,317, property 2,104, and human health and safety 5,926 (**Table 3.6**). Starlings lethally removed by WS-Colorado accounted for an average of 3.4% per year of the statewide population. The remaining Colorado starling population (with the addition of the young produced) would be approximately 2,356,804 starlings on average each year.

Table 3.10. Cumulative impact analysis for European starlings lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

EUROPEAN STARLING IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,303,862	1,163,685	1,381,823	1,001,788	1,133,724	**1,196,976**
Females to Males	50:100	50:100	50:100	50:100	50:100	**50:100**
% Breeding Females	44.4%	44.4%	44.4%	44.4%	44.4%	**44.4%**
Estimated Number Breeding Females	193,165	172,398	204,715	148,413	167,959	**177,330**
Avg. Clutch	4.45	4.45	4.45	4.45	4.45	**4.45**
Avg. Nests	2	2	2	2	2	**2**
% Fledge	76.1%	76.1%	76.1%	76.1%	76.1%	76.1%
Young Produced/Post-breeding	1,308,285	1,167,633	1,386,511	1,005,187	1,137,570	**1,201,037**
Total Colorado Numbers	2,612,147	2,331,318	2,768,334	2,006,975	2,271,294	**2,398,014**
WS Take (%)	3.1%	1.5%	0.8%	5.4%	7.4%	**3.4%**
WS-CO Take of Total Colorado Numbers	40,942	17,266	10,413	53,977	83,452	**41,210**
Remaining Total	2,571,205	2,314,052	2,757,921	1,952,998	2,187,842	**2,356,804**

Table 3.11. Species estimates and trends from Partners in Flight (version 2.0), USGS Breeding Bird Survey data (2013 – 2017) using PIF detectability factors, and Rocky Mountain Avian Data Center IMBCR density trend data. *Here the red indicates a significant decline in the population according to the BBS trend estimate from 2005 to 2015.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	BBS 2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
European Starling	200	1	1.19	655,983	895,301	-4.16	(-7.19, -1.35)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
European Starling	CO	895,301	1	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
European Starling	CO	Trend	0.98	3.56	68

PIF Data Quality Rating		IMBCR C.V. %		Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

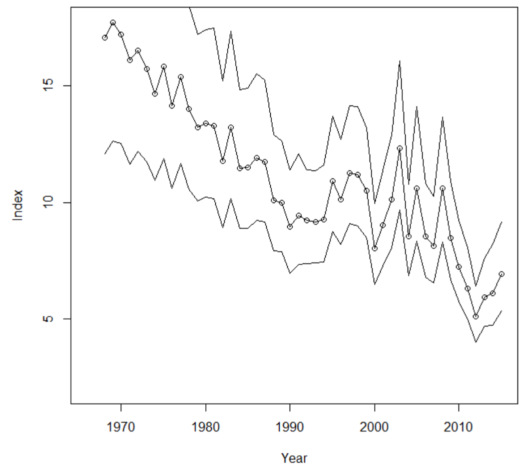


Figure 3.6 European starling annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year. (Sauer et al. 2017).

Indirect Impacts. In addition to the above analysis, it must be reiterated that starlings are not indigenous to North America and are not protected by federal or state law. Therefore, the take of starlings by the WS-Colorado BDM activities is considered to have a minimal/low level of magnitude impact on the human environment since starlings are not an indigenous component of ecosystems in Colorado. Indirectly the removal of starlings could prove beneficial for many native cavity nesting species such as the sapsuckers, whose populations have declined as a result of nesting competition (Koenig 2003).

Cumulative Impacts. Leading up to the species impact analysis we previously discussed the merits and short-comings of the available bird species data. For the purpose of our analysis the breeding bird estimates were obtained from the Rocky Mountain Avian Data Center. These estimates document short-term changes in surveyed bird populations and allow us to compare these estimates to more long-term data sets such as the Partner's in Flight and Breeding Bird Survey.

Species estimates in Colorado range from approximately 1,303,862 (RMADC 2017), 655,983 (BBS 2013-2017), and 895,301 (PIF 1998-2007) (Partners in Flight Science Committee 2013, Bird Conservancy of the Rockies 2019, Sauer et al. 2017, Pardieck et al. 2018). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. In Colorado, the RMADC using the IMBCR protocol have documented a decline (median 0.98) in European starling populations (**Table 3.11**). Although, this data should be cautiously interpreted since the "f" or probability the trend is in the direction of the mean (i.e. confidence in the direction of the trend) is 68%. Similarly, Breeding Bird Survey trend estimates from 2005-2015, show European starlings declining by -4.16% per year (which is not significant since the credible interval does not include 0); with significant long-term, indicated as significant by the red font (according to BBS), (1966-2015) declines both nationwide and within Colorado (-1.90%/year) (**Figure 3.6**) (Sauer et al. 2017).

Throughout the year, local starling populations are expected to increase during the fall and winter months, as starlings from more northern states migrate into Colorado to escape inclement weather conditions. In addition to the lethal removal of starlings by WS-Colorado, other resource owners and managers likely lethally remove additional numbers of starlings to reduce damage. Since this species is not afforded the protection of the Migratory Bird Treaty Act, resource owners and managers suffering damage are allowed to remove starlings by shooting, trapping, or using commercially available pesticides for certified pesticide applicators. Local take data, obtained by the National Research Center, suggests that CAFOs' (n=20) operating starling traps lethally remove 1,500 to 3,000 starlings per week from November – March 1 (S. Werner, NWRC, personal communication, Nov. 2018). With this in mind, European starling populations within Colorado likely experience mortality as a result of a variety of situations, not related to WS-Colorado BDM including: weather, private take, collisions with windows and buildings, encounters with domestic cats, et cetera (**Table 3.1**). **Table 3.10** provides a cumulative impact analysis for WS-Colorado BDM from FY 20103 to FY2017. In FY13, WS-Colorado had the highest estimated lethal removal of 7.4% of the total Colorado starlings in local populations. This would not be sufficient to cause the state number of starlings to decline and the average lethal removal of 3.4% of the state estimates would be a low magnitude of take. However, starlings are an invasive species and if a decline occurred this would be considered a favorable outcome. WS-Colorado will have no limitations on potential take of non-native species.

Feral Pigeon. Introduced by colonists in the early 17th century, feral pigeons (also known as rock pigeons or rock doves) now thrive throughout the New World. Wild rock pigeons, native to Europe and Africa, traditionally live in rock crevices on cliff faces and caves across a range of coastal and upland habitats. In North America, feral rock pigeons have adapted to become human commensals, where they inhabit farm buildings, barns, silos, bridges, highway overpasses, and other human infrastructure.

<u>Direct Impacts.</u> Since feral pigeons are an introduced (non-native) species, they are one of several groups of birds not protected by the Migratory Bird Treaty Act. The Rocky Mountain Avian Data Center estimates feral pigeon populations to be approximately 82,277 individuals throughout Colorado (**Table 3.12**). Although, feral pigeons may attain sexual maturity during their first year of age, most young birds do not breed due to a lack of suitable nesting sites (Murton et al. 1972). In North America, feral pigeons raise on average 6.5 broods per year with females laying 2 eggs per clutch (Burley 1980, Lowther and Johnston 2014). Incubation begins once the last egg is laid and both sexes will incubate the eggs for up to 18 days (Burley 1980, Lowther and Johnston 2014). Once hatched, 43% of these birds will survive to day 50 and once they reach sexual maturity 65.5% will survive annually (Lowther and Johnston 2014).

Using these parameters, an average population of feral pigeons with 63.6% of the females breeding will produce 190,506 fledglings annually (**Table 3.12**). From FY2013 to FY2017 WS-Colorado lethally removed on average 4,816 birds per year, 6 nests, and dispersed 26,274 birds per year (**Table 3.9**). During this time WS-Colorado performed 58,081 work tasks involving feral pigeons related to agriculture 2,429, property 1,455, and human health and safety 54,197 (**Table 3.6**). Feral pigeons lethally removed by WS-Colorado accounted for an average of 8.99% per year. The remaining feral pigeon population (with the addition of the young produced) would be approximately 239,245 birds on average each year. At this time, we are unaware of the take by Nuisance Wildlife Control Operators or other individuals/entities.

Table 3.12. Cumulative impact analysis for feral pigeons (i.e., rock doves, rock pigeons) lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

FERAL PIGEON IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	87,277	30,468	34,925	48,751	66,349	**53,554**
% Breeding Females	63.6%	63.6%	63.6%	63.6%	63.6%	**63.6%**
Estimated Number Breeding Females	55,540	19,389	22,225	31,023	42,222	**34,080**
Avg. Clutch	2	2	2	2	2	**2**
Avg. Nests	6.5	6.5	6.5	6.5	6.5	**6.5**
% Fledge	43.0%	43.0%	43.0%	43.0%	43.0%	**43.0%**
Young Produced/Post-breeding	310,468	108,383	124,238	173,421	236,021	**190,506**
Total Colorado Numbers	397,745	138,851	159,163	222,172	302,370	**244,060**
WS Take (%)	5.1%	13.7%	14.6%	8.0%	9.7%	**10.2%**
WS-CO Take of Total Colorado Numbers	4,468	4,192	5,097	3,916	6,405	**4,816**
Remaining Total	393,277	134,659	154,066	218,256	295,965	**239,245**

Table 3.13. Species estimates for feral pigeons and trends from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Feral Pigeons	200	1	1.57	129,800	231,758	-1.6	(-5.53, 1.46)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
Rock Pigeon	CO	231,758	1	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Rock Pigeon	CO	Trend	0.91	5.49	95

PIF Data Quality Rating		IMBCR C.V. %		Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

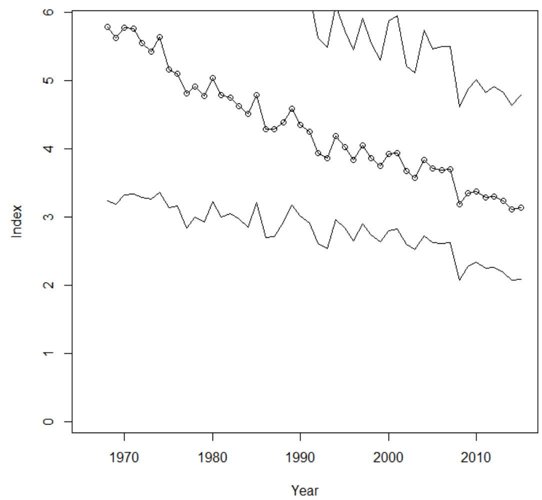


Figure 3.7 Feral pigeon annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the region for a year. (Sauer et al. 2017).

Indirect Impacts. In the majority of situations, any BDM involving lethal removal of feral pigeons by WS-Colorado would be restricted to isolated individual sites or communities. The reduction of these feral pigeon populations may led to a noticeable reduction in birds observed at nearby urban areas (e.g. parks). Residence who regularly feed feral pigeons in the park may notice a reduction in these populations, however, there would still be feral pigeons present. If a large feral pigeon damage management project occurred in an adjacent rural area, this could result in hundreds or thousands of feral pigeons being removed. The magnitude of population size reductions at local parks would be difficult to quantify since feral pigeons are rarely banded or marked. Residence may similarly notice decreased numbers of feral pigeons in local city parks when private Nuisance Wildlife Control personnel conduct feral pigeon damage management projects.

In those cases where feral pigeons are causing damage or are a nuisance, a reduction in local populations would be considered a beneficial impact on the human environment because the affected property owner or administrator would request the action to stop or reduce damage at their site.

Cumulative Impacts. Leading up to the impact analysis we previously discussed the merits and short-comings of the available bird species data. For the purpose of our analysis the breeding bird estimates were obtained from the Rocky Mountain Avian Data Center. These estimates document short-term changes in surveyed bird populations and allow us to compare these estimates to more long-term data sets such as the Partner's in Flight and Breeding Bird Survey.

Species estimates in Colorado range from approximately 87,277 (RMADC 2017), 231,758 (BBS 2013-2017), and 231,758 (PIF 1998-2007) (Partners in Flight Science Committee 2013, Bird Conservancy of the Rockies 2019, Sauer et al. 2017, Pardieck et al. 2018). In Colorado, the RMADC using the IMBCR protocol have documented a decline (median 0.91) in feral pigeon populations (**Table 3.13**). Although, this data should be cautiously be interpreted since the "f" or probability the trend is in the direction of the mean (i.e. confidence in the direction of the trend) is 95%. Similarly, Breeding Bird Survey trend estimates from 2005-2015, show feral pigeons declining by -1.6% per year (which is not significant since the credible interval does not include 0) (**Figure 3.7**) (Sauer et al. 2017).

Feral pigeons are classified as an invasive species by the U.S. Fish and Wildlife Service and a Migratory Depredation Permit is not required to lethally remove an average of 8.99%/year of the total Colorado feral pigeon numbers. This level of take would have a minimal/low magnitude of impact on state wide species numbers. WS-Colorado will have no limitations on potential take of non-native species.

House Sparrow. Native to Eurasia and northern Africa and introduced into North America in 1851, house sparrows are year-round non-migratory residents through the continent. The majority of house sparrows breed in human modified environments such as farms, and residential/urban areas (Lowther and Cink 2006).

Direct Impacts. The Rocky Mountain Avian Data Center estimates house sparrow populations to be approximately 1,539,038 individuals throughout Colorado (**Table 3.14**). House sparrows form monogamous pairs and may produce as many as 4 broods per year (Lowther and Cink 2006). During breeding season, nesting pairs will start a new clutch approximately 10 days following the young leaving the nest (Lowther and Cink 2006). Females typically lay 5 eggs per clutch followed by clutches of 6 and 4 eggs, respectively (Lowther and Cink 2006). Nesting pairs that experience repeated nesting failure may initiate clutches up to 8 times per year (Lowther and Cink 2006). With an average annual Colorado number of 1,745,955 house sparrows, 56.1% of the breeding females will fledge 7,900,295 offspring each year (**Table 3.14**).

From FY2013 to FY2017 WS-Colorado completed 747 BDM work tasks involving: property 3 and human health and safety 744 (**Table 3.6**). Annually WS-Colorado lethally removed an average of 45/year house sparrows, dispersed 226/ year, and released 62/year birds (**Table 3.9**). In Colorado, house sparrows are non-migratory and form large winter roosts, often in the thousands. Requests for assistance typically relate to noise complaints and bird fecal dropping accumulations related to large winter roosts. Other requests for assistance, involve custodial maintenance costs for the removal of house sparrow nests which can serve as a fire hazards when they built in buildings and other structures. At this time we are unaware of the amount of house sparrows lethally removed by private entities or individuals including Nuisance Wildlife Control Operators (NWCOs).

Table 3.14. Cumulative impact analysis for house sparrows lethally removed in Colorado by WS from FY2013 to FY2017. * Colorado Breeding estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

HOUSE SPARROW IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,539,038	2,048,721	2,108,521	1,575,468	1,458,029	**1,745,955**
% Breeding Females	56.1%	56.1%	56.1%	56.1%	56.1%	**56.1%**
Estimated Number Breeding Females	864,021	1,150,159	1,183,731	884,473	818,543	**980,185**
Avg. Clutch	5	5	5	5	5	**5**
Avg. Nests	4	4	4	4	4	**4**
% Fledge	40.3%	40.3%	40.3%	40.3%	40.3%	40.3%
Young Produced/Post-breeding	6,964,012	9,270,283	9,540,873	7,128,855	6,597,453	**7,900,295**
Total Colorado Numbers	8,503,050	11,319,004	11,649,394	8,704,323	8,055,482	**9,646,250**
WS Take (%)*	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
WS-CO Take of Total Colorado Numbers	81	57	12	12	62	**45**
Remaining Total	8,502,969	11,318,947	11,649,382	8,704,311	8,055,420	**9,646,206**

^WS Take on average is 0.0026%.

Table 3.15. Species estimates and trends for house sparrows from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data. *Here the red indicates a significant decline in the population according to the BBS trend estimate from 2005 to 2015.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
House Sparrows	125	1	1.06	181,031	2,072,348	-5.23	(-7.74, -2.87)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
House Sparrow	CO	2,072,348	1	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
House Sparrow	CO	Trend	1	3.44	53

PIF Data Quality Rating		IMBCR C.V. %		Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

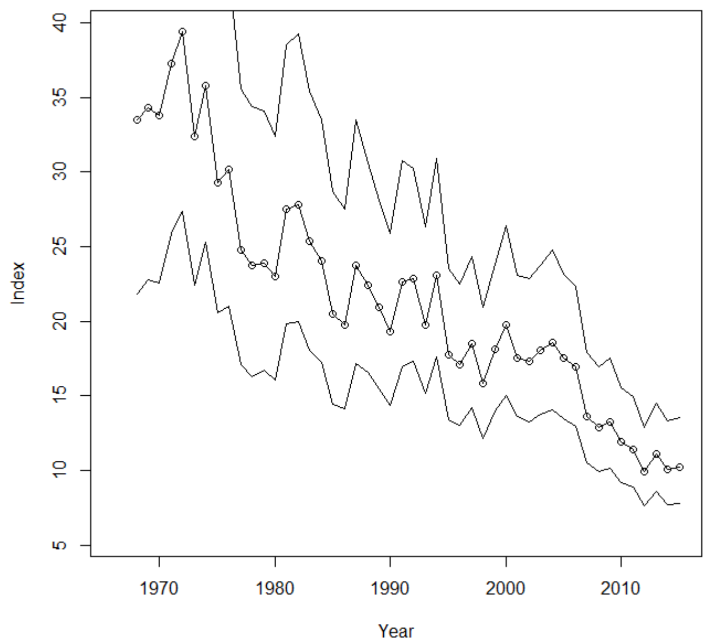


Figure 3.8 House sparrow annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the region for a year. (Sauer et al. 2017).

Indirect Impacts. Since house sparrows are considered an invasive species they are not protected by the Migratory Bird Treaty and private citizens do not need a permit to lethally remove them. While we do expect that the public lethally remove house sparrows, in urban damage situations, at CAFOs and dairies, we do not know the magnitude of this take. The annual lethal removal of 0.0026% of the house sparrow population is not anticipated to have any noticeable indirect impacts on local bird populations.

Cumulative Impacts. WS-Colorado conducts minimal BDM for house sparrows in Colorado, averaging 45 taken from FY13 to FY17. A cumulative impact analysis, combining all WS take, would show that this would possibly account for an average of 0.0026%/year of the expected annual mortality (**Table 3.14**). House sparrow estimates for Colorado range from 1,539,038 (RMADC 2017), 181,031 (BBS 2013-2017), and 2,072,348 (PIF 1998-2007) (Partners in Flight Science Committee 2013, Bird Conservancy of the Rockies 2019, Sauer et al. 2017, Pardieck et al. 2018) (**Table 3.14, 3.15**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality.

In Colorado, the RMADC using the IMBCR protocol have documented a static trend (median 1) in house sparrow populations (**Table 3.15**). Although, this data should be cautiously be interpreted since the "f" or probability the trend is in the direction of the mean (i.e. confidence in the direction of the trend) is 53%. Similarly, Breeding Bird Survey trend estimates from 2005-2015, show significant long-term (indicated in red font) house sparrow populations declining by -5.23% per year (which is not significant since the credible interval does not include 0) (**Figure 3.8**) (Sauer et al. 2017).

House sparrows are classified as an invasive species by the U.S. Fish and Wildlife Service and a Migratory Depredation Permit is not required to lethally remove an average of 0.0026%/year of the total Colorado house sparrow numbers. This level of take would have a minimal/low magnitude of impact on this species' numbers. WS-Colorado will have no limitations on potential take of non-native species.

Eurasian Collared-Doves. Following multiple introductions and escapes from private avian collections, Eurasian collared doves have quickly colonized nearly every state in the U.S. and Mexico (**Figure 3.10**) (Romagosa 2012). Native to subtropical Asia, this invasive species thrive in human altered landscapes around suburbs, agricultural production, and livestock operations (Fujisaki et al. 2010).

Direct Impacts. Throughout Colorado, these gregarious invasive doves are a common sight at bird feeders and it appears exceedingly likely that they will become a permanent addition to the aviafauna community (Romagosa 2012). Eurasian collared doves reach sexual maturity following their first year of life. Breeding females are multibrooded and can lay 3-6 clutches (median 4.5) per year (Romagosa 2012). The majority of these nests contain 2 eggs however, clutch size may vary based on location (Robertson 1990, Romagosa 2012). Only 29% of these chicks will fledge; and as adult birds, their annual mortality rate is estimated at 64.4% (Romagosa 2012).

Given an average Eurasian dove estimate of 272,067 birds, with 63.9% of the adult females in breeding approximately 453,743 chicks will be fledged (**Table 3.16**). From FY 2013 to FY 2017, WS-Colorado performed 2,260 involing Eurasian collared dove damage associated with agriculture 185, property 122, and human health and safety 1,953 (**Table 3.6**). During this period of time, WS-Colorado lethally removed on average 255 Eurasian doves per year and dispersed an average of 1,055 birds per year (**Table 3.9**). The lethal removal of this species by WS-Colorado accounts for an average take of 0.0937% of the total Colorado Eurasian collared dove numbers (**Table 3.16**). At this time WS-Colorado is unaware of the magnitude of Eurasian collared dove lethal removal by other private resource owners/managers and/or other entities including NWCOs.

Table 3.16. Cumulative impact analysis for Eurasian collared doves lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

EURASIAN COLLARED-DOVE IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)	366,511	400,148	234,862	221,049	137,765	**272,067**
% Breeding Females	63.9%	63.9%	63.9%	63.9%	63.9%	**63.9%**
Estimated Number Breeding Females	234,197	255,690	150,074	141,248	88,030	**173,848**
Avg. Clutch	2	2	2	2	2	**2**
Avg. Nests	4.5	4.5	4.5	4.5	4.5	**4.5**
% Fledge	29.0%	29.0%	29.0%	29.0%	29.0%	**29.0%**
Young Produced/Post-breeding	611,253	667,352	391,694	368,657	229,759	**453,743**
Total Colorado Numbers	977,764	1,067,500	626,556	589,706	367,524	**725,810**
WS Take (%)*	0.0%	0.1%	0.1%	0.1%	0.3%	**0.1%**
WS-CO Take of Total Colorado Numbers	59	240	346	160	469	**255**
Remaining Total	977,705	1,067,260	626,210	589,546	367,055	**725,555**

^WS Take on average is 0.0937%.

Table 3.17. Species estimates and trends for Eurasian collared doves from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Eurasian collared dove	200	1.75	1.53	501,797	NA	39.33	(30.70, 48.24)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Population Calculator	Data Quality	Range Coverage
Eurasian collared dove	CO	NA	NA	NA

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Eurasian collared dove	CO	Trend	1.26	4.24	100

PIF Data Quality Rating		IMBCR C.V. %		Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

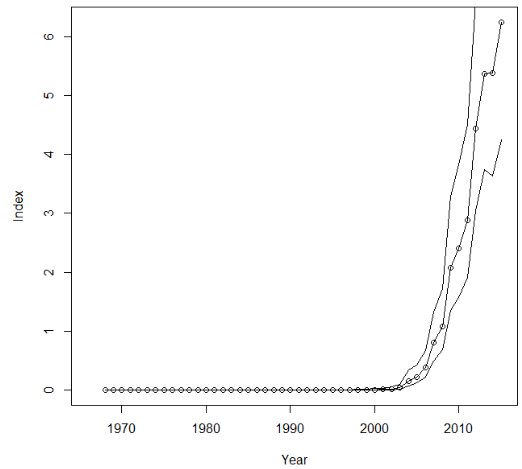


Figure 3.9 Eurasian collared dove annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the region for a year. (Sauer et al. 2017).

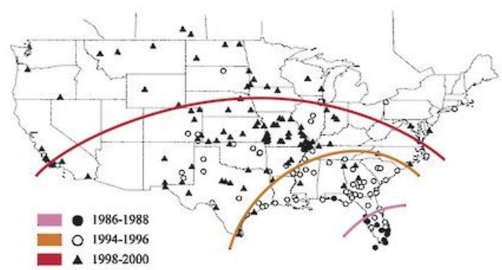


Figure 3.10. Eurasian collared dove expansion in the USA from 1986-2000 (Romagosa 2012).

__Indirect Impacts.__ In any given year, an unknown amount of Eurasian collared doves are harvested by sportsman. The impacts of these activities, as well as, the undocumented removal of this species by other private resource owners/managers is unknown. The anticipated number of Eurasian collared-doves lethally removed by WS-Colorado would likely be extremely low as compared to that of sport hunter harvest. The lethal removal of this species is considered to have a low level of impact on the human environment since Eurasian starlings are considered an invasive species. Indirectly, the removal of this species may benefit other native columbids such as mourning doves.

__Cumulative Impacts__. Species estimates in Colorado for Eurasian collared doves range from approximately 366,511 (RMADC 2017) to 501,797 (BBS 2013-2017) (Bird Conservancy of the Rockies 2019, Sauer et al. 2017, Pardieck et al. 2018). In Colorado, the RMADC using the IMBCR protocol have documented an increase (median 1.26) in Eurasian collared dove populations with an "f" or probability the trend in the direction of the mean (i.e. confidence in the direction of the trend) at 100% (**Table 3.17**). Similarly, Breeding Bird Survey trend estimates from 2005-2015, show Eurasian collared dove populations increasing by 39.33% per year (which is significant since the credible interval does not include 0) (**Table 3.17**, **Figure 3.9**) (Sauer et al. 2017). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. WS-Colorado will have no limitations on potential take of non-native species.

Feral Waterfowl and Poultry. Occasionally in Colorado, species of domestic waterfowl and poultry are either intentionally or accidently released into the wild. Often these species are observed foraging or roaming through parks, cemeteries, golf courses, and other natural landscapes. In many situations were these birds are intentionally introduced into an urban area, the property owner/manager are rarely consulted. In such situations, introduced feral waterfowl or poultry often reproduce to levels that exceed the social carrying capacity of an area and cause damage to community resources.

Feral waterfowl can create severe problems including damage to landscaping and grass, water contamination, disease, and hybridizing with wild ducks. The chickens and other poultry are more of a nuisance and typically do not cause as much damage as waterfowl.

Direct Impacts. WS-Colorado did not lethally remove any feral poultry or waterfowl from FY2013 to FY2017. Populations of feral waterfowl or poultry have been known to cause damage to ornamental plants and landscaping, contaminate water sources with fecal droppings and or pathogens, and in the case of feral waterfowl, they may hybridize with native waterfowl species. Gallinaceous feral poultry are more likely to cause a nuisance by chasing cars, pets, or humans rather than causing damage to property. While some people would benefit from the removal of these feral populations and their associated damage others would miss their aesthetic associations with these species.

Indirect Impacts. However, opportunities to feed feral waterfowl and are abundant and other local populations likely exist close to the areas of removal. It should be noted that many parks have "No Feeding" policies or statutes, but these are often disregarded and not readily enforced. We are not aware of any indirect impacts on feral poultry and waterfowl due to BDM conducted by WS-Colorado.

Cumulative Impacts. The take of feral poultry and waterfowl by WS-Colorado is considered to be of no impact on the human environment since feral domestic ducks and geese, chickens, peacocks, and guineas are not indigenous components of ecosystems in Colorado. Under Alternative 1, we anticipate that feral poultry/waterfowl would continue to be taken occasionally by WS-Colorado. The take of feral poultry and waterfowl by WS-Colorado is considered negligible and may have beneficial impacts on native wildlife populations. WS-Colorado will have no limitations on potential take of non-native species.

***Exotic Birds**.* As with any undomesticated species kept in captivity, exotic bird species may occasionally be intentionally or accidently released from private collections in Colorado. WS-Colorado would respond to requests for assistance when these exotic species are associated with damage to a resource.

Direct Impacts. WS-Colorado did not lethally remove any exotic birds from FY2013 to FY2017. Thus, WS-Colorado has had no impact on exotic bird species populations within the state.

Indirect Impacts. The take of these exotic species would have no impact on the human environment since they are not indigenous components of ecosystems in Colorado.

Cumulative Impacts. WS-Colorado expects that the lethal removal of exotic bird species will have no to a low level magnitude of impact (if these species are lethally removed) because Colorado does not have any established breeding populations of these species. Under Alternative 1, we anticipate that if exotic birds were found in Colorado WS-Colorado would occasionally lethally remove them. The lethal removal of exotic bird species by WS-Colorado would be considered negligible and may have beneficial impacts on native wildlife populations. WS-Colorado will have no limitations on potential take of non-native species.

Native Doves and Pigeons

Colorado commonly hosts 3 species of native doves and pigeons including the mourning dove, white-winged dove, and band-tailed pigeons; on rare occasions Inca doves and common ground-dove have additionally been seen.

<u>Direct Impacts.</u> From FY2013 to FY2017 WS-Colorado recorded 4,183 work tasks associated with mourning dove damage related to property 58 and human health and safety 4,125 (**Table 3.6**). WS-Colorado did receive any other request for assistance related to any other native dove or native pigeon species in FY2013 to FY2017 (**Table 3.6**).

Mourning doves are one of the most abundant endemic birds to North America (Otis et al. 2008). As a habitat generalist, this species breeds in a wide range of ecological surroundings. Adults of this species reach sexual maturity at one year of age, however, the number of hatch year birds that are capable of breeding each year varies by sex and geographic location (Otis et al. 2008). For the purpose of our analysis, we are estimating that none of the first year female birds are reproducing. In subsequent years, the percentage of breeding females is calculated using a life table and an annual adult survival rate of 43% (Otis et al. 2008). Breeding female mourning doves may make multiple nesting attempts per year ranging from 2-7 per year, and lay 2 eggs per clutch (Otis et al. 2008). Fledgling success varies by region. Otis (2003) estimated that in the northern central management unit approximately 80% of chicks fledge.

Based on these parameters, an average breeding mourning dove numbers in Colorado of 1,195,254 birds would produce an average of approximately 1,601,084 young per year (**Table 3.19**). On average, WS-Colorado lethally removes 1,776 mourning doves per year, removed 2 nests, and disperses an average of 15,697 birds/year (**Table 3.18**). This represents an average lethal removal of 0.1486% of the average total Colorado mourning doves. Thus, the low magnitude of take is not expected to have a significant impact on state populations of mourning doves due to BDM by WS-Colorado.

Table 3.18. Native dove and native pigeon species hazed and lethally removed from damage situations from FY2013-17 by WS-Colorado. * Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

<table>
<tr><th colspan="7">Native Pigeons and Doves</th></tr>
<tr><th colspan="5">WS Bird Damage Management Activities</th><th colspan="2">State Populations (Calendar Year)</th></tr>
<tr><th>Fiscal Year (FY)</th><th>Avian Species</th><th>Removed</th><th>Dispersed</th><th>Relocated</th><th>Breeding Estimates (Colorado)*</th><th>% taken by WS-CO</th></tr>
<tr><td>2017</td><td rowspan="6">Mourning Dove</td><td>2,442</td><td>11,619</td><td>0</td><td>1,270,778</td><td>0.2%</td></tr>
<tr><td>2016</td><td>926</td><td>4,078</td><td>0</td><td>1,151,581</td><td>0.1%</td></tr>
<tr><td>2015</td><td>1,342</td><td>13,033</td><td>0</td><td>1,091,121</td><td>0.1%</td></tr>
<tr><td>2014</td><td>1,647</td><td>30,552</td><td>0</td><td>1,237,646</td><td>0.1%</td></tr>
<tr><td>2013</td><td>2,524</td><td>19,203</td><td>0</td><td>1,225,144</td><td>0.2%</td></tr>
<tr><td>Average</td><td>1,776</td><td>15,697</td><td>0</td><td>1,195,254</td><td>0.1%</td></tr>
</table>

Table 3.19. Cumulative impact analysis for mourning doves lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

MOURNING DOVE IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,270,778	1,151,581	1,091,121	1,225,144	1,237,646	**1,195,254**
% Breeding Females in Population	41.9%	41.9%	41.9%	41.9%	41.9%	**41.9%**
Estimated Number Breeding Females	531,954	482,057	456,748	512,851	518,084	**500,339**
Avg. Clutch	2	2	2	2	2	**2**
Avg. Nests	2	2	2	2	2	**2**
% Fledge	80%	80%	80%	80%	80%	**80%**
Young Produced/Post-breeding	1,702,251	1,542,583	1,461,595	1,641,123	1,657,870	**1,601,084**
Total Colorado Numbers	2,973,029	2,694,164	2,552,716	2,866,267	2,895,516	**2,796,338**
WS Take (%)*	0.2%	0.1%	0.1%	0.1%	0.2%	**0.1%**
WS-CO Take of Total Colorado Numbers	2,442	926	1,342	1,647	2,524	**1,776**
Remaining Total	2,970,587	2,693,238	2,551,374	2,864,620	2,892,992	**2,794,562**

^WS Take on average is 0.1486%.

Table 3.20. Species estimates and trends for native dove and native pigeon populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameter data. *Here the red indicates a significant decline in the population according to the BBS trend estimate from 2005 to 2015.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 1998-2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Band-tailed Pigeon	200	1.75	1.47	6,665	11,091	-6.43	(-20.50, 7.81)	
Mourning Dove	200	1.75	1.31	2,605,400	4,266,401	-2.51	(-3.96, -1.11)	
White-winged Dove‡	200	1.5	1.39	491	160	23.68	(5.62, 51.27)	
White-winged Dove*						18.61	(8.01, 28.18)	

‡ BBS Southern/Rockies BCR 16

*Shortgrass Prairie BCR 18

Table 3.21. Species estimates and trends for native dove and native pigeon populations from Partners in Flight (version 2.0) and Rocky Mountain Avian Data Center IMBCR density and trend data.

Partners in Flight version 2.0 (1998-2007)					
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**	
Mourning dove	CO	4,266,402	0	0	
IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Mourning dove	CO	Trend	0.98	1.05	97
Band-tailed pigeon	CO	Trend	0.77	13.56	96

PIF Data Quality Rating		IMBCR C.V. %		Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

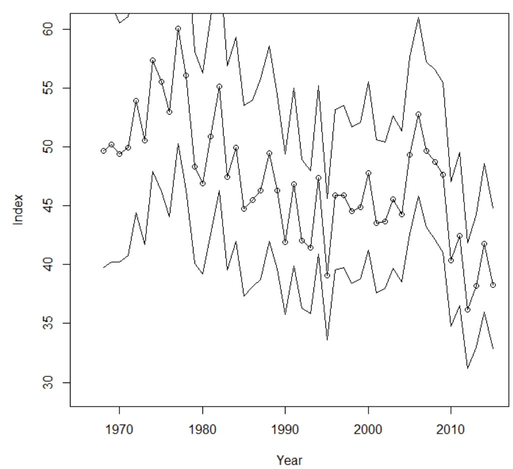


Figure 3.11. Mourning dove annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Table 3.22. Native dove and native pigeon numbers harvested by hunters in the Central Flyway from 2013-17 (USGS 2018).

Species	Year	Hunter Harvest in Colorado
Mourning Dove	2013	**176,894**
	2014	**173,116**
	2015	**204,471**
	2016	**141,248**
	2017	**117,645**
White-winged Dove	2013	**1,744**

	2014	**1,861**
	2015	**1,402**
	2016	**415**
	2017	**2,097**
Band-tailed Pigeon	2013	**40**
	2014	**424**
	2015	**171**
	2016	**231**
	2017	**30**

<u>Indirect Impacts.</u> Mourning doves are abundant in Colorado and is mostly likely to be involved in BDM at airports and property. In Colorado mourning doves are a game species and on average between 2013 to 2017, 162,675 birds were harvested by hunters (USGS 2018) (**Table 3.22**). In addition to mourning doves, hunters additionally harvested on average 1,504 white-winged doves, and 179 band-tailed pigeons from 2013 to 2017 (USGS 2018). Although, band-tailed pigeons and white-winged are rarely the focus of BDM activities, there is always the possibility that they could be at a future time.

Band-tailed pigeons occupy western Colorado and are more likely to be involved in BDM at orchards. At this time, WS-Colorado has not documented any associated damage with this species and has not conducted BDM for them. Based on the current average take of native dove and native pigeon species, it is not likely that hunters would notice a decline in these species based on WS-Colorado BDM. Similarly, it is unlikely that the public will notice a reduction in mourning dove abundance at bird feeders. In the future, white-winged doves may become more common, and since their populations are expanding, they may result in conflicts with resource owners where WS-Colorado may be requested to provide assistance. Due to the negligibly low average percentage of lethally removed Colorado mourning dove population and no lethal removal of any other native dove or native pigeon species we do not expect any significant indirect impacts to these populations due to BDM by WS-Colorado.

<u>Cumulative Impacts.</u> In analyzing the species estimates for these three native dove and pigeon species in Colorado, the Rocky Mountain Avian Data Center (RMADC) estimates mourning dove populations to be at 1,20,778 (2017), Partners in Flight (PIF) (1998-2015) estimate 4,266, 401, and Breeding Bird Survey (BBS 2013-2017) raw data using the PIF detectability factors estimate is 2,605,400 (**Table 3.18, 3.19, 3.20**). White-winged dove populations are not available through the RMADC, PIF (1998-2015) estimates 160 birds in Bird Conservation Regions (BCR) 16 and 18, and the BBS (2013-2017) raw data using PIF detectability factors estimate is 491 birds. Band-tailed pigeon population estimates for Colorado are RMADC 101 (2017), PIF (1998-2005) 11,091, and BBS (2013-2017) using PIF detectability factors estimate 6,665 (**Table 3.20**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality.

Throughout Colorado, mourning dove and band-tailed pigeon populations seem to be declining. For mourning doves, RMADC data indicates a 97% confident declining trend and BBS trend data from 2005-2015 similarly indicates a significant long term decline of -2.51% change/year. Similarly, RMADC indicates they are 96% confident that band-tailed pigeon trends are in decline and BBS trend estimate data from 2005-2015 indicates a non-significant -6.43% change/year (**Table 3.21**). It should be noted that in Colorado, there is not enough available data to compare state trends in white-winged dove populations for this same period of time. However, white-wing dove populations in BCR region 16 (Southern Rockies) and BCR 18 (Short-grass prairie) indicate significant positive trends of 23.68% change/year and 18.61 change/year respectively (**Table 3.20**). Under Alternative 1, we anticipate negligible impacts to local native dove and pigeon populations and no adverse impacts to overall native dove and pigeon populations in Colorado. WS-Colorado take will not exceed 1% of the total population in Colorado.

Blackbirds

The Blackbird group, herein, includes the following species: red-winged blackbirds, yellow-headed blackbirds, Brewer's blackbird, common grackles, and brown-headed cowbirds. During FY2013 to FY2017, WS-Colorado lethally removed on average per year 2,420 red-winged blackbirds, 131 Brewer's blackbirds, 75 common grackles, and 10 brown-headed cowbirds (**Table 3.23**). We will not be performing a species impact analysis on yellow-headed blackbirds since no individuals of this species were removed in the five-year time frame. However, we have included some data for yellow-headed blackbirds for reference (**Table 3.24, 3.25**). The majority of these species, with the exception of Brewer's blackbird are part of a Depredation order for blackbirds, cowbirds, crows, grackles, and magpies. Here we split the species included in this depredation order between blackbird and corvid groups for further analysis.

Table 3.23. Blackbird species hazed and lethally removed from damage situations from FY2013-17 by WS-Colorado. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Blackbird spp.						
WS Bird Damage Management Activities					State Populations (Calendar Year)	
Fiscal Year (FY)	**Avian Species**	**Removed**	**Dispersed**	**Relocated**	**Breeding Estimates (Colorado)***	**% taken by WS-CO**
2017	**Red-winged blackbirds**	1,922	21,412	0	1,046,396	0.2%
2016		1,282	14,824	0	854,676	0.1%
2015		1,077	20,260	0	698,771	0.2%
2014		751	28,974	0	685,679	0.1%
2013		7,069	112,010	0	822,583	0.9%
Average		**2,420**	**39,496**	**0**	**821,621**	**0.3%**
2017	**Yellow-headed blackbirds**	0	0	0	6,479	0.0%
2016		0	0	0	3,063	0.0%
2015		0	0	0	8,272	0.0%
2014		0	40	0	10,096	0.0%
2013		0	0	0	5,918	0.0%
Average		**0**	**8**	**0**	**6,766**	**0.0%**
2017	**Brewer's blackbirds**	0	0	0	864,171	0.0%
2016		141	3	0	1,109,431	0.0%
2015		186	35	0	868,929	0.0%
2014		216	0	0	899,654	0.0%
2013		114	0	0	834,591	0.0%

Average		**131**	**8**	**0**	**915,355**	**0.0%**
2017	**Common grackles**	225	245	0	1,141,251	0.0%
2016		12	40	0	686,790	0.0%
2015		26	135	0	924,010	0.0%
2014		105	200	0	763,833	0.0%
2013		9	63	0	1,040,051	0.0%
Average		**75**	**137**	**0**	**911,187**	**0.0%**
2017	**Brown-headed cowbirds**	52	13	0	1,207,437	0.0%
2016		0	0	0	797,642	0.0%
2015		0	0	0	852,580	0.0%
2014		0	0	0	997,243	0.0%
2013		0	0	0	1,006,792	0.0%
Average		**10**	**3**	**0**	**972,339**	**0.0%**

Table 3.24. Species estimates and trends for blackbird spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameter data. *Here the red indicates a long-term significant decline in the population according to the BBS trend estimate from 2005 to 2015 and blue indicates a significant long-term increase.

Species	**Detectability Parameter Factors (PIF)**			**BBS Data w/ PIF Detectability Parameters (2013- 2017)**	**PIF Estimates 2015**	**BBS Trend Estimates 2005-2015 (% change per year)**	**2005-2015 Credible Interval**	**BBS Data**
	Dist.	**Pair**	**Time**					
Red-winged blackbird	200	1.25	1.42	2,011,135	2,174,073	-3.26	(-4.54, -2.00)	
Yellow-headed blackbird	200	1	1.45	96,199	105,875	-0.2	(-4.19, 3.92)	
Brewer's blackbird	200	1.25	1.32	650,590	780,997	-2.31	(-3.81, -0.96)	
Common grackle	200	1.25	1.5	746,667	1,068,207	-0.49	(-3.40, 2.53)	
Brown-headed cowbird	125	1.75	1.17	1,222,269	1,349,827	0.73	(-1.29, 2.82)	

Table 3.25. Species estimates and trends for blackbird spp. populations from Partners in Flight (version 2.0) and Rocky Mountain Avian Data Center IMBCR density and trend data.

Partners in Flight version 2.0 (1998-2007)					
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**	
Red winged blackbird	CO	2,174,073	0	0	
Yellow-headed blackbird	CO	105,875	0	0	
Brewer's blackbird	CO	780,997	0	0	
Common grackle	CO	1,068,207	1	0	
Brown-headed cowbird	CO	1,349,827	0	0	
IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Red winged blackbird	CO	Trend	0.94	3.98	94
Yellow-headed blackbird	CO	Trend	0.78	10	99
Brewer's blackbird	CO	Trend	1	3	99
Common grackle	CO	Trend	1	3	60
Brown-headed cowbird	CO	Trend	1	2	76

PIF Data Quality Rating		**IMBCR C.V. %**		**Trend Estimate**	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Red-winged Blackbirds. Red-winged blackbirds are one of the most commonly studied and abundant species within the U.S. Like most blackbird species in which males are more colorful than females, breeding males exhibit vibrant glossy black plumage with red epaulets.

Direct Impacts. Yearly, populations of red-winged blackbirds in Canada and the northern U.S. begin migrating to southern states every October (Dolbeer 1978). These migrants return to these northerly locations from mid-February to mid-May (Yasukawa and Searcy 2019). Other populations in the southern and western U.S. are believed to be non-migratory (Yasukawa and Searcy 2019). From FY2013 to 2017, WS-Colorado performed 47,487 work tasks related to red-winged blackbirds involving agriculture 4,570 and human health and safety 42,917 (**Table 3.6**). On average, WS-

Colorado lethally removes 2,420 red-winged blackbirds each year and disperses on average 39,496 birds/year (**Table 3.23**).

Female red-winged blackbirds sexually mature and begin breeding in the second year of their life (Yasukawa and Searcy 2019). Annual survival rates for this species range from 42.1% – 62.0% here we used the median of 52.1% to calculate the percentage of breeding females in the population which equals 422,776 of an average population of 821,621 (**Table 3.26**). Red-winged blackbirds have a strong polygynous mating season and will typically attempt to raise additional brood if the first nesting attempt fails (mean 1.7) (Yasukawa and Searcy 2019). During each nesting attempt, females will lay 2.43 to 3.7 eggs (mean 3.28) and 55% of the chicks produced will eventually fledge (Yasukawa and Searcy 2019). In our population impact analysis, 422,776 breeding females would produce an average of 1,296,569 offspring each year (**Table 3.26**). With an annual lethal removal of on average 2,420 birds/year this would equal an average lethal take of 0.2946% of the total Colorado red-winged numbers (**Table 3.26**). Thus, the low magnitude of take is not expected to have a significant impact on state populations of red-winged blackbirds due to BDM by WS-Colorado.

Table 3.26. Cumulative impact analysis red-winged blackbirds lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

RED-WINGED BLACKBIRD IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,046,396	854,676	698,771	685,679	822,583	**821,621**
% Breeding Females	51.5%	51.5%	51.5%	51.5%	51.5%	**51.5%**
Estimated Number Breeding Females	538,437	439,785	359,562	352,825	423,271	**422,776**
Avg. Clutch	3.28	3.28	3.28	3.28	3.28	**3.28**
Avg. Nests	1.7	1.7	1.7	1.7	1.7	**1.7**
% Fledge	55%	55%	55%	55%	55%	**55%**
Young Produced/Post-breeding	1,651,278	1,348,732	1,102,704	1,082,044	1,298,087	**1,296,569**
Total Colorado Numbers	2,697,674	2,203,408	1,801,475	1,767,723	2,120,670	**2,118,190**
WS Take (%)*	0.2%	0.1%	0.2%	0.1%	0.9%	**0.3%**
WS-CO Take of Total Colorado Numbers	1,922	1,282	1,077	751	7,069	**2,420**
Remaining Total	2,695,752	2,202,126	1,800,398	1,766,972	2,113,601	**2,115,770**

*WS Take on average is 0.2946%.

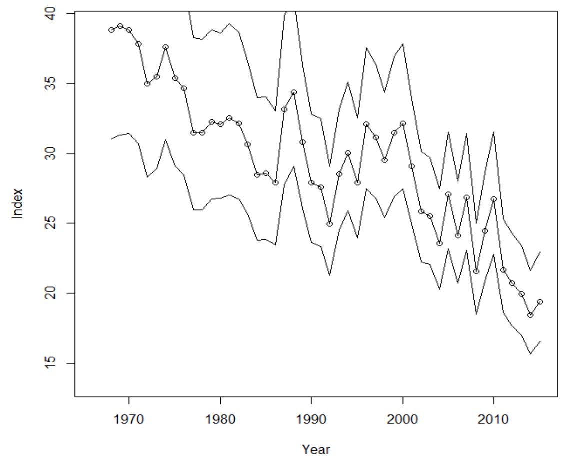


Figure 3.12. Red-winged blackbird annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year. (Sauer et al. 2017).

Indirect Impacts. Assuming that human-induced mortality is mostly compensatory, instead of additive, to natural mortality, this level of lethal removal (0.2946%) by WS-Colorado would have a low level of impact. However, it should be noted that private entities and individuals are allowed to lethally remove red-winged black-birds under 50 CFR 21.43, the Depredation order for blackbirds, cowbirds, crow, grackles, and magpies to protect resources from damage. Since individuals and other entities, other than WS-Colorado, are not likely to report the lethal removal this species, the magnitude of the actions on the state populations is unknown. Residents that leave near areas where red-winged blackbird BDM activities are being conducted (e.g. CAFOs, dairies, agricultural fields), would likely not notice a significant decline in the number of blackbirds present during migration season. In fact, Sawin et al. (2003), found that when floater males (males that are unsuccessful in establishing a territory) were removed during a given year, there was no observable impact on populations or subsequent numbers of floaters in the following year. This suggests that recruitment and immigration factors are capable of replacing parts of the populations that are lost in previous seasons and that when habitat is available, those populations will remain stable.

Cumulative Impacts. In analyzing the available red-winged blackbird data, RMADC (2017) estimates a Colorado population of 1,046,396 with trend data indicating that populations are declining (**Table 3.26**). Similarly, BBS trend estimates from 2005-2015 indicate long term significant population declines with an annual decline of -3.26% (**Table 3.24**). In analyzing recent 2013- 2017 BBS data using PIF detectability parameters (time, pair, distance) red-wing blackbird populations are hovering around 2,011,135 individuals and PIF data from 1998-2015 indicate a population of 2,174,073 (**Table 3.24, 3.26**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality.

As discussed previously, WS-Colorado annually removes an average of 0.2946% of red-winged blackbirds within the state. Under Alternative 1, we anticipate a low level of magnitude impact on both local and state wide populations of red-winged blackbirds. However, the take by other individuals is difficult to determine since a permit is not required to lethally remove red-winged blackbirds and at this time it is not possible to quantify this level of take. WS-Colorado take will not exceed 1% of the total red-winged blackbirds in Colorado.

Brewer's Blackbirds. Brewer's blackbirds occupy a wide variety of habitats throughout Colorado. However, they seem to prefer open habitat such as agricultural lands, pastures, golf courses, parks, clearcuts, and other human altered landscapes (Martin 2002). In some migratory Colorado populations within the Colorado Plateau region, birds have been documented to migrate over 2,500 km into Mexico (Martin 2002). During migration, Brewer's blackbirds will regularly forage with other conspecifics or in mixed populations with other blackbird species.

Direct Impacts. From FY2013 to FY2017 WS-Colorado recorded 1,207 work tasks associated with Brewer's blackbird damage related to agriculture 1,168 and human health and safety 39 (**Table 3.6**). On average over a 5 year period, WS-Colorado removed 131 Brewer's blackbirds per year and dispersed an average of 8 per year (**Table 3.23**).

Depending on habitat conditions and population sex ratios, Brewer's blackbirds may alternate between monogamous (e.g. single nests) or polygynous (e.g. colony nesting) mating systems (Martin 2002). Both males and females become sexually mature as second-year birds and attempt to breed every year thereafter (Martin 2002). Females typically raise one brood per season but double-brooding may occur in non-migratory populations (Martin 2002). Clutches may range from 1 to 8 eggs (mean 4.98 eggs/nest) and result in a 39.9% fledgling rate (Martin 2002). Once this birds reach adulthood they have an annual survival rate of 30% for females and between 38-54% for males (Fankhauser 1967).

Given an average breeding estimate of 915,355 birds with an annual female survival rate of 30%, 29.6% of the remaining population will reproduce each year. Therefore, an average breeding number of 270,739 females will produce 532,002 young per year making the Colorado average total 1,447,357 Brewer's blackbirds. With an annual average lethal removal of 0.0144% that would leave an estimated average of 1,447,226 Brewer's blackbirds. Thus, the low magnitude of take is not expected to have a significant impact on state populations of Brewer's blackbirds due to BDM by WS-Colorado.

Table 3.27. Cumulative impact analysis Brewer's blackbirds lethally removed in Colorado by WS from FY2013 to FY2017.

BREWER'S BLACKBIRD IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	864,171	1,109,431	868,929	899,654	834,591	**915,355**
% Breeding Females	29.6%	29.6%	29.6%	29.6%	29.6%	**29.6%**
Estimated Number Breeding Females	255,600	328,142	257,007	266,095	246,851	**270,739**
Avg. Clutch	5	5	5	5	5	**5**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	39.3%	39.3%	39.3%	39.3%	39.3%	**39.3%**
Young Produced/Post-breeding	502,254	644,798	505,019	522,876	485,062	**532,002**
Total Colorado Numbers	1,366,425	1,754,229	1,373,948	1,422,530	1,319,653	**1,447,357**
WS Take (%)*	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
WS-CO Take of Total Colorado Population	0	141	186	216	114	**131**
Remaining Total	1,366,425	1,754,088	1,373,762	1,422,314	1,319,539	**1,447,226**

^WS Take on average is 0.0144%.

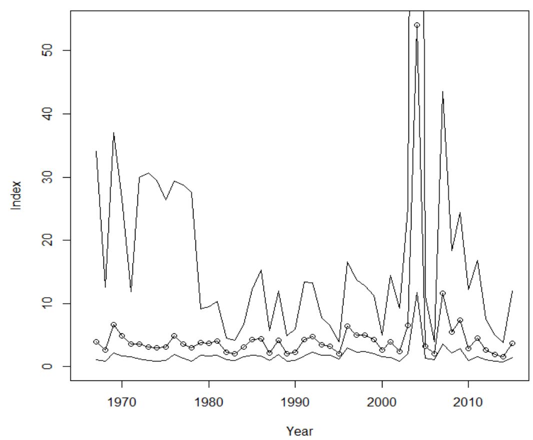


Figure 3.13. Brewer's blackbird annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

<u>Indirect Impacts.</u> As stated previously, individuals are able to lethally remove Brewer's blackbirds like other blackbird species without a permit under Depredation Order 50 CFR 21.43. Although the USFWS requires any bird species taken under this order to be reported annually, WS-Colorado believed that few people are aware that an annual report must be filed. Additionally, while Brewer's blackbirds feed on agricultural waste, such as spilled grain, they primarily consume insect pests in agricultural crops (Neff and Meanly 1957). The low-magnitude of WS-Colorado's lethal take of Brewer's blackbirds (0.0144%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events at such a low level.

Cumulative Impacts. In analyzing the available data, RMADC (2017) estimates a Colorado Brewer's blackbird numbers 864,171 with trend data indicating that populations are reaming static (**Table 3.23**). BBS trend from 2005-2015 indicate long term significant declines with an annual decline of -2.31% (**Table 3.24**). In analyzing recent 2013 - 2017 BBS data using PIF detectability parameters (time, pair, distance) Brewer's blackbird populations are hovering around 650,590 individuals and PIF data from 1998-2015 indicates state estimates at 780,997 (**Table 3.24**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality.

As discussed previously, WS-Colorado annually removes an average of 0.0144% of the total number of Brewer's blackbirds within the state. Under Alternative 1, we anticipate a low level of magnitude impact on both local and state wide populations of Brewer's blackbirds. However, the take by other individuals is difficult to determine since a permit is not required to lethally remove Brewer's blackbirds and at this time it is not possible to quantify this level of take. WS-Colorado take will not exceed 1% of the total population in Colorado.

Common Grackles. Within the past 50 years the once uncommon common grackle, has invaded the western U.S. (Peer and Bollinger 1997). Rapid population expansions by this had led to it becoming one of the most notorious agricultural avian pests of North America (Peer and Bollinger 1997). Common grackles feed primarily on plant seeds and fruits (70-75%) with insects and other vertebrate components rounding out the remaining 25-30% of their diet (Meanley 1971, Peer and Bollinger 1997). Nationwide, common grackles along with red-winged blackbirds are responsible for the majority of bird damage to ripening corn (Besser and Brady 1986).

Direct Impacts. The Rocky Mountain Avian Data Center (2017) estimates Colorado common grackle populations at 1,141,251 (**Table 3.28**). Partner's in Flight estimates from 1998 to 2015 suggest that 1,068,207 common grackles reside within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates state common grackle numbers at 746,667 (**Table 3.24**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. From FY2013 to FY2017, WS-Colorado lethally removed on average 75 common grackles/year, removed 6 nests, and dispersed on average 137 birds/year.

Every year, starting in March, common grackles form monogamous pairs and begin building their nests (Peer and Bollinger 1997). Breeding pairs usually produce one brood per year, with clutch sizes ranging from 1 to 7 eggs (mean 4.8) (Peck and James 1987, Peer and Bollinger 1997). Of the eggs lain, 33.0% to 65.0% (median 49.0%) will successfully produce fledglings (Peer and Bollinger 1997). After reaching adulthood, male common grackles have a 49.9% annual mortality rate and females have a 53.5% mortality rate (Frankhauser 1971).

Using these parameters, an average of 911,187 common grackles would produce an estimated 1,132,210 young per year (**Table 3.28**). During 2013 to 2017, WS-Colorado lethally removed an average of 0.0083% common grackles per year (**Table 3.28**). The remaining common grackle numbers in that state (with the addition of the young produced) would be approximately 2,043,322 birds on average each year. At this time, we are unaware of the take of common grackles by Nuisance Wildlife Control Operators (NWCOs) or other individuals/entities.

Table 3.28. Cumulative impact analysis common grackles lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

COMMON GRACKLES IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,141,251	686,790	924,010	763,833	1,040,051	**911,187**
% Breeding Females	52.8%	52.8%	52.8%	52.8%	52.8%	**52.8%**
Estimated Number Breeding Females	602,925	362,832	488,156	403,534	549,461	**481,382**
Avg. Clutch	4.8	4.8	4.8	4.8	4.8	**4.8**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	49.0%	49.0%	49.0%	49.0%	49.0%	**49.0%**
Young Produced/Post-breeding	1,418,080	853,382	1,148,143	949,113	1,292,332	**1,132,210**
Total Colorado Numbers	2,559,331	1,540,172	2,072,153	1,712,946	2,332,383	**2,043,397**
WS Take (%)*	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
WS-CO Take of Total Colorado Numbers	225	12	26	105	9	**75**
Remaining Total	2,559,106	1,540,160	2,072,127	1,712,841	2,332,374	**2,043,322**

^WS Take on average is 0.0083%.

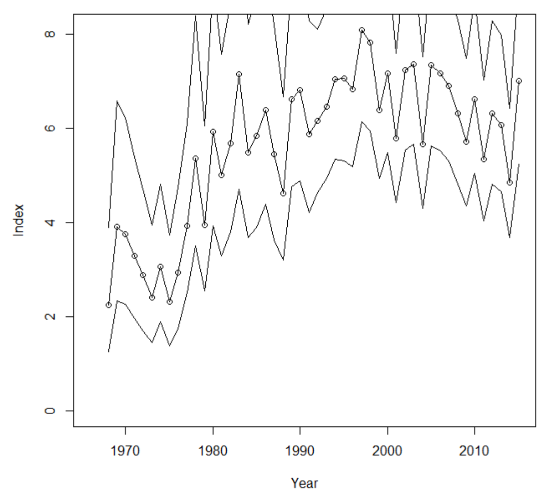


Figure 3.14. Common grackles annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. We considered potential impacts such as nest abandonment due to BDM hazing activities, but most of these activities would be conducted on airport properties. Common grackles typically nest in elevated conifers or evergreen trees. Since stands of such trees do not typically occur on airports where these hazing activities would be employed it is not expected that these actions will adversely impact common grackle populations within the state. As with other species in this group, private individuals are allowed to lethally remove common grackles under the depredation order 50 CFR 21.43. The low-magnitude of WS-Colorado's lethal take common grackles (0.0083%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events.

Cumulative Impacts. In examining short-term and long-term trends, common grackle populations have been significantly increasing by 103% change/year from 1966 to 2015 (BBS 1966 -2015) (Sauer et al. 2017). More recent BBS trend data indicates a significant long term population increase, with a slight decline of -0.49% change per year from 2005 – 2015 (Sauer et al. 2017). Other trend estimates (2008-2018), indicate that common grackle populations remain static (Bird Conservancy of the Rockies 2019). Under Alternative 1, we anticipate that the average low magnitude of take (<.1%) of common grackles by WS-Colorado would be considered negligible and would not adversely impact the state wide population of common grackles or human environment. WS-Colorado take will not exceed 1% of the total common grackles in Colorado.

Brown-headed Cowbirds. As obligate brood parasites, the fledgling success of brown-headed cowbirds depends largely on the host bird species care of their young and the amount of intranest competition between chicks (McGeen 1972). The Colorado Breeding Bird Atlas (II) documented 119 records of brown-headed cowbird nest parasitism on 37 host bird species. Historically, these "Buffalo Birds" followed bison herds across the short-grass plains and fed on invertebrates disturbed by their movements (Lowther 1993). Today, this species has adapted to living in agricultural and suburban landscapes, consequently exposing naïve bird populations to increased brood parasitism.

Brown-headed cowbirds occur throughout North America and have been documented to forage several kilometers per day in a wide array of habitats. Dolbeer (1982) found that this species traveled roughly 800-850 km between breeding and overwintering range. Cowbirds begin to migrate in early March, at which time they join other mixed-species blackbird populations and communal roosts as they migrate to more southern latitudes (Lowther 1993).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 13 work tasks involving brown-headed cowbirds related to human health and safety (**Table 3.6**). On average, WS-Colorado lethally removes 10 brown-headed cowbirds per year and disperses 3 average/year (**Table 3.23**). The Rocky Mountain Avian Data Center (2017) estimates Colorado brown-headed cowbird populations at 1,207,437 (**Table 3.23**). Partner's in Flight population estimates from 1998 to 2015 suggest 1,349,827 brown-headed cowbirds reside within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates a cowbird population of 1,222,269 (**Table 3.24**). This represents an average annual lethal removal of 0.0011% of total Colorado cowbird numbers.

Brown-headed cowbirds vary in their breeding strategies. In areas where there is a high density of host species nests, cowbirds form mostly monogamous pairs (Elliot 1980). In low density host species areas, cowbirds are mostly polygynous and populations are highly male dominated (Elliot 1980, Teather and Weatherhead 1995). Throughout North America cowbirds have been reported as parasitizing the nests of over 220 species of birds (Lowther 1993). Host species range in size from 10 g (gnatcatchers) to 150 g (meadowlarks) (Lowther 1993).

Female cowbirds sexually mature and begin breeding at one year of age (Lowther 1993). Annually, females may breed for 56 days and lay an average of .68 eggs/day, producing 41 eggs/season (Fleisher et al. 1987). The survival of cowbird eggs depends on the host species and intra-nest competition; the survival rate of cowbird eggs from chick to fledgling is approximately 13% (McGeen

1972, Woodward and Woodward 1979). Because this species parasitizes over 220 species of birds, measuring the nesting success is particularly difficult to define or obtain (Lowther 1993).

Furthermore, since the usual definition for a "clutch" does not apply here we will use the term "sequences" of daily egg laying with a pause of 1 or more days between. Scott and Ankney (1983) found that cowbirds lay "sequences" of 1-7 eggs (mean of 4.0-4.6) with a 2 day pause interval throughout the breeding season. So, females may lay 40 egg/season (Scott and Ankney 1980, Scott and Ankney 1983, Fleischer et al. 1987). In captivity 1st year female cowbirds lay 16.4 eggs/season with a laying rate of 0.56 eggs/day. During their 2nd season these same birds will lay 26.4 egg/season (Jackson and Roby 1992).

Using these parameters, an average annual breeding estimates of 972,339 cowbirds would successfully fledge 2,010,281 nestlings, raising post-fledgling estimates to approximately 2,982,620 brown-headed cowbirds (**Table 3.29**). Once immature birds have reached adulthood, their annual survival rate is approximately 48.5% for males and 40.4% for females (Fankhauser 1971). With a lethal take averaging 10 birds per year, WS-Colorado would lethally remove 0.0011% of the total Colorado brown-headed cowbird numbers. That leaves an estimated average of 2.9 million brown-headed cowbirds in Colorado (**Table 3.29**).

Table 3.29. Cumulative impact analysis brown-headed cowbirds lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

BROWN-HEADED COWBIRD IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	1,207,437	797,642	852,580	997,243	1,006,792	**972,339**
% Breeding Females	39.8%	39.8%	39.8%	39.8%	39.8%	**39.8%**
Estimated Number Breeding Females	480,065	317,135	338,978	396,494	400,291	**386,593**
Avg. eggs/season	40	40	40	40	40	**40**
Avg. Nests	N/A	N/A	N/A	N/A	N/A	**N/A**
% Fledge	13.0%	13.0%	13.0%	13.0%	13.0%	**13.0%**
Young Produced/Post-breeding	2,496,340	1,649,101	1,762,683	2,061,770	2,081,512	**2,010,281**
Total Colorado Numbers	3,703,777	2,446,743	2,615,263	3,059,013	3,088,304	**2,982,620**
WS Take (%)*	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
WS-CO Take of Total Colorado Numbers	52	0	0	0	0	**10**
Remaining Total	3,703,725	2,446,743	2,615,263	3,059,013	3,088,304	**2,982,610**

^WS Take on average is 0.0011%.

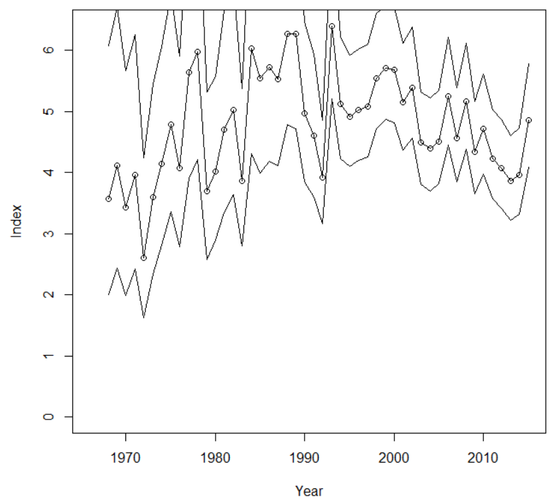


Figure 3.15. Brown-headed cowbird annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Brown-headed cowbirds would most likely be targeted at airports to reduce hazards to aircraft. They also could be targeted by WS, private individuals, and other agencies to protect livestock feed, crops, and T&E bird species from nest parasitism. It should be noted that few cowbirds would be taken for the protection of crops. Since we do not have the ability to properly measure the fledgling success of brown-headed cowbirds but know that they on average lay 40 eggs or more per season, we anticipate that if any indirect impacts were to occur it would be to the benefit of local native bird populations which are parasitized by this species. Furthermore, as with other species in this group, private individuals are allowed to lethally remove brown-headed cowbirds under the depredation order 50 CFR 21.43. The low-magnitude of WS-Colorado's average annual lethal take of cowbirds (0.0011%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events.

Cumulative Impacts. In examining short-term and long-term trends, brown-headed cowbird populations have been increasing by 0.73% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017). Other trend estimates (2008-2018), indicate that cowbird populations remain static (Bird Conservancy of the Rockies 2019). In analyzing recent 2013- 2017 BBS data using PIF detectability parameters (time, pair, distance) cowbird populations are hovering around 1,222,269 individuals and PIF data from 1998-2015 indicates Colorado numbers of 1,349,827 (**Table 3.24, 3.29**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (<.1%) of cowbirds by WS-Colorado would be considered negligible and would not adversely impact the state wide numbers of common grackles or human environment. WS-Colorado take will not exceed 1% of the total brown-headed cowbirds in Colorado.

Swallows, Nighthawks, and Swifts

Colorado is home to six native species of swallows including: tree swallows, violet-green swallows, northern rough-winged swallows, bank swallows, cliff swallows, and barn swallows. Of these swallow species, WS-Colorado receives the most requests for assistance involving cliff swallows. Other birds in this group include common nighthawks, and swift species such as black swifts, chimney swifts, and white-throated swifts. WS-Colorado did not receive any BDM requests for assistance related to these other species from FY2013 to FY20107, although WS-Colorado may occasionally receive requests for BDM assistance with these species in the future. Requests for assistance usually relate to swallows, nighthawks, and swifts (aerialists), building nests on buildings and other infrastructure. These nests pose a risk to human health and safety from nest insect infestations that spread to livestock, or bird collisions with aircraft in airport environments.

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 13,228 work tasks related to nighthawks (1) and swallows (13,227) (**Table 3.6**). The majority of these tasks involved cliff swallows (12,712) and barn swallows (515) (**Table 3.6**). Cliff swallow work tasks involved: property 5 and human health and safety 12,707 (**Table 3.6**). Barn swallow work tasks involved property 1 and human health and safety 514 (**Table 3.6**). The one night hawk work task involved human health and safety at an airport. In response to these incidents WS-Colorado lethally removed on average 1,044 cliff swallows/year, 176 cliff swallow nests, 5 barn swallows average/year, 1 barn swallow nest, and 0 nighthawks per year from FY13-17. Similarly in this time period WS-Colorado dispersed on average 10,050 cliff swallows/year, 137 barn swallows, and 0 nighthawks. BDM methods specifically for swallows are discussed in Gorenzel and Salmon (1994), and in **Chapter 2**.

Thomas Say discovered cliff swallows in Colorado during Stephen Long's expedition to the Rocky Mountains in 1820 (Brown et al. 2017). However, Silvestre Velez de Escalante first described this colonial breeding bird in September 1776 while on an expedition in the Wasatch Range of Utah. (Brown et al. 2017). Historically, cliff swallows have been associated with the western mountains of the Rockies, Sierra Nevadas, and Cascasde mountains. Over the last 100 to 150 years this species has expanded its range across the Great Plains and into north east Canada; building nests under human infrastructure such as bridges and highway culverts.

The Rocky Mountain Avian Data center (RMADC) using the Integrated Monitoring in Bird Conservation Regions (IMBCR) protocol estimates cliff swallow populations to be approximately 2,235,453 birds and they are 97% confident that these populations are declining throughout Colorado (**Table 3.30**, **Table 3.31**). Similarly, Partner's in Flight estimate cliff swallow populations to be roughly 1,195,093 birds (Partners in Flight 2017). Breeding Bird Survey trend estimates suggest that cliff swallow populations are non-significantly declining by -0.69% per year (Sauer et al. 2017). More recent BBS raw data (2013 – 2017) using PIF detectability parameters (time, pair, distance, adjustments) estimate cliff swallow numbers of 1,113,766 in Colorado (Pardiek et al. 2018, Partners in Flight 2017). Despite these overall abundances, swallow populations such as cliff swallows are less effectively surveyed by BBS since birds are often locally concentrated and may move their colonies from year to year (Brown et al. 2017). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality.

As stated previously, for our analysis we will be relying on demography and estimate information gathered from scientific literature as well as the Cornell Lab of Ornithology's Birds of North America database which has an extensive reference for life history information on over 760 species of birds. Cliff swallows migrate from their breeding range in early August and September to regions of South America (Brown et al. 2017). Conversely, birds leave these overwintering grounds in early February and begin to arrive in parts of the U.S. in late February.

Cliff swallows arrive in Colorado in mid-April and remain until late September. Both males and females reach sexual maturity at one year of age and will share the responsibility of incubating the eggs. Breeding females lay one clutch of 1 to 6 eggs (median 3.48) annually (Brown and Brown 1989).

Typically, 26% of the chicks hatched will successfully fledge; and once these birds reach adulthood, 20 – 80% will survive annually (Roche et al. 2013).

Based on these parameters, an average 2,028,075 cliff swallows with 49.7% breeding females would produce 905,868 offspring for a total of 2,933,944 birds. On average, WS-Colorado lethally removed 1,044 cliff swallows per year and dispersed an average of 10,050 birds/year from FY2013 to FY2017. The remaining cliff swallow numbers (with the addition of the young produced) would be approximately 2,932,900 birds on average each year. At this time, we are unable to quantify the take by Nuisance Wildlife Control Operators or other individuals/entities within Colorado (**Table 3.31**).

Table 3.30. Estimates and trends for cliff swallows from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Cliff swallows	200	1.00	1.24	1,113,766	1,195,093	-0.69	(-2.89, 2.05)	

Partners in Flight version 2.0 (1998-2007)				
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**
Cliff swallow	CO	1,195,093	1	0

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Cliff swallow	CO	Trend	0.93	3.23	97

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Table 3.31. Cumulative impact analysis cliff swallows lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

CLIFF SWALLOWS IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	2,235,453	1,346,645	1,832,303	1,995,158	2,730,817	**2,028,075**
% Breeding Females	49.7%	49.7%	49.7%	49.7%	49.7%	**49.7%**
Estimated Number Breeding Females	1,112,110	669,939	911,548	992,566	1,358,547	**1,008,942**
Avg. Clutch	3.48	3.48	3.48	3.48	3.48	**3.48**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	26%	26%	26%	26%	26%	**26%**
Young Produced/Post-breeding	998,497	601,498	818,424	891,165	1,219,758	**905,868**
Total Colorado Numbers	3,233,950	1,948,143	2,650,727	2,886,323	3,950,575	**2,933,944**
WS Take (%)*	0.05%	0.06%	0.06%	0.04%	0.05%	**0.05%**
WS-CO Take of Total Colorado Numbers	1,196	875	1,049	741	1,357	**1,044**
Remaining Total	3,232,754	1,947,268	2,649,678	2,885,582	3,949,218	**2,932,900**

^WS Take on average is 0.051%.

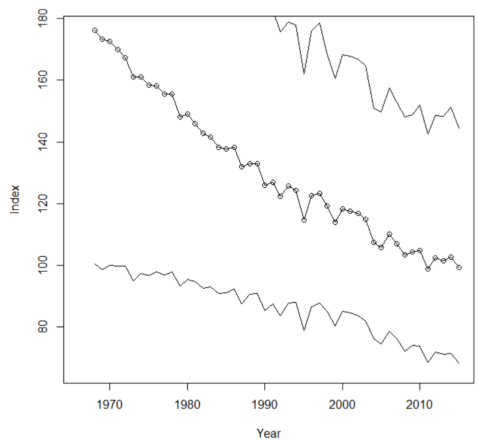


Figure 3.16. Cliff swallow annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

<u>Indirect Impacts.</u> Here we considered potential indirect impacts due to increased swallow colony dispersal at a local level. However given the variability in fidelity to breeding sites and winter home range among individuals and species, local BDM activities are not likely to adversely impact statewide populations of birds within this group. We know of no other indirect impacts to these species due to BDM conducted by WS-Colorado. We anticipate that indirect impacts to local populations of cliff swallows under Alternative 1 would be negligible, and we expect no indirect impacts to statewide populations.

Cumulative Impacts. In examining short-term and long-term trends, cliff swallow populations have been declining by -0.69% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017) (**Table 3.30**). Similarly BBS trend estimates (2008-2018), indicate that cliff swallow populations are declining (Bird Conservancy of the Rockies 2019). In analyzing recent 2013- 2017 BBS data using PIF detectability parameters (time, pair, distance) cliff swallow populations are hovering around 1,113,766 individuals and PIF data from 1998-2015 indicates Colorado numbers of 1,195,093 (**Table 3.30, 3.31**). Under Alternative 1, we anticipate that the average low magnitude of take (0.0515%) of cliff swallows by WS-Colorado would be considered negligible and would not adversely impact the state-wide numbers of cliff swallows or human environment. WS-Colorado take will not exceed 1% of the total population in Colorado.

Grassland Passerine Species

Several species of passerines that live in or utilize grasslands habitats are attracted to airport environments due to their vast expanses of native or monoculture grass habitats. True grassland species include meadowlarks, horned larks, pipits, lark buntings, and some sparrow species. Any of these grassland species may at one time or another be the target of BDM at airports throughout Colorado to protect human health and safety. Other species of birds, more common in open woodland environments such as flycatchers/kingbirds, thrashers, buntings, and finches, often forage in airport environments and may similarly be target by BDM activities when they are found in airport environments. For the most part, requests for BDM assistance related to these grassland species is confined to airport environments and involves protecting human health and safety of the public, passengers and airport personnel as they travel both internationally, nationally, or locally.

From FY2013 to FY2017 WS-Colorado recorded 19,822 BDM work tasks related to eastern kingbirds 16, western kingbirds 1,253, horned larks 16,557, and western meadowlarks 1,996 (**Table 3.6**). In response to thesetasks, WS-Colorado removed and dispersed the following species: horned larks 1,193 average birds removed/year and 28,211 average birds dispersed/year; western meadowlarks 464 average birds removed/year and 3,758 average birds dispersed/year; western kingbirds 124 average birds removed/year and 1,416 average birds dispersed/year; lark buntings 64 average birds removed/year and 1,817 average birds dispersed/year; house finches 0 average birds removed/year and 528 average birds dispersed/year; and western bluebirds 0 average birds removed/year and 54 average birds dispersed/year (**Table 3.32**). Additionally, 24 western kingbird nests and 1 western meadowlark nest were removed. As mentioned previously, we will only be performing impact analysis on bird species that have an annual average lethal take of 10 or more. Within the grassland passerine group these include: horned larks, western meadowlarks, western kingbirds, and lark buntings.

Table 3.32. Grassland species hazed and lethally removed from damage situations from FY2013-2017 by WS-Colorado.

Grassland and Open Woodland spp.						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Freed	Breeding Estimates (Colorado)	% taken by WS-CO
2017	Horned larks	2,347	63,658	0	11,687,044	0.0%
2016		458	8,630	0	12,776,475	0.0%
2015		637	29,610	0	11,768,687	0.0%
2014		1,148	21,939	0	14,061,789	0.0%
2013		1,375	17,217	0	13,264,055	0.0%
Average		**1,193**	**28,211**	**0**	**12,711,610**	**0.0%**
2017	Western meadowlarks	727	3,381	0	4,333,245	0.0%
2016		464	2,075	0	4,321,595	0.0%
2015		314	4,925	0	3,273,378	0.0%
2014		348	4,911	0	2,985,613	0.0%
2013		466	3,499	2	3,309,378	0.0%
Average		**464**	**3,758**	**0**	**3,644,642**	**0.0%**
2017	Western kingbirds	173	1,080	0	912,575	0.0%
2016		75	1,263	0	661,548	0.0%
2015		121	1,149	0	825,165	0.0%
2014		109	2,292	0	962,126	0.0%
2013		141	1,294	0	1,037,766	0.0%
Average		**124**	**1,416**	**0**	**879,836**	**0.0%**
2017	Lark buntings	28	340	0	8,376,879	0.0%
2016		22	730	0	9,272,800	0.0%
2015		1	656	0	9,961,972	0.0%
2014		180	6,200	0	7,460,432	0.0%
2013		91	1,161	0	5,092,695	0.0%
Average		**64**	**1,817**	**0**	**8,032,956**	**0.0%**
2017	House finch	0	2,293	0	1,385,710	0.0%
2016		0	248	0	1,101,029	0.0%
2015		0	0	0	1,117,002	0.0%
2014		0	100	0	961,901	0.0%
2013		0	0	0	1,014,335	0.0%
Average		**0**	**528**	**0**	**1,115,995**	**0.0%**
2017	Western bluebirds	0	200	0	113,349	0.0%
2016		0	34	0	70,761	0.0%

Grassland and Open Woodland spp.						
2015		0	0	0	310,420	0.0%
2014		0	35	0	98,570	0.0%
2013		0	0	0	166,473	0.0%
Average		**0**	**54**	**0**	**151,915**	**0.0%**

Table 3.33. Estimates and trends for grassland spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Horned larks	200	2	1.29	4,979,270	7,758,535	-2.12	(-3.58, -1.06)	
Western meadowlarks	200	1.5	1.24	4,666,136	6,497,006	-1.28	(-2.43, -0.11)	
Western kingbirds	200	2	1.63	1,469,183	2,081,780	0.64	(-1.14, 2.29)	
Lark buntings	200	1	1.07	1,467,820	1,928,051	9.01	(2.88, 15.35)	

PIF Data Quality Rating	
0	Good BBS coverage
1	Poor BBS coverage
2	Poor BBS coverage
3	Poor BBS coverage
4	Poor BBS coverage

IMBCR C.V. %	
<50%	Robust Estimate
50 - 100%	Marginal
>100%	Poor

IMBCR Trend Estimate	
>1	Increasing
1	Static
<1	Decreasing

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Table 3.34. Estimates and trends for grassland spp. from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Partners in Flight version 2.0 (1998-2007)					
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**	
Horned larks	CO	7,758,535	0	0	
Western meadowlarks	CO	6,497,006	0	0	
Western kingbirds	CO	2,081,780	0	0	
Lark buntings	CO	1,928,051	0	0	
IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Horned larks	CO	Trend	0.94	0.83	100
Western meadowlarks	CO	Trend	1.02	1.02	96
Western kingbirds	CO	Trend	0.99	1.85	80
Lark buntings	CO	Trend	1.04	3.08	86

PIF Data Quality Rating	
0	Good BBS coverage
1	Poor BBS coverage
2	
3	
4	

IMBCR C.V. %	
<50%	Robust Estimate
50 - 100%	Marginal
>100%	Poor

IMBCR Trend Estimate	
>1	Increasing
1	Static
<1	Decreasing

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Horned Larks. Linnaenus first named this species *Alauda alpestris* which roughly translates from latin "lark of the high mountains" (Beason 1995). Horned larks breed throughout North America from portions of the artic to the highlands of Mexico, and into portions of Asia (Beason 1995). This species prefers open, shortgrass prairie ecosystems with large expanses of bareground and grass clipped to a few centimeters in height (i.e. airport environments) (Weins et al. 1987, Beason 1995).

Direct Impacts. In Colorado, horned larks have been documented breeding at elevations up to 13,123 ft (Colorado Breeding Bird Atlas, 2016). Male and female horned larks attain sexual maturity at one year of age with females lay between 2 to 5 eggs (mean 4.0) annually (Beason 1995). Of the eggs lain, only 49% will survive to leave the nest as fledglings (Beason 1995).

Further details on adult horned lark annual mortality rates are unknown. For this analysis we are substituting the annual mortality rate of another member of the Passerellidae family, the dark-eyed junco. This species is fairly common year-round in Colorado and experiences a 49% annual mortality rate (Nolan et al. 2002). Using these parameters an annual average horned lark population of 8,032,956 birds would produce 7,753,376 young each year.

From FY2013 to FY2017, WS-Colorado recorded 16,557 work tasks involving horned larks related to agriculture 955 and human health and safety 15,602 (**Table 3.6**). On average, WS-Colorado lethally removed 1,193 horned larks per year and dispersed 28,211 horned larks on average/year (**Table 3.32**). The Rocky Mountain Avian Data Center (2017) estimates Colorado horned lark populations to be approximately 11,687,044 (**Table 3.35**). Partner's in Flight population estimates from 1998 to 2015 suggest 7,758,535 horned larks reside year-round within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates horned lark populations are 4,979,270 (**Table 3.33**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. This represents an average annual lethal removal of 0.0094% of the total Colorado horned lark numbers.

Table 3.35. Cumulative impact analysis horned larks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

HORNED LARKS IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	11,687,044	12,776,475	11,768,687	14,061,789	13,264,055	**12,711,610**
% Breeding Females in	64.5%	64.5%	64.5%	64.5%	64.5%	**64.5%**
Estimated Number Breeding Females	7,542,702	8,245,810	7,595,394	9,075,339	8,560,489	**8,203,947**
Avg. Clutch	3	3	3	3	3	**3**
Avg. Nests	2	2	2	2	2	**2**
% Fledge	53.0%	53.0%	53.0%	53.0%	53.0%	**53.0%**
Young Produced/Post-breeding	23,985,793	26,221,676	24,153,352	28,859,578	27,222,356	**26,088,551**
Total Colorado Numbers	35,672,837	38,998,151	35,922,039	42,921,367	40,486,411	**38,800,161**
WS Take (%)*	0.02%	0.00%	0.01%	0.01%	0.01%	**0.01%**
WS-CO Take of Total Colorado Numbers	2,347	458	637	1,148	1,375	**1,193**
Remaining Total	35,670,490	38,997,693	35,921,402	42,920,219	40,485,036	**38,798,968**

^WS Take on average is 0.0094%.

Table 3.36. Estimates and trends for horned larks from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Horned lark	200	2	1.29	4,979,270	7,758,535	-2.12	(-3.58, -1.06)	

Partners in Flight version 2.0 (1998-2007)				
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**
Horned lark	CO	7,758,535	0	0

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Horned lark	CO	Trend	0.94	0.83	100

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

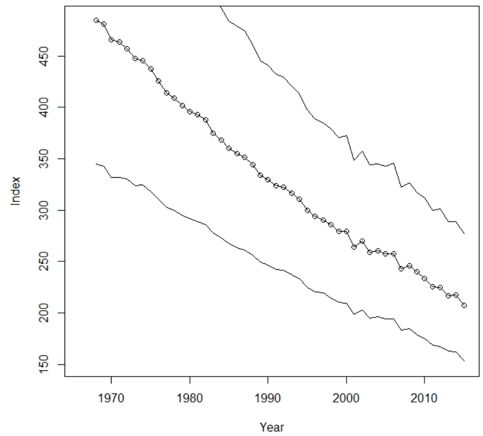


Figure 3.17. Horned lark annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Horned larks are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of horned larks (0.0094%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, horned lark populations have been significantly declining by -2.12% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017) (**Table 3.33**). Similarly RMADC trend estimates (2008-2018), indicate that horned lark populations are declining (Bird Conservancy of the Rockies 2019). In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) horned lark populations are hovering around 4,979,270 individuals and PIF data from 1998-2015 indicates a Colorado population of 7,758,535 (**Table 3.33**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.0094%) of horned larks by WS-Colorado, in airport environments would be considered negligible and would not adversely impact the state wide population or human environment. WS-Colorado take will not exceed 1% of the total population in Colorado.

Western Meadowlarks. First named by James Audubon in 1844, the western meadowlark interestingly is more closely related to New World blackbird species than lark species (Davis and Lanyon 2008). Easily recognized by its white tail margins and yellow breast, meadowlarks occupy native grasslands and converted croplands. Year-round residents of Colorado, western meadowlarks predominately feed on grain seeds during the winter and early spring, invertebrates in late spring and summer, and weed seeds during the fall (Davis and Lanyon 2008).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 1,996 BDM work tasks involving western meadowlarks related to property 65 and human health and safety 1,931 (**Table 3.6**). On average, WS-Colorado lethally removed 464 western meadowlarks per year, removed 1 nest, and dispersed 3,758 western meadowlarks on average/year (**Table 3.32**). The Rocky Mountain Avian Data Center (2017) estimates Colorado western meadowlark populations to be approximately

4,333,245 (**Table 3.37**). Partner's in Flight estimates from 1998 to 2007 suggest 6,497,006 western meadowlarks reside year-round within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates western meadowlark populations are 4,666,136 (**Table 3.33, 3.34, 3.38**). This represents an average annual lethal removal of 0.0127% of the total Colorado western meadowlark numbers (**Table 3.37**).

Male and female western meadowlarks reach sexual maturity during their second year of life (Davis and Lanyon 2008). As a polygynous species, males usually breed with two females concurrently. Breeding females may lay several clutches of each year due to nesting failures. But, no more than two of these clutches are likely to be successful (Davis and Lanyon 2008). Each clutch may contain 3 to 7 eggs (median 5) and only 42% of these eggs will be fledged from the nest (Davis and Lanyon 2008). In wild populations, the annual survival rate is hard to determine because adults rarely return to natal locations. Here, we used the annual survival rate of the red-winged blackbird, another member or the Icteridae family that is widely distributed year-round throughout Colorado.

Using these parameters annual average western meadowlark numbers of 3,644,642 would annually produce an average of 7,876,672 young (**Table 3.37**). Given that WS-Colorado removed on average 464 western meadowlarks per year, the annual lethal take for this species would equal 0.0127% of the total Colorado western meadowlark numbers (**Table 3.37**).

Table 3.37. Cumulative impact analysis western meadowlarks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

WESTERN MEADOWLARKS IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado	4,333,245	4,321,595	3,273,378	2,985,613	3,309,378	**3,644,642**
% Breeding Females	51.5%	51.5%	51.5%	51.5%	51.5%	**51.5%**
Estimated Number Breeding Females	2,229,728	2,223,733	1,684,360	1,536,286	1,702,884	**1,875,398**
Avg. Clutch	5	5	5	5	5	**5**
Avg. Nests	2	2	2	2	2	**2**
% Fledge	42.0%	42.0%	42.0%	42.0%	42.0%	**42.0%**
Young Produced/Post-breeding	9,364,858	9,339,680	7,074,310	6,452,402	7,152,112	**7,876,672**
Total Colorado Numbers	13,698,103	13,661,275	10,347,688	9,438,015	10,461,490	**11,521,314**
WS Take (%)*	0.02%	0.01%	0.01%	0.01%	0.01%	**0.01%**
WS-CO Take of Total Colorado Numbers	727	464	314	348	466	**464**
Remaining Total	13,697,376	13,660,811	10,347,374	9,437,667	10,461,024	**11,520,850**

^WS Take on average is 0.0127%.

Table 3.38. Estimates and trends for western meadowlarks from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Western meadowlark	200	1.5	1.24	4,666,136	6,497,006	-1.28	(-2.43, -0.11)	[blue]

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
Western meadowlark	CO	6,497,006	0	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Western meadowlark	CO	Trend	1.02	1.22	96

PIF Data Quality Rating	
0	Good BBS coverage
1	Poor BBS coverage
2	
3	
4	

IMBCR C.V. %	
<50%	Robust Estimate
50 - 100%	Marginal
>100%	Poor

IMBCR Trend Estimate	
>1	Increasing
1	Static
<1	Decreasing

BBS Trend Estimate Data 1966 - 2015	
[red]	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
[yellow]	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
[blue]	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

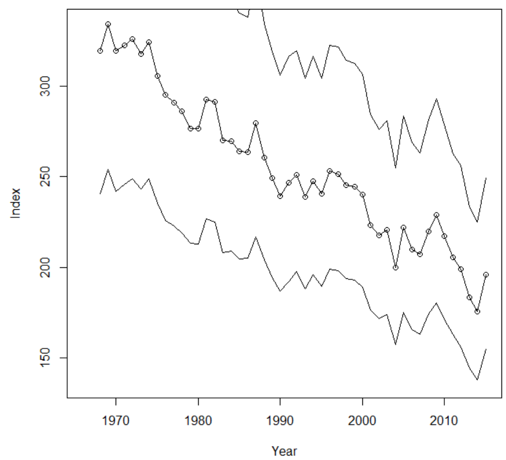


Figure 3.18. Western meadowlark annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Western meadowlarks are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of western meadowlarks (0.0127%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, western meadowlark populations have been significantly declining by -1.28% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017). Conversely, RMADC trend estimates (2008-2018), are 96% confident that western meadowlark populations are increasing (Bird Conservancy of the Rockies 2019). In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) western meadowlark populations are hovering around 4,666,136 individuals and PIF data from 1998-2015 indicate Colorado numbers of 6,497,006 (**Table 3.38**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.0127%) of western meadowlarks by WS-Colorado, in airport environments would be considered negligible and would not adversely impact the state-wide numbers or human environment. WS-Colorado take will not exceed 1% of the total western meadowlark populations in Colorado.

Western Kingbirds. Western kingbirds occupy a variety of habitats including woodlands, savannahs, riparian forests, shrublands, cropland, pastures, and urban areas; however, they usually remain below 7,000 ft in elevation (Gamble and Bergin 2012). In Colorado, western kingbirds are common on the eastern plains and scattered throughout the lower elevations of the western slope. As a neotropical migrant, this species departs from their breeding grounds in starting mid-July to wintering areas in Mexico and Central America (Gamble and Bergin 2012).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 1,253 BDM work tasks involving western kingbirds related to property 17 and human health and safety 1,236 (**Table 3.6**). On average, WS-Colorado lethally removed 124 western kingbirds per year, removed 24 nests, and dispersed

1,416 western kingbirds on average/year (**Table 3.32**). The Rocky Mountain Avian Data Center (2017) estimates Colorado western kingbird populations to be approximately 912,575 (**Table 3.39**). Partner's in Flight population estimates from 1998 to 2015 suggest 2,081,780 western kingbirds reside year-round within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates western kingbird populations are 1,469,183 (**Table 3.34, 3.40**). This represents an average annual lethal removal of 0.0008% of the total Colorado western kingbird numbers.

Western kingbirds sexually mature during their first year of age and produce one brood/season (Gamble and Bergin 2012). Females lay 2 to 7 eggs per clutch (average 4) and on average 1.3 young fledge/clutch (Gamble and Bergin 2012). In wild populations, the annual survival rate is hard to determine because adults rarely return to natal locations. Here, we used the annual survival rate of the eastern kingbird, a closely related member of the Tyrannidae family.

Using these parameters annual average western kingbird estimates of 879,836 would annually produce an average of 752,079 young (**Table 3.39**). Given that WS-Colorado removed on average 464 western kingbirds per year, the annual lethal take for this species would equal 0.0127% of total Colorado western kingbird numbers (**Table 3.39**).

Table 3.39. Cumulative impact analysis western kingbird lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

WESTERN KINGBIRDS IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	912,575	661,548	825,165	962,126	1,037,766	**879,836**
% Breeding Females	65.8%	65.8%	65.8%	65.8%	65.8%	**65.8%**
Estimated Number Breeding Females	600,049	434,990	542,574	632,631	682,367	**578,522**
Avg. Clutch	4	4	4	4	4	**4**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	32.5%	32.5%	32.5%	32.5%	32.5%	**32.5%**
Young Produced/Post-breeding	780,064	565,488	705,347	822,420	887,077	**752,079**
Total Colorado Numbers	1,692,639	1,227,036	1,530,512	1,784,546	1,924,843	**1,631,915**
WS Take (%)*	0.02%	0.01%	0.01%	0.01%	0.01%	**0.0%**
WS-CO Take of Total Colorado Numbers	173	75	121	109	141	**124**
Remaining Total	1,692,466	1,226,961	1,530,391	1,784,437	1,924,702	**1,631,791**

^WS Take on average is 0.0141%.

Table 3.40. Estimates and trends for western kingbirds from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Western kingbird	200	2	1.63	1,469,183	2,081,780	0.64	(-1.14, 2.29)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
Western kingbird	CO	2,081,780	0	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Western kingbird	CO	Trend	0.99	1.85	80

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

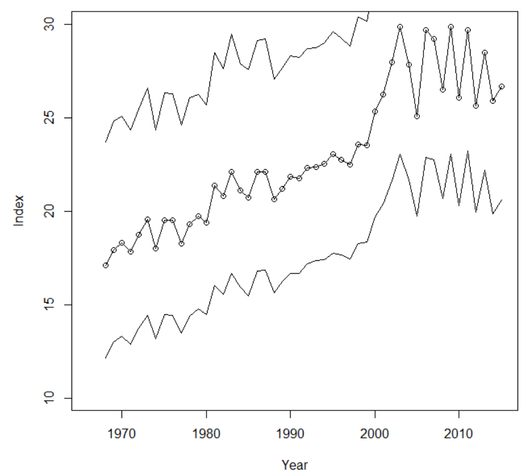


Figure 3.19. Western kingbirds annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Western kingbirds are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.0141%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, western kingbird populations have been non-significantly increasing by 0.64% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017). Conversely, RMADC trend estimates (2008-2018), are 80% confident that western kingbird populations are decreasing (Bird Conservancy of the Rockies 2019). In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) western kingbird populations are hovering around 1,469,183 individuals and PIF data from 1998-2015 indicate Colorado numbers of 2,08,780 (**Table 3.40**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.0141%) of western kingbirds by WS-Colorado, in airport environments would be considered negligible and would not adversely impact the state wide population or human environment. WS-Colorado take will not exceed 1% of the total western kingbirds in Colorado.

Lark Buntings. Colorado's state bird, the lark bunting, breeds in the grasslands and shrub-steppes of the high plains (Shane 2000). In late July populations of 20-50 birds begin forming and most migrate along the high eastern plains of the Rocky Mountains to winter in Texas, Arizona, and Mexico (Shane 2000).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 2,659 BDM work tasks involving lark buntings related to human health and safety (**Table 3.6**). On average, WS-Colorado lethally removed 64 lark buntings per year and dispersed 1,817 lark buntings on average/year (**Table 3.32**). The Rocky Mountain Avian Data Center (2017) estimates Colorado lark bunting populations to be approximately 8,376,879 (**Table 3.41**). Partner's in Flight population estimates from 1998 to 2015 suggest 1,928,051 reside within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates lark bunting populations are 1,467,820 (**Table 3.42**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. This represents an average annual lethal removal of 0.0018% of total Colorado lark bunting numbers.

Both male and female lark buntings breed during their second year of life (Shane 2000). Females select males based on beak size, body mass and shape, wing-patch size, and color (Chaine and Lyon 2008). In general, females will only produce one clutch each season, laying 3.6 to 4 eggs (Shane 2000). Of these eggs roughly 49.8% will fledge (Shane 2000).

Similar to other passerine species, a lack of banded bird recoveries has led to insufficient data regarding adult annual survival rates. Here we again used the dark eyed junco adult annual mortality rate (49%) to calculate the percent of breeding females in a population. Using these parameters, given an average annual number of 8,032,956 lark buntings in Colorado with 48.5% of the breeding females producing young, each year an average of 7,756,376 young would be added annually (**Table 3.41**). Given an average annual removal rate by WS-Colorado of 0.008%, this would leave 15,786,267 lark buntings left in Colorado (**Table 3.41**).

Table 3.41. Cumulative impact analysis lark bunting lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

LARK BUNTINGS IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	8,376,879	9,272,800	9,961,972	7,460,432	5,092,695	**8,032,956**
% Breeding Females	48.5%	48.5%	48.5%	48.5%	48.5%	**48.5%**
Estimated Number Breeding Females	4,058,900	4,493,006	4,826,935	3,614,848	2,467,594	**3,892,257**
Avg. Clutch	4	4	4	4	4	**4**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	49.8%	49.8%	49.8%	49.8%	49.8%	**49.8%**
Young Produced/Post-breeding	8,085,329	8,950,068	9,615,254	7,200,778	4,915,448	**7,753,376**
Total Colorado Numbers	16,462,208	18,222,868	19,577,226	14,661,210	10,008,143	**15,786,331**
WS Take (%)*	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
WS-CO Take of Total Colorado Numbers	28	22	1	180	91	**64**
Remaining Total	16,462,180	18,222,846	19,577,225	14,661,030	10,008,052	**15,786,267**

^WS Take on average is 0.0008%.

Table 3.42. Estimates and trends for lark buntings from Partners in Flight (version 2.0), Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters, and Rocky Mountain Avian Data Center IMBCR density and trend data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Lark bunting	200	1	1.07	1,467,820	1,928,051	9.01	(2.88, 15.35)	

Partners in Flight version 2.0 (1998-2007)				
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**
Lark bunting	CO	1,928,051	0	0

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Lark bunting	CO	Trend	1.04	3.08	86

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

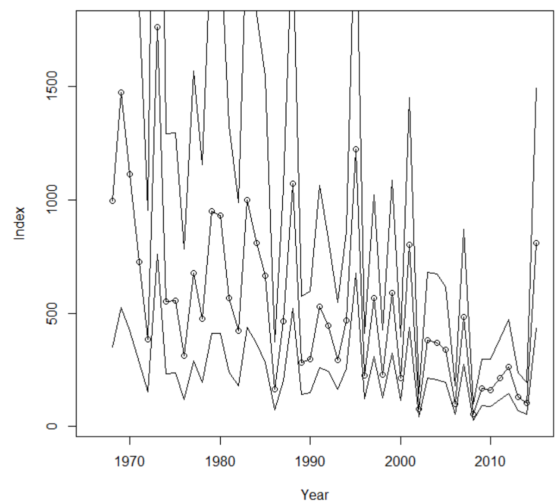


Figure 3.20. Lark bunting annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Lark buntings are most often removed in airport environments to reduce hazards to aircraft. The low-magnitude of WS-Colorado's average annual lethal take of (0.0008%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, lark bunting populations have been significantly increasing by 9.01% change/year from 2005 to 2015 (BBS 2005 -2015) (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 86% confident that lark bunting populations are increasing (Bird Conservancy of the Rockies 2019). In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) lark bunting populations are hovering around 1,928,051 individuals and PIF data from 1998-2015 indicate Colorado numbers of 1,467,820 (**Table 3.42**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.008%) of local lark bunting populations by WS-Colorado, in airport environments would be considered negligible and would not adversely impact the state wide population or human environment. WS-Colorado take will not exceed 1% of the total lark buntings in Colorado.

Waterfowl

Several species of waterfowl are present in Colorado during some portion of the year with most occurring during migration and winter. These species, 19 ducks, 5 geese, 1 swan, 1 coot, and 1 crane, primarily pass through Colorado from their northern breeding grounds. Of these, 16 species of waterfowl commonly breed in the state and are documented on BBS transects: the Canada goose, gadwall, American wigeon, mallard, blue-winged teal, cinnamon teal, northern shoveler, Northern pintail, green-winged teal, redhead, ring-necked duck, lesser scaup, common merganser, ruddy duck, American coot, and sandhill crane (USGS 2012). Four other species have been documented on BBS routes prior to 2006 in Colorado including the wood duck, canvasback, bufflehead, and hooded merganser, but only in minimal numbers. Additionally, Colorado has 15 species of ducks, swans, and geese and 2 gallinules that are accidental in the state.

Conservation efforts over the last several decades such as closely regulating hunter harvest, slowing the loss of wetlands, and improving the quality of wetland habitat have helped reverse declining numbers in the early to mid-twentieth century for many waterfowl species. In response to the conservation efforts of wildlife managers, sportsmen, conservationists, and others, waterfowl populations, particularly Canada geese, snow geese, Ross's geese, and mallards, have flourished in recent years. These species of waterfowl, especially the midcontinent populations of geese, are considered "overabundant" and cause extensive damage to natural resources (snow geese are damaging their breeding grounds from their sheer numbers), agricultural crops, property, and other resources, and can pose a threat to human health and safety, especially at airports. Of the 44 species that have been found in Colorado, including accidentals, any could be associated with a BDM project at an airport, but few actually damage other resources such as agricultural crops.

WS-Colorado lethally removed 9 species of waterfowl from FY2013 to FY2017, with Canada geese, mallards, and blue-winged teal having an average lethal removal of 10 or more (**Table 3.43**). The majority of these species are lethally removed in airport environments to protect human health and safety of the public and airport personnel, although some were collected for disease surveillance within the state. It should be noted that any of these waterfowl species could be involved in BDM and could be taken, though the 5 year averages in **Table 3.43** gives a good indication of the species and the numbers that would likely be involved in WS-Colorado BDM.

In analyzing the species that are commonly involved in WS-Colorado BDM activities, only mallards (-2.27%/year) and northern pintail (-1.07%/year) are experiencing significant long-term declines (**Table 3.44**)(Sauer et al. 2017). Other species such as Canada geese (7.21%/year), blue-winged teal (3.59%/year), gadwall (1.69%/year), American coot (2.44%/year), ring-necked duck (4.47%/year), canvasback duck (2.62%/year), redhead duck (2.22%/year), and sandhill cranes (12.59%/year) have experienced increases from 2005-2015 (**Table 3.44**)(Sauer et al. 2017). Additionally, green-winged teal populations from 2005-2015 show a non-significant decline of -2.85% per year and northern shoveler populations are experiencing a significant increase of 18.3%/year (**Table 3.44**)(Sauer et al. 2017). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality.

In all, most waterfowl populations are doing well despite annual harvests from sportsmen in the thousands, a much higher percentage of the total number removed by WS-Colorado. **Table 3.45** and **3.46** gives estimated waterfowl populations average hunter harvest in the Central and Pacific flyways, as well as in Colorado.

Table 3.43. Waterfowl species hazed and lethally removed from damage situations from FY2013-2017 by WS-Colorado. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years. Canada geese numbers are based on CPW resident population estimates (Gammonley 2019).

Waterfowl spp.						
WS Bird Damage Management Activities					Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Breeding Population Estimates (Colorado)	% Population taken by WS-CO
2017	**Mallard ducks**	232	1,151	358	35,698	0.6%
2016		65	1,119	248	42,159	0.2%
2015		83	24,385	132	27,700	0.3%
2014		69	1,125	0	23,500	0.3%
2013		93	2,444	1	30,054	0.3%
Average		**108**	**6,045**	**148**	**31,822**	**0.3%**
2017	**Canada geese**	265	42,431	0	44,000	0.6%
2016		434	66,721	0	44,000	1.0%
2015		182	214,503	0	44,000	0.4%
2014		288	168,514	0	44,000	0.7%
2013		402	102,847	0	44,000	0.9%
Average		**314**	**119,003**	**0**	**44,000**	**0.7%**
2017	**Blue-winged teal ducks**	3	35	18	2,260	0.1%
2016		0	120	9	3,965	0.0%
2015		6	233	10	3,876	0.2%
2014		16	143	0	1,632	1.0%
2013		24	653	0	1,420	1.7%
Average		**10**	**237**	**7**	**2,631**	**0.4%**
2017	**Gadwall ducks**	2	12	127	3,612	0.1%
2016		0	31	36	1,724	0.0%
2015		0	85	43	573	0.0%
2014		2	142	0	2,592	0.1%
2013		0	0	0	1,364	0.0%
Average		**1**	**54**	**41**	**1,973**	**0.0%**
2017	**Northern shoveler ducks**	1	56	8	960	0.1%
2016		0	0	0	1,027	0.0%
2015		2	60	6	174	1.1%
2014		16	58	0	820	2.0%
2013		11	69	0	935	1.2%
Average		**6**	**49**	**3**	**783**	**0.8%**
2017	**American coots**	0	65	0	10,593	0.0%
2016		0	0	0	86,941	0.0%
2015		0	0	0	16,124	0.0%
2014		0	0	0	4,262	0.0%

2013		0	0	0	5,629	0.0%
Average		**0**	**13**	**0**	**24,710**	**0.0%**
2017	**Ring-necked ducks**	0	212	0	NA	0.0%
2016		0	135	0	NA	0.0%
2015		0	0	0	NA	0.0%
2014		0	40	0	NA	0.0%
2013		0	0	0	N/A	0.0%
Average		**0**	**77**	**0**	**NA**	**0.0%**
2017	**Green-winged teal ducks**	0	0	0	1,075	0.0%
2016		2	42	5	1,317	0.2%
2015		3	163	0	3,325	0.1%
2014		15	465	0	2,714	0.6%
2013		3	216	0	2,513	0.1%
Average		**5**	**177**	**1**	**2,189**	**0.2%**
2017	**Canvasback ducks**	0	0	0	NA	0.0%
2016		0	35	9	NA	0.0%
2015		0	0	0	NA	0.0%
2014		0	0	0	NA	0.0%
2013		0	0	0	NA	0.0%
Average		**0**	**7**	**2**	**NA**	**0.0%**
2017	**Redhead ducks**	0	0	0	NA	0.0%
2016		0	121	4	NA	0.0%
2015		0	0	0	NA	0.0%
2014		0	0	0	NA	0.0%
2013		0	159	0	NA	0.0%
Average		**0**	**56**	**1**	**NA**	**0.0%**
2017	**Cinnamon teal ducks**	0	0	0	NA	0.0%
2016		0	2	26	NA	0.0%
2015		0	14	11	NA	0.0%
2014		0	0	0	NA	0.0%
2013		0	0	0	NA	0.0%
Average		**0**	**3**	**7**	**NA**	**0.0%**
2017	**Northern pintail ducks**	0	0	0	700	0.0%
2016		0	0	0	633	0.0%
2015		0	2,432	0	6,506	0.0%
2014		7	381	0	549	1.3%
2013		0	47	0	662	0.0%
Average		**1**	**572**	**0**	**1,810**	**0.1%**
2017	**Sandhill cranes**	0	0	0	715	0.0%
2016		1	125	0	579	0.2%
2015		0	1,777	0	281	0.0%
2014		0	114	0	272	0.0%

2013		4	8,651	0	408	1.0%
Average		**1**	**2,133**	**0**	**451**	**0.2%**
2017	**Lesser scaup**	0	0	0	18	0.0%
2016		0	0	0	42	0.0%
2015		0	0	0	23	0.0%
2014		0	0	0	23	0.0%
2013		13	29	0	58	22.4%
Average		**3**	**6**	**0**	**33**	**7.9%**

Table 3.44. Estimates and trends for waterfowl spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	RMADC C.V. Average (2013-2017)	RMADC Estimated Average (2013-2017)	BBS Data w/PIF (2013-2017)	Detectability Parameter Factors (PIF)	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	BBS Data
Mallard duck	**91.6**	31,822	71,185	**2**	**-2.27**	**CO**	**(-5.44, 0.41)**	
Canada goose (resident)	**216.4**	11,565	104,832	**2**	**7.21**	**CO**	**(0.17, 15.19)**	
Blue-winged teal duck	**172.8**	2,630	4,167	**2**	**3.59**	**CO**	**(-5.72, 14.29)**	
Gadwall	**623.2**	1,973	17,492	**2**	**1.69**	**CO**	**(-3.23, 8.89)**	
Northern shoveler	**264.6**	783	4,284	**2**	**18.3**	**CO**	**(4.88, 36.00)**	
American coot	**416.0**	9,059	25,471	**2**	**2.44**	**CO**	**(-3.06, 8.69)**	
Ring-necked duck	**NA**	NA	4,009	**2**	**4.47**	**CO**	**(-5.66, 12.61)**	
Green-winged teal duck	**229.2**	2,188	4,009	**2**	**-2.85**	**CO**	**(-10.25, 3.46)**	
Canvasback duck	**NA**	NA	118	**2**	**2.62**	**BCR 10**	**(-12.58, 12.10)**	
Redhead duck	**NA**	NA	2,476	**2**	**2.22**	**CO**	**(-9.05, 12.21)**	
Cinnamon teal duck	**NA**	NA	4,678	**2**	**-2.91**	**CO**	**(-11.21, 3.27)**	
Northern pintail duck	**281.8**	1,810	1,494	**2**	**-1.07**	**CO**	**(-10.32, 12.47)**	

Sandhill crane	**120.0**	451	5,031	**2**	**12.59**	**CO**	**(3.57, 19.67)**	
Lesser scaup	**882.6**	37	8,097	**2**	**-3.23**	**CO**	**(-9.64,3.49)**	

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State/Region**	**Metric**	**Median**	**CV**	**f (%)**
Mallard	CO	Trend	0.92	6.73	89
Blue-winged teal	Colorado	Trend	1.14	19.2	79
Canada goose (resident)	Colorado	Trend	0.99	5.07	59

PIF Data Quality Rating		**IMBCR C.V. %**		**IMBCR Trend Estimate**	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Table 3.45. Mallard and blue-winged teal USFWS hunter harvest estimates in the Central and Pacific flyways, hunter harvest in Colorado, and Central flyway estimates.

Species	Year	USFWS Estimated Harvest Central Flyway	USFWS Estimated Harvest Pacific Flyway	Colorado Harvest	Central Flyway Population Estimates
Mallard	2013	74,084	715,358	34,122	2,126,645
	2014	813,668	785,215	54,497	1,594,569
	2015	714,448	766,165	40,510	1,639,358
	2016	716,017	830,356	47,573	1,943,698
	2017	610,977	863,583	44,130	1,999,759
Blue-winged teal	2013	403,571	43,178	11,483	2,129
	2014	411,700	32,366	9,347	6,082
	2015	390,079	28,507	3,317	28,009
	2016	378,980	44,032	4,198	14,241
	2017	324,435	58,753	2,894	23,921

Table 3.46. Canada goose USFWS hunter harvest estimates in the Central, Hi-Line Population, and Rocky Mountain Population hunter harvest in Colorado, and Central flyway population estimates.

Species	Year	USFWS Estimated Harvest Central Flyway	USFWS Estimated Harvest Pacific Flyway	Colorado Harvest	Central Flyway Population Estimate	Hi-Line Population Estimate	Rocky Mt. Population Estimate
Canada Goose	2013	682,310	253,604	91,554	1,693,482	286,753	14,966
	2014	695,472	286,154	101,543	1,603,125	280,194	13,659
	2015	479,426	247,582	67,723	1,813,801	238,844	9,172
	2016	586,558	250,559	93,085	1,550,219	281,324	13,384
	2017	667,891	277,226	95,410	1,718,048	341,302	37,831

Mallards, American Wigeons, and Other Ducks. WS-Colorado took minimal numbers of ducks from FY2013 to FY2015 (**Table 3.43**). Mallards and wigeons cause similar damage to Canada geese, primarily to landscaping, greens on golf courses, and water quality. Mallards, in particular, can contaminate swimming pools and other landscaped water features with bird fecal material. Generally, these species are hazed from damage situations, but Mallards in particular, habituate rapidly to hazing methods without lethal reinforcement. From FY2013 to FY2017 WS-Colorado lethally removed on average/year 108 mallards, 0 American widgeon, 10 blue-winged teal, 1 gadwall, 6 northern shoveler, 0 ring-necked duck, 5 green-winged teal, 0 canvasback, 0 redhead, 0 cinnamon teal, and 1 northern pintail (**Table 3.43**). During this same time period, WS-Colorado dispersed on average/year 6,045 mallards, 0 American widgeon, 237 blue-winged teal, 54 gadwall, 49 northern shoveler, 77 ring-necked duck, 177 green-winged teal, 7 canvasback, 56 redhead, 3 cinnamon teal, and 572 northern pintail (**Table 3.43**). These numbers represent a minimal percentage of their populations and, if taken, would have a low magnitude of impact on their populations

Mallard. In North America, mallard ducks are the most abundant of the dabbling ducks. Commonly recognized by male's characteristic green head, gray flanks, and black tail-curl, both wild and domestic mallards are the standard against which all other ducks are compared. A year-round resident of Colorado, this species is commonly found throughout the state with higher concentrations being observed along the Front Range and North Park areas.

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 3,083 BDM work tasks involving mallard ducks related to agriculture 323, human health and safety 2,514, and natural resources 246 (**Table 3.6**). On average, WS-Colorado lethally removed 108 mallard ducks per year and dispersed 6,045 on average/year (**Table 3.43**). The Rocky Mountain Avian Data Center (2017) estimates Colorado mallard populations to be approximately 35,698 (**Table 3.47**). Breeding Bird Survey population trend estimates from 2005 to 2015 suggest mallard populations in Colorado are facing significant long-term declines of -2.27%/year and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters (Rich et al. 2004) indicates mallard populations are hovering around 71,185 birds (**Table 3.44, 3.48**). Mallards sexually mature during their first year of age and produce one brood/season (Drilling et al. 2018). Females lay 1 to 13 eggs per clutch (average 8.7) and on average 35% of the ducklings that hatch fledge (Drilling et al. 2018). In wild populations, the annual survival rate is hard to determine, but is estimated for adult males to be 62-68% and for adult females 54-59% (Drilling et al. 2018).

Using these parameters an annual average of 31,822 mallards would annually produce an average of 54,769 young (**Table 3.47**). Given that WS-Colorado removed on average 108 mallards per year, the annual lethal take for this species would equal 0.3406% of total Colorado mallard numbers (**Table 3.47**).

Table 3.47. Cumulative impact analysis mallard ducks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

MALLARD DUCK IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	35,698	42,159	27,700	23,500	30,054	**31,822**
% Breeding Females	56.5%	56.5%	56.5%	56.5%	56.5%	**56.5%**
Estimated Number Breeding Females	20,177	23,829	15,657	13,283	16,987	**17,986**
Avg. Clutch	8.7	8.7	8.7	8.7	8.7	**8.7**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	35%	35%	35%	35%	35%	**35%**
Young Produced/Post-breeding	61,439	72,559	47,674	40,446	51,726	**54,769**
Total Colorado Numbers	97,137	114,718	75,374	63,946	81,780	**86,591**
WS Take (%)	0.6%	0.2%	0.3%	0.3%	0.3%	**0.3%**

MALLARD DUCK IMPACT ANALYSIS						
WS-CO Take of Total Colorado Numbers	232	65	83	69	93	**108**
Remaining Total	96,905	114,653	75,291	63,877	81,687	**86,483**

^WS Take on average is 0.3406%.

Table 3.48. Estimates and trends for mallard populations from Breeding Bird Survey data (1966-2015)(Sauer et al. 2017).

BBS Trend Estimates 1966-2015						
Species	**State Region**	**Trend Estimates 1966-2015 (% change per year)**	**1966-2015 Credible Interval**	**Trend Estimates 2005-2015 (% change per year)**	**2005-2015 Credible Interval**	**Color Code Trend**
Mallard	Northern Rockies (BCR 10)	-0.18	(-1.03, 0.67)	0.37	(-1.39, 2.39)	
Mallard	Southern Rockies (BCR 16)	-0.9	(-2.14, 0.32)	-0.33	(-3.00, 2.52)	
Mallard	Shortgrass Prairie (BCR 18)	-1.13	(-3.42, 0.49)	-0.70	(-4.43, 3.13)	
Mallard	CO	-2	(-2.72, -0.44)	-2.27	(-5.44, 0.41)	

Figure 3.21. Mallard duck annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

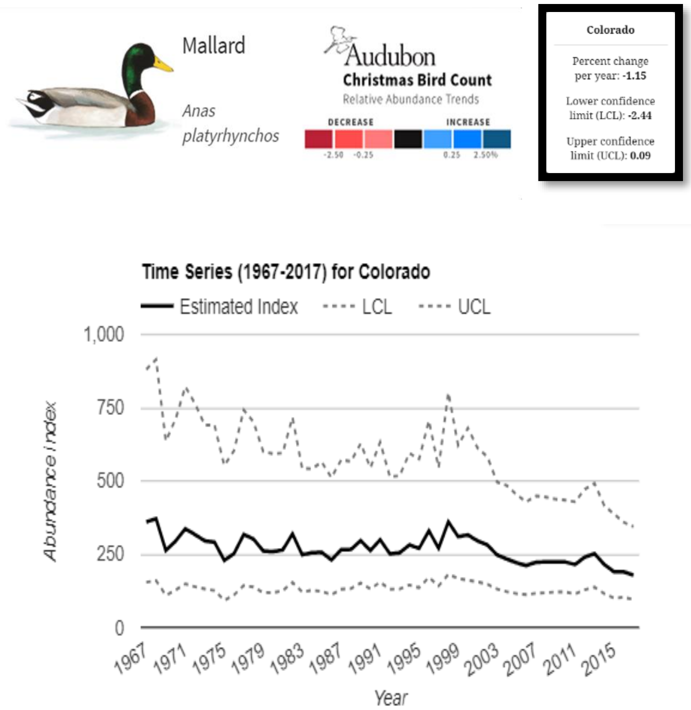


Figure 3.22. Estimated mallard duck population abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

<u>Indirect Impacts</u>. Mallard ducks are most often removed in airport environments to reduce hazards to aircraft and to a lesser extent in agricultural damage situations. The low-magnitude of WS-Colorado's average annual lethal take of (0.3406%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced. Furthermore, mallard populations are more likely impacted by hunter harvest throughout the Central and Pacific flyways as seen in **Table 3.45**. The lethal removal of this species is regulated by the USFWS in these regions and if these populations were not viable (able to account for this lethal removal and not be extirpated) then these populations should similarly be able to re-bound from WS-Colorado's limited take.

<u>Cumulative Impacts.</u> In examining short-term and long-term trends, mallard populations have been facing significant long-term declines from 1966 to 2015 of -1.55%/year and by -2.27%% from 2005-2015 (**Table 3.44, 3.48**) (Sauer et al. 2017). Additionally, **Table 3.48** shows that similar declines are being observed throughout BCR 10 (Northern Rockies) -0.18%/year from 1966-2015, BCR 16 (Southern Rockies) -0.9%/year, and BCR 18 (Shortgrass prairie) -1.13%/year (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 89% confident that mallard populations are declining (Bird Conservancy of the Rockies 2019). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. We can visualize these abundance trends by analyzing **Figures 3.21** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.22** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide an estimated number, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that mallard populations are declining by -1.15%/year from 1967 – 2017 in Colorado (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (0.3406%) of mallards by WS-Colorado would be considered negligible and would not adversely impact the state wide numbers or human environment. WS-Colorado take will not exceed 1% of the mallards in Colorado.

It should be noted that many species of ducks, especially those that breed in Arctic areas where some birds from Asia or Europe mingle with them, could be collected to sample for international diseases such as H5N1 highly pathogenic avian influenza. This could increase the level of take during a given year depending on the species targeted for collection. However, when possible, data would be collected from hunter harvested ducks or with capture and release methods.

Blue-winged teal. Another small dabbling duck, the blue-winged teal breed throughout the north-central U.S. and Canada. Blue-winged teal pair up in late winter and migrate in early spring. This species prefers small shallow ponds and wetlands with an abundance of grass and a limited amount of brush cover (Livezey 1981).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 1,143 work tasks involving blue-winged teal related to agriculture 19, human health and safety 1,113, and natural resources 11(**Table 3.6**). On average, WS-Colorado lethally removed 10 blue-winged teal ducks per year, dispersed 237 on average/year, and released 7 on average/year (**Table 3.43**). The Rocky Mountain Avian Data Center (2017) estimates Colorado blue-winged teal populations to be approximately 2,260 (**Table 3.49**). Breeding Bird Survey trend estimates from 2005 to 2015 suggest blue-winged teal populations in Colorado are facing non-significant increases of 3.59%/year and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters (Rich et al. 2004) indicates blue-winged teal populations are hovering around 4,167 birds (**Table 3.44, 3.50**).

Female blue-winged teal reach sexual maturity at one year of age and typically return to their natal breeding range. Nesting begins in late April with females laying on average 10 eggs per clutch with one brood per season (Rohwer et al 2002). Reproductive success varies each season, but on average 20% of ducklings that hatch will fledge (Rohwer et al. 2002). Annual adult survival is estimated to be 52% for adult females and 44% for adult males (Rohwer et al. 2002).

Using these parameters an annual average of 2,631 blue-winged teal would annually produce an average of 2,707 young (**Table 3.49**). Given that WS-Colorado removed on average 10 blue-winged teal per year, the annual lethal take for this species would equal 0.3725% of the total Colorado blue-winged teal numbers (**Table 3.49**).

Table 3.49. Cumulative impact analysis blue-winged teal lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

BLUE-WINGED TEAL IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	2,260	3,965	3,876	1,632	1,420	**2,631**
% Breeding Females	51.5%	51.5%	51.5%	51.5%	51.5%	**51.5%**
Estimated Number Breeding Females	1,163	2,040	1,994	840	731	**1,354**
Avg. Clutch	10	10	10	10	10	10
Avg. Nests	1	1	1	1	1	**1**
% Fledge	20%	20%	20%	20%	20%	**20%**
Young Produced/Post-breeding	2,326	4,080	3,989	1,680	1,461	**2,707**
Total Colorado Numbers	4,586	8,045	7,865	5,621	2,881	**5,800**
WS Take (%)	0.1%	0.0%	0.2%	0.2%	1.7%	**0.4%**
WS-CO Take of Total Colorado Numbers	3	0	6	16	24	**10**
Remaining Total	4,583	8,045	7,859	5,605	2,857	**5,790**

^WS Take on average is 0.3725%.

Table 3.50. Estimates and trends for blue-winged teal populations from Breeding Bird Survey data (1966-2015)(Sauer et al. 2017).

BBS Trend Estimates 1966-2015						
Species	**State Region**	**Trend Estimates 1966-2015 (% change per year)**	**1966-2015 Credible Interval**	**Trend Estimates 2005-2015 (% change per year)**	**2005-2015 Credible Interval**	**Color Code Trend**
Blue-winged teal	Northern Rockies (BCR 10)	-4.77	(-24.64, -1.30)	1.58	(-5.72, 11.17)	
Blue-winged teal	Southern Rockies (BCR 16)	-2.84	(-6.96, 2.23)	-3.16	(-13.72, 11.68)	
Blue-winged teal	Shortgrass Prairie (BCR 18)	3.32	(-1.49, 7.49)	18.46	(7.20, 32.76)	
Blue-winged teal	CO	1	(-2.00, 4.16)	3.59	(-5.72, 14.29)	

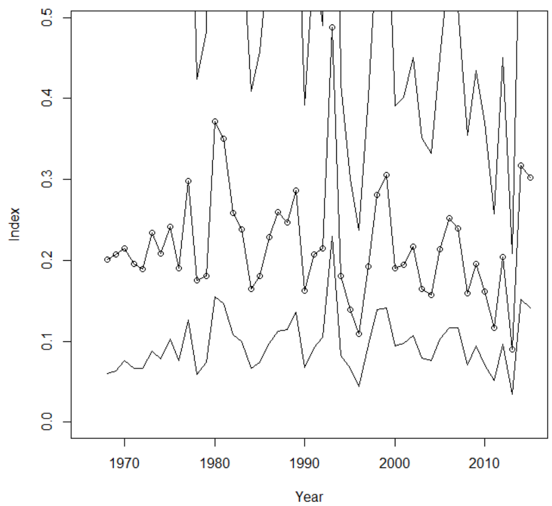


Figure 3.23. Blue-winged teal annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

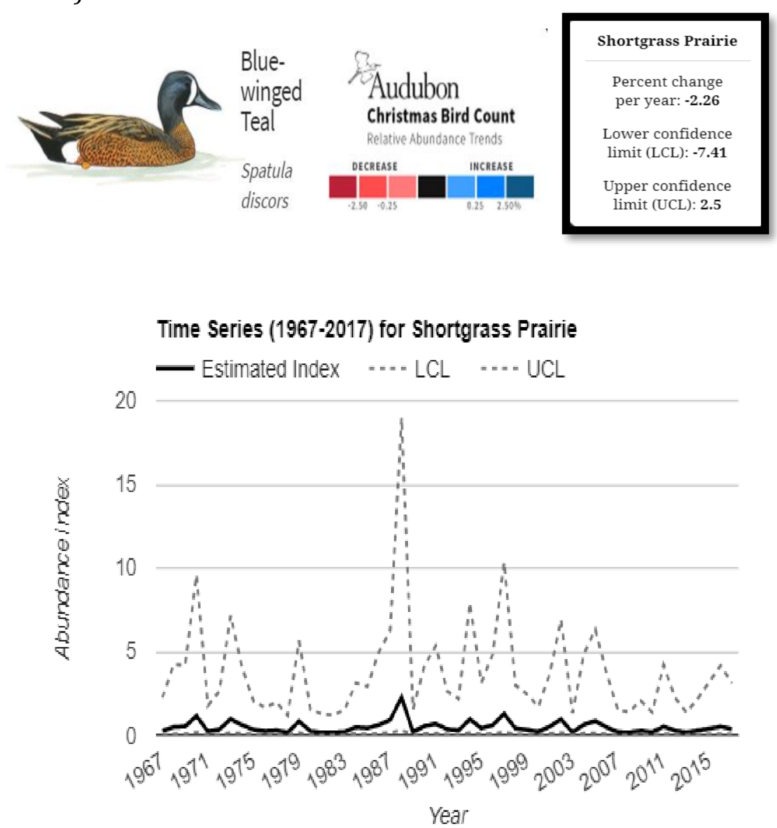


Figure 3.24. Estimated blue-winged teal population abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. Blue-winged teal are most often removed in airport environments to reduce hazards to aircraft and to a lesser extent in agricultural damage situations. The low-magnitude of WS-Colorado's average annual lethal take of (0.3725%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced. Furthermore, blue-winged teal populations are more likely impacted by hunter harvest throughout the Central and Pacific flyways as seen in **Table 3.45**. The lethal removal of this species is regulated by the USFWS in these regions and if these populations were not viable (able to account for this lethal removal and not go extinct) then these populations should similarly be able to re-bound from WS-Colorado's limited take.

Cumulative Impacts. In examining short-term and long-term trends, blue-winged teal populations have been facing non-significant increases of 3.59%% from 2005-2015 (**Table 3.44, 3.50**) (Sauer et al. 2017). However, **Table 3.50** shows that throughout BCR 10 (Northern Rockies)blue-winged teal populations are declining by -4.77%/year from 1966-2015 and were found to be increasing from 2005-2015 by 1.58%/year; in BCR 16 (Southern Rockies) populations seem to be decling by -2.84%/year 1966 to 2015, and by -3.16%/year from 2005 to 2015; and in BCR 18 (Shortgrass prairie) populations are increasing by 3.32%/year from 1966 to 2015 and 18.46%/year from 2005 to 2015 (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 79% confident that blue-winged teal populations are declining in Colorado (Bird Conservancy of the Rockies 2019). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. We can visualize these abundance trends by analyzing **Figures 3.23** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.24** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide an estimated number, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that blue-winged teal populations are declining by -2.26%/year from 1967 – 2017 in BCR 18 (Shortgrass Prairie) (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (0.3725%) of blue-winged teal by WS-Colorado would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 1% of the total blue-winged teal in Colorado.

It should be noted that many species of ducks, especially those that breed in Arctic areas where some birds from Asia or Europe mingle with them, could be collected to sample for international diseases such as H5N1 highly pathogenic avian influenza. This could increase the level of take during a given year depending on the species targeted for collection. However, when possible, data would be collected from hunter harvested ducks or with capture and release methods.

Canada Geese

In the United States, Canada geese (*Branta canadensis*) are federally protected by the Migratory Bird Treaty Act. Resident Canada geese are defined by the USFWS as individuals that nest and/or reside predominantly within the coterminous United States (USFWS 2001). Over the past several decades, populations of Canada geese throughout the US have experienced a fourteen fold increase from 250,000 to 3.5 million individuals (Schmidt 2004).

Populations of Canada geese are managed by federal and state agencies such as the US Fish and Wildlife Service and Colorado Parks and Wildlife. These regulatory agencies typically manage these populations based on distinct breeding areas affinities. Throughout migration and winter, numerous individuals or populations of individuals from different regions often converge. This leads to large populations of birds that breed outside of Colorado and migrate to other locals to mix with other populations that winter within Colorado. Additionally, many Canada geese that breed in Colorado often move to lower elevations during the winter months and still others leave Colorado to overwinter in other states (primarily New Mexico) (Gammonley 2019).

Three continental populations of Canada geese occur in Colorado: Hi-Line Population (HLP), Rocky Mountain Population (RMP), and Central Flyway Arctic-Nesting Canada and cackling geese (CFAN).

Hi-Line Population (HLP)

Populations of HLP Canada geese nest from portions of Canada (southeastern Alberta and southwestern Saskatchewan) to areas of eastern Montana, Wyoming, and Colorado (Gammonley 2019). Individuals within the HLP primarily winter in Montana, Wyoming, Colorado, and New Mexico (Dubovsky 2018). Within Colorado, resident Canada geese that breed east of the Continental Divide are considered to be part of the HLP. Concentrations of breeding, non-breeding, and molting HLP geese can be seen in the spring and summer throughout portions of North Park (Jackson County), South Park (Park County), the San Luis Valley (Alamosa, Conejos, Costilla, and Rio Grande counties, and portions of Hinsdale, Mineral, and Saguache counties), and the Northern Front Range (Adams, Arapahoe, Boulder, Broomfield, Denver, Jefferson, Larimer, and Weld counties). Smaller local HLP populations, may be seen throughout the spring and summer in Pueblo and El Paso counties. Additionally, scattered breeding populations occur at low densities throughout eastern Colorado.

The Waterfowl Breeding Population and Habitat Survey (WBHS), conducted annually by the US Fish and Wildlife Service, provides an index of HLP Canada geese in Canada and Montana. Although Colorado and Wyoming HLP are not included in this survey, the results indicate a seven-fold increase in HLP numbers from the 1970s to the present (**Figure 3.25**)(Gammonley 2019). In 2018, the HLP was estimated to be approximately 409,200 birds (343,700 – 474,800). As the HLP has grown, the numbers of HLP geese seen during the fall migration, winter, and spring migration has increased in eastern Colorado (Gammonley 2019).

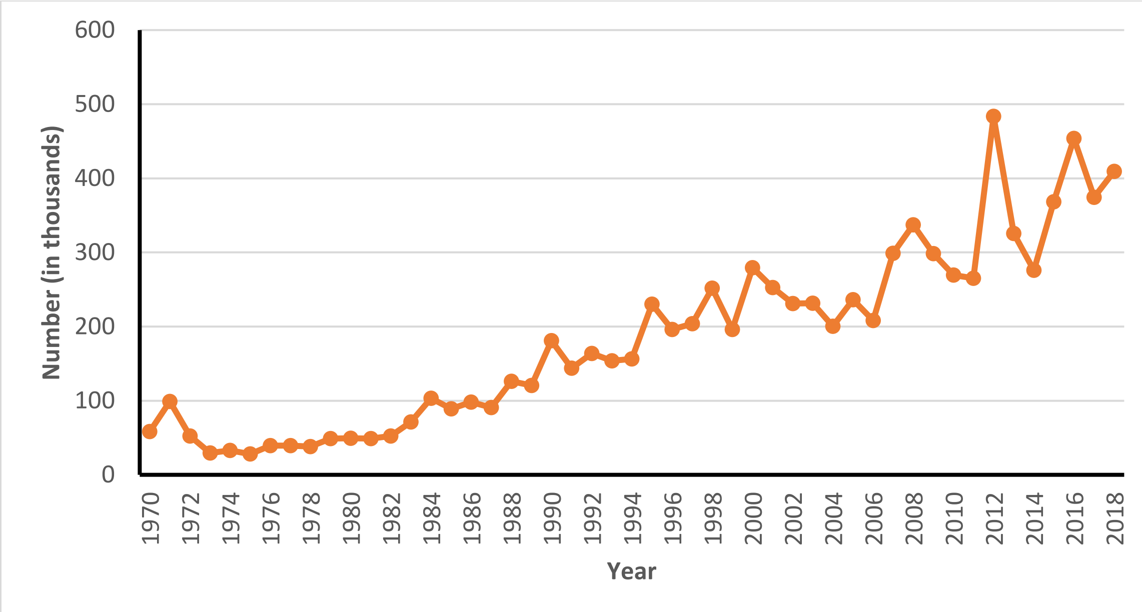


Figure 3.25. Estimates of Hi-Line Population Canada geese from the U.S. Fish and Wildlife Service Waterfowl Breeding Population and Habitat Survey in Alberta, Saskatchewan, and Montana (U.S. Fish and Wildlife Service 2018).

Rocky Mountain Population (RMP)

Canada geese within the Rocky Mountain Population (RMP) nest in southern Alberta, western Montana, Wyoming, Colorado, and the intermountain regions of Utah, Idaho, and eastern Nevada (Pacific Flyway Council 2000, Gammonley 2019). Birds within these populations primarily winter in central and southern California, Arizona, Nevada, Utah, Idaho, Colorado, Wyoming, and Montana (Gammonley 2019). In Colorado, resident Canada geese that breed west of the Continental Divide are classified as part of the RMP. Concentrations of breeding, non-breeding, and molting RMP geese occur during the summer and spring in Middle Park (Grand County) and throughout the river valleys in western Colorado (Gammonley 2019).

Similar to the WBPHS estimates for the HLP, RMP Canada geese documented in portions of Alberta and Montana provide a breeding index for RMP populations (U.S Fish and Wildlife Service 2018). In 2018, the WBPHS documented 252,700 (188,600 - 316,800) RMP geese in these areas. This indicates a nine-fold increase from the 1970s to present (**Figure 3.26**). Local populations of RMP geese in western Colorado has increased over the years, with breeding populations spending the fall and winter in Colorado (Sanders and Dooley 2014).

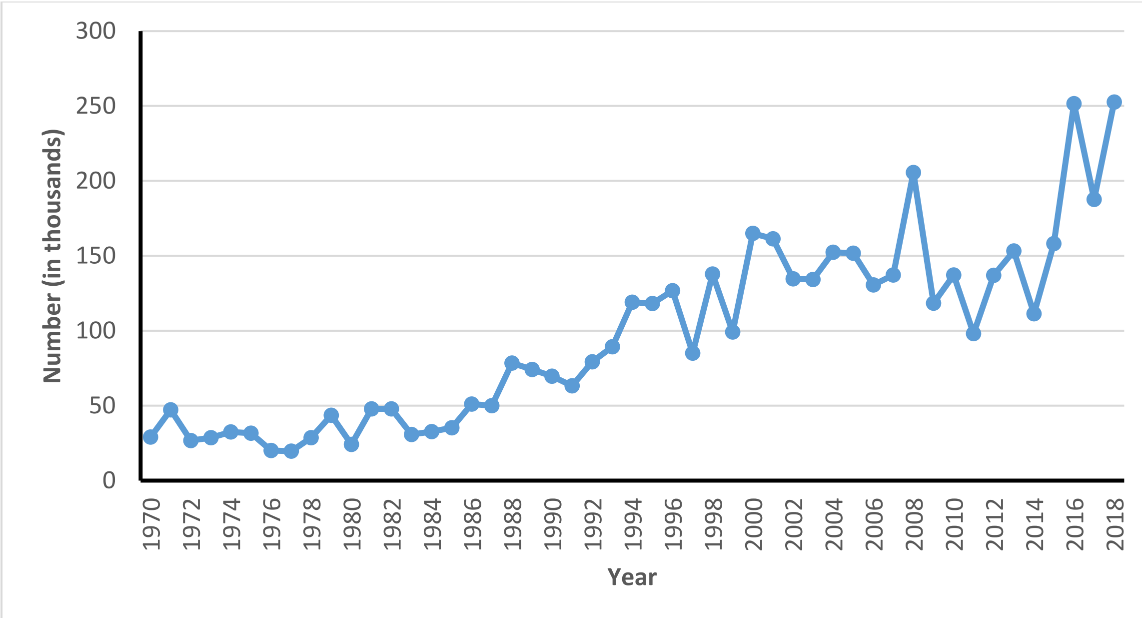


Figure 3.26. Estimates of Rocky Mountain Population Canada geese from the U.S. Fish and Wildlife Service Waterfowl Breeding Population and Habitat Survey in Alberta and Montana (U.S. Fish and Wildlife Service 2018).

Central Flyway Arctic-Nesting Canada and cackling geese (CFAN)

Central Flyway Arctic-Nesting Canada and cackling geese (CFAN) populations primarily consist of cackling geese that nest north of the tree line in arctic Canada. Although, smaller portions of Canada geese that nest near the tree line in this region are also included in this count (Gammonley 2019). Current population estimates of artic nesting Canada and cackling geese remain at approximately 2,500 (**Figure 3.27**). The USFWS does not consider CFAN geese to be resident birds. Previously CFAN, populations were managed by the USFWS as separate populations within BCRs (Shortgrass Prairie and Tallgrass Prairie). Today, these populations are referred to as the West-tier and East-tier CFAN (Dubovsky 2018). In 2016, Lincoln approximations derived from annual estimates of total harvest and harvest rates, indicates a CFAN abundance of 2,562,400 birds (1,565,400 – 3,559,300) (Dubovsky 2018, Gammonley 2019).

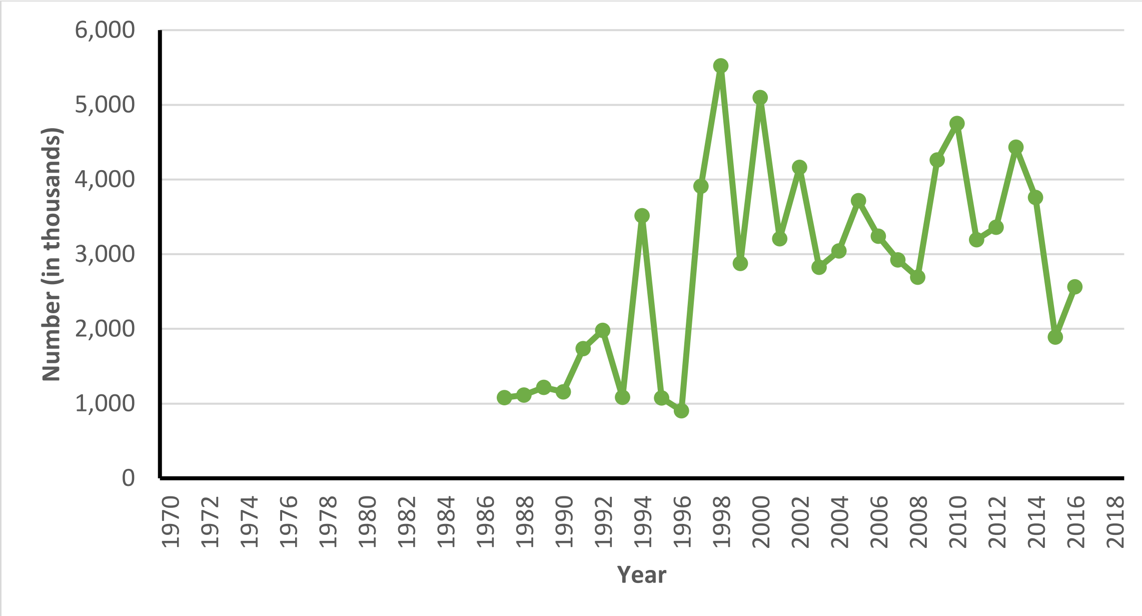


Figure 3.27. Estimates of adult Central Flyway Arctic Nesting Canada and cackling geese (Dubovsky 2018).

Local Breeding Populations in Colorado

Historical records indicate that many local breeding Canada geese were eliminated throughout Colorado as a result of human settlement (Szymczak 1975). However, by the 1950s, local breeding RMP geese were found in northwestern Colorado along the Yampa, Green, and Little Snake rivers; and limited numbers of breeding Canada geese were similarly seen throughout eastern Colorado (Rutherford 1967, Szymczak 1975). Locally, within the Denver metropolitan area, small non-migratory populations began to become established after the release of a captive decoy population in the 1930s (Rutherford 1967, Szymcazk 1975).

Similar to other state agencies in the 1950s, Colorado began efforts to establish or re-establish local breeding populations of Canada geese in the San Luis Valley, North Park, and north-central Front Range foothills from 1966-1957 (Szymczak 1975). In the 1960s, breeding populations were established in north central Colorado (Fort Collins) in a concerted effort to supply transplant populations for areas east of the Continental Divide (Gammonley 2019). Canada goose re-introductions continued to occur until the 1990s, and were successful in establishing local populations of breeding Canada geese throughout the Front Range corridor, mountain parks, and western valleys (Gammonley 2019).

Today, it is unknown how many resident Canada geese occur throughout Colorado due to a lack of rigorous breeding population surveys. However, Colorado Parks and Wildlife has calculated a rough index using banding studies (**Table 3.51**). Leg banding studies conducted by CPW during the summer molt period from 2000-2006, indicated a potential summer statewide population of 17,400 – 26,100 Canada geese (Gammonley 2010, Sanders and Dooley 2014).

Table 3.51. Resident Canada geese captured using large-scale banding operations in Colorado (Gammonley 2010, Sanders and Dooley 2014).

Banding area	Years	Geese banded/year	Banded geese recaptured/year	Total geese captured/year
RMP range		1,537	440	1,977
Northwest	2002-2006	84	12	96
West central	2002-2006	958	292	1,250
Southwest	2003-2006	283	68	351
Middle Park	2000-2006	212	68	280
HLP range		4,053	2,678	6,731
North Park	2002-2006	1,195	739	1,934
South Park	2003-2006	719	323	1,042
San Luis Valley	2002-2006	393	292	685
Front Range	2003-2008	1,746	1,324	3,070
Statewide total		**5,590**	**3,118**	**8,708**

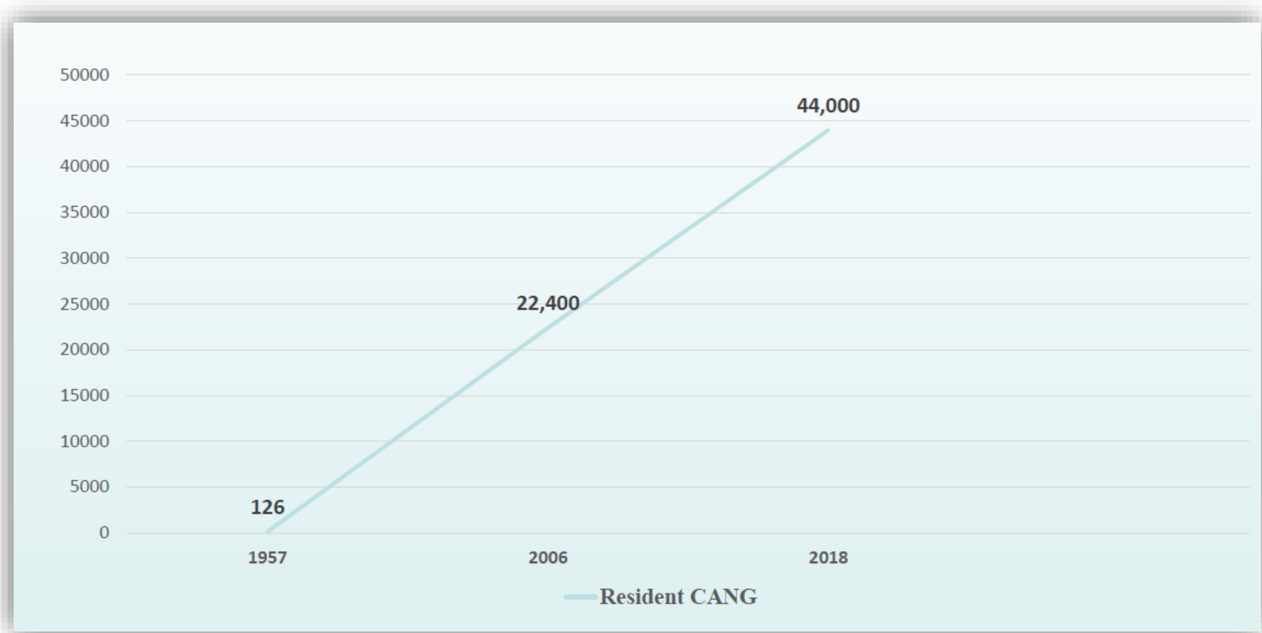


Figure 3.28. Resident Canada geese in Colorado from 1957 to 2018 (Gammonley 2019).

The migratory (wintering) population of Canada geese in Metropolitan Denver are considered part of the Hi-Line Population within the Central Flyway (Dubovsky 2018). The number of Hi-Line geese (HLP) wintering in northeastern Colorado and metropolitan Denver has increased 6-fold over the last 30 years (39,000 to 239,000 birds). Wintering geese typically begin arriving throughout late September and populations are noticeably absent after mid-March.

Similar to wintering populations, populations of resident (nesting) Canada geese have also increased from 120 individuals in 1955 to 44,000 nesting pairs in 2017 along the Front Range and plains of Colorado (Jim Gammonley, Colorado Parks and Wildlife, pers. communication, 2017). Due to translocations and introductions during the 1950s to the 1990s throughout Colorado, locally breeding Canada goose populations, herein referred to as nesting Canada goose populations, have increased significantly and exceeded the social carrying capacity in many areas of the Front Range.

As a result, Canada geese that breed and molt in Colorado are largely non-migratory, have high annual survival rates, low natural mortality rates, and breed at an early age; combined with their natural natal homing instinct this species has the potential to continue expanding throughout urban/suburban areas (Sanders and Dooley 2014). Most of the nesting goose populations on the Front Range occur along the Interstate 25 corridor stretching from Colorado Springs to Fort Collins (**Figure 3.28**). Geese in these areas, generally return to natal areas and/or reside/nest year-round from April through August, except when inclement weather forces birds south to in search of open water, food, or shelter. According to the most recently adopted management plan, in 2000 by the Central Flyway Council, all populations of Canada geese currently nesting in the Central Flyway are considered in excess of objective baseline levels by state wildlife agencies (Gabig 2000).

Damage associated with nesting Canada geese was not reported by any of the ten participating states within the Central Flyway until the early 1990s (Gabig 2000). Today, damage and conflicts associated with Canada geese are a commonplace occurrence throughout numerous jurisdictions along the I-25 Corridor on the Front Range and seem to culminate in the Denver Metropolitan area. With populations of nesting geese escalating, research suggests that management efforts need to be implemented in order to address nuisance complaints (Groepper et al 2008). Alterations in land use, installations of artificial reservoirs, water retention basins, golf courses, and other habitat modifications have created a favorable environment for nesting Canada geese. As a result, landowners and property managers are now voluntarily implementing goose damage management programs in response to increasing Canada goose populations.

Due to their limited local movements and close association with non-hunted urban areas, resident Canada geese have higher survival rates as compared to migrant geese during the fall and winter. Resident geese in general live between 15-25 years, tend to breed earlier in life, and lay larger clutches of eggs than migrant geese. On average, resident geese begin breeding at 2-3 years of age and lay a nest averaging 5 eggs per year throughout their lifetime.

It is estimated that there are approximately 1,534 breeding pairs of geese in metropolitan Denver, plus an unknown number of non-breeding geese, residing with the park complexes. Since the implementation of nest and egg treatment programs on a limited number of parks from 2013 through 2017, annual nest productivity has averaged around 1.8% of eggs laid per year which has slowed population growth rates. However, despite this human caused decline in nesting success within these managed areas, the overall population of Canada geese residing in the Denver Metropolitan area have increased approximately 800% since 2013 as a result of immigration and unregulated goose reproduction throughout the area as a whole. The current annual growth rate for Canada geese nesting on the larger parks in Denver is 41% per year despite intensive nest and egg treatment efforts in select areas (**Figure 3.29**). We believe part of the growth rate is attributable to local population movements in metropolitan Denver. Estimates were generated using a Simulated Population

Management Tool for Canada Geese (SPRAG) with default population parameters entered into the matrix.

Direct Impacts. WS-Colorado has conducted BDM for overabundant resident Canada Geese, primarily in urban areas where they were causing excessive damage. However, several projects have also been implemented for migratory Canada Geese, in airport environments where they pose a threat to human health and safety. Other projects involved associated damage at a water treatment plant and human safety where nesting geese were attacking pedestrians/bicyclists when they neared the nest. Similar to the Colorado Parks and Wildlfie Management Plan for Resident Canada geese, WS-Colorado will continue to respond to wildlife damage complaints within urban and suburban areas as well as human health and safety requests for assistance involving Canada geese in some rural areas (in relation to airport environments, landfills, wastewater treatment, etc.). At each location, it will be under the desgression of the individual or entity requesting help as to the number of geese (typically 5-10) that will be left on the property for aesthetic enjoyment. Furthermore, as stated by CPW resident Canada goose management plan, WS-Colorado will rely on hunters to regulate Canada goose populations in rural habitats (unless they directly impact human health and safety as in airport environments). Resident Canada geese will be taken in urban or suburban areas to alleviate local conflicts in accordance with the Colorado Parks and Wildlife Management Plan for Resident Canada Geese where the state will maintain a stable statewide population trend and current county level distribution for population impact analysis (Gammonley 2019). Further, Colorado Parks and Wildlife is not concerned about population level impacts of wildlife damage management activities in urban or suburban areas (Gammonley 2019). Here urban and suburban areas are defined as areas under the jurisdiction of local cities and townships within designated zoning areas.

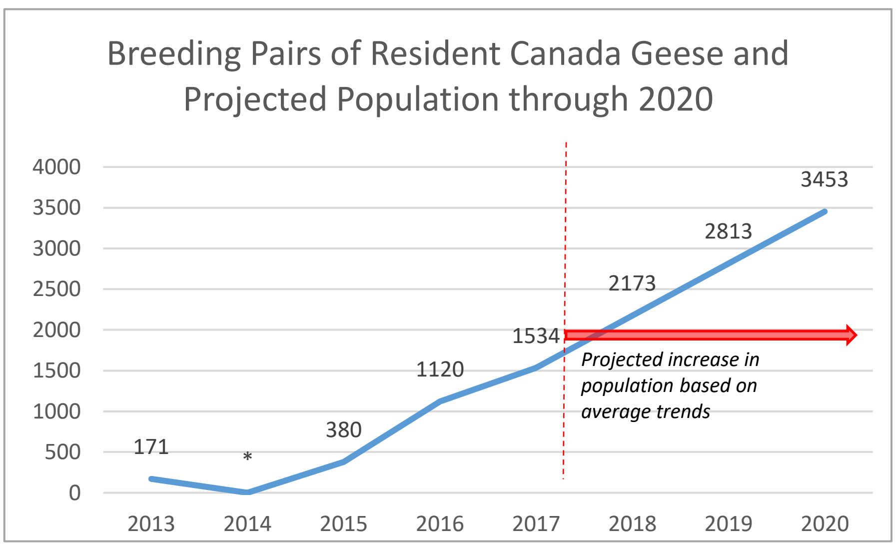


Figure 3.29. Approximate number of breeding pairs of resident Canada geese at 8 high use parks in the Denver Metro area from 2013 through 2017. Projected population increase through 2020 is estimated based on historical trends and continuation of current management efforts by Denver Parks and Recreation. *no data found for 2014.

WS-Colorado averaged lethally removed on average 314 birds/year and 5 nests from FY2013 to FY2017. Additionally, WS-Colorado hazed on average 119,003 Canada geese/year from FY2013 to FY2017), primarily at airports (**Table 3.43**). Following a similar pattern to other areas where geese were introduced or transplanted, WS could be requested to conduct "culling" to reduce populations considered overabundant, especially in parks and at golf courses with considerable damage. The estimated number of "resident" Canada Geese in Colorado, as documented by CPW, was approximatley 44,000 geese in 2018 (J. Gammonley, CPW, pers. Commun.) and 17,100- 26,000 geese in 2006 by Sanders and Dooley (2014). Furthermore, the Denver metropolitan area alone has an estimated 10,153 geese.

Canada geese in Colorado are found primarily in cities along the Front Range, though they are increasingly common in western Colorado. Canada geese have 1 nest per year, average 5.6 eggs per nest, start breeding as 2 year olds (3rd year), with 2 year olds having 28 – 59% mortality of goslings fledge/female and 4 year olds or older having 2.1 goslings fledge/female (Mowbray et al. 2002). Assuming that adult annual survival rates vary from 46% to 90% (mean 68%), 67.5% of the females in an average population of 11,565 birds should fledge 17,182 goslings (Mowbray et al. 2002).

Thus, an annual average take of 0.7141% of the annual average total of 44,000 would leave 109,057 birds in the state numbers (**Table 3.52**). For Canada goose removals, WS-Colorado would coordinate removal efforts with other state, federal, and local officials. However, WS-Colorado believes that most of these projects would be conducted in June and early July when geese are flightless (due to molt).

Table 3.52. Cumulative impact analysis resident (nesting) Canada geese lethally removed in Colorado by WS using Colorado Breeding Estimates obtained from CPW Resident Canada Goose Management Plan (median number used).

RESIDENT (NESTING) CANADA GOOSE IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado*	44,000	44,000	44,000	44,000	44,000	**44,000**
% Breeding Females	67.5%	67.5%	67.5%	67.5%	67.5%	**67.5%**
Estimated Number Breeding Females	29,714	29,714	29,714	29,714	29,714	**29,714**
Avg. Clutch	5	5	5	5	5	**5**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	44%	44%	44%	44%	44%	**44%**
Young Produced/Post-breeding	65,371	65,371	65,371	65,371	65,371	**65,371**
Total Colorado Numbers	109,371	109,371	109,371	109,371	109,371	**109,371**
WS Take (%)	0.6%	1.0%	0.4%	0.6%	0.9%	**0.7%**
WS-CO Take of Total Colorado Numbers	265	434	182	288	402	**314**
Remaining Total	109,106	108,937	109,189	109,083	108,969	**109,057**

*WS Take on average is 0.7141%.

Table 3.53. Estimates and trends for nesting or resident Canada geese populations from Breeding Bird Survey data (1966-2015)(Sauer et al. 2017).

BBS Trend Estimates 1966-2015						
Species	**State Region**	**Trend Estimates 1966-2015 (% change per year)**	**1966-2015 Credible Interval**	**Trend Estimates 2005-2015 (% change per year)**	**2005-2015 Credible Interval**	**Color Code Trend**
Canada goose	CO	7	(3.88, 10.46)	7.21	(0.17, 15.19)	

Table 3.54. Canada goose USFWS hunter harvest estimates in the Central flyway, CFAN East and West Tier, Colorado, and estimates for Hi-Line Population and Rocky Mountain Populations.

Species	Year	USFWS Estimated Harvest Central	USFWS Estimated Harvest Pacific Flyway	Colorado Harvest	Central Flyway Estimates	Hi-Line Population	Rocky Mt. Population	CFAN East Tier	CFAN West Tier
Canada Goose	2013	682,310	253,604	91,554	1,693,482	286,753	14,966	NA	NA
	2014	695,472	286,154	101,543	1,603,125	280,194	13,659	188,068	379,214
	2015	479,426	247,582	67,723	1,813,801	238,844	9,172	280,438	547,700
	2016	586,558	250,559	93,085	1,550,219	281,324	13,384	172,297	452,913
	2017	667,891	277,226	95,410	1,718,048	341,302	37,831	222,882	468,094

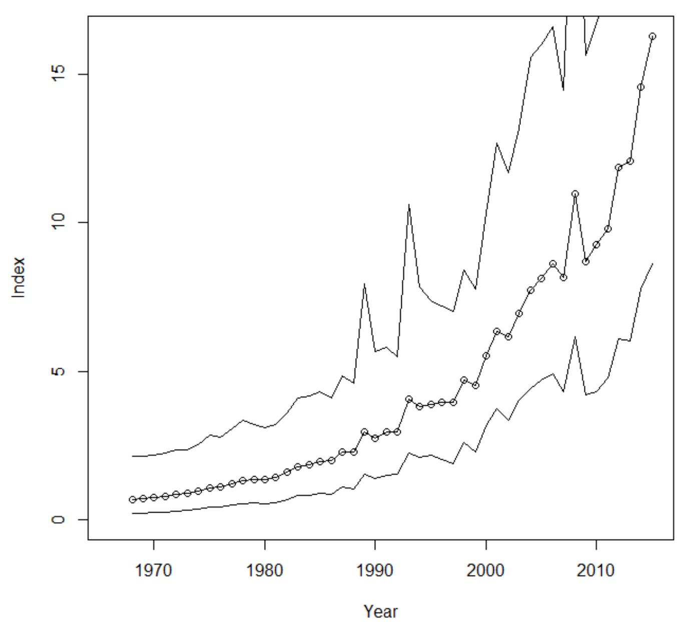


Figure 3.30. Nesting or resident Canada geese annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Cumulative Impacts. In examining short-term and long-term trends, Canada goose populations have been facing significant long-term increases of 7.21%% from 2005-2015 in Colorado (**Table 3.53**) (Sauer et al. 2017). Additionally, **Table 3.53** shows that throughout Colorado Canada geese are significantly increasing by 7% /year from 1966-2015). Conversely, RMADC trend estimates (2008-2018), are 59% confident that Canada goose populations are declining in Colorado (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figures 3.25** from US Fish and Wildlife Service **Figure 3.26, 3.27** (Olson 2018, Dubovsky 2018). Under Alternative 1, we anticipate that the average low magnitude of take (0.7141%) of Canada geese by WS-Colorado would be considered negligible and would not adversely impact the state wide numbers or human environment. WS-Colorado take of resident Canada geese will not exceed 10% of the total population in Colorado. Additionally, WS-Colorado take will not exceed 1% of migratory populations of Canada geese wintering (November – March) in Colorado.

From June through July of 2019, per an agreement with Denver Parks and Recreation, WS-Colorado conducted Canada goose roundups at four parks in Denver, Colorado. WS-Colorado used live "drive-traps" to capture Canada geese during the molt (i.e. when geese are flightless) in four Denver Parks. WS-Colorado removed a total of 1,662 geese from four Denver Parks (Washington 576, City 703, Sloan's 235, and Garfield 148). As per **Chapter 2** *Protective Measures* of the EA, some geese were left in Denver Parks following Canada goose roundups to ensure continued public enjoyment of wildlife within Denver parks.[11]

Corvids

All species of corvids (crows, ravens, magpies, and jays) have the potential to cause damage to resources. However, only a few species are routinely involved in WS-Colorado's BDM activities including: common ravens, black-billed magpies, and American crows. These species are most commonly associated with damage to agriculture (including livestock) and human health & safety at airports. Common ravens cause the most consistent problems (related to livestock predation, as well as to other resources such as property) and have been the focus of several BDM activities. American crows often damage crops and congregate in large numbers that are a nuisance or cause damage at feedlots. Periodically, crows are responsible for livestock predation on lambs and caves.

Large numbers of these corvid species may be taken during a single BDM project, primarily during winter when large populations form. Chihuahuan ravens in southeastern Colorado also causes damage, but much less so. Jays rarely cause problems in Colorado, but have the potential to do so. Jays include Steller's, blue, Western scrub, and gray jays and Clark's nutcracker.

Throughout the U.S. corvid populations are increasing simultaneously with increasing urbanization (Marzluff et al. 1994, 2001). Increasing corvid populations subsequent increase the need for BDM actions associated with these species. WS-Colorado did not lethally remove any other species of corvid during FY2013-2017. However, WS-Colorado anticipates that it could potentially lethally remove any of the corvids discussed here, but will likely continue to work with the 3 species annually taken.

[11] This information was requested during the public comment period for the EA and is provided here. Although the information is outside of the timeframe of analysis of the CAGO management section.

Table 3.55. Corvid species hazed and lethally removed from damage situations from FY2013-2017 by WS-Colorado.

Corvid spp.						
WS Bird Damage Management Activities					**State Population Size (Calendar Year)**	
Fiscal Year (FY)	**Avian Species**	**Removed**	**Dispersed**	**Relocated**	**Breeding Estimates (Colorado)**	**% taken by WS-CO**
2017	**Common ravens**	35	188	0	137,942	0.0%
2016		13	58	0	128,628	0.0%
2015		23	104	0	137,568	0.0%
2014		5	52	0	123,407	0.0%
2013		11	55	0	130,812	0.0%
Average		**17**	**91**	**0**	**131,671**	**0.0%**
2017	**Black-billed magpies**	25	56	0	188,656	0.0%
2016		17	171	0	204,896	0.0%
2015		6	129	5	209,160	0.0%
2014		4	48	0	179,998	0.0%
2013		6	146	0	178,852	0.0%
Average		**12**	**110**	**1**	**192,312**	**0.0%**
2017	**American crow**	0	0	0	31,427	0.0%
2016		15	42	0	34,749	0.0%
2015		10	197	0	29,835	0.0%
2014		22	67	150	26,900	0.1%
2013		14	54	151	38,360	0.0%
Average		**12**	**72**	**60**	**32,254**	**0.0%**

Table 3.56. Estimates and trends for corvid spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	**Detectability Parameter Factors (PIF)**	**BBS Data w/ PIF**		**BBS Trend Estimates**		**BBS Data**

	Dist.	Pair	Time	Detectability Parameters (2013- 2017)	PIF Estimates 2015	2005-2015 (% change per year)	2005-2015 Credible Interval	
Common raven	400	1.00	1.30	91,172	48,208	3.05	(0.92, 4.88)	
Black-billed magpie	300	1.75	1.25	419,373	353,398	4.61	(2.14, 7.26)	
American crow	400	1.75	1.55	154,349	131,754	4.13	(1.92, 6.50)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
Common raven	CO	48,208	0	0
Black-billed magpie	CO	353,398	0	0
American crow	CO	131,754	1	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Common raven	CO	Trend	1.04	2.10	97
Black-billed magpie	CO	Trend	1.04	2.01	99
American crow	CO	Trend	0.92	4.26	99

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Common Ravens. One of the most widely distributed species in the world, the common raven occupies portions of North America, Asia, Europe, and North Africa (Boarman and Heinrich 1999). In many areas of the west, common raven adaptability, predacious habits, and **close association with anthropogenic resources** make it a prime indicator of human disturbance (Boarman 1993, Restani and Marzluff 2001). Supplemental feeding sources such as garbage, agricultural crops, and road carrion afford ravens an adaptive advantage over other not readily adaptable feeders; allowing these populations to increase to un-naturally high densities in some areas (Liebezeit and George 2002). As a result, WS' Western Region has seen an increase in raven BDM requests for assistance over the last several decades.

In most areas, ravens are year-round residents with little evidence of migration from radio-tagged or marked populations in North America (Goodwin 1986, Boarman and Heinrich 1999). However, the species has been known to move into adjacent areas during non-breeding season. There has been some speculation as to whether some of the birds in populations of floaters may be migrants (Boarman and Heinrich 1999). Floaters are primarily immature and non-breeding birds (i.e., fledgling, 1 and 2-year-old birds) that typically band together in populations of 50 or more. These populations are loose-knit and wide-ranging (Goodwin 1986). Ravens do not breed until their third year, though some unsuccessful attempts to nest have been documented for 2-year old birds (Boarman and Heinrich 1999). Common ravens have one nest per year, re-nesting if the first attempt fails, with a typical clutch size of 3 to 7, averaging 5.3 (Boarman and Heinrich 1999). Age structure in raven populations is unknown, but it is assumed for this analysis that “floaters” or sub-adult birds make up 34% of the population as with crows. Fledgling success (number fledged/egg) varied, but in Wyoming 31% of common raven chicks fledge (Boarman and Heinrich 1999).

Like many other species, the adult annual survival rate of common ravens is unknown. Here we substituted the annual morality rate (94%) of a similar corvid species, the American crow for these calculations (Caffrey 1999). Using these parameters, an average estimated breeding population of 131,671 in Colorado would fledge roughly 196,080 ravens for a total population of 327,751 (**Table 3.57**). From FY2013 to FY2017, WS-Colorado recorded 275 work tasks related to common ravens involving: agriculture 4 and human health and safety 271 (**Table 3.6**).

On average, WS-Colorado lethally removed 17 ravens per year and dispersed 91 average/year (**Table 3.55**). This represents an average annual lethal removal of 0.0132% of the total Colorado common raven population. The Rocky Mountain Avian Data Center (2017) estimates Colorado raven populations to be approximately 137,942 (**Table 3.57**). Partner’s in Flight population estimates from 1998 to 2015 suggest 48,208 reside year-round within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates common raven populations are 91,172 (**Table 3.56, 3.58**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Based on these calculations, even with an annual removal of 0.132% of the common raven population this would leave an average population of approximately 327,734 ravens per year.

Table 3.57. Cumulative impact analysis common ravens lethally removed in Colorado by WS from FY2013 to FY2017. Data is from Integrated Bird Monitoring Conservation Regions for Colorado. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

COMMON RAVEN IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	137,942	128,628	137,568	123,407	130,812	131,671
% Breeding Females	90.6%	90.6%	90.6%	90.6%	90.6%	90.6%
Estimated Number Breeding Females	125,026	116,584	124,687	111,852	118,564	119,343
Avg. Clutch	5.3	5.3	5.3	5.3	5.3	5.3
Avg. Nests	1	1	1	1	1	1
% Fledge	31.0%	31.0%	31.0%	31.0%	31.0%	31.0%
Young Produced/Post-breeding	205,418	191,548	204,861	183,773	194,800	196,080
Total Colorado Numbers	343,360	320,176	342,429	307,180	325,612	327,751
WS Take (%)*	0.02%	0.01%	0.02%	0.00%	0.01%	**0.01%**

WS-CO Take of Total Colorado Numbers	35	13	23	5	11	17
Remaining Total	343,325	320,163	342,406	307,175	325,601	327,734

^WS Take on average is 0.0132%.

Table 3.58. Estimates and trends for common raven populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Common raven	400	1.00	1.30	91,172	48,208	3.05	(0.92, 0.488)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
Common raven	CO	48,208	0	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Common raven	CO	Trend	1.04	2.10	97

PIF Data Quality Rating	
0	Good BBS coverage
1	Poor BBS coverage
2	
3	
4	

IMBCR C.V. %	
<50%	Robust Estimate
50 - 100%	Marginal
>100%	Poor

IMBCR Trend Estimate	
>1	Increasing
1	Static
<1	Decreasing

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

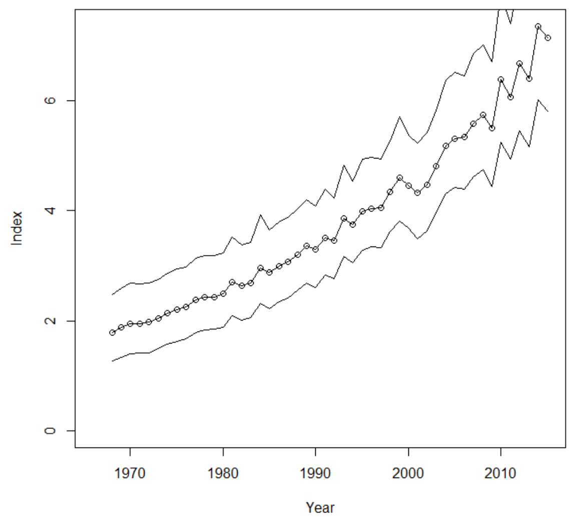


Figure 3.31. Common raven annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in Colorado for a year (Sauer et al. 2017).

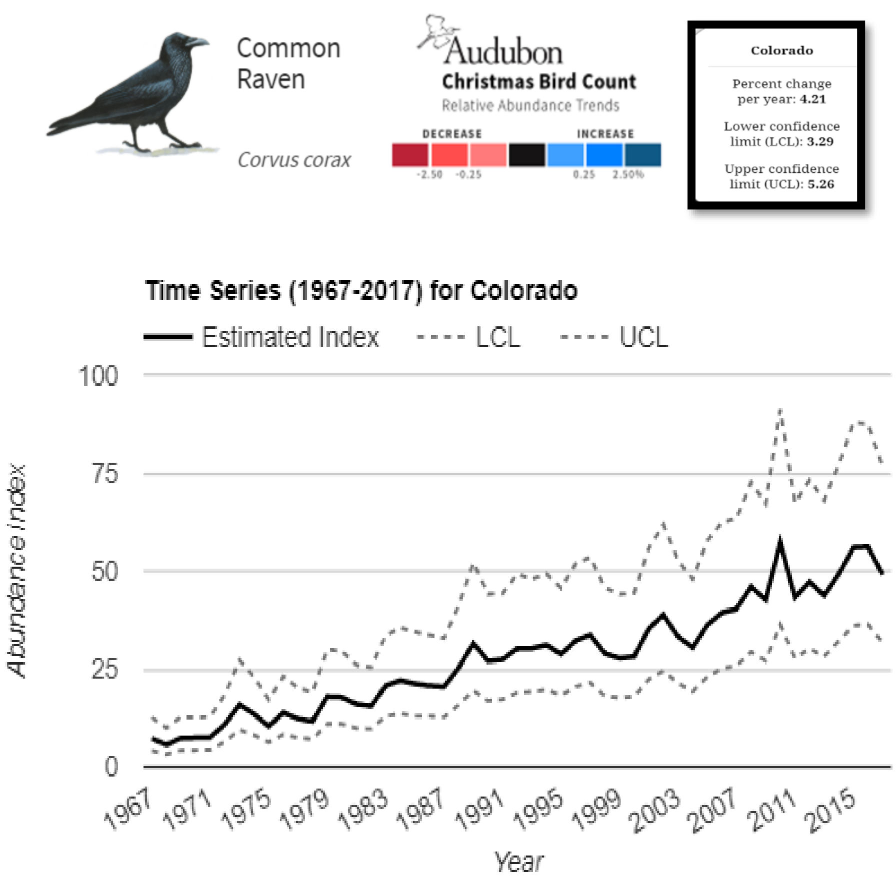


Figure 3.32. Estimated common raven abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. Common ravens are most often removed in airport environments to reduce hazards to aircraft and to a lesser extent in agricultural damage situations. The low-magnitude of WS-Colorado's average annual lethal take of (0.0132%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced. Also, if WS-Colorado becomes more involved in sage grouse management then an integrated approach to managing anthropogenic resources would contribute to reducing local raven abundances dependent on man-made food resources (e.g., landfills, livestock feed, other man-made foods, man-cause nesting structures and planted trees). Lethal take of ravens by WS-Colorado would increase if the program entered into agreements with other agencies to conserve sage grouse. Raven populations utilizing antropogenic food resources are at unnaturally high local abundance levels across the west.

Ravens are a species that seems to adjust well to human populations and benefits from antropogenic resources. As more people move to Colorado there will likely be additional anthropogenic resources that come available to ravens resulting in greater population growth and harmful population level impacts to native species depredated by ravens.

Cumulative Impacts. In examining short-term and long-term trends, common raven populations have been significantly increasing by 2.98% from 1966 to 2015 and by 3.05% from 2005-2015 (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 97% confident that common raven populations are increasing (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figures 3.31** from Breeding Bird Survey population trends and Christmas Bird Count data **Figure 3.32** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide an estimated number, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that common raven populations are increasing by 4.21%/year from 1967 – 2017 (National Audubon Society 2010).

In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) raven populations are hovering around 91,172 individuals and PIF data from 1998-2015 indicate a Colorado estimate of 48,208 (**Table 3.56, 3.58**). Under Alternative 1, we anticipate that the average low magnitude of take (0.0132%) of common ravens by WS-Colorado, in airport environments would be considered negligible and would not adversely impact the state wide numbers or human environment. WS-Colorado take will not exceed 5% of the total common raven populations in Colorado.

American Crows. American crows are found in a wide variety of habitats; especially open areas with sparse tree cover including alpine meadows, prairies, and human–modified habitats such as city parks, golf courses, landfills, highway right-of-ways, and cemeteries (Verbeek and Caffrey 2002). Considered year-round residents, local populations may fluctuate as birds move throughout Colorado during the fall and winter months. Although, crow populations are most frequently seen along the Front Range and southern portions of the state, adverse climatic conditions (i.e. harsher winters) in surrounding areas may bolster local populations from year to year as reflected in the CBCs (National Audubon Society 2010).

<u>Direct Impacts.</u> From FY13 to FY17 WS-Colorado recorded 419 work tasks related to American crows involved in BDM related to: agriculture 1, property 4, and human health and safety 414 (**Table 3.6**). Due to their large size and populationing behavior crows serve as a wildlife hazard at airports. WS-Colorado uses several methods to lethally remove this species including: shooting, DRC-1339, and live trapping followed by euthanasia. Lethal strategies are intended to reduce the population of crows causing damage where they have not successfully been deterred by nonlethal measures. The damage threat from crows, along with their abundance, was significant enough that a Depredation Order was issued by the USFWS to allow the take of crows "*when found committing or about to commit depredations upon ornamental or agricultural crops, federal, state or special concern wildlife species, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance*" with no Federal permit (50 CFR 21.43). Crows lethally removed under this depredation order (50 CFR 21.43) are required to be reported annually. However, WS-Colorado believes a large majority of public take using this order is under-reported or not reported and thus WS-Colorado is unavailable to quantify public take for this analysis.

From FY13 to FY17, WS-Colorado lethally removed a yearly average of 12 birds and dispersed 72 (**Table 3.55**). American crows do not become sexually mature until after their second year of age (third year). Populations typically consist of 34% juveniles, and many form populations with other non-breeders or assist adults in raising nestlings (Verbeek and Caffrey 2002). Crows construct nests of branches and twigs 5-18 m above the ground and lay 3 to 7 eggs (average 5) once per year (Verbeek and Caffrey 2002, Johnson 1994). An estimated 38.6% of the chicks hatched will fledge (Verbeek and Caffrey 2002). Once American crows reach adulthood they have an annual mortality rate of 94.3% (Caffrey 1999).

Using these parameters, an average of 32,254 American crows with 30,389 breeding females would successfully fledge about 58,650 nestlings, raising post-fledgling numbers to roughly 90,904 American crows. With an annual lethal removal of 0.0378% of these numbers (for this analysis) on average 12, that would leave 90,892 American crows in Colorado (**Table 3.59**).

Table 3.59. Cumulative impact analysis American crows lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

AMERICAN CROW IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	31,427	34,749	29,835	26,900	38,360	**32,254**
% Breeding Females	94.2%	94.2%	94.2%	94.2%	94.2%	**94.2%**
Estimated Number Breeding Females	29,609	32,739	28,109	25,344	36,141	**30,389**
Avg. Clutch	5	5	5	5	5	**5**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	38.6%	38.6%	38.6%	38.6%	38.6%	**38.6%**
Young Produced/Post-breeding	57,146	63,187	54,251	48,914	69,753	**58,650**
Total Colorado Numbers	88,573	97,936	84,086	75,814	108,113	**90,904**
WS Take (%)*	0.00%	0.04%	0.03%	0.08%	0.04%	**0.04%**
WS-CO Take of Total Colorado Numbers	0	15	10	22	14	**12**
Remaining Total	88,573	97,921	84,076	75,792	108,099	**90,892**

^WS Take on average is 0.0378%.

Table 3.60. Estimates and trends for American crow populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	**Detectability Parameter Factors (PIF)**			**BBS Data w/ PIF Detectability Parameters (2013- 2017)**	**PIF Estimates 2015**	**BBS Trend Estimates 2005-2015 (% change per year)**	**2005-2015 Credible Interval**	**BBS Data**
	Dist.	**Pair**	**Time**					
American crow	400	1.75	1.55	154,349	131,754	4.13	(1.92,6.50)	

Partners in Flight version 2.0 (1998-2007)				
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**
American crow	CO	131,754	1	0

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
American crow	CO	Trend	0.92	4.26	99

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

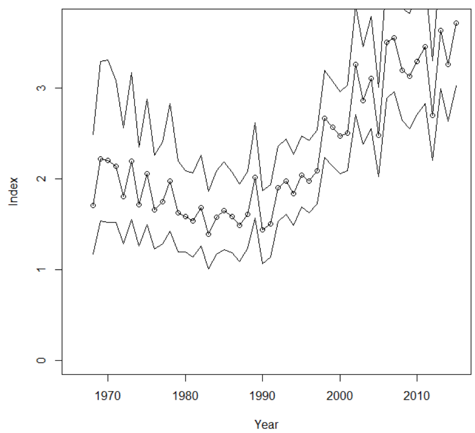


Figure 3.33. American crow annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

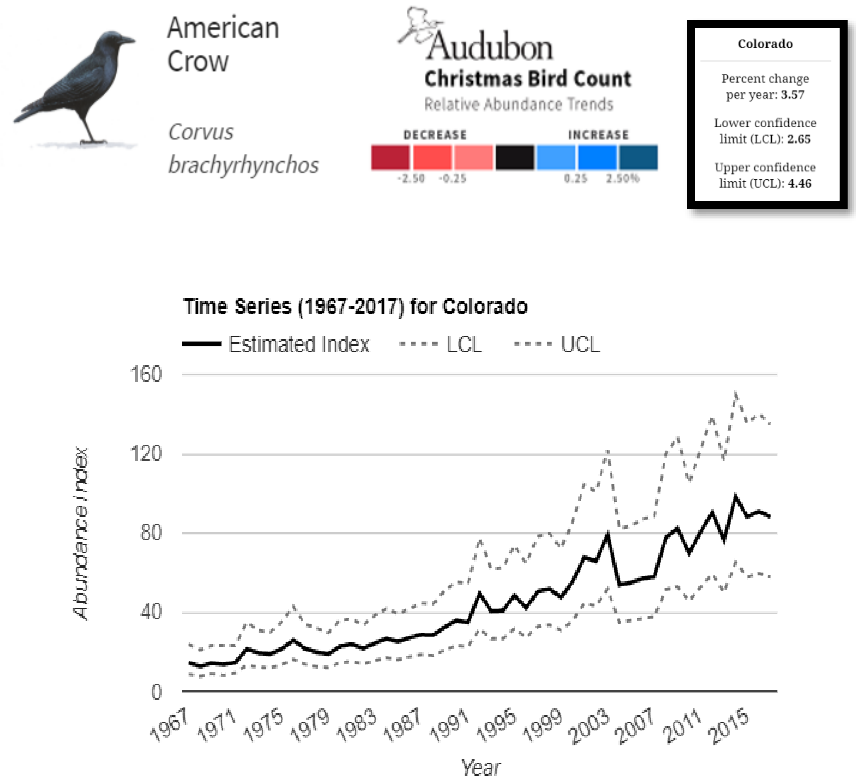


Figure 3.34. Estimated American crow abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

<u>Indirect Impacts.</u> Considering the variability of American crow populations within the state, and our inability to quantify private take under Depredation Order 50 CFR 21.43, the low-magnitude of WS-Colorado's average annual lethal take of American crows (0.0378%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events.

<u>Cumulative Impacts.</u> In examining short-term and long-term trends, American crow populations have been significantly increasing by 1.67% from 1966 to 2015 and by 4.13% from 2005-2015 (Sauer et al. 2017). Similarly, RMADC population trend estimates (2008-2018), are 99% confident that American crow populations are increasing (Bird Conservancy of the Rockies 2019). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. We can visualize these abundance trends by analyzing **Figure 3.33** from Breeding Bird Survey population trends and Christmas Bird Count data **Figure 3.34** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide an estimate number, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that American crow populations are increasing by 3.57%/year from 1967 – 2017 (National Audubon Society 2010).

In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) American crow populations are hovering around 154,349 individuals and PIF data from 1998-2015 indicate Colorado numbers of 131,754 (**Table 3.60**). Under Alternative 1, we anticipate that the average low magnitude of take (0.0378%) of American crows by WS-Colorado, in airport environments would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 1% of the total American crows in Colorado.

Black-billed Magpies. First encountered by Lewis and Clark in 1804, black-billed magpies are one of twelve subspecies of magpies found throughout Europe, Asia, and North America (Trost 1999). In North America, black-billed magpies have two disjunt breeding populations. Northern populations of magpies range from southern Alaska to British Columbia and breed in southern Alaska. While southern populations breed in central Alberta, into southern California, and on into portions of Kansas, Nebraska, and the Dakotas (Trost 1999). In Colorado, black-billed magpies are year-round residents and are most frequently seen in central and western portions of the state (Hayworth and Weathers 1984).

Direct Impacts. Black-billed magpies begin breeding from March until late July, although at higher elevations, up to 10,000 ft, individuals usually nest significantly later (Trost 1999). Evidence suggests that more yearling females breed more than yearling males, however once birds reach sexual maturity females will lay from 6.12 to 6.58 eggs per nest (Buitron 1988, Hochachka 1988, Trost 1999). Typically 2 to 4 young fledge per clutch as nestling face starvation, siblicide, and sibling cannibalism (Reynold 1996, Buitron 1988). In our calculations, we used the fledgling success rate of common ravens (31%) (Boarman and Heinrich 1999). Magpies typically raise one clutch per season, but in the event of nesting failure two to three other attempts will be made (Dhindsa and Boag 1990).

Using these parameters, an average estimated breeding number 192,312 magpies in Colorado would fledge roughly 242,916 fledglings for a total of 435,229 (**Table 3.61**). From FY2013 to FY2017, WS-Colorado recorded 476 work tasks related to black-billed magpies involving: property 1 and human health and safety 475 (**Table 3.6**). On average WS-Colorado lethally removed 12 magpies/year and dispersed an average of 110 bird/year from FY2013 to FY2017 and removed 4 nests (**Table 3.55**). With an annual lethal removal of 0.006% of the population, that would leave 435,217 black-billed magpies in Colorado.

Indirect Impacts. It should be noted that West Nile virus has been documented in Colorado since 2002 and is more than likely responsible for some corvid related mortality. WS-Colorado has no way to determine the magnitude this disease has had on local or statewide populations, but in analyzing BBS trend data, it seems an unlikely limiting factor. Limiting factors, for this species expansion, are likely related to inadequate nesting sites due to urbanization and habitat fragmentation (Trost 1999). Investigations reported to the Central Flyway Technical Section in 2017 indicated local black-billed magpie abundnaces on the prairie have declined due to West Nile Virus (Lowney 2017, unpublished notes). The declines correalate to counties with high incidence of West Nile Virus in humans. Considering the variability of black-billed magpie populations within the state, and our inability to quantify private take under Depredation Order 50 CFR 21.43, the low-magnitude of WS-Colorado's average annual lethal take of black-billed magpies (0.006%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events.

Table 3.61. Cumulative impact analysis black-billed magpies lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

BLACK-BILLED MAGPIES IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding in Colorado (RMADC)*	188,656	204,896	209,160	179,998	178,852	192,312
% Breeding Females	62.7%	62.7%	62.7%	62.7%	62.7%	62.7%
Estimated Number Breeding Females	118,262	128,442	131,115	112,835	112,116	120,554
Avg. Clutch	6.5	6.5	6.5	6.5	6.5	6.5
Avg. Nests	1	1	1	1	1	1
% Fledge	31%	31%	31%	31%	31%	31%
Young Produced/Post-breeding	238,298	258,811	264,197	227,362	225,914	242,916
Total Colorado Numbers	426,954	463,707	473,357	407,360	404,766	435,229
WS Take (%)*	0.01%	0.01%	0.00%	0.00%	0.0%	**0.01%**
WS-CO Take of Total Colorado Numbers	25	17	6	4	6	12
Remaining Total	426,929	463,690	473,351	407,356	404,760	435,217

^WS Take on average is 0.006%.

Table 3.62. Estimates and trends for black-billed magpie populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time					
Black-billed magpie	300	1.75	1.25	419,373	353,398	4.61	(2.14, 7.26)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Population Calculator	Data Quality	Range Coverage
Black-billed magpie	CO	353,398	0	0

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Black-billed magpie	CO	Trend	1.04	2.01	99

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

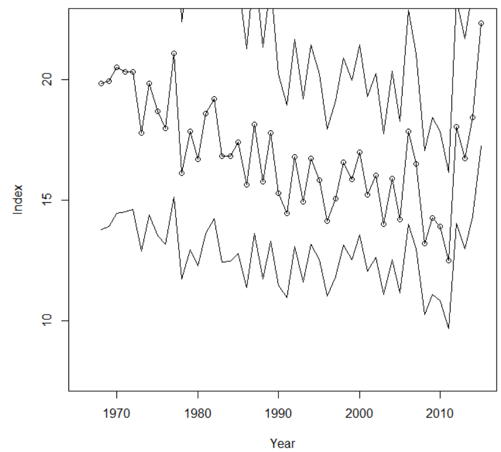


Figure 3.35. Black-billed magpie annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

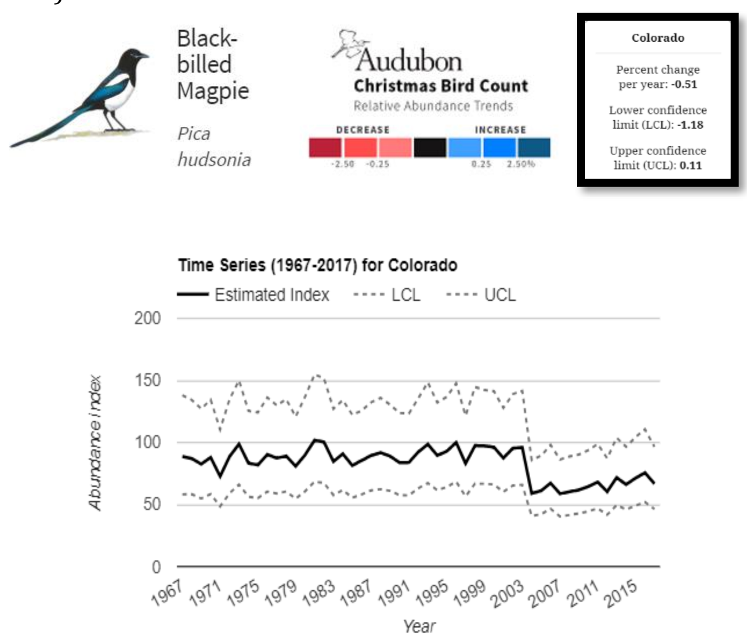


Figure 3.36. Estimated black-billed magpie abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

<u>Cumulative Impacts.</u> In examining short-term and long-term trends, black-billed magpie populations have been significantly increasing by 4.61% from 2005-2015 (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 99% confident that magpie populations are increasing (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figures 3.35** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.36** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a population estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that magpie populations are declining by -0.51%/year from 1967 – 2017 (National Audubon Society 2010).

In analyzing recent 2013-2017 BBS data using PIF detectability parameters (time, pair, distance) magpie populations are hovering around 419,373 individuals and PIF data from 1998-2015 indicate a Colorado population of 353,398 (**Table 3.62**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.006%) of black-billed magpies by WS-Colorado, predominately in airport environments would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 1% of the black-billed magpies in Colorado.

Raptors

Colorado is home to many species of raptors including vultures, buteos (hawks with broad wings), falcons, accipiters (forest falcons), harriers (marsh hawk), eagles, owls, and shrikes. Although, most species rarely cause damage, most species within this group pose a strike risk at airports, while others occasionally depredate livestock and poultry, and a few attack and strike people that near their nests. The most common problem species with the highest number of work tasks associated with them (> 100 from FY2013 to FY2017) were red-tailed, ferruginous, rough-legged hawks, bald eagles, and swainson's hawks, northern harriers, and turkey vultures (**Table 3.6**). In addition to these, 14 other raptors have had work tasks associated with them from FY2013 to FY2017 (**Table 3.6**).

It should be noted that some species such as short-eared owls may have work tasks associated with them, but may not be a result of actual damage. Some work tasks involve receiving a call of an injured owl which is picked up by a Wildlife Specialist and transferred to a rehabilitator (owls are frequently struck and injured by passing cars while they are hunting). "Damage" for this type of activity is often recorded as human health and safety because it causes stress to the persons seeing the injured owl, but there was no damage per se.

Raptors are difficult to haze from air operating areas at airports primarily because they pay little attention to pyrotechnics and other sound-scaring devices. In these situations, raptors are trapped and translocated to minimize the strike hazard posed by collisions with aircraft. Raptors are a leading hazard at airports and cause significant damage to aircraft with most raptor strikes occurring at heights less than 500 feet above the ground (Dolbeer 2006), often at or near the airfield.

Of the species that breed in Colorado, no species declined significantly from 1966 to 2009, but ferruginous hawk populations are experiencing a -0.02 %/year population trend and northern harrier hawks are experiencing long-term declines of -1.89%/year from 1966-2015. On the other hand, the turkey vulture, red-tailed hawk, bald eagle, Swainson's hawk, American kestrel, great horned owl, golden eagle, loggerhead shrike, and prairie falcons are experiencing positive trends. Here we analyze five species of raptors with an annual average take of 10 or more.

Table 3.63. Raptor species hazed and lethally removed from damage situations from FY2013-2017 by WS-Colorado. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Raptors spp.						
WS Bird Damage Management Activities					**State Population Size (Calendar Year)**	
Fiscal Year (FY)	**Avian Species**	**Removed**	**Dispersed**	**Relocated**	**Breeding Estimates (Colorado)**	**% taken by WS-CO**
2017	**Red-tailed hawk**	110	952	114	48,342	0.2%
2016		82	1,058	131	52,367	0.2%
2015		109	1,542	105	56,598	0.2%
2014		107	1,788	89	42,785	0.3%
2013		118	1,533	69	37,126	0.3%
Average		**105**	**1,375**	**102**	**47,444**	**0.2%**
2017	**Northern harrier hawk**	17	342	3	5,528	0.3%
2016		20	214	1	3,660	0.5%
2015		19	799	0	3,960	0.5%
2014		9	121	0	4,204	0.2%
2013		18	275	7	3,648	0.5%
Average		**17**	**350**	**2**	**4,200**	**0.4%**
2017	**American kestrel falcon**	11	163	2	27,387	0.0%
2016		7	205	0	30,885	0.0%
2015		16	36	0	36,613	0.0%
2014		11	191	0	31,887	0.0%
2013		26	503	4	28,266	0.1%
Average		**14**	**220**	**1**	**31,008**	**0.0%**
2017	**Swainson's hawk**	9	134	1	19,052	0.0%
2016		12	13	3	14,017	0.1%
2015		17	138	0	11,794	0.1%
2014		13	573	5	16,809	0.1%
2013		22	332	1	24,710	0.1%
Average		**15**	**238**	**2**	**17,276**	**0.1%**
2017	**Ferruginous hawk**	7	16	2	198	3.5%
2016		14	150	3	4,771	0.3%
2015		12	416	10	3,539	0.3%
2014		7	225	7	220	3.2%
2013		10	148	1	234	4.3%
Average		**10**	**191**	**5**	**1,792**	**0.6%**
2017	**Great horned owl**	7	13	102	3,665	0.2%
2016		5	14	92	4,352	0.1%

Raptors spp.						
2015		3	12	52	4,231	0.1%
2014		1	3	55	1,905	0.1%
2013		3	8	69	2,919	0.1%
Average		**4**	**10**	**74**	**3,414**	**0.1%**
2017	**Turkey vulture**	4	59	0	6,546	0.1%
2016		9	34	0	4,485	0.2%
2015		9	186	0	7,718	0.1%
2014		8	37	0	7,037	0.1%
2013		16	87	0	7,009	0.2%
Average		**9**	**81**	**0**	**6,559**	**0.1%**
2017	**Golden eagle**	0	26	0	176	0.0%
2016		0	0	0	626	0.0%
2015		0	0	0	493	0.0%
2014		0	0	0	680	0.0%
2013		0	77	0	522	0.0%
Average		**0**	**21**	**0**	**499**	**0.0%**
2017	**Loggerhead shrike**	0	35	0	20,104	0.0%
2016		0	0	0	15,022	0.0%
2015		0	0	0	24,260	0.0%
2014		0	0	0	33,319	0.0%
2013		0	0	0	48,967	0.0%
Average		**0**	**7**	**0**	**28,334**	**0.0%**
2017	**Bald Eagle**	0	0	0	76	0.0%
2016		0	195	2	36	0.0%
2015		0	331	1	44	0.0%
2014		0	203	0	80	0.0%
2013		0	242	0	85	0.0%
Average		**0**	**194**	**1**	**64**	**0.0%**
2017	**Rough-legged hawk***	0	0	0	NA	0.0%
2016		0	0	0	NA	0.0%
2015		2	142	2	NA	0.0%
2014		32	938	27	NA	0.0%
2013		11	263	20	NA	0.0%
Average		**9**	**269**	**10**	**NA**	**0.0%**
2017	**Prairie falcon**	0	0	0	NA	0.0%
2016		0	0	0	NA	0.0%
2015		0	0	0	NA	0.0%

Raptors spp.						
2014		0	0	0	NA	0.0%
2013		0	16	10	NA	0.0%
Average		**0**	**3**	**2**	**NA**	**0.0%**

Table 3.64. Estimates and trends for raptor spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 1998 - 2007	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	Color Code Trend
	Dist.	Pair	Time						
Red-tailed hawk	300	1.25	1.42	61,195	47,220	2.61	CO	(0.96, 4.41)	
Northern harrier hawk	300	2	1.18	7,494	21,096	-1.16	CO	(-5.44, 3.40)	
American kestrel falcon	200	1.25	1.21	761,210	79,054	0.33	CO	(-1.91, 2.87)	
Swainson's hawk	300	1.5	1.14	73,932	56,111	1.93	CO	(-0.24, 4.88)	
Ferruginous hawk	300	1.25	1.14	7,061	8,704	-0.02	CO	(-3.74, 299)	
Great horned owl	300	2	11.62	111,913	112,757	0.49	CO	(-2.33, 3.40)	
Turkey vulture	400	1.75	2.46	33,969	25,951	2.99	CO	(-0.48, 6.48)	
Golden eagle	400	1.75	1.53	6,044	4,923	0.39	CO	(-3.46, 5.14)	
Loggerhead shrike	NA	NA	NA	NA	248,838	0.002	CO	(-3.47, 3.48)	
Bald eagle	300	1.25	1.65	3,023	NA	16.11	CO	(6.72, 30.37)	

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 1998 - 2007	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	Color Code Trend
	Dist.	Pair	Time						
Rough-legged hawk	300	1.25	1.14	50	NA	NA	NA	NA	NA
Prairie falcon	NA	NA	NA	NA	5,610	3.27	CO	(-0.50, 7.85)	

Table 3.65. Population estimates and trends for raptor spp. populations from Partners in Flight (version 2.0).

Partners in Flight version 2.0 (1998-2007)				
Species	State	BBS Calculator	Data Quality	Range Coverage
Red-tailed hawk	CO	47,220	0	0
Northern harrier hawk	CO	21,096	2	0
American kestrel falcon	CO	79,054	1	0
Swainson's hawk	CO	56,111	1	0
Ferruginous hawk	CO	8,704	1	0
Great horned owl	CO	112,757	1	0
Turkey vulture	CO	25,951	1	0
Golden eagle	CO	4,923	1	0
Loggerhead shrike	CO	248,838	2	0
Bald eagle	CO	NA	NA	NA
Rough-legged hawk	CO	NA	NA	NA
Prairie falcon	CO	5,610	2	0

Table 3.66. Estimates and trends for raptor spp. populations Rocky Mountain Avian Data Center (Bird Conservancy of the Rockies 2017).

IMBCR 2008-2018 Density Abundance Trend Data					
Species	State	Metric	Median	CV	f (%)
Red-tailed hawk	CO	Trend	1.06	2.72	98
Northern harrier hawk	CO	Trend	1.04	9.59	64
American kestrel falcon	CO	Trend	1.02	4.18	72
Swainson's hawk	CO	Trend	0.93	4.49	94

IMBCR 2008-2018 Density Abundance Trend Data					
Ferruginous hawk	CO	Trend	1.04	12.89	60
Great horned owl	CO	Trend	1.13	7.68	95
Turkey vulture	CO	Trend	1.02	5.38	69
Golden eagle	CO	Trend	0.96	12.50	63
Loggerhead shrike	CO	Trend	0.99	6.36	54
Bald eagle	CO	Trend	0.87	14.58	82
Rough-legged hawk	CO	Trend	NA	NA	NA
Prairie falcon	CO	Trend	1.12	14.43	76

Red-tailed Hawks. Red-tailed hawks are one of the most abundant raptor species in North America. Occupying a range of habitats, this species occurs from central Alaska, south to Venezuela and east to the Virgin Islands (Preston and Beane 2009). Typically this species inhabits open areas interspersed with trees or other structures.

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 334 work tasks associated with red-tailed hawks. These requests involved property 5 and human health and safety 329 (**Table 3.6**). In response to these tasks WS-Colorado lethally removed on average 105 birds/year, dispersed 1,375/year, and translocated 102/year (**Table 3.63**). The Rocky Mountain Avian Data Center (2017) estimates Colorado red-tailed hawk populations to be approximately 48,342 (**Table 3.67**). Partner's in Flight estimates from 1998 to 2015 suggest 47,220 red-tailed hawks reside year-round within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates red-tailed hawk populations are 61,195 (**Table 3.64, 3.65**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. This represents an average annual lethal removal of 0.2058% of total Colorado red-tailed hawk numbers.

The percentage of red-tailed hawks that breed in a given year is unknown. In Wisconsin, 10% of resident birds failed to breed in a given year (Preston and Beane 2009). In North America, red-tailed hawks typically raise one clutch per year with an average of 2.96 eggs (Preston and Beane 2009). Of the eggs lain, 45.3% will fledge (Johnson 1975). Although the exact annual morality rate of red-tailed hawks is unknown, here we used the mortality rate (71%) for a similar raptor species the ferruginous hawk (Schmutz et al. 2008). Using these parameters an annual average of 47,444 red-tailed hawks would annually produce an average of 43,704 young (**Table 3.67**). Given that WS-Colorado removed on average 105 red-tailed hawks per year, the annual lethal take for this species would be 0.2058% of total numbers.

Table 3.67. Cumulative impact analysis red-tailed hawks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

RED-TAILED HAWK IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	48,342	52,367	56,598	42,785	37,126	**47,444**
% Breeding Females	70.6%	70.6%	70.6%	70.6%	70.6%	**70.6%**
Estimated Number Breeding Females	34,124	36,965	39,952	30,201	26,207	**33,490**
Avg. Clutch	2.9	2.9	2.9	2.9	2.9	**2.9**
Avg. Nests	1	1	1	1	1	1
% Fledge	45%	45%	45%	45%	45%	**45%**
Young Produced/Post-breeding	44,532	48,239	52,137	39,413	34,200	**43,704**
Total Colorado Numbers	92,874	100,606	108,735	82,198	71,326	**91,148**
WS Take (%)*	0.2%	0.2%	0.2%	0.2%	0.3%	**0.2%**
WS-CO Take of Total Colorado Numbers	110	82	109	107	118	**105**
Remaining Total	92,764	100,524	108,626	82,091	71,208	**91,042**

^WS Take on average is 0.2058%.

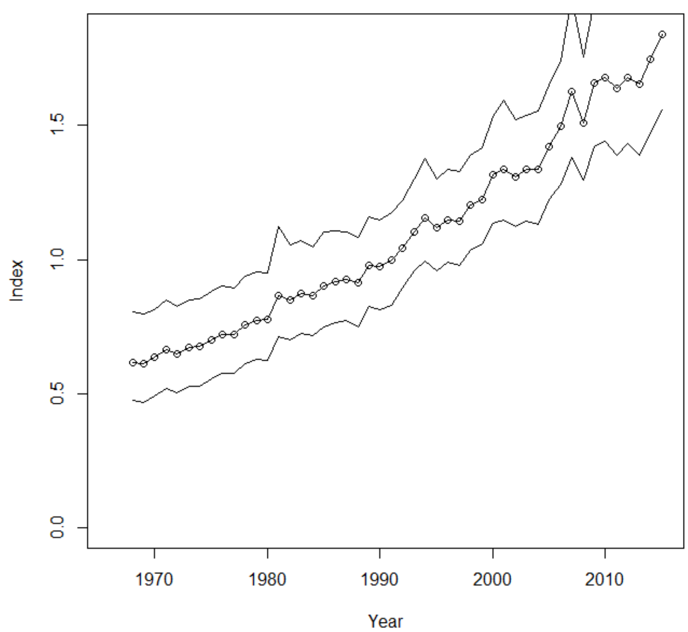


Figure 3.37. Red-tailed hawk annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

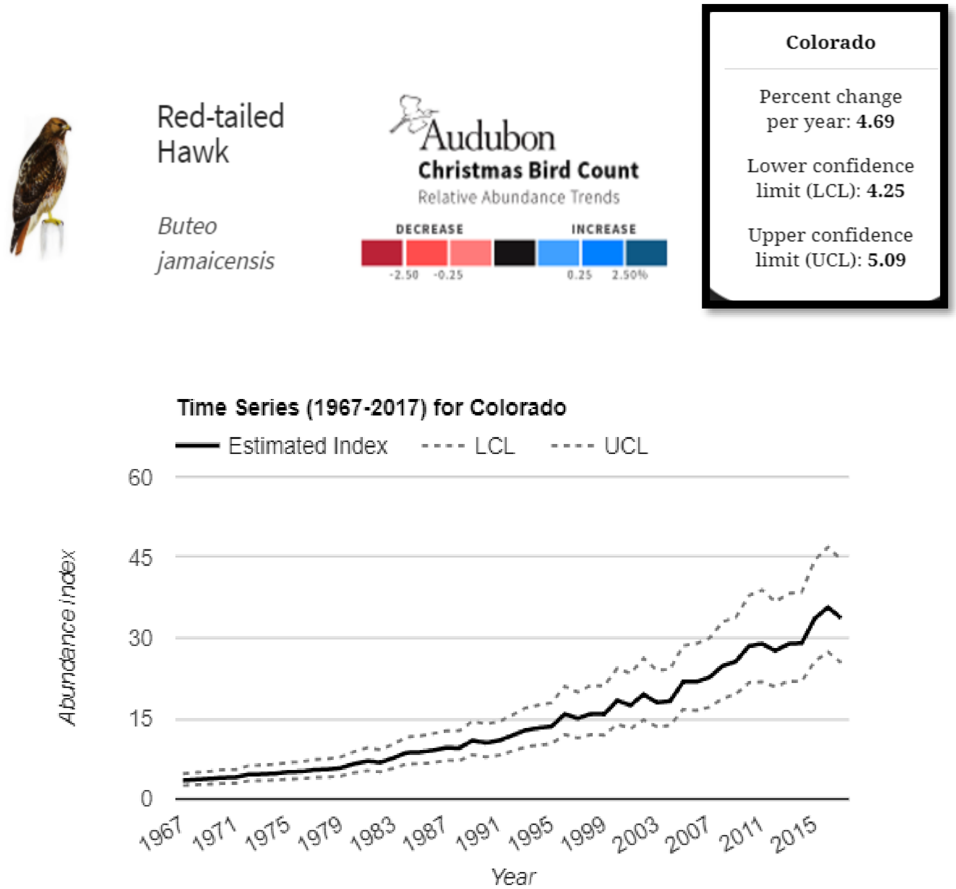


Figure 3.38. Estimated red-tailed hawk abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. Red-tailed hawks are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.2058%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, red-tailed hawk populations have been significantly increasing by 2.61% from 2005-2015 (**Table 3.64**)(Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 98% confident that red-tailed hawk populations are in increasing across the state (**Table 3.67**) (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figures 3.37** from Breeding Bird Survey population trends and Christmas Bird Count data **Figure 3.38** (Sauer et al 2019, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a numeric estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that red-tailed hawk populations are increasing by 4.69%/year from 1967 – 2017 (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (0.2058%) of red-tailed hawk by WS-Colorado would be considered negligible and would not adversely impact state wide numbers of common grackles or human environment. WS-Colorado take will not exceed 1% of the red-tailed hawks in Colorado.

Swainson's Hawk. Every autumn Swainson's hawks migrate more than 10,000 km to "winter" in areas of South America (Bechard et al. 2010). During migration, this gregarious species migrates in large populations that may reach numbers of up to 350,000 birds (Bechard et al. 2010). In the west, this species is predominantly associated with croplands, shelterbelts, and agricultural landscapes (Schmutz 1989).

<u>Direct Impacts.</u> From FY2013 to FY2017, WS-Colorado recorded 275 work tasks associated with Swainson's hawk. These requests involved property 1 and human health and safety 274 (**Table 3.6**). In response to these work tasks WS-Colorado lethally removed on average 15 birds/year, dispersed 238/year, and translocated 2/year (**Table 3.63**). The Rocky Mountain Avian Data Center (2017) estimates Colorado Swainson's hawk populations to be approximately 19,052 (**Table 3.68**). Partner's in Flight population estimates from 1998 to 2015 suggest 56,111 Swainson's hawks breed within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates Swainson's hawk populations are 73,932 (**Table 3.64, 3.65**). It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. This represents an average annual lethal removal of 0.0487% of the total Colorado Swainson's hawk numbers.

On average most Swainson's hawks do not breed until they are 3 years or older (Bechard et al. 2010). However, some studies have documented 2-year-old females breeding, no other additional information is available on the percentages of Swainson's hawk's age structure related to breeding. Starting in mid-April through early May, Swainson's hawks begin arriving in Colorado. Females typically lay one clutch of eggs per season ranging from 1 to 4 eggs (mean=2.3) (Bechard et al. 2010). On average, 51.7% of chicks fledge the nest and once they reach adulthood these individuals experience an 84.3% annual mortality rate (Bechard et al. 2010).

Using these parameters an annual average of 17,276 Swainson's hawks would annually produce an average of 17,283 young (**Table 3.68**). Given that WS-Colorado removed on average 15 Swainson's hawks per year, the annual lethal take for this species would be 0.0487% of the total state number of Swainson's hawks.

Table 3.68. Cumulative impact analysis Swainson's hawks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

SWAINSON'S HAWK IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	19,052	14,017	11,794	16,809	24,710	**17,276**
% Breeding Females	84.1%	84.1%	84.1%	84.1%	84.1%	**84.1%**
Estimated Number Breeding Females	16,028	11,792	9,922	14,141	20,788	**14,534**
Avg. Clutch	2.3	2.3	2.3	2.3	2.3	2.3
Avg. Nests	1	1	1	1	1	**1**
% Fledge	52%	52%	52%	52%	52%	52%
Young Produced/Post-breeding	19,059	14,022	11,798	16,815	24,719	**17,283**

SWAINSON'S HAWK IMPACT ANALYSIS						
Total Colorado Numbers	38,111	28,039	23,592	33,624	49,429	**34,559**
WS Take (%)*	0.05%	0.08%	0.1%	0.08%	0.01%	**0.09%**
WS-CO Take of Total Colorado Numbers	9	12	17	13	22	**15**
Remaining Total	38,102	28,027	23,575	33,611	49,407	**34,544**

^WS Take on average is 0.0845%.

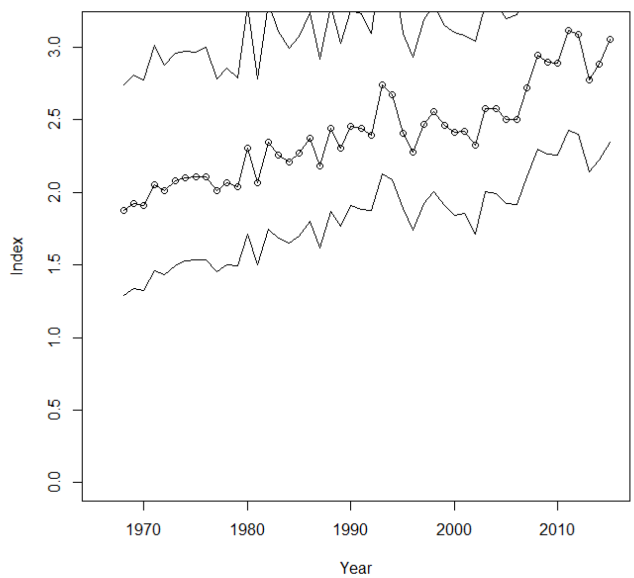


Figure 3.39. Swainson's hawk annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

Indirect Impacts. Swainson's hawks are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.0845%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced. Notably, this species experienced sharp declines in the 1960s and 1970s following the decline of its main prey species the Richardson's ground squirrel (*Spermophilus richardsonii*) and pesticide use in their wintering grounds in Argentina (migration area) (Bechard et al. 2010).

Cumulative Impacts. In examining short-term and long-term trends, Swainson's hawk populations have been significantly increasing by 21.93% from 2005-2015 (**Table 3.64, 3.65**) (Sauer et al. 2017). However, RMADC trend estimates (2008-2018), are 94% confident that Swainson's hawk populations are in declining across the state (**Table 3.66**) (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figure 3.39** from Breeding Bird Survey trends (Sauer et al 2019). Under Alternative 1, we anticipate that the average low magnitude of take (0.0845%) of Swainson's hawk by WS-Colorado would be considered negligible and would not adversely impact the state wide number of Swainson's hawks or human environment. Also, the apparent large decline in wintering Swainson's hawks ended about 30 years ago and has stabilized at lower abundance. WS-Colorado take will not exceed 1% of the total population in Colorado.

Ferruginous Hawk. The largest of the buteo species, Ferruginous hawks breed in 17 states in the western U.S and 3 provinces in Canada (Ng et al. 2017). Inhabiting grasslands, shrub-steepes, and deserts this species builds its nests on cliffs, oil and gas infrastructures, haystacks, and transmission towers (Ng et al. 2017). Prior to the decline in American bison, Ferruginous hawks often partially constructed nests made of bison wool and bones (Ng et al. 2017).

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 365 work tasks associated with Ferruginous hawks (**Table 3.6**). These tasks involved property 8 and human health and safety 357 (**Table 3.6**). In response to these requests WS-Colorado lethally removed on average 10 birds/year, dispersed 191/year, and translocated 5/year (**Table 3.63**). The Rocky Mountain Avian Data Center (2017) estimates Colorado Ferruginous hawk populations to be approximately 198 (**Table 3.63, 3.66**). Partner's in Flight estimates from 1998 to 2015 suggest 8,704 Ferruginous hawks breed within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates Ferruginous hawk populations are 7,061 (**Table 3.64, 3.65**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality.

Typically, Ferruginous hawks do not breed until they are 2 years or older (Ng et al. 2017). Due to a variety of conditions including weather, prey availability, and location of breeding sites, a variable number of pairs will breed in a given year. Beginning in mid-March, Ferruginous hawks will begin nesting with females laying 2-4 eggs (average 3) per clutch (Ng et al. 2017). Nestlings hatch asynchronously and roughly 68% of chicks will fledge (Ng et al. 2017). Once these individuals reach adulthood they will have an annual adult survival rate of 71% (Ng et al. 2017). Using these parameters an annual average Ferruginous hawk population of 1,792 birds would annually produce an average of 2,581 young (**Table 3.69**). Given that WS-Colorado removed on average 10 Ferruginous hawks per year, the annual lethal take for this species would be 0.5579% on average.

Table 3.69. Cumulative impact analysis Ferruginous hawks lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

FERRUGINOUS HAWK IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated in Colorado (RMADC)*	198	4,771	3,539	220	234	**1,792**
% Breeding Females (in other locations)	70.6%	70.6%	70.6%	70.6%	70.6%	**70.6%**
Estimated Number Breeding Females	140	3,368	2,498	155	165	**1,265**
Avg. Clutch	3	3	3	3	3	3
Avg. Nests	1	1	1	1	1	**1**
% Fledge	68%	68%	68%	68%	68%	**68%**
Young Produced/Post-breeding	285	6,870	5,096	317	337	**2,581**
Total Colorado Numbers	483	11,641	8,635	537	571	**4,373**
WS Take (%)*	3.5%	0.3%	0.3%	3.2%	4.3%	**0.6%**
WS-CO Take of Total Colorado Numbers	7	14	12	7	10	**10**
Remaining Total	476	11,627	8,623	530	561	**4,363**

^WS Take on average is 0.5579%.

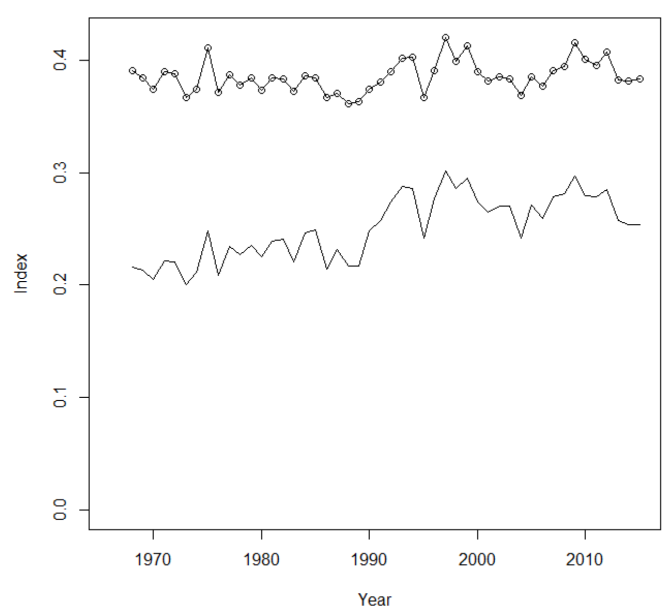


Figure 3.40. Ferruginous hawk annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

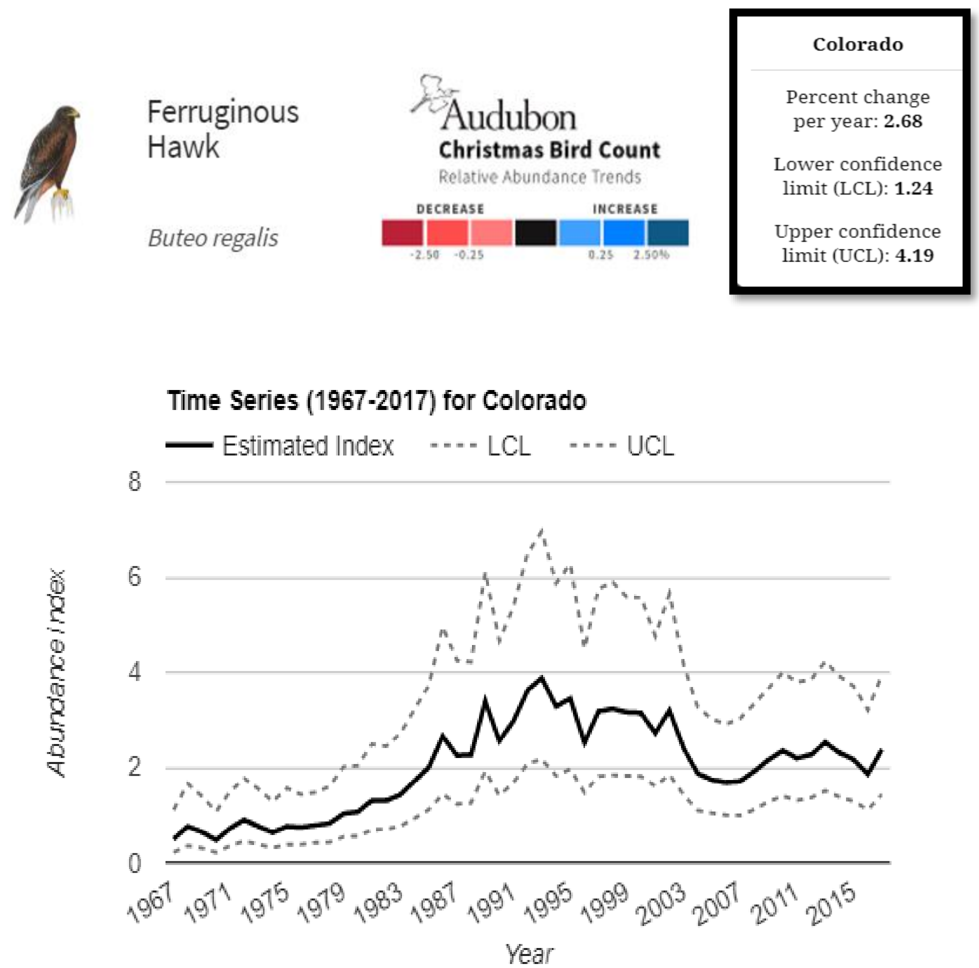


Figure 3.41. Estimated Ferruginous hawk abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

<u>Indirect Impacts</u>. Ferruginous hawks are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.5579%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

<u>Cumulative Impacts.</u> In examining short-term and long-term trends, Ferruginous hawk populations have been non-significantly declining by -0.02% from 2005-2015 (**Table 3.63**)(Sauer et al. 2017). However, RMADC population trend estimates (2008-2018), are 60% confident that Ferruginous hawk populations are in increasing across the state (**Table 3.66**) (Bird Conservancy of the Rockies 2019). In looking at BBS data from 2013 to 2017 using PIF detectability parameters from Rich et al. (2004) an estimated 7,061 Ferruginous hawks occupy Colorado annually. Similarly, Partners in Flight estimates Ferruginous hawk populations of 8,704 birds. We can visualize these abundance trends by analyzing **Figures 3.40** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.41** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a numerical estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that Ferruginous hawk populations are increasing by 2.68%/year from 1967 – 2017 (National Audubon Society 2010). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.5579%) of Ferruginous hawk by WS-Colorado would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 3% of ferruginous hawks in Colorado.

Northern Harriers. The only North American member of the genus *Circus*, Northern harrier hawks are slender, medium sized, white rumped raptors. Breeding below 7,800 ft in elevation, this species nests in a variety of native and non-native habitats including marshes, upland prairies, grasslands, desert shrub-steppe, and riparian woodland.

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 280 work tasks associated with Northern harriers (**Table 3.6**). These tasks involved property 18 and human health and safety 262 (**Table 3.6**). In response to these requests WS-Colorado lethally removed on average 17 birds/year, dispersed 350/year, and translocated 2/year (**Table 3.63**). The Rocky Mountain Avian Data Center (2017) estimates Colorado Northern harrier hawk populations to be approximately 5,528 (**Table 3.70**). Partner's in Flight population estimates from 1998 to 2015 suggest 21,096 Northern harrier hawks breed within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates Northern harrier hawk populations are roughly 7,494 (**Table 3.64**).

Northern harriers exhibit semi-social and polygynous breeding. Females construct one nest per season and lay on average 4.4 eggs per clutch (Smith et al. 2011). On average 1.8 chicks will fledge per nest (Smith et al. 2011). Adult annual mortality rates were estimated to be 30% (Smit et al. 2011). Using these parameters an annual average Northern harrier population of 4,200 birds would annually produce an average of 5,261 young (**Table 3.70**). Given that WS-Colorado removed on average 17 Northern harrier hawks per year, the annual lethal take for this species would be 0.5579% on average.

Table 3.70. Cumulative impact analysis Northern harrier lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

NORTHERN HARRIER IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado	5,528	3,660	3,960	4,204	3,648	**4,200**
% Breeding Females	69.6%	69.6%	69.6%	69.6%	69.6%	**69.6%**
Estimated Number Breeding Females	3,848	2,548	2,756	2,926	2,539	**2,923**
Avg. Clutch	4.4	4.4	4.4	4.4	4.4	4.4
Avg. Nests	1	1	1	1	1	**1**
% Fledge	41%	41%	41%	41%	41%	**41%**
Young Produced/Post-breeding	6,924	4,585	4,960	5,266	4,570	**5,261**
Total Colorado Numbers	12,452	8,245	8,920	9,470	8,218	**9,461**

NORTHERN HARRIER IMPACT ANALYSIS						
WS Take (%)*	0.3%	0.5%	0.5%	0.2%	0.5%	**0.4%**
WS-CO Take of Total Colorado Numbers	17	20	19	9	18	**17**
Remaining Total	12,435	8,225	8,901	9,461	8,200	**9,444**

^WS Take on average is 0.3952%.

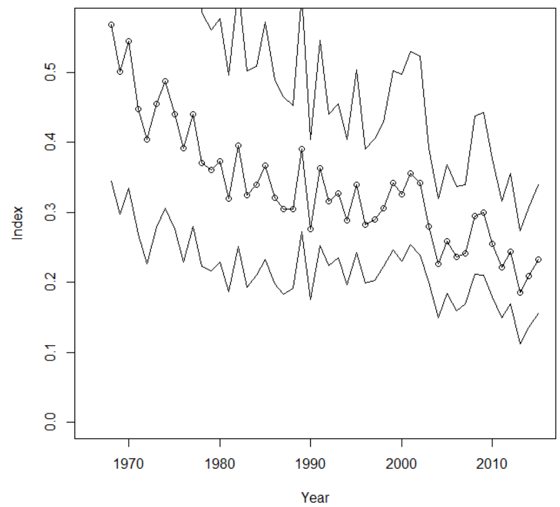


Figure 3.42. Northern harrier annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

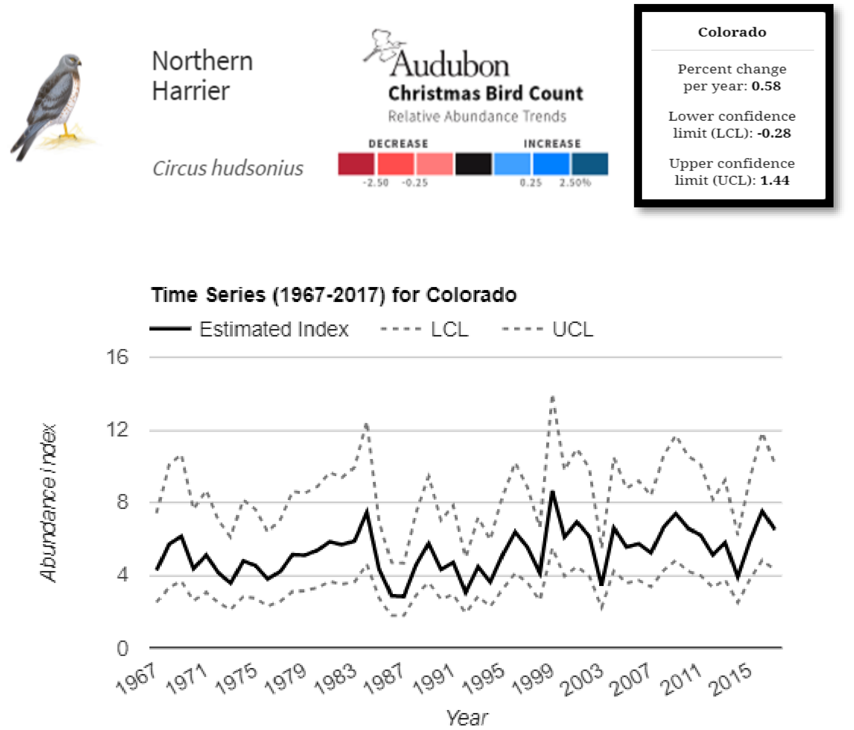


Figure 3.43. Estimated Northern harrier abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

<u>Indirect Impacts</u>. Northern harriers are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.3952%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

<u>Cumulative Impacts.</u> In examining short-term and long-term trends, Northern harrier populations have been significantly facing long-term declines of -1.89% from 1966-2015 and by -1.16%/year from 2005 to 2015 (**Table 3.65**) (Sauer et al. 2017). RMADC trend estimates (2008-2018), are 64% confident that Northern harrier populations are in increasing across the state (**Table 3.70**) (Bird Conservancy of the Rockies 2019). In looking at BBS data from 2013 to 2017 using PIF detectability parameters from Rich et al. (2004) an estimated 7,494 Northern harriers occupy Colorado annually. Similarly, Partners in Flight estimates Northern harrier hawk populations of 21,096 birds. It should be noted that this data should be cautiously analyzed as depicted by the color-coded data quality. We can visualize these abundance trends by analyzing **Figures 3.42** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.44**(Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a numerical estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that Northern harrier populations are increasing by 0.58%/year from 1967 – 2017 (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (0.3952%) of Northern harriers by WS-Colorado would be considered negligible and would not adversely impact state wide numbers of common grackles or human environment. WS-Colorado take will not exceed 1% of Northern harriers in Colorado.

American kestrel. Once known as the sparrow hawk, American kestrels are the smallest and most abundant of the North American falcons. As many as 17 different subspecies occur throughout the Americas ranging from Alaska to Tierra del Fuego, Argentina (Smallwood and Bird 2002). American kestrels predominately inhabit open areas covered by short ground vegetation. In Colorado, this year-round resident species breeds up to elevations of 10,000 ft (Colorado Breeding Bird Atlas 2016). As obligate secondary cavity nesters, American kestrels nesting success depends on the availability of woodpecker excavated cavities, crevices in rocks, and artificial nest boxes.

Direct Impacts. The Rocky Mountain Avian Data Center (2017) estimates Colorado American kestrel populations to be approximately 27,387 (**Table 3.71**). Partner's in Flight estimates from 1998 to 2015 suggest 79,054 American kestrels breed within Colorado; and Breeding Bird Survey data (2013 – 2017) using PIF detectability parameters indicates kestrel populations are 761,210 (**Table 3.64**). From FY2013 to FY2017, WS-Colorado recorded 346 work tasks associated with American kestrels (**Table 3.6**); and on average lethally removed 14 American kestrels/year, dispersed 220/year, and translocated 1/year (**Table 3.63**).

Eighty percent of American kestrels breed as yearlings and once every year thereafter (Henny 1972). Females lay 4 to 5 eggs/clutch (mean 4.6) and raise one brood per season (Smallwood and Bird 2002). Young typically leave the nest at 28-31 days with roughly 49% of the chicks that hatch fledging (Smallwood and Bird 2002). Once these birds reach adulthood, they will have an annual mortality rate of 55% (Smallwood and Bird 2002). Using these parameters an annual average 31,008 American kestrels would annually produce an average of 38,188 young (**Table 3.71**). Given that WS-Colorado removed on average 14 American kestrels per year, the annual lethal take for this species would be 0.0458% of state numbers.

Table 3.71. Cumulative impact analysis American kestrels lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

AMERICAN KESTREL IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	27,387	30,885	36,613	31,887	28,266	**31,008**
% Breeding Females	54.8%	54.8%	54.8%	54.8%	54.8%	**54.8%**
Estimated Number Breeding Females	14,995	16,910	20,046	17,458	15,476	**16,977**
Avg. Clutch	4.6	4.6	4.6	4.6	4.6	**4.6**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	49%	49%	49%	49%	49%	**49%**
Young Produced/Post-breeding	33,729	38,037	45,092	39,271	34,812	**38,188**
Total Colorado Numbers	61,116	68,922	81,705	71,158	63,078	**69,196**
WS Take (%)*	0.0%	0.0%	0.0%	0.0%	0.1%	**0.0%**
WS-CO Take of Total Colorado Numbers	11	7	16	11	26	**14**
Remaining Total	61,105	68,915	81,689	71,147	63,052	**69,181**

^WS Take on average is 0.0458%.

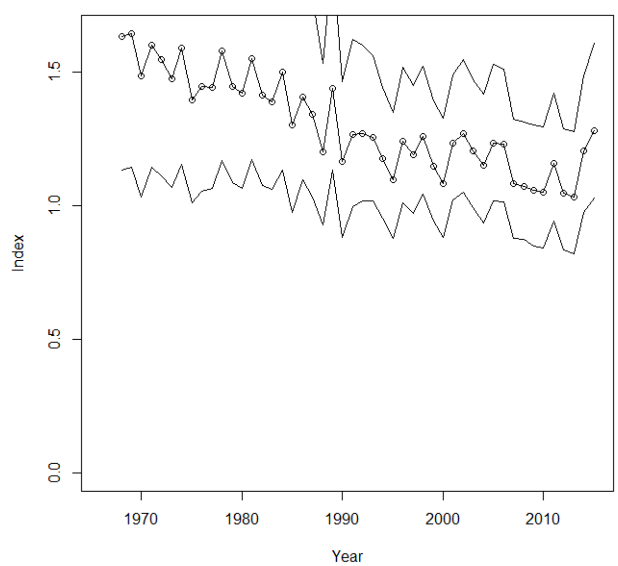


Figure 3.44. American kestrel annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

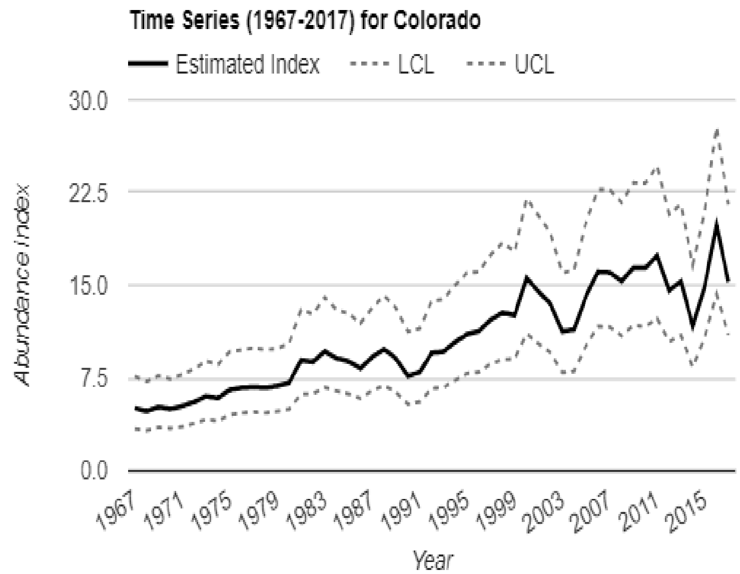


Figure 3.45. Estimated American kestrel abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. American kestrels are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.0458%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, American kestrel populations have been non-significantly increasing by 0.33% from 2005-2015 (**Table 3.64**)(Sauer et al. 2017). RMADC trend estimates (2008-2018), are 72% confident that American kestrel populations are in increasing across the state (**Table 3.66**) (Bird Conservancy of the Rockies 2019). In looking at BBS data from 2013 to 2017 using PIF detectability parameters from Rich et al. (2004) an estimated 761,210 kestrels occupy Colorado annually. Partners in Flight (2015) estimates American kestrel populations of 79,054 birds. We can visualize these abundance trends by analyzing **Figures 3.44** from Breeding Bird Survey population trends and Christmas Bird Count data **Figure 3.45**(Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a population estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that American kestrel populations are increasing by 2.49%/year from 1967 – 2017 (National Audubon Society 2010). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. Under Alternative 1, we anticipate that the average low magnitude of take (0.0458%) of American kestrels by WS-Colorado would be considered negligible and would not adversely impact the state wide population or human environment. WS-Colorado take will not exceed 1% of the American kestrels in Colorado.

Bald and Golden Eagle Population Impact Analysis

During the early 1900s, populations of bald eagles experienced drastic declines in the lower 48 states of the U.S. These declines were primarily attributed to a loss of nesting habitat, pesticide contamination, shooting, and poisoning. The Bald Eagle Protection Act was passed in 1940 in an attempt to bolster this species numbers. This act, prohibits the take or possession of bald eagles or their parts. In 1962, the Bald Eagle Protection Act was amended to include golden eagles, and is now referred to as the Bald and Golden Eagle Protection Act. Under the Endangered Species Preservation Act of 1966, certain populations of bald eagles were listed as "endangered." In 1973, the Endangered Species Act was passed and all populations of bald eagles in the lower 48 states, except in Minnesota, Wisconsin, Michigan, Washington, and Oregon which were listed as threatened in 1978, were listed as endangered. As bald eagle populations recovered, all populations of eagles in the lower 48 states were reclassified as threatened in 1995. In 1999, bald eagle populations had reached or exceeded the recovery goals and this species was proposed for removal from the Endangered Species Act. On June 28, 2007, bald eagles were officially de-listed from the ESA with the exception of the Sonora Desert bald eagle population. However, although removed from the ESA across much of its range, bald eagles are still afforded protection under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

From FY2013 to FY2017, WS-Colorado recorded 298 work tasks related to bald and golden eagles (**Table 3.6**). Requests were related to agriculture 2 (golden eagles), property 1 (bald eagles), and human health and safety 295 (bald eagles 235, golden eagles 60) (**Table 3.6**). On average WS-Colorado dispersed 194 bald eagles/year, 21 golden eagles/year, and translocated 1 bald eagle during this 5 year time period (**Table 3.63**). Most of these activities were conducted in airport environments where eagles pose a large strike hazard to commercial and private aircraft and their passengers.

Current BBS data from 2013 to 2017 in Colorado, indicates breeding estimates of 6,044 golden eagles and 3,023 bald eagles, based on detectability factors from Rich et al (2004) (Pardieck et al. 2018). RMADC (2017) had estimates of 176 golden eagles and 76 bald eagles. BBS survey-wide trends for these species were positive with the golden eagle having a non-significant trend of 0.39%/year and bald eagle population significant trends of 16.11%/year from 2005-2015 in Colorado. WS-Colorado employs harassment methods to disperse bald and golden eagles from airport environments and when possible, may translocate individuals to other areas of the state. Lethal take of bald or golden eagles would be unlikely to occur under any of the proposed action alternatives as they are protected by the Bald and Golden Eagle Protection Act. Furthermore, WS-Colorado abides by all measures and stipulations listed by the USFWS in permits issued for the harassment of these species at airports to reduce aircraft strikes. Under Alternative 1 WS-Colorado would have no impact on local or state wide populations of bald or golden eagles since none of these species were lethally removed under BDM from FY2013 to FY2017. WS-Colorado would only lethally take eagles when permitted by the USFWS on a case by case basis.

Shorebirds

Colorado hosts 34 species of shorebirds regularly, 7 accidentally, and/or likely extinct as in the case of the Eskimo curlew. Ten species of shorebirds breed in Colorado, with the remainder of species spending short periods of time during the spring and late-summer/fall migrating through the state. From FY2013 to FY2017, WS-Colorado dispersed on average/year 272 killdeer, 14 American avocets, 9 willet, 11 Wilson's phalarope, 6 white-faced ibis, and 29 American pelicans. During this same period of time, WS-Colorado lethally removed on average/year 26 killdeer, 0 American avocets, 1 willet, 0 Wilson's phalarope, 0 white-faced ibis, and 0 American white pelican. Most of WS-Colorado's work with these species is confined to airport environments where these medium to large bodied birds pose a threat to human health and safety when being struck by aircraft. Or, as in the case of American white pelicans, they threaten a resource such as at aquaculture facilities. WS-Colorado recorded 869 work tasks related to shorebirds from FY2013 to FY2017. These involved killdeer (property 1, human health and safety 410); American avocet (human health and safety 117); willet (human health and safety 68); Wilson's phalarope (human health and safety 67); white-faced ibis (human health and safety 52); and American white pelicans (agriculture 3, human health and safety 149, and natural resources 2). Most shorebirds are hazed from airfields, but some such as the Upland Plover and Killdeer are difficult to haze out of an area because they readily nest in grassland habitat found at airports.

Of these species, killdeer were the only species lethally removed with an average take of more than 10 birds per year and as such will be analyzed below (**Table 3.72**). In conducting impact analysis for shorebird species, much like waterfowl, we are using published species reports in scientific literature, Christmas Bird Count trend estimates, Rocky Mountain Avian Data Center IMBCR species counts, Breeding Bird Survey raw data from 2013 to 2017 with detectability parameters from Rich et al. (2004), and BBS trend estimates from 2005-2015 (Sauer et al. 2017, Bird Conservancy of the Rockies 2019, National Audubon Society 2010, Partners in Flight 2017, Pardieck et al. 2018).

Table 3.72. Cumulative impact analysis shorebirds lethally removed or hazed in Colorado by WS from FY2013 to FY2017. *Colorado Breeding Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Shorebirds spp.						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Breeding Estimates (Colorado)	% taken by WS-CO
2017	Killdeer	42	94	0	242,522	0.0%
2016		24	28	0	165,329	0.0%
2015		21	149	0	217,910	0.0%
2014		21	842	0	164,442	0.0%
2013		21	247	0	182,062	0.0%
Average		**26**	**272**	**0**	**194,453**	**0.0%**
2017	American Avocets	0	0	0	35,882	0.0%
2016		0	0	0	685	0.0%
2015		0	0	0	788	0.0%

Shorebirds spp.						
2014		0	0	0	692	0.0%
2013		0	72	0	1,163	0.0%
Average		**0**	**14**	**0**	**7,842**	**0.0%**
2017	**Willet**	0	0	0	NA	0.0%
2016		0	0	0	NA	0.0%
2015		0	0	0	NA	0.0%
2014		0	0	0	NA	0.0%
2013		5	44	0	NA	0.0%
Average		**1**	**9**	**0**	**NA**	**0.0%**
2017	**Wilson's Phalaropes**	0	0	0	800	0.0%
2016		0	0	0	982	0.0%
2015		0	0	0	302	0.0%
2014		0	57	0	697	0.0%
2013		0	0	0	812	0.0%
Average		**0**	**11**	**0**	**719**	**0.0%**
2017	**White faced ibis**	0	0	0	1,588	0.0%
2016		0	0	0	1,589	0.0%
2015		0	0	0	1,184	0.0%
2014		0	0	0	2,890	0.0%
2013		0	32	0	2,210	0.0%
Average		**0**	**6**	**0**	**1,892**	**0.0%**
2017	**American white pelican**	0	0	0	2,111	0.0%
2016		0	0	0	1,265	0.0%
2015		0	0	0	503	0.0%
2014		2	17	0	816	0.2%
2013		0	127	0	819	0.0%
Average		**0**	**29**	**0**	**1,103**	**0.0%**

Table 3.73. Estimates and trends shorebird populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	RMADC C.V. Average (2013-2017)	RMADC Estimate Average (2013-2017)	BBS Data w/PIF Detect. Parameter Rich et al. 2004 (2013-2017)	Detectability Parameter Factors (PIF)	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	Color Code Trend
Killdeer	**38.2**	194,453	55,580	**2**	-2.58	CO	(-4.48, -0.67)	
American avocet	**283.8**	7,842	4,167	**2**	-2.88	CO	(-8.89, 6.87)	
Willet	**NA**	NA	39	**2**	0.21	BCR 10	(-6.04, 6.23)	
Wilson's phalarope	**555.0**	719	6,132	**2**	4.08	CO	(-5.87, 20.41)	

IMBCR 2008-2018 Density Abundance Trend Data

Species	State	Metric	Median	CV	f (%)
Killdeer	CO	Trend	0.93	3.39	96
American avocet	CO	Trend	0.99	19.59	48
Willet	CO	Trend	NA	NA	NA
Wilson's phalarope	CO	Trend	0.79	17.40	93

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Table 3.74. Shorebird species estimates from Andres et al. 2012. Here long-term means over the last 30 years and short-term means over the last decade.

Species	Estimates 2012	Certainty/range	Trend long term	Trend short term
Killdeer	**2,000,000**	low	Significant decline	Apparent decline
American avocet	**450,000**	low	Stable	Significant decline
Willet	**90,000**	low	Apparent decline	Stable
Wilson's phalarope	**1,500,000**	low	Apparent decline	Unknown

Killdeer. One of the familiar and wide-spread species of American plovers, killdeer are found in a variety of habitats ranging from mudflats, gravel bars, short-grass meadows, gravel rooftops, gravel parking lots, and golf courses (Jackson and Jackson 2000). Although technically categorized as a shorebird, killdeer are commonly seen in areas of sparse or low vegetation near a water source. Depending on the elevation these year-round residents of Colorado, begin breeding in early April (lower elevations) and May (higher elevations) (Laubhan and Gammonley 2000).

<u>Direct Impacts.</u> From FY2013 to FY2017, WS-Colorado recorded 411 work tasks involving killdeer related to property 1 and human health and safety 410 (**Table 3.6**). On average, WS-Colorado lethally removed 26 killdeer per year, removed 1 nest, and dispersed 272 on average/year (**Table 3.72**). The Rocky Mountain Avian Data Center (2017) estimates Colorado killdeer populations to be approximately 242,522 (**Table 3.72**). Since waterfowl and shorebirds are not readily detected by Partner's in Flight and the Breeding Bird Survey the following data should be cautiously analyzed. Breeding Bird Survey data (2013 – 2017) using a detectability factor of 2 from Rich et al. (2004) indicates killdeer populations are 55,580 (**Table 3.73**).

Sexually mature at one year of age, killdeer form monogamous pairs during breeding season. Females lay one clutch containing 4 eggs per season (Jackson and Jackson 2000). Of the eggs lain, only 4% will fledge (Jackson and Jackson 2000). Once these birds reach adulthood, we used the annual survival rate of the semipalmated polver 71% (Badzinski 2000).

Using these parameters an annual average of 194,453 killdeer would annually produce an average of 21,962 young (**Table 3.75**). Given that WS-Colorado removed on average 26 killdeer per year, the annual lethal take for this species would equal 0.0133% of the total Colorado killdeer populations (**Table 3.75**).

Table 3.75. Cumulative impact analysis killdeer lethally removed in Colorado by WS from FY2013 to FY2017.

KILLDEER IMPACT ANALYSIS						
	FY17	FY16	FY15	FY14	FY13	**Avg.**
Estimated Breeding in Colorado (RMADC)*	242,522	165,329	217,910	164,442	182,062	**194,453**
% Breeding Females	70.6%	70.6%	70.6%	70.6%	70.6%	**70.6%**
Estimated Number Breeding Females	171,192	116,703	153,819	116,077	128,514	**137,261**
Avg. Clutch	4	4	4	4	4	**4**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	4%	4%	4%	4%	4%	**4%**
Young Produced/Post-breeding	27,391	18,672	24,611	18,572	20,562	**21,962**
Total Colorado Numbers	269,913	184,001	242,521	183,014	202,624	**216,415**
WS Take (%)*	0.02%	0.01%	0.01%	0.01%	0.01%	**0.01%**
WS-CO Take of Total Colorado Numbers	42	24	21	21	21	**26**
Remaining Total	269,871	183,977	242,500	182,996	202,603	**216,389**

^WS Take on average is 0.0133%.

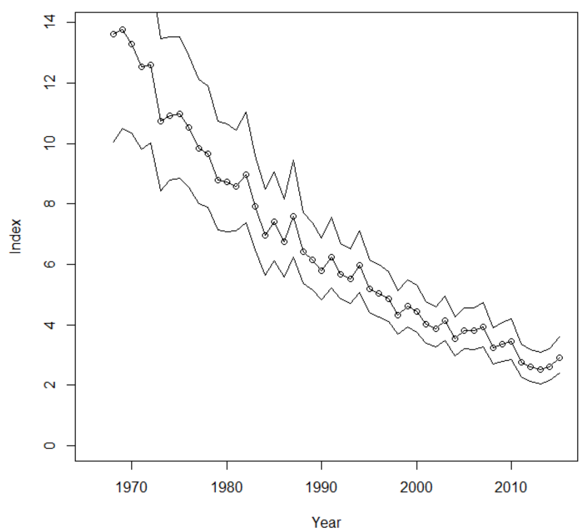


Figure 3.46. Killdeer annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

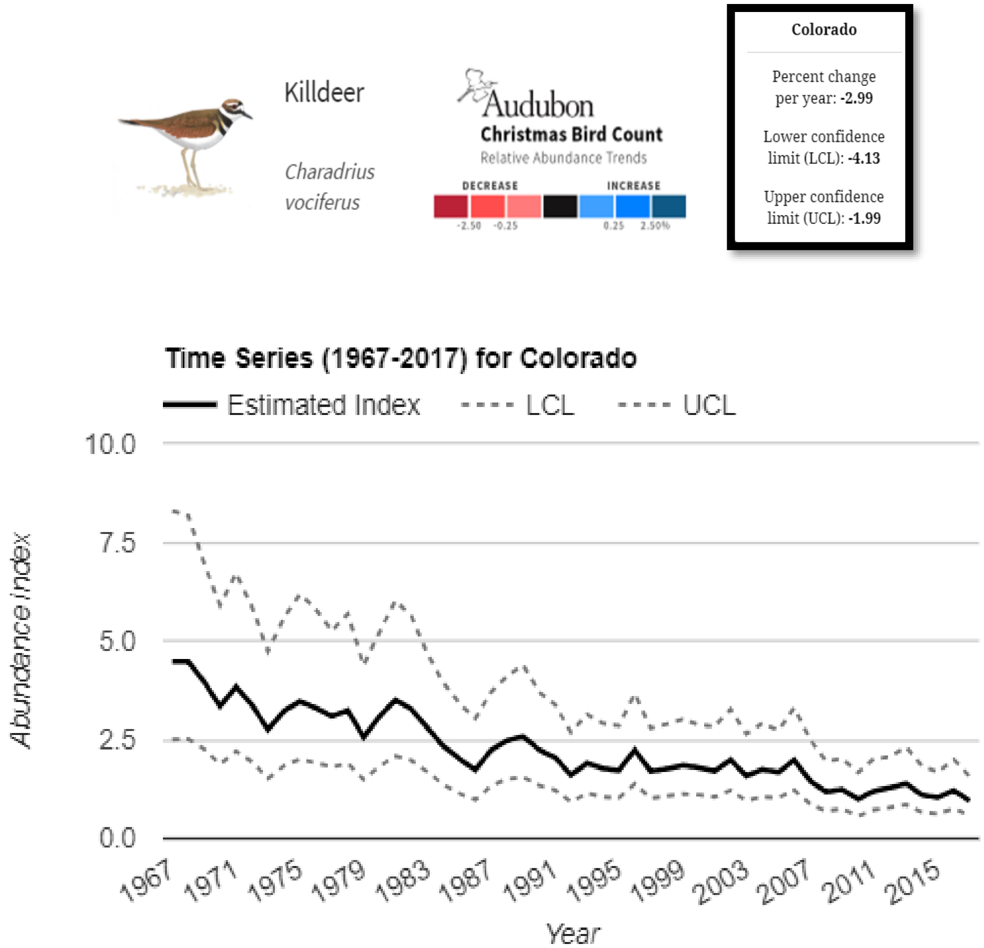


Figure 3.47. Estimated killdeer abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. Killdeer are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (0.0133%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, killdeer populations have been significantly declining by -2.58 % from 2005-2015 (Sauer et al. 2017). Similarly, RMADC trend estimates (2008-2018), are 96% confident that killdeer populations are in decline (Bird Conservancy of the Rockies 2019). We can visualize these abundance trends by analyzing **Figures 3.46** from Breeding Bird Survey trends and Christmas Bird Count data **Figure 3.47** (Sauer et al 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a numerical estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that killdeer populations are declining by -2.99%/year from 1967 – 2017 (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (0.0133%) of killdeer by WS-Colorado would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 1% of the total killdeer in Colorado.

Wading and Waterbirds Birds

Eight species of wading birds, herons, egrets, and bitterns are regularly found in Colorado with an additional 9 that are rare or accidental including the Roseate Spoonbill and Wood Stork in addition to the others. The most common requests for assistance involving these species in Colorado are from airports to reduce their strikes. Wading birds also cause damage at aquaculture facilities (individual wading birds preying on fish at an aquaculture facility) and property in urban residential areas where they are a human health and safety concern (roosts). These conflicts may require the take of some individuals to reinforce hazing efforts, but often do not involve the take of any. Thus, the impact to these species populations is typically negligible under the proposed action. WS- Colorado conducts minimal BDM for wading bird problems. To illustrate the small scope of the conflicts with wading and waterbirds in Colorado, WS-Colorado recorded 154 work tasks related to great blue herons 88, white-faced ibis 52, black-crowned night herons 14, and American white pelicans 154 (**Table 3.6**). These tasks were related to property 21, human health and safety 279, and natural resources 8 (**Table 3.6**).

WS-Colorado lethally removed on average 1 great blue heron/year and hazed on average 8 great blue heron/year, 6 white-faced ibis/year, and 29 pelicans per year from FY2013 to FY2017 (**Table 3.76**). In looking at trends in **Table 3.77** populations of both white-faced ibis and American white pelcians are non-significantly increasing by 4.48%/year and 10.3%/year respectively (Sauer et al. 2017). While great blue heron populations are non-significantly declining by -1.27%/year (Sauer et al. 2017).

Wading bird and waterbirds (such as American white pelicans) are found seasonally in Colorado are relatively common in North America. WS-Colorado anticipates that some of these bird species will be taken lethally. This would likely be conducted for a significant problem that developed at an airport or a significant urban roost that created a nuisance or health and safety concerns. Lethal shooting is generally used to reinforce harassment methods and is conducted at airports where very damaging strikes could occur or in residential areas where a roost has formed. Urban roosts are mostly dispersed prior to nesting using hazing devices (lasers have proven successful in some situations). WS believes that few wading birds will ever be taken and that WS will have no impact on any species' population. Wading birds, their nests, eggs and young are protected by the Migratory Bird Treaty Act; any form of take requires a permit from the USFWS. WS-Colorado does not anticipate take will exceed 1% of the total species in this group population in Colorado.

Table 3.76. Cumulative impact analysis wading and waterbird spp. birds lethally removed or hazed in Colorado by WS from FY2013 to FY2017. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Wading and Waterbirds spp.						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Estimates (Colorado)	% taken by WS-CO
2017	**Great Blue Heron**	0	0	0	14,846	0.0000%
2016		0	0	0	7,729	0.0000%
2015		0	0	0	2,437	0.0000%
2014		6	39	0	6,514	0.0921%
2013		0	0	0	10,066	0.0000%
Average		**1**	**8**	**0**	**8,318**	**0.0144%**
2017	**White faced ibis**	0	0	0	1,588	0.0%
2016		0	0	0	1,589	0.0%
2015		0	0	0	1,184	0.0%
2014		0	0	0	2,890	0.0%
2013		0	32	0	2,210	0.0%
Average		**0**	**6**	**0**	**1,892**	**0.0%**
2017	**American white pelican**	0	0	0	2,111	0.0%
2016		0	0	0	1,265	0.0%
2015		0	0	0	503	0.0%
2014		2	17	0	816	0.2%
2013		0	127	0	819	0.0%
Average		**0**	**29**	**0**	**1,103**	**0.0%**

Table 3.77. Estimates and trends wading and waterbird spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	RMADC C.V. Average (2013-2017)	RMADC Estimated Average (2013-2017)	BBS Data w/PIF Detect. Parameter Rich et al. 2004 (2013-2017)	Detectability Parameter Factors (PIF)	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	BBS Data
White faced ibis	**511.8**	1,892	10,416	**2**	4.48	CO	(-12.34, 19.25)	
American white pelican	**137.0**	1,103	25,353	**2**	10.3	CO	(-3.22, 22.81)	

Species	RMADC C.V. Average (2013-2017)	RMADC Estimated Average (2013-2017)	BBS Data w/PIF Detect. Parameter Rich et al. 2004 (2013-2017)	Detectability Parameter Factors (PIF)	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	BBS Data
Great Blue Heron	270.0	8,318	8,648	2	-1.27	CO	(-5.99, 2.66)	

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Great Blue Heron	CO	Trend	0.96	7.66	63
White faced ibis	CO	Trend	0.68	20.76	96
American white pelican	CO	Trend	1.15	9.44	91

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
(red)	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
(yellow)	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
(blue)	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Larids.

Five species of gulls commonly migrate through or winter in Colorado coming from their northern breeding grounds. Franklin's gull, Bonaparte's gull, ring-billed gull, California gull, and herring gull, are the species that are most likely be encountered in Colorado during migration and winter. Isolated colonies of California gulls have been known to breed in north-central Colorado. Throughout the United States, gulls are primarily taken for depredation management primarily at airports, landfills, and aquaculture facilities.

Table 3.78. Larid species hazed and lethally removed from damage situations from FY2013-2017 by WS-Colorado. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Larids spp.						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Estimates (Colorado)	% taken by WS-CO
2017	Ring-billed gulls	4	222	0	574	0.7%
2016		18	503	0	631	2.9%
2015		69	2,330	0	676	10.2%
2014		40	778	0	1,002	4.0%
2013		15	186	0	509	2.9%
Average		**29**	**804**	**0**	**678**	**4.3%**
2017	California gulls	0	113	0	706	0.0%
2016		1	203	0	864	0.1%
2015		26	749	0	3,467	0.7%
2014		8	724	0	1,457	0.5%
2013		0	0	0	2,616	0.0%
Average		**7**	**358**	**0**	**1,822**	**0.4%**

Table 3.79. Estimates and trends larid spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	RMADC C.V. Average (2013-2017)	RMADC Estimated Average (2013-2017)	BBS Data w/PIF Detect. Parameter Rich et al. 2004 (2013-2017)	Detectability Parameters (2013- 2017)	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	Color Code Trend
Ring-billed gull	678.4	678	865	2	-4.98	Colorado	(-24.78, 18.89)	
California gull	474.8	1822	156,559	2	14.7	Colorado	(3.01, 27.97)	

Table 3.80. Estimates and trends for larid spp. populations Rocky Mountain Avian Data Center (Bird Conservancy of the Rockies 2017).

IMBCR 2008-2018 Density Abundance Trend Data					
Species	**State**	**Metric**	**Median**	**CV**	**f (%)**
Ring-billed gull	CO	Trend	1.01	7.68	63
California gull	CO	Trend	0.57	18.45	99

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Ring-billed gull. Nearly wiped in the1850s-1920s by human development and harassment, ring-billed gulls are now commonly seen throughout North America (Pollet et al. 2012). Broadly distributed, ring-billed gulls are seen in Colorado during the winter months. Small populations of these birds overwinter locally, while others merely migrate through on their way to more southern locales from December to February.

Direct Impacts. From FY2013 to FY2017, WS-Colorado recorded 2,593 work tasks involving ring-billed gulls related to: 6 agriculture, 2,586 human health and safety, and 1 property (**Table 3.6**). On average, WS-Colorado lethally removed 29 ring-billed gulls per year and dispersed 804 birds/year (**Table 3.78**). The Rocky Mountain Avian Data Center (2017) estimates Colorado ring-billed gull numbers to be on average 678 (**Table 3.78**). Since gulls much like other waterbirds and shorebirds, are not readily detected by Partner's in Flight and the Breeding Bird Survey the following data should be cautiously analyzed (as depicted by the color coded data quality). Breeding Bird Survey data (2013 to 2017) analyzed using a detectability factor of 2 from Rich et al. (2004) indicates that ring-billed gull estimates in Colorado are approximately 865 (**Table 3.79**).

Typically, ring-billed gulls overwinter or migrate through Colorado, although occasionally some isolated individuals may breed in the state. Specific information on breeding age is limited. However, Southern (1968) and Ludwig (1974) found that 53.6% and 57.7% of 3-4 year old birds were breeding. Other evidence suggests that ring-billed gull breeding age may be based on colony age and stability (Pollet et al. 2012). Once sexually mature, females lay 2-4 eggs (mode 3) once per year (Pollet et al. 2012). The mean number of fledglings per pair can range from 0.77 to 2.53 (median fledge rate 49%) (Blokpoel and Tessier 1986). As these fledglings become adults they have an annual mortality rate of 13% (Pollet et al. 2012).

Using these parameters, an annual average of 678 ring-billed gulls could produce an average of 861 young (**Table 3.81**). Given that WS-Colorado removed on average 29 ring-billed gulls per year, the annual lethal take for this species would equal 4.3042% of the ring-billed gull numbers (**Table 3.81**).

Table 3.81. Cumulative impact analysis ring-billed gulls lethally removed in Colorado by WS from FY2013 to FY2017. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

RING-BILLED GULL IMPACT ANALYSIS						
	FY17	**FY16**	**FY15**	**FY14**	**FY13**	**Avg.**
Estimated Breeding Population in Colorado (RMADC)*	574	631	676	1,002	509	**678**
% Breeding Females	85.8%	85.8%	85.8%	85.8%	85.8%	**85.8%**
Estimated Number Breeding Females	493	541	580	860	437	**582**
Avg. Clutch	3	3	3	3	3	**3**
Avg. Nests	1	1	1	1	1	**1**
% Fledge	49%	49%	49%	49%	49%	**49%**
Young Produced/Post-breeding	729	801	858	1,272	646	**861**
Total Colorado Numbers	1,303	1,432	1,534	2,274	1,155	**1,539**
WS Take (%)*	0.7%	2.9%	10.2%	4.0%	2.9%	**4.3%**
WS-CO Take of Total Colorado Numbers	4	18	69	40	15	**29**
Remaining Total	1,299	1,414	1,465	2,234	1,140	**1,510**

*WS Take on average is 4.3042%.

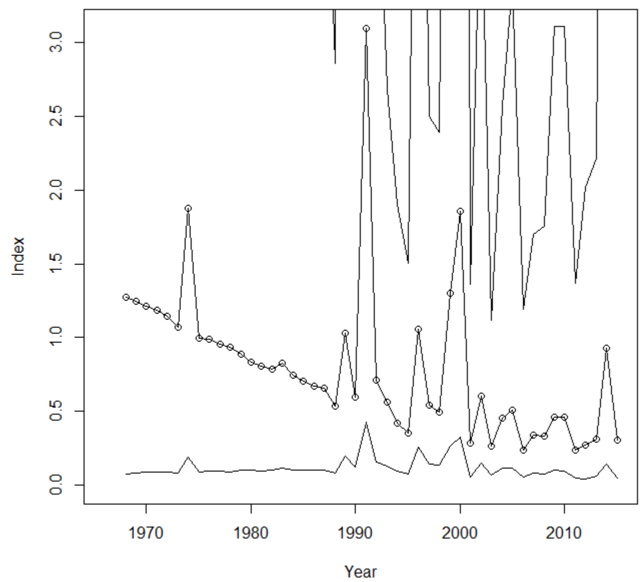


Figure 3.48. Ring-billed gull annual population indexes. The indexes are relative abundance estimates for all years which represent the mean count of birds on a typical route in the Colorado for a year (Sauer et al. 2017).

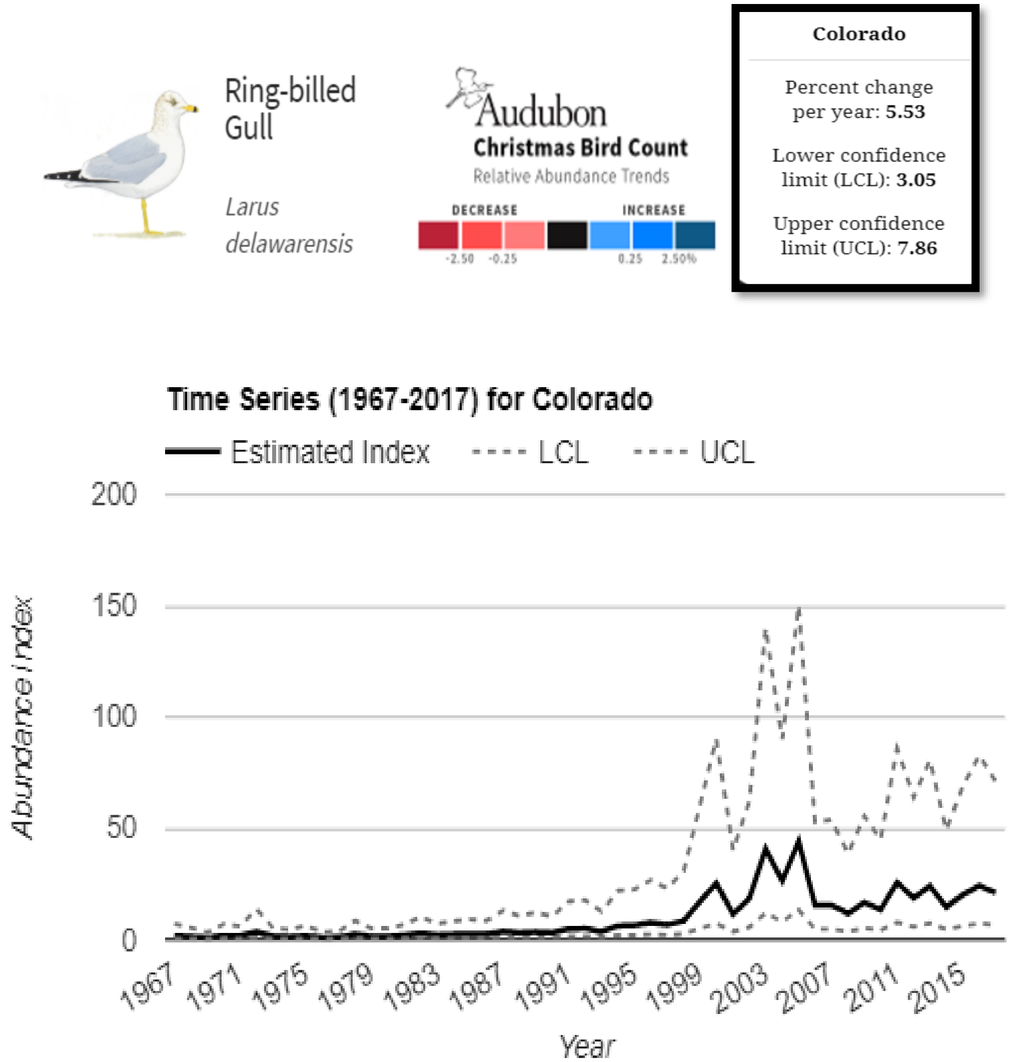


Figure 3.50. Estimated ring-billed gull abundance index from Christmas Bird Counts 1967-2017 including upper and lower confidence limits (National Audubon Society 2010).

Indirect Impacts. Ring-billed gulls are predominately the target of BDM within airport environments across the state. The low-magnitude of WS-Colorado's average annual lethal take of (4.3042%) would have a low magnitude of impact on local and state populations and would probably not be discernable from natural mortality events. Additionally, considering that most of these activities will be occurring in airport environments, most of the general public would not notice a decline in local populations but would rather experience increased bird-strikes were their populations not reduced.

Cumulative Impacts. In examining short-term and long-term trends, ring-billed gull populations have been non-significantly declining by -4.98 % from 2005-2015 (Sauer et al. 2017). Conversely, RMADC trend estimates (2008-2018), are 63% confident that ring-billed gull populations are in increasing (Bird Conservancy of the Rockies 2019). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. We can visualize these abundance trends by analyzing **Figures 3.48** from Breeding Bird Survey trends and Christmas Bird Count data

Figure 3.49 (Sauer et al. 2017, National Audubon Society 2010). Although the Christmas Bird Count data does not provide a numerical estimate, it does provide us with a relative abundance trend similar to the BBS. Here this data indicates that ring-billed gull populations are increasing by 5.53%/year from 1967 – 2017 (National Audubon Society 2010). Under Alternative 1, we anticipate that the average low magnitude of take (4.3042%) of ring-billed gulls by WS-Colorado would be considered negligible and would not adversely impact state wide numbers or human environment. WS-Colorado take will not exceed 6% of Colorado ring-billed gull populations.

Woodpeckers.

Colorado is home to thirteen species of woodpeckers (woodpeckers, flickers, sapsuckers, nuthatches). These medium sized birds (7 to 15 inches long), feed on wood-boring insects, vegetable matter, berries, or tree sap. Of these, Northern flickers are the most common woodpecker species involved in BDM requests for assistance. The majority of these requests are related to technical assistance in obtaining a Form 37 (issued by WS-Colorado) as part of a Migratory Bird Depredation Permit application process with the US Fish and Wildlife Service. Occasionally, operational work is conducted at airport facilities to prevent bird strikes. From FY2013 to FY2017 WS-Colorado recorded 174 work tasks related to Northern flickers involving: 97 property and 77 human health and safety. During this same period, WS-Colorado recorded 14 work tasks related to white-breasted nuthatches and 5 work tasks related to downy woodpeckers involving property damage. Due to the low level of take, we are not analyzing these species. However, available data indicates that Northern flickers appear to be increasing throughout the state (**Table 3.83, 3.84**). WS-Colorado take will not exceed 1% of woodpecker species in Colorado.

Table 3.82. Woodpecker *spp.* (Northern flicker) hazed (scared with frightening devices or other nonlethal method) and lethally removed (firearms, DRC-1339, trap, handcaught) from damage situations from FY13 to FY17 by WS-Colorado. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Woodpecker spp.						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Breeding Estimates (Colorado)	% taken by WS-Colorado
2017	Northern flicker	0	0	0	NA	0
2016		0	0	0	NA	0
2015		8	30	0	529,399	<1
2014		0	0	0	NA	0
2013		0	0	0	NA	0
Average		**2**	**6**	**0**	**529,399**	**<1**

Table 3.83. Estimates and trends woodpecker spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	Color Code Trend
	Dist.	Pair	Time						
Northern flicker	200	1.25	1.18	2,435	195,287	0.64	CO	(-1.48, 2.72)	

Table 3.84. Estimates and trends for woodpecker spp. populations Rocky Mountain Avian Data Center (Bird Conservancy of the Rockies 2017).

Partners in Flight version 2.0 (1998-2007)				
Species	**State**	**BBS Calculator**	**Data Quality**	**Range Coverage**
Northern Flicker	CO	195,287	0	0

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	**<50%**	Robust Estimate	**>1**	Increasing
1	Poor BBS coverage	**50 - 100%**	Marginal	**1**	Static
2		**>100%**	Poor	**<1**	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Gallinaceous Birds.

Gallinaceous birds are primarily ground-dwellers with short, rounded wings and short strong bills. Flight is usually very brief for these species, as they prefer to walk. The primary damage that these species cause is damage to crops and safety hazards at airports. During FY2013 to FY2017 WS-Colorado recorded 34 work tasks involving quail related to human health and safety (airports). Since WS-Colorado did not take any of these species lethally, WS had no long-term impact on any of them. WS-Colorado take will not exceed 1% of the gallinaceous bird species in Colorado, discussed here.

Open Woodland Birds.

Several open woodland bird species are found in Colorado that can cause damage. The most notable of these, other than those discussed above such as starlings, are the American robin, mountain and western bluebird Northern mockingbird, cedar waxwing, Bohemian waxwing, Northern cardinal, and house and Cassin's finches. These species can damage fruit crops, but are the biggest problem for grape and berry producers. Other species, especially American robins and bluebirds, can be strike threats at airports. American robins, mountain and western bluebirds, house and Cassin's finches, and Northern cardinals are found in Colorado year-round. The mockingbird is the only species that mostly leaves for the winter whereas the Bohemian waxwings only winter in Colorado. Cedar waxwings occur in Colorado during migration and winter, but small breeding population do occur in the state.

From FY2013 to FY2017 WS-Colorado staff entered 639 work tasks involving American robins related to human health and safety (predominately at airports) (**Table 3.6**). During this time, WS-Colorado removed an average of 0 American robins per year, 50 Mountain bluebirds per year, and 0 western bluebirds. Similarly, WS-Colorado dispersed on average 68 American robins per year, 77 mountain bluebirds, and 54 western bluebirds (**Table 3.85)**. In Colorado, available data suggests that on average 2,652,696 American robins, 746,576 mountain bluebirds, and 130,554 western bluebirds live within the state (**Table 3.85**). In examining short-term and long-term trends, American robin populations have been significantly declining by -0.16 %, mountain bluebirds have been non-significantly declining by -0.51%, and western bluebirds have significantly increased by 4.27%, from 2005-2015 (Sauer et al. 2017) (**Table 3.86**). It should be noted that this data should be cautiously analyzed as depicted by the color coded data quality. Here, we only are examine WS-Colorado take of mountain bluebirds since on average 50 are lethally removed per year. WS-Colorado take will not exceed 1% of open woodland species populations in Colorado.

Table 3.85. Open woodland birds *spp.* (robins, finches, flycatcher) hazed (scared with frightening devices or other nonlethal method) and lethally removed (firearms, DRC-1339, trap, handcaught) from damage situations from FY2013 to FY2017 by WS-Colorado. *Colorado Estimates obtained from the Rocky Mountain Avian Data Center for specified calendar years.

Other Birds						
WS Bird Damage Management Activities					State Population Size (Calendar Year)	
Fiscal Year (FY)	Avian Species	Removed	Dispersed	Relocated	Breeding Estimates (Colorado)	% taken by WS-CO
2017	**American robin**	0	0	0	2,677,273	0.0%
2016		0	0	0	2,672,386	0.0%
2015		0	0	0	2,690,098	0.0%
2014		0	295	75	2,635,129	0.0%
2013		2	45	0	2,588,595	0.0%
Average		**0**	**68**	**15**	**2,652,696**	**0.0%**
2017	**Mountain Bluebirds**	0	384	0	827,117	0.0%
2016		0	250	0	605,327	0.0%
2015		0	0	0	944,314	0.0%
2014		0	0	0	686,691	0.0%

Other Birds						
2013		0	0	0	669,432	0.0%
Average		**0**	**126**	**0**	**746,576**	**0.0%**
2017	**Western Bluebirds**	0	200	0	42,971	0.0%
2016		0	34	0	92,426	0.0%
2015		0	0	0	235,774	0.0%
2014		0	35	0	119,162	0.0%
2013		0	0	0	162,436	0.0%
Average		**0**	**54**	**0**	**130,554**	**0.0%**

Table 3.86. Estimates and trends frugivorous spp. populations from Partners in Flight (version 2.0) and Breeding Bird Survey data (2013-2017) with Partners in Flight Detectability Parameters data.

Species	Detectability Parameter Factors (PIF)			BBS Data w/ PIF Detectability Parameters (2013- 2017)	PIF Estimates 2015	BBS Trend Estimates 2005-2015 (% change per year)	BBS Region	2005-2015 Credible Interval	BBS Data
	Dist.	Pair	Time						
American robin	200	2	2.34	4,864,604	4,845,860	-0.16	CO	(-1.10, 0.81)	
Mountain bluebird	NA	NA	NA	340,639	NA	-0.51	CO	(-2.84, 1.78)	
Western bluebird	125	2	1.82	2,077,533	195,683	4.27	CO	(-2.38, 11.46)	

Partners in Flight version 2.0 (1998-2007)

Species	State	BBS Calculator	Data Quality	Range Coverage
American robin	CO	4,845,860	0	0
Mountain bluebird	CO	NA	NA	NA
Western bluebird	CO	195,683	1	0

PIF Data Quality Rating		IMBCR C.V. %		IMBCR Trend Estimate	
0	Good BBS coverage	<50%	Robust Estimate	>1	Increasing
1	Poor BBS coverage	50 - 100%	Marginal	1	Static
2		>100%	Poor	<1	Decreasing
3					
4					

BBS Trend Estimate Data 1966 - 2015	
	Important deficiency. Low abundance (< 0.1 bird/rt), Small samples (< 5 rts). Imprecise results (not able to detect 5% change per year)
	Data deficiency. Low abundance (< 1 bird/rt). Small samples (< 14 routes). Imprecise (not able to detect 3% change per year)
	Has at least 14 samples. Moderate precision, and moderate abundance. Still may not provide valid results.

Summary

Based on WS-Colorado's determination and USFWS concurrence, the employment of methods by WS would not likely adversely affect any non-target species, including threatened and endangered species (Olson 2018, Dubovsky 2018). These occurrences would be rare and should not affect the overall population of any species. WS continually monitors, evaluates and makes modifications as necessary to methods or strategy when providing operational assistance, to not only reduce damage but also to minimize potentially harmful effects to target and non-targets. Additionally, WS consults with the USFWS to determine the potential risks to federally and state listed threatened and endangered species in accordance with the ESA and local laws; along with submitting annual reports to these entities to ensure that any non-target take by WS is considered as part of management objectives. Potential impacts to non-target species, including threatened and endangered species from the recommendation of methods by WS is expected to be variable. If methods are employed as recommended by WS-Colorado and according to label requirements (in the case of chemical methods) potential risks to non-targets would be low.

Issue B: Impact of BDM on Non-target Bird Populations, Including T & E Species.

As discussed previously, a concern is often raised about the potential impacts to non-target species, including T&E species, from the use of BDM methods to resolve damage caused by birds. Potential adverse impacts to non-targets occur from the employment of methods to address bird damage. Under the proposed action, WS-Colorado could provide both technical assistance and operational assistance to those persons requesting assistance. The use of nonlethal methods as part of an integrated operational assistance activities would be similar to those risks to non-targets discussed in the other alternatives.

T&E, and Sensitive Species

WS did not lethally or nonlethally target any federally or state listed T&E species from FY13 to FY17 (**Table 3.8**). The inherent safety features of most BDM methods such as DRC- 1339 has precluded or minimized hazards to listed species. None of the other damage management methods described in the proposed action alternative pose any hazard, other than potentially the short term harassment or capture, to non-target or T&E species. WS completed a Section 7 consultation with USFWS in 2011 and USFWS concurred with the Protective Measures that WS has in place to avoid the take of T&E species. An additional Section 7 consultation was conducted in 2018 looking specifically at impacts of T&E species from BDM activities. The conclusions from both Section 7 consultations were similar. USFWS and WS did not anticipate affecting T&E species other than potentially inadvertently hazing them at an airport while WS personnel were hazing other species. Raptor traps, mist nets, noose mats, and toxicants could have the potential for also taking other species, but Protective Measures are in place to avoid take. On the other hand, BDM could unintentionally benefit T&E species. Examples of potential benefits to a listed T&E species would be the reduction of local cowbird populations which could reduce nest parasitism on the endangered Southwestern willow flycatcher or the management of birds that could directly predate on adult Interior least terns or Snowy plovers, their nests, eggs or young, as discussed above. And finally, birds accidentally hazed from airfields would be benefit those species, because it would reduce their potential to be struck by aircraft and killed. Thus, WS-Colorado concludes that impacts to T&E and sensitive species by WS would have a low magnitude of impact on any of these species

Proposed Action

Protective Measures for bird damage management in Colorado discussed in **Chapter 2** ensure risks to non-target wildlife species, including threatened and endangered species, would be reduced or prevented under the proposed action alternative. Pertinent Protective Measures include not only the WS' Decision Model (WS Directive 2.201), an evaluation process for the appropriateness of methods (WS Directive 2.101) and the use of integrated management (WS Directive 2.105) but also several other Protective Measures including the following. WS-Colorado personnel are trained and experienced in wildlife identification and in the selection of and implementation of methods which are as species-specific as possible thus reducing the risks to non-target wildlife including threatened and endangered species. Management actions are directed towards specific birds or groups of birds responsible for causing damage or posing threats. WS-Colorado consults with the USFWS or CPW to determine the potential risks to federally and state listed threatened and endangered species in accordance with the ESA and local, state, and federal rules and regulations. Nonlethal methods are given priority when addressing requests for assistance (WS Directive 2.101). Non-target animals captured in traps are released unless it is determined that the animal would not survive and or that the animal cannot be safely released. To limit the possibility that birds which died from DRC-1339 are scavenged by non-targets, WS-Colorado would retrieve all dead birds to the extent possible and dispose of them in accordance with WS Directive 2.515.

Issue C: Impacts of Bird Damage Management Methods on Public and Pet Safety and the Environment.

An additional issue often raised is the potential risks to human health and safety associated with the methods employed to manage damage caused by birds. Both chemical and non-chemical methods have the potential to have adverse effects on human health and safety. Risks can occur both to persons employing methods and persons coming into contact with methods. Risks can be inherent to the method itself or related to the misuse of the method. Potential effects of damage management activities on human health and safety under each of the three alternatives are analyzed below.

Proposed Action

Protective Measures for bird damage management in Colorado discussed in **Chapter 2** ensure risks to human health and safety would be reduced or prevented. Pertinent Protective Measures include not only the WS' Decision Model (WS Directive 2.201), an evaluation process for the appropriateness of methods (WS Directive 2.101) and the use of integrated management (WS Directive 2.105) but also several other Protective Measures including the following. WS-Colorado identifies hazards in advance of work assignments and provides employees with personal protective equipment (PPE). WS-Colorado's employees must adhere to safety requirements and use appropriate PPE. WS employees are required to work cooperatively to minimize hazards and immediately report unsafe working conditions (WS Directive 2.601). Damage management activities would be conducted away from areas of high human activity (e.g., in areas closed to the public) or during periods when human activity is low (e.g., early mornings, at night) to the extent possible. Although hazards to human health and safety from both nonlethal and lethal methods exist, those methods would generally be regarded as safe when used by individuals trained and experienced in their use and with regard and consideration of possible risks to human health and safety.

Although some risk of bodily harm exists from the use of nonlethal non-chemical methods, when used appropriately and with consideration of possible risks these methods can be used with a high degree of safety. If used incorrectly, physical exclusion devices (e.g., electric fencing), frightening devices / deterrents (e.g., propane exploders, pyrotechnics, lasers, paintballs) can pose safety hazards. Other nonlethal methods available for use under any of the alternatives are live-capture traps (see **Chapter 2**). Risks of most live-capture traps to human health and safety (decoy traps, nest box traps, clover/funnel/pigeon traps, mist nets, bow nets, hand nets, panel nets/drive traps, raptor traps) are small to non-existent. Risks of other live-capture traps including cannon/rocket nets, net guns and padded-jaw pole to human health and safety are greater. However, proper application of cannon/rocket nets, net guns and padded-jaw pole requires trained and experienced personnel to be present at all times. Live capture traps can only be triggered through direct activation of the device. Therefore, if left undisturbed, these traps would pose no risk. Under the proposed action, all WS personnel who use these devices would be trained and experienced in their use and required to wear appropriate PPE (WS Directive 2.601). WS would not implement these methods in locations or in such a manner in which they would pose hazards to WS staff or the public. When recommending these methods, WS would caution those persons against their misuse.

WS personnel are trained and experienced in the use of firearms. WS employees who use shooting as a method must comply with WS Directive 2.615 and all standards described in the WS Firearms Safety Training Manual. Directive 2.615 requires that personnel undergo regular training, adhere to a set of safety standards, submit to drug testing, and are subject to the Lautenberg Amendment. WS' recommendation that hunting or shooting be used would not increase risks to human health and safety above those already inherent with hunting birds. When used appropriately and with consideration of human safety, risks associated with firearms are minimal. When recommending that hunting or shooting be used, WS would caution against the improper use of firearms. Since the use of firearms would be available under any of the alternatives and their use could occur whether WS was consulted or not, the risks to human health and safety would be similar among all the alternatives.

As mentioned previously, the avicide DRC-1339 is only available for use by WS. However, a product containing the same active ingredient as DRC-1339, Starlicide, is commercially available as a restricted-use pesticide and would be available under any of the alternatives. A common concern regarding the use of chemicals is the risk to human health and safety. WS personnel that use DRC-1339 would be certified as pesticide applicators by the Colorado Department of Agriculture and be required to adhere to all certification requirements set forth in FIFRA and Colorado pesticide control laws and regulations. WS would follow all label requirements. Following label requirements of DRC-1339 or Starlicide eliminates these risks. When recommending the use of Starlicide, WS would caution against its misuse. Given the strict application requirements this avicide, WS does not anticipate any negative impacts on human health and safety. Additionally, WS does not anticipate any increased risks to human health and safety from providing technical assistance regarding Starlicide because it is commercially available as a restricted-use pesticide and would be available under any of the alternatives.

To limit the possibility that the public is exposed to birds which died from DRC-1339, WS would retrieve all dead birds to the extent possible and dispose of them in accordance with WS Directive 2.515. Locations where treated bait may be placed are determined based on product label requirements (e.g., distance from water, specific location restrictions), the target bird species use of the site (determined through pre-baiting and an acclimation period), non-target use of the area (areas with non-target activity are not used or abandoned), and based on human safety (e.g., in areas restricted or inaccessible by the public or where warning signs have been placed). Once appropriate locations were determined, treated baits would be placed in feeding stations or would be broadcast using mechanical methods (ground-based equipment or hand spreaders) and by manual broadcast (distributed by hand) per label requirements. Once baited using the diluted mixture (treated bait and untreated bait) when required by the label, locations would be monitored for non-target activity and to ensure the safety of the public. After each baiting session, all uneaten bait would be retrieved. The pre-baiting period allows treated bait to be placed at a location only when target birds were conditioned to be present at the site and provides a higher likelihood that treated bait would be consumed by the target species, which makes it unavailable for potential exposure to humans. To be exposed to the bait, someone would have to approach a bait site and handle treated bait. If the bait had been consumed by target species or was removed by WS, then treated bait would no longer be available and human exposure to the bait could not occur. Therefore, direct exposure to treated bait during the baiting process would only occur if someone approached a bait site that contained bait and if treated bait was present, would have to handle treated bait.

Factors that minimize any risk of public health problems from the use of DRC-1339 are: 1) its use is prohibited within 50 feet of standing water and cannot be applied directly to food or feed crops (DRC1339 is not applied to feed materials that livestock can feed upon), 2) DRC-1339 is highly unstable and degrades rapidly when exposed to sunlight, heat, or ultraviolet radiation (the half-life is about 25 hours; in general, DRC-1339 on treated bait material is almost completely broken down within a week if not consumed or retrieved), 3) the chemical is more than 90% metabolized in target birds within the first few hours after they consume the bait. Therefore, little material is left in bird carcasses that may be found or retrieved by people, 4) application rates are extremely low (EPA 1995), 5) a human would need to ingest the internal organs of birds found dead from DRC-1339 to be exposed, and 6) the EPA has concluded that, based on mutagenicity (the tendency to cause gene mutations in cells) studies, this chemical is not a mutagen or a carcinogen (i.e., cancer-causing agent) (EPA 1995).

Of additional concern is the potential exposure of people to crows harvested during the regulated hunting season that have ingested DRC-1339 treated bait. Baiting using DRC-1339 to reduce crow damage could occur during the period of time when crows can be harvested. Although baiting could occur in rural areas during those periods, most requests for assistance to manage crow damage during the period of time when crows can be harvested occur in urban areas associated with urban crow roosts. Crows using urban communal roost locations often travel long distances to forage before returning to the roost location during the evening.

For a crow that ingested DRC-1339-treated bait to pose a potential safety risk to someone harvesting crows during the hunting season, a hunter would have to harvest a crow that ingested DRC-1339 treated bait and subsequently consume certain portions of the crow. The mode of action of DRC-1339 requires ingestion by crows so handling a crow harvested or found dead would not pose any primary risks to human safety. Although not specifically known for crows, in other sensitive species, DRC-1339 is metabolized and/or excreted quickly once ingested. In starlings, nearly 90% of the DRC-1339 administered dosages well above the LD50 for starlings was metabolized or excreted within 30 minutes of dosage (Cunningham et al. 1979). In one study, more than 98% of a DRC-1339 dose delivered to starlings could be detected in the feces within 2.5 hours (Peoples and Apostolou 1967) with similar results found for other bird species (Eisemann et al. 2003). Once death occurs, DRC-1339 concentrations appear to be highest in the gastrointestinal tract of birds, but some residue could be found in other tissue of carcasses examined (Giri et al. 1976, Cunningham et al. 1979, Johnston et al. 1999) with residues diminishing more slowly in the kidneys (Eisemann et al. 2003). However, most residue tests to detect DRC-1339 in tissues of birds have been completed using DRC-1339 dosages that far exceeded the known acute lethal oral dose for those species tested and far exceeds the level of DRC-1339 that would be ingested from treated bait. Johnston et al. (1999) found DRC-1339 residues in breast tissue of boat-tailed grackles (*Quiscalus major*) using acute doses ranging from 40 to 863 mg/kg. The acute lethal oral dose of DRC-1339 for boat-tailed grackles has been estimated to be ≤ 1 mg/kg, which is similar to the LD50 for crows (Eisemann et al. 2003). In those boat-tailed grackles consuming a trace of DRC-1339 up to 22 mg/kg, no DRC-1339 residues were found in the gastrointestinal track nor found in breast tissue (Johnston et al. 1999).

In summary, nearly all of the DRC-1339 ingested by sensitive species is metabolized or excreted quickly, normally within a few hours. Residues of DRC-1339 have been found in the tissues of birds consuming DRC-1339 at very high dosage rates that exceed current acute lethal dosages achieved under the label requirements of DRC-1339. Residues of DRC-1339 ingested by birds appear to be primarily located in the gastrointestinal tract of birds.

Other chemical methods that could be used or recommended are Starlicide® and Avitrol. Starlicide is DRC-1339 in a product available to the general public. Avitrol® is classified as an avian distressing agent and is normally used to deter target bird species from using certain problem areas. This chemical repels birds by poisoning a few individual members of a population of birds, causing distress behavior in the birds that consume treated baits from a mixture of treated and untreated bait. These distress calls then generally frighten the other birds from the site. Only a small number of birds need to be affected to cause alarm in the rest of the population. In most cases, those birds that consume the treated bait will die (Johnson and Glahn 1994).

No adverse effects to human safety have occurred from WS' use of methods to alleviate bird damage from FY 2013 through FY 2017. The risks to human safety from the use of nonlethal and lethal methods, when used appropriately and by trained personnel, is considered low. The amount of chemicals used or stored by WS and cooperating agencies would be minimal to ensure human safety. Based on potential use patterns, the chemical and physical characteristics of the above-mentioned toxicants and repellents, and factors related to the environmental fate, no cumulative impacts are expected from the chemical components used or recommended by the WS activities.

Other BDM

Other nonlethal BDM chemicals that might be used or recommended by WS-Colorado include repellents such as methyl anthranilate (MA is the artificial grape flavoring used in foods and soft drinks sold for human consumption), which has been used as an area repellent and is researched as a livestock feed additive. Anthraquinone and Methiocarb are other nonlethal BDM chemicals that may be used or recommend to repel birds from resources. Such chemicals must undergo rigorous testing and research to prove safety, effectiveness, and low environmental risks before they would be registered by EPA or FDA. Any operational use of these chemicals would be in accordance with labeling requirements under FIFRA and state pesticide laws and regulations which are established to avoid unreasonable adverse effects on the environment. Following labeling requirements and use restrictions are a built-in mitigation measure that would assure that use of registered chemical products would avoid significant adverse effects on human health.

Anthraquinone (Flight Control®Plus, Avipel®), is relatively nontoxic to the environment with the amount of active ingredient used in the different formulations, especially following label instructions. The active ingredients in many repellents are listed on the EPA's 25b exempt list and, as such, are considered to have relatively low risk to the environment. Registration requirements for these chemicals are reduced because they are relatively nontoxic. Most repellents have only "Caution" on the labels because they are relatively nontoxic. These can typically be purchased by the public. WS-Colorado did not have any incidents involving the public or pets conducting BDM from FY13 to FY17.

Methiocarb (Measurol®) The active ingredient is injected into eggs which are placed in artificial nests or on elevated platforms. Upon ingestion, birds develop post-ingestional malaise (Mason et al. 1989) and develop an aversion to consuming similar-looking eggs.

Impacts of Activities on Human Health and Pet Safety

Prior to and during the use of nonlethal and lethal methods, WS-Colorado employees would consider the risks to human and pet safety based on location and methods being used. Potential risks to human and pet safety from the use of these methods may have greater impacts in urban areas than in rural areas (e.g. population density). Consideration would be given to the location where damage management activites occur based on property ownership. Activities performed on private property in rural areas allow greater monitoring and control. The risk to human health and pet safety would be less in such situations. When activites are performed in urban/suburban areas the risks to human and pet safety increases. The risk of the public encountering damage management methods and the corresponding risks increase in parks and near other public use areas. WS-Colorado generally conducts damage management activities when human activity is minimal (e.g. early morning, night) or in areas where human activity is minimal (e.g. areas closed to the public).

Consumption of Wildlife Resources

With changes in the global economy, people throughout North America and Europe are taking advantage of more locally available food sources (such as wildlife). Many of these communities have limited access to sufficient food due to inadequate money or other resources. When examining the environmental contaminant concentration risks to humans, the greatest at-risk groups are those that rely on "traditional food systems." The term "traditional food systems" refers to food species that are available to a particular culture from natural resources and the accepted patterns of their use (Kuhnlein and Chan 2000). These groups are typically indigenous peoples in ecological settings of Alaska and other areas of the United States, Canada, Greenland, and northern Europe, and less frequently people that practice primarily subsistence lifestyles (Kuhnlein and Chan 2000). Here we examine how the presence of contaminants in traditional food systems impacts indigenous peoples and how insights from these systems relate on a drastically smaller scale to limited wildlife consumption in the U.S.

When the consumption of a food source does not pose a life-threatening risk (i.e. wildlife resources) these activities are not governed by food industry regulations. Ultimately, the decision to harvest and consume these items are the responsibility of the harvester and consumer. Often, consumption advisories are issued based on the contaminate residue limits and consumers should remain vigilant in assuring that these recommendations are not exceeded.

Risk Factors

Studies examining the effects of chronic low-dose exposure to contaminants among human populations remain controversial due to inconsistent findings among studies. These results are also confounded by factors such as malnutrition, smoking, substance abuse, genetics, medications or supplement use, and pre-existing health conditions. Risk determinations for populations are not static due to evolving data on contaminants, the consequences of their use, and health effects. Published advisories or guidelines are typically based on maximum residue limits or tolerable intakes and estimated consumption levels (Kuhnlein and Chan 2000). Subsequently, consuming food resources more often than the daily allotment or not consuming food in off-seasons or when the resource are not available have not been studied.

Contaminates

Chemical contaminates are primarily those that are transported long-range or from local sources due to geology or industrial activities such as mining and pesticide use. These compounds can accumulate in wildlife and plants depending on multiple factors (pH, temperature, soil type, molecular structure of chemicals, concentration, organic-carbon content, and physiology) and their bioavailability in the soil, sediments, water, and plants. Once a contaminant is ingested by an organism, it can be subject to bioaccumulation or facilitate the transfer of the compound to other organisms. The degree of bioaccumulation in food webs depends on the length of the food chain, number of species it passes through, biomagnification, solubility in lipids or water, and inertness of the chemical. Biomagnification, the continuous increase in chemical concentrations in a food chain, is highest in fish and marine mammals or sea birds (Kuhnlein and Chan 2000).

Contaminant levels in wildlife resources vary regionally depending on local mineralogy, mining operations, proximity to heavy industrialization, and military sites (Tsipoura et al. 2011). The age, sex, and diet of animals can similarly impact individual's exposure. Like dietary assessments for nutrient intake, human contaminant exposure through food consumption is measured by assessing the level of food intake and the potential contaminant level within the food. Consuming a large quantity of a food source with a low contaminant level frequently could potentially expose the consumer to the same relative risk as consuming a small amount of food with high contaminant levels. The extent of risk derived from dietary data and dietary standards for contaminants related to contaminate exposure must be carefully considered; especially in situations where these foods pose a low risk to the consumer, substantially contribute to the sustainable health of a community, and have societal benefits.

Cultures that regularly consume wildlife resources potentially containing contaminants, such as indigenous peoples, rely on dietary intake guidelines published by health organizations such as the Agency for Toxic Substances and Disease Registry, Joint Food and Agricultural Organization, World Health Organization Expert Committee on Food Additives, and U.S. Environmental Protection Agency. These dietary standards, including contaminant-intake guidelines, express tolerable intakes for every day consumption for life (micrograms of contaminant per kilogram of body weight per day) and incorporate safety precautions based on orders of magnitude for contaminate standards (**Figure 3.50**).

Contaminant	Organization (reference) and guideline (μg/kg bw/d) Health Canada (51): ADI/TDI/PTDI	ATSDR (6): Minimum risk levels	JECFA/WHO (121): ADI/PTDI	EPA (32): Reference dose
Arsenic	2.0 (121)	0.3 (Chronic)	2.0 (inorganic)	0.3
Cadmium	1.0 (121)	0.2 (Chronic)	1.0	1.0
Lead	3.57(121)	na[b]	3.57	na
Mercury	0.471 (M Hg) 0.714 (Hg)	0.3 (M Hg, chronic)	0.471 (M Hg) 0.714 (Hg)	0.003
Aldrin	0.1 (121)	2 (Acute) 0.03 (Chronic)	0.1	0.03
Chlordane	0.05[c]	1 (Acute) 0.6 (Chronic)	0.5	0.5
Chlorinated benzenes	na	100 (Dichloro-benzene)	na	0.8
DDT	20	0.5 (Acute)	20	0.5
Dieldrin	0.1 (121)	0.07 (Acute) 0.05 (Chronic)	0.1	0.05
Dioxin	0.00001 (TCDD equivalents)	0.000001	0.000001–0.000004	na
HCH	0.3[c]	na	na	0.3
PCB	1.0	na	na	0.7
Toxaphene	0.2	5 (Acute) 1 (Intermediate)	na	na

[a]Abbreviations: ADI/TDI/PTDI, Acceptable Daily Intake/Provisional Tolerable Daily Intake; ATSDR, Agency for Toxic Substances and Disease Registry; JECFA/WHO, Joint Food and Agricultural Organization/World Health Organization Expert Committee on Food Additives; ADI/PTDI, Acceptable Daily Intake/Provisional Tolerable Daily Intake; EPA, U.S. Environmental Protection Agency; DDT, dichlorodiphenyl-trichloroethane; HCH, hexachlorocyclohexanes; PCB, Polychlorinated biphenyls, TCDD, 2,3,7,8-tetrachloridibenzo-p-dioxin.
[b]Not available
[c]Health Canada, personal communication.

Figure 3.50. Example of a dietary intake guideline used by indigenous peoples consuming traditional food resources (Kuhnlein and Chan 2000).

In 1999, the Environmental Protection Agency (EPA) identified the Vasquez Boulevard and Interstate 70 site (VB/I-70) as a Superfund site, one that is on their National Priorities List, and eligible for Superfund resources, environmental investigation and cleanup processes, and public participation opportunities. The EPA is the lead agency for this site (See **Figure 3.51**) and is working in cooperation with the Colorado Department of Public Health and Environment on mitigation activities.

The EPA has divided the VB/I-70 site into three operable units. Operable Unit 1 (OU1) included residential soils in more than 4,500 yards in all or parts of six Denver neighborhoods: Cole, Clayton, Swansea/Elyria, southwest Globeville and a small section of northern Curtis Park. Operable Unit 2 (OU2) was the site of the former Omaha & Grant Smelter, and today is the location of the Denver Coliseum and surrounding businesses. Operable Unit 3 (OU3) was the site of the former Argo Smelter, and today is a commercial area adjacent to and northwest of the interchange of Interstate 70 and Interstate 25. As discussed in Chapter 2 - Protective Measures, WS-Colorado would bury or incinerate

Canada geese living in areas potentially polluted by mining operations, smelting, or where glycol ponding occurs. This would include within Superfund areas and any resident geese removed from water sources within 2 miles of a water feature (where geese reside) within the Superfund site.

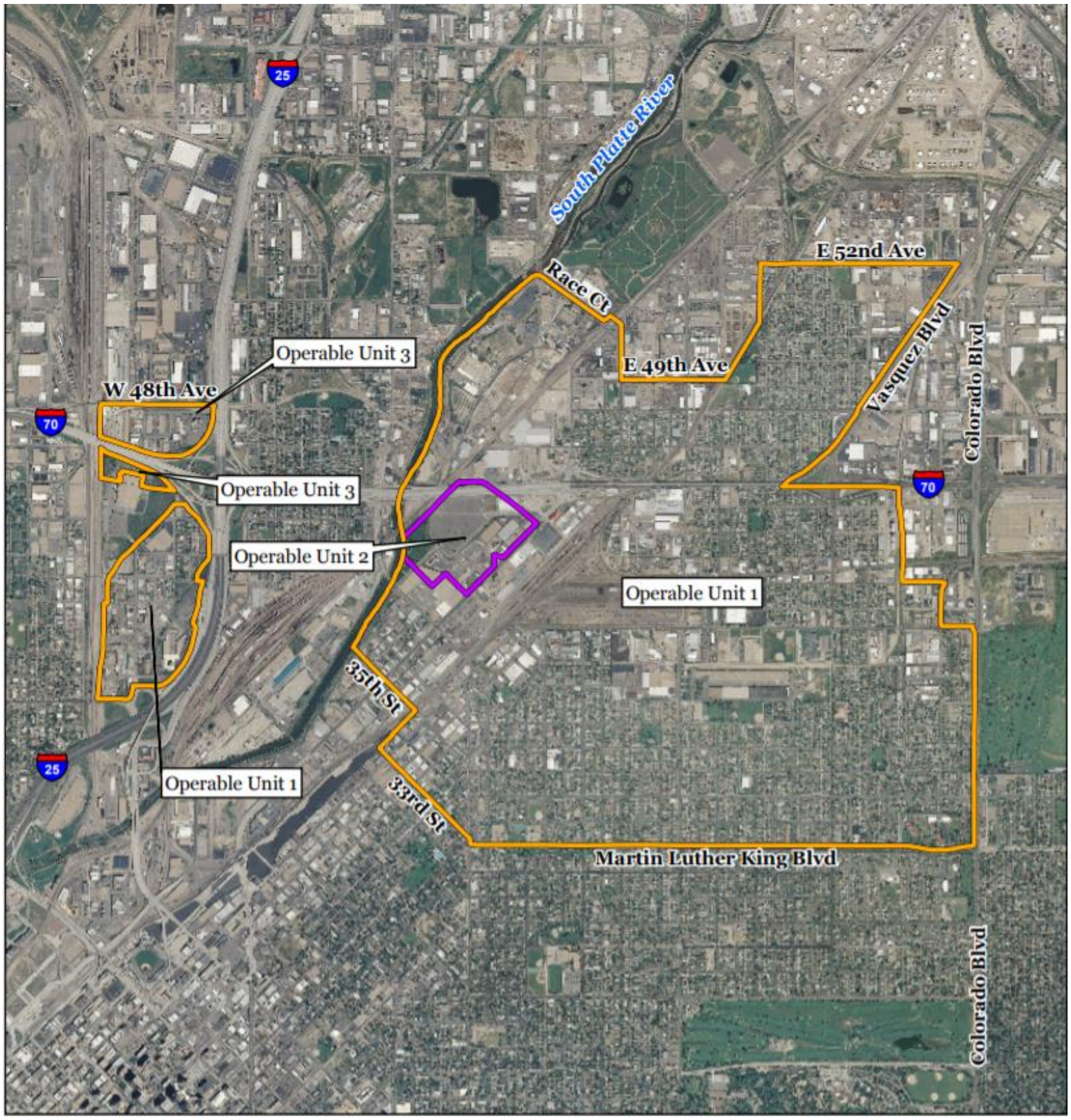


Figure 3.51. Vasquez Boulevard & Interstate 70 (VB/I-70) Superfund site. Historical locations for commercial/industrial smelting operations including Rocky Mountain West, Omaha & Grant, and Argo. Beginning in the 1870s, these sites processed gold, copper, silver, lead, and zinc. As a result, heavy metals can be found in area soils that, in some cases, can pose a health risk to people living in the vicinity. Groundwater may also be impacted at these locations. The EPA have and will continue to conduct mitigation and containment efforts in and around these sites. For more information please visit (https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0801646#bkgr).

Concerns Regarding Exposure to Anticholinesterase Compounds, and Lead (Pb)

In the U.S. organophosphorus and carbamate compounds have largely replaced hydrocarbons for pesticide use (Franson and Smith 1999). Poisoning from exposure to these anticholinesterase agents occur in free ranging bird species. Pb poisoning from the ingestion of spent lead shot or the ingestion of lead fishing tackle is also occasionally seen in wild birds. However, since the ban of lead shot for waterfowl hunting in 1991, lead in birds declined sharply and occurs less frequently (Havera et al. 1994).

The diagnosis of free-ranging bird mortality events can be difficult due to a wide range of diseases, contaminants, and toxins. Necropsy evaluations and laboratory testing are required to conclusively confirm a cause of death in these situations. The National Wildlife Health Center (NWHC), a part of the U.S. Department of Interior, performs investigations and conducts research on specific wildlife health issues (Franson and Smith 1999). Investigations consist of individual mortalities in raptors, endangered species, and large-scale die-offs, primarily in waterfowl. Below are some of the listed signs of specific poisoning events as described by veterinarians and researchers with the NWHC.

Anticholinesterase Poisoning

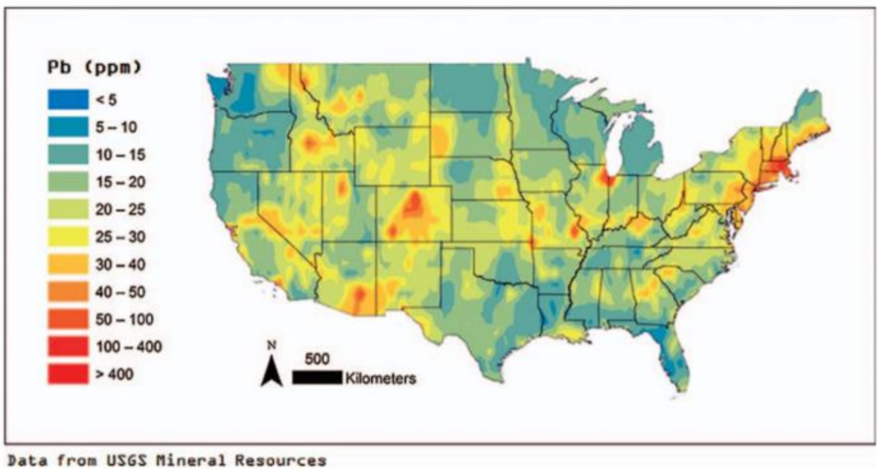
Pesticides containing organophosphorus and carbamate pesticides are relatively short-lived. These compounds have replaced the more persistent chlorinated hydrocarbon pesticides in the U.S. Organophosphorus and carbamate compounds work by inhibiting the transmission of nerve impulses. This results in accumulations of acetylcholine at nerve synapses and leads to continual firing of the nervous system. This eventually causes the paralysis of respiratory muscles, leading to death. Birds are particularly susceptible to the toxic effects of anticholinesterase compounds. Clinical signs of exposure in birds, may include: convulsions, lethargy (i.e. fatigue or sluggish), dyspnea (i.e. shortness of breath), ataxia (i.e. impaired coordination), paralysis, tremors, and neurological signs (Franson and Smith 1999). Sublethal effects (i.e. not causing death) include: alterations in thermoregulations, behavioral changes, and impaired reproduction.

Waterfowl (including geese), passerines (i.e. song birds), and raptors (i.e. hawks) are the most frequently affected by anticholinesterase pesticides (Tsipoura et al. 2011). Animals suspected of dying from anticholinesterase poisoning should be evaluated by necropsy examination and laboratory analysis. Birds dying from exposure to these compounds may display traumatic lesions as a result of convulsions or other abnormal behaviors. WS-Colorado activities involving waterfowl roundups would be conducted predominately in urban/suburban areas. Prior to the removal of the animals from these locations, WS-Colorado personnel observe and count the birds regularly to monitor molting (i.e. loss of feathers). WS-Colorado personnel do not collect sick or dying animals (due to natural causes unless they are a part of a research project) and make note of any abnormal behavior in these populations (as described above). In areas where animals are exhibiting signs of anticholinesterase toxicity, animals would be lethally removed (according to AVMA guidelines) and buried or incinerated, if necessary during roundup activities. In some cases, other authorities (i.e. agency, organization, landowner, or manager) may be advised of the situation and the fate of these birds would be determined by that authorities' existing protocols. When waterfowl, such as Canada geese, are live-captured by WS and processed by state health department approved businesses, the state health department evaluates and issues statements regarding the acceptability of the meat for human consumption. For example: "*Based on our review of the existing nuisance goose meat data, it appears that chemical contaminants in general should not be a human health concern in properly processed goose meat*" (T. Forti email to M. Lowney, June 11, 2011).

Lead (Pb) Poisoning

Lead is a metabolic poison that can lead to illness and mortality in more than 120 species of North American avifauna. Long recognized as an ecological and human health hazard, Pb has negative consequences for all organisms studied. While Pb occurs naturally as a trace element in geological materials, human activities have also increased its distribution and abundance. Lead is used in a variety of productions or during the production of products including: batteries, caulks, pigments, dyes, metal alloys, and aviation fuels. The low cost of Pb, low melting point, malleability, corrosion resistance, and high density make this metal the primary component used in the manufacturing of fishing tackle and ammunition (Haig et al. 2014).

Wildlife can be exposed to Pb through a variety of anthropogenic sources such as mining, smelting, legacy lead based paints, ammunition, and fishing tackle (Haig et al. 2014). The mobility and diverse foraging strategies of bird species may contribute to their potential exposure and consequent toxicological impairment. Sub-lethal and lethal toxic responses and exposures have been documented in more than 120 species (Haig et al. 2014). However, the scope of this problem is difficult to quantify due to the rapid onset of toxicity and low detectability in species that are not commonly monitored.



Spatial distribution of soil Pb concentrations (ppm dry weight) across the continental United States. These background levels range from 50 to 400 ppm; soil concentrations that exceed ~100 ppm are considered elevated. Pb levels in soil near mines, smelters, and similar sites can range upward of 12,000 ppm. Data were obtained from the USGS National Geochemical Survey database (http://mrdata.usgs.gov/geochem/). Spatial interpolation of Pb concentrations was conducted in ArcMap 10.0, based on data density of one sample per 289 km^2.

Figure 3.52. Distribution of Pb in soil across the U.S. (Haig et al. 2014).

Pb in the Environment

Pb is widely distributed across the globe because of mining, coal combustion, smelting, battery products, waste incineration, and fuel additives (Haig et al. 2014). Of all the Pb brought into production, models estimate that nearly 48% is lost to the environment (Haig et al. 2014). Total global anthropogenic Pb emissions from gasoline combustion, mining, smelting, refining, and manufacturing are approximately 28-times that from all natural sources (Scheuhammer and Dickson 1996).

In the U.S., more than 69,000 metric tons of Pb were used in the past for ammunition manufacturing in 1 year (Haig et al. 2014). Similarly, Pb fishing weight sales in the U.S. equals approximately 3,977 metric tons annually (Haig et al. 2014). While these estimates provide valuable context for the use of Pb in anthropogenic manufacturing, it is important to note that these values are unrepresentative of the actual amount of Pb distributed and available for avian exposure.

Currently, data quantifying potential exposure coefficients that are needed to accurately estimate the amount of Pb available for avian consumption are non-existent. This includes the proportion of lead ammunition and lead fishing tackle that is actually used after purchase; the amount of Pb ammunition used in outdoor environments (where birds could be exposed); the amount of Pb ammunition and tackle (used in outdoor environments) that are lost or abandoned and available for avian consumption (i.e. bullet fragments); and the probability that a bird would find the available Pb and be exposed (Haig et al. 2014).

Historic hunting areas serve as a representation of the potential Pb exposure risk to wild birds. Confined hunting areas for waterfowl and dove species are indicative of the amount of Pb deposited from long-term hunting activities. Before 1991, when Pb shot was banned for use in waterfowl hunting, studies estimated Pb pellet densities of nearly 2 million pellets ha^{-1} (Haig et al. 2014). In dove hunting fields, where Pb shot is still legally used, spent shot densities range from tens of thousands to hundreds of thousand pellets per hectare (Haig et al. 2014).

However, several factors impact the amount of time Pb in these landscapes are available for avian consumption. Flint and Schamber (2010) suggest that historical Pb deposits from hunting and fishing in wetlands would only be available for waterfowl consumption for ≥ 25 years. Relying on this data, the risk of Pb exposure to waterfowl in wetland environments should be nearly eliminated given that it has been 28 years since the ban of Pb use in waterfowl hunting.

Notably, legacy Pb exposure in some species may still exist due to their foraging behaviors. Species that forage at deeper depths in the sediment (e.g. swans) obviously have a greater chance of being exposed to legacy Pb. Recent deposits of Pb would be most available to feeding waterfowl, however unlikely due to the waterfowl Pb shot ban in 1991. As Pb settles to the bottom of wetland environments, the bottom type influences the long-term availability of shotgun pellets. Areas with silt or peat bottom were shown to have a limited carry-over capacity for Pb shot (White and Stendell 1977). Firm bottom types (e.g. heavy textured clay loam) provide a long-term firm base for Pb accumulations near the surface (White and Stendell 1977). Other upland species (e.g. doves and pheasants) may also be exposed to legacy Pb deposited in wetland environments if wetlands experience seasonal drying events (Haig et al. 2014).

Impacts on Avian Physiology

The primary route of exposure in terrestrial and aquatic systems is through the ingestion of Pb pellets, fragments, or weights. Pb can also be ingested during foraging activates when soil/sediment material is contaminated with wastes from nonferrous mining or smelting activities, exposure to leaded gasoline combustion, and waste incineration polluted with Pb containing products (Tsipoura et al. 2011). Pb is absorbed by the circulatory system following the maceration of grit, seeds, and other objects in the bird's gizzard. Once absorbed into the body, toxicological effects vary and interspecific Pb tolerances differ widely among species and individual animals (Tsipoura et al. 2011). This variability makes it difficult to assess the risk of Pb poisoning solely on the basis of blood Pb levels (Haig et al. 2014).

Acute (i.e. short term) Pb poisoning may occur rapidly in birds. These individuals may not display characteristic signs of emaciation or lack of coordination (Haig et al. 2014, Tsipoura et al. 2011). Chronic exposures (i.e. long-term) include weakness, ataxia, emaciation, anemia, and green staining of feces (Franson and Smith 1999, Tsipoura et al. 2011). At necropsy, lead poisoned birds may have an impacted esophagus and proventriculus with green staining of the gizzard lining, enlarged gall bladder, and green staining of the intestinal lining (Haig et al. 2014). While many lead poisoning cases in birds are chronic, some may die quickly following the ingestion of large amounts of Pb. Sick birds may also exhibit unusual vocalizations (high-pitched) and remain separated from healthy geese. In one known instance, sick birds did not flee when approached and had a clear, watery discharge from their bills (Haig et al. 2014).

Numerous studies evaluating toxicological response to Pb exposure lack consistency, standardized approaches, and ecological relevancy (Haig et al. 2014). Studies with relatively similar Pb exposure levels, have shown clear impacts on blood chemistry, egg production, behavior, and survival while others demonstrate limited responses (Haig et al. 2014, Tsipoura et al. 2011). Differences in methodology may explain some of this variance, but it is more likely that intrinsic interindividual and interspecific inconsistencies are responsible for these changes. This makes it difficult to make assertions about Pb poisoning across multiple bird taxa and managing Pb risks challenging.

Additionally, studies that report elevated Pb levels from dead birds and make assumptions that these individuals died from Pb poisoning often bias (under or over estimate) mortality rates (Haig et al. 2014). In some cases, Pb may be responsible for individual deaths; the tremendous level of bird sensitivities to Pb among species and individuals makes the use of blood and tissue samples as a diagnostic test for Pb poisoning problematic (Haig et al. 2014). The cumulative body of scientific evidence clearly suggests that Pb exposure from ammunition and fishing tackle is directly correlated to Pb poisoning cases in birds each year. While this is clearly a threat to species such as endangered California condors, the impact of Pb exposure on other bird species is less clear given the availability of other anthropogenic mortality sources (domestic cats, collisions with airplanes, powerlines, fixed objects, and vehicles) (Haig et al. 2014).

Pb Detection in Waterfowl

There are multiple techniques for estimating Pb-shot ingestion rates in waterfowl including: gizzard surveys, blood-Pb concentrations or protoporphyrin measurements, and d-aminolevulinic acid dehydratase enzyme inhibition (Scheuhammer and Dickson 1996). All of these methods have a relatively narrow “window” of effectiveness to detect elevated Pb exposure. Bone-Pb concentrations provide a more accurate indication of prior Pb exposure in waterfowl. Pb has a high affinity to mineralized tissues and readily accumulates in bone. Once deposited, Pb has an exceptionally long biological half-life. A biological half-life refers to the time it would take for half of the compound to be removed from the body through biological processes. The half-life of Pb in the blood is approximately 28-36 days and 10 years in bone.

A duck that has ingested one or more grains of Pb-shot should have a detectable elevated bone-Pb concentration for the rest of its life (Scheuhammer and Dickson 1996). Studies examining bone-Pb concentrations typically sample juvenile dabbling duck species. Juveniles are used since any detectable Pb exposure would be attributed almost exclusively to Pb exposure during the first few months of life. Dabbling duck species (mallards, and black ducks) are chosen because they frequent shallow water areas and feed on surface level aquatic larvae, plants, and insects. This behavior would likely expose them to Pb shot or Pb contaminants if they were present in an environment.

Pb concentrations in waterfowl bones reflect acute or chronic exposure to Pb not only from ingested shot or tackle, but to other anthropogenic sources or from the natural weathering of Pb (White and Stendell 1977). Waterfowl dying from Pb exposure contain elevated levels of bone-Pb, many over 100 ppm (White and Stendell 1977). Adult and immature waterfowl with no known history of exposure to Pb have bone-Pb levels < 10 ppm (White and Stendell 1977). Canada geese (n=19) that were raised in captivity or had no known history of Pb exposure had bone-Pb concentration of 2 to 11 $\mu g\ g^{-1}$ compared to 80 wild birds suspected of dying from Pb poisoning with bone-Pb concentrations of 7 to 389 $\mu g\ g^{-1}$ (Scheuhammer and Dickson 1996).

In experimental studies, 6-month-old male mallards fed a nutritious diet and dosed with 1 (#4 Pb shot) contained bone-Pb concentrations of 10 ppm 5 weeks after treatment (White and Stendell 1977). Mallards fed diets of corn or rice and given 1-5 grains of (#4 Pb shot) contained bone-Pb concentrations of 66 to 154 ppm of lead two weeks after exposure (White and Stendell 1977). In another study, first-year male mallards fed 25 ppm of Pb for 12 weeks did not exhibit elevated bone-Pb levels (White and Stendell 1977).

Approximately, 3 weeks post-ingestion, Pb shot will have passed through a bird or become eroded (Scheuhammer and Dickson 1996). Three to eight weeks post-ingestion blood-protoporhyrin, -Pb, and –d-aminoleculinic acid dehydratase (ALA-d) levels will have returned to normal (Scheuhammer and Dickson 1996). Therefore, these indicators are not suitable for estimating the lifetime exposure levels of birds to Pb.

Pb Shot Contamination in Edible Portions of Game Birds and Its Dietary Implications

Almost 28 years have passed since the nationwide ban in 1991 of Pb shot for waterfowl hunting. Prior to this regulation, it was estimated that 2-3% of fall waterfowl mortality in North America were associated with lead poisoning (Kelly et al. 2011). Since the implementation of a ban on lead-based ammunition, several studies have assessed its effectiveness in reducing Pb exposure in waterfowl populations. Anderson et al. (2000) estimated that this ban reduced lead related mortality of mallards in the Mississippi Flyway by 64% and saved 1.4 million ducks during fall migration (Kelly et al. 2011). A similar decline (44%) of blood Pb exposure in American black ducks was documented in the Mississippi Flyway during this period (Kelly et al. 2011). While this regulation reduced Pb pellet ingestions by waterfowl, it did not reduce the numbers of Pb-poisoned eagles submissions to a raptor rehabilitation center in Minnesota during a five year period (Kelly et al. 2011). Kelly et al. (2011) suggested that these on-going Pb poisoning cases in raptors could partially be attributed to the ingestion of fragmented Pb bullets in the discarded viscera of field processed deer.

Prior to the ban on the use of Pb shot for waterfowl hunting, approximately 2-3% of North American waterfowl died of Pb poisoning from the ingestions of spent shot (Scheuhammer et al. 1998). Regulations prohibiting the use of Pb shot for hunting primarily have been established to protect waterfowl and other bird species. However, predatory wildlife are often exposed to Pb after consuming game animals with Pb shot or pellet fragments embedded in their tissues (Scheuhammer et al. 1998).

Twenty-four years ago, 20% of sampled waterfowl carried embedded Pb shot in their tissues form nonlethal/non-crippling shots (Scheuhammer et al. 1998). Millions of birds likely carried one or more Pb or other metal shot pellet and fragments of pellets embedded in their flesh following hunting activities (Scheuhammer et al. 1998). The percentage of waterfowl carrying embedded Pb shot today is likely minimal, considering that Canada geese live on average 10-24 years and mallard ducks live on average 5-10 years in the wild. However, there are likely similar correlations of game birds carrying non-toxic shot such as steel since the Pb ban in 1991.

For people that consume wild-game, if a whole Pb shot pellet were to be consumed this would add to their normal Pb exposure (Sheuhammer et al. 1998). In mammals (including humans) most undigested foreign materials are rapidly expelled from the gastrointestinal tract (Scheuhmmer et al. 1998). The small size of Pb shot and density may cause it to be retained intraluminally or in the appendix (Scheuhammer et al. 1998). Individuals with 1-2 Pb pellets in their appendices experienced Pb blood levels almost double of those seen in control individuals (Scheuhammer et al. 1998).

Wild game consumers may also be exposed to dietary exposure to Pb shot from the presence of small Pb fragments heterogeneously scattered throughout edible tissues (Scheuhammer et al. 1998). Although the ingestion of tissue-bound Pb may serve as a potential source for Pb exposure in animals and humans available evidence on this phenomenon is tenuous (Tsuji et al. 1999). Scheuhammer et al. (1998), demonstrated small fragments of metallic Pb may be present in game bird muscle tissues even though there are no obvious signs of Pb pellets. Pb concentrations in individual game birds varied greatly and ranged from 5.5 μg/g to almost 4,000 μg/g (average 211 μg/g) (Scheuhammer et al. 1998).

People who regularly consume large quantities of meat containing lead shot may be affected by an increase in Pb exposure (Tsuji et al. 1999). Elevated dentine-Pb levels were observed in adult and children's teeth collected in 1997 from First Nation Cree in western Canada (Tsuji et al. 1999). Radiographic evidence also found that 15% of First Nation Cree in this region had Pb pellets located in their gastrointestinal tracts (Tsuji et al. 1999). Other evidence suggests that elevated Pb levels in humans may be correlated to the use of Pb during hunting activities among the First Nation Cree in the James Bay region.

Elevated blood-Pb levels were documented in all age groups two months after goose hunting season (Tsuji et al. 1999). While shooting firearms, airborne Pb particles are generated following the ignition of primers and mechanical abrasion as Pb ammunition passes through the barrel (Tsuji et al 1999). Experimental animal studies suggest that Pb particles inhaled into the lungs may have toxic consequences (Tsuji et al. 1999). Additionally, humans can be exposed to Pb as a result of handling Pb ammunition and cleaning firearms (Tsuji et al. 1999).

Waterfowl Hunter Compliance with Nontoxic Shot Regulations

Since the implementation of the Pb ammunition ban, manufactures have increased their production of numerous non-lead alternatives for hunting both small and large game and non-game species (Kelly et al. 2011). During the 1991-1992 hunting season, nontoxic shot was required by for all waterfowl sport hunting in the U.S. Havera et al. (1994) conducted a study shortly after the implementation of these regulations in Illinois. From 1989 to 1991 the authors found that 98.9% of ducks and 96.5% of Canada geese were harvested with nontoxic shot (Havera et al. 1994). This study, along with others, demonstrated that the federal effort toward banning Pb shot was instrumental in increasing the use of steel shot by waterfowl hunters in Illinois.

Consumption of Donated Canada goose Meat

Every year millions of people throughout the U.S. face food insecurity (Horak et al. 2014). Because these households do not have proper food resources the demand for food assistance is high (Horak et al. 2014). In many cases, families seek food assistance from local soup kitchens, food pantries, schools, and charitable organizations. Serving meals and providing nutritious food items that meet USDA guidelines to such large groups of people, especially in metropolitan areas, can be taxing. Across the U.S., numerous charitable food organizations have established cooperative relationships with wild game hunters and other organizations in need of quality protein sources such as meat. Organizations such as "Hunters for the Hunger" and "Sportsmen Against Hunger" donate high quality fresh meat to people in need. From 2009 to 2010 hunters donated more than 2,500,000 lbs of meat to such organizations (Horak et al. 2014). Similarly, several USDA Wildlife Services state programs donate more than 60 tons of wild game (deer, moose, feral hogs, goats, geese, and ducks) to charitable organizations each year (Horak et al. 2014). In fiscal year 2007, USDA Wildlife Services donated 6,443 lbs of goose meat from nine Wildlife Services programs.

Although commercially produced meats are often subjected to routine screenings for contaminants, no public health entity routinely monitors contaminants in wildlife game. To ensure the safety of consuming wild game meat donations, WS studied 17 contaminants of concern in breast meat of wild Canada geese. Residue concentrations of the contaminants of concern (COC) included: arsenic, cadmium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, selenium, thallium, zinc, organic chemicals, dichlorodiphenyldichloroethylene, and polychlorinated biphenyls (PCBs). Exposure ratios for each COC were calculated by dividing the exposure for that COC by the recommended exposure limits (**Figure 3.53**). Additionally, when edible portions of resident Canada goose tissue was tested and found to have Pb in the tissue, sometimes .177 caliber pellets were found in the tissue which explained the elevated Pb levels detected during testing.

Exposure ratio calculated using maximum consumption by age class and maximum residues

	Exposure ratio							
Consumer age	Arsenic	Cadmium	Calcium	Cobalt	Copper	Iron	Lead	Magnesium
Adult (≥20 yr)	0.04	0.00	0.02	0.85	9.59	1.15	156.65	0.31
Youth (12–19 yr)	0.06	0.01	0.03	1.21	13.68	1.65	223.40	0.44
Children (3–12 yr)	0.08	0.01	0.04	1.54	17.36	2.09	283.52	0.56

	Exposure ratio							
Consumer age	Manganese	Molybdenum	Selenium	Thallium	Zinc	Mercury[a]	Organochlorines	PCB
Adult (≥20 yr)	0.06	0.05	0.95	144.24	0.41	6.48	0.37	0.11
Youth (12–19 yr)	0.08	0.07	1.36	205.71	0.59	9.24	0.52	0.16
Children (3–12 yr)	0.11	0.09	1.72	261.07	0.75	11.72	0.66	0.21

[a] Hg-aa.

Figure 3.53. Exposure ratio calculated using maximum consumption of COCs by age class and maximum COC residues (Horak et al. 2014).

When the exposure ratios were calculated using the maximum consumption and maximum residue concentrations, the levels for cobalt, copper, iron, lead, mercury, selenium, and thallium were all >1 for all age classes. Meaning that consumers above the 99th percentile would be exposed to these compounds at higher than the recommended limits. (Percentiles work by dividing participants into 99 groups, also known as percentiles. The 99th percentile is the highest. There is no such thing as a 100th percentile. Thus, if you were to take a test and were in the 99th percentile that means 99% of people (that participated) are below you. So you are in the top 1%.)

Horak et al. (2014) found that more than 99% of adults were below the exposure limits for COCs evaluated. When the goose meat was ground and combined (from 10 animals), 99.2% and 99.8% of adults would be below the exposure limits for lead and mercury, respectfully. In persons aged 12 to 19 years of age 98.9 and 99.2% would not exceed the limits for lead and mercury. If this meat was consumed only three times per week, 100% of persons aged 12 to 19 years would be below the mercury exposure limit and 99.7% would be below the lead limits. In all other food consumption scenarios with cobalt, copper, iron, and selenium consuming ground meat three times per week, 100% would be below the exposure limits for these contaminants. In persons aged 3 to 12 years, eating ground meat (from 10 animals and mixed) 3 times per week 99.5% would be consuming below the lead exposure limits, 100% would be below the mercury exposure limits.

The average concentrations of COCs in Canada goose meat were similar to those reported from commercially raised poultry. However, the individual variability of COC concentrations between animals was higher than those observed in commercial poultry operations. Different types of meat preparation and limiting the meat consumed in a given time frame can minimize concerns of adverse effects due to environmental contaminants. Processing and combining ground meat from multiple animals can also dilute any possible contaminants. To reduce the overall potential exposure to contaminates goose meat can be served only a few times each week. All geese that are donated by WS-Colorado for human consumption are live captured, transported to a wild game or custom meat processor, and approved for donation by the Colorado Department of Health and Environment. Additionally, the meat remains frozen after processing, contains proper instructions for safe cooking, and confirmed by the department that there are no known disease or illness concerns from this species of wild geese. It should also be noted that any approved CDPHE processors follow industry specific safeguards related to the processing of meat intended for human consumption.

Issue D: Impacts of BDM on Sociocultural Resources.

People often enjoy viewing, watching, and knowing birds exist as part of the natural environment and gain aesthetic enjoyment in such activities. Those methods available to alleviate damage are intended to disperse and/or remove birds. Nonlethal methods are intended to exclude or make an area less attractive, which disperses birds to other areas. Similarly, lethal methods are intended to remove those birds identified as causing damage or posing a threat of damage. The effects on the aesthetic value of birds as it relates to the alternatives are discussed below.

Proposed Action

The implementation or recommendation of methods by WS-Colorado under this alternative would result in the dispersal, exclusion, or removal of individuals or small groups of birds to alleviate damage and threats. In some instances where birds were dispersed or removed, the ability of interested persons to observe and enjoy those birds would likely temporarily decline. Even the use of exclusionary devices could lead to the dispersal of wildlife if the resource being damaged was acting as an attractant, because once the attractant was removed or made unavailable, the birds would likely disperse to other areas. WS has no authority to regulate take or harassment of birds. That authority rests with the USFWS and CPW. Therefore, WS-Colorado's involvement in bird damage management activities would not increase the number of birds taken or dispersed. Those birds removed or dispersed by WS under this alternative, would likely be those same birds that could and likely would be removed or dispersed by those individuals experiencing damage in the absence of assistance from WS. Since those birds removed or dispersed by WS under this alternative could be removed by other entities, WS' involvement in removing those birds would not likely be additive to the number of birds that could be taken in the absence of WS' involvement. The lethal take of birds can occur either without a permit if those species are non-native, during hunting seasons, under depredation orders, or through the issuance of depredation permits by the USFWS or CPW.

Operational assistance would only be conducted by WS after a request for assistance was received and after a memorandum of understanding, cooperative service agreement, or other comparable document listing all the methods the property owner or manager will allow to be used on property they own and/or manage was signed by WS and those requesting assistance. WS' take of birds over the last five years has been of low magnitude when compared to population estimates, population trends and other available information (see Issue A, Alternative 1 for additional information on impacts to target bird populations). Given the limited take proposed by WS under this alternative, when compared to the known sources of mortality of birds and their population information, damage management activities conducted by WS pursuant to the proposed action would not adversely affect the aesthetic value of birds.

Relocation of nuisance roosting or nesting populations of birds (*e.g.,* blackbird/starling roosts, vulture roosts) with harassment can sometimes result in the birds causing the same or similar problems at the new location. If WS is providing operational assistance in relocating such birds, coordination with local authorities to monitor the birds' movements is generally conducted to assure they do not reestablish at other undesirable locations.

Therefore, we believe that bird populations will not be impacted under this alternative and people will have continued opportunities to see and enjoy wildlife. At the same time, those that find wildlife undesirable at specific locations (*e.g.,* geese on golf courses) would be able to enjoy the site without specific types of damages (*e.g.,* excrement on walkways and fairways). Thus, the broadest satisfaction would likely be available under this alternative.

Impacts on Hunting Canada geese in Colorado

WS-Colorado resident Canada goose management activities would primarily be conducted on populations where hunting access is restricted (e.g. airports, urban and suburban areas) or has been ineffective (e.g. urban and suburban areas). In these areas, Canada goose survival rates are high due to a lack of natural predators and limited exposure to hunting. In these areas, vehicle collisions and round-up activities would be the most common cause of mortality (Conover 1998). The implementation of other management methods may even disperse geese from areas where damage is occurring to areas outside the damage areas, and result in geese moving into areas accessible by legal hunters.

A concern that is occasionally raised by interested parties is that WS-Colorado's activities would adversely impact the ability of licensed citizens to harvest geese during regulated hunting seasons. The recent 5-year average of Canada geese harvested by hunters an average of 622,000 in the Central flyway; 263,000 in the Pacific flyway; and 89,000 in Colorado according to the USFWS. The average lethal take by WS-Colorado of 10% of the total resident (nesting) Canada goose population, would have no adverse direct or indirect impacts on the availability of migratory Canada geese available for the sport hunting community's opportunity to harvest geese (**Table 3.56** where legally allowed).

Issue E: Impacts of Bird Damage Management on Humaneness and Animal Welfare Concerns.

As described in **Chapter 2**, humaneness and animal welfare concerns associated with methods available to reduce bird damage has been identified as an issue. The humaneness and animal welfare concerns of the methods as they relate to the alternatives are discussed below.

Proposed Action

As previously discussed, 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. The challenge in coping with this issue is how to achieve the least amount of animal suffering.

Bird damage management methods viewed by some persons as inhumane would be employed or recommended by WS-Colorado under this alternative. These methods would include shooting, trapping, toxicants, and repellents. Despite Protective Measures designed to maximize humaneness, the perceived stress and trauma associated with being held in a trap until the WS employee arrives at the capture site to dispatch or release the animal is unacceptable to some persons. Other bird damage management methods used to take target animals, including shooting, result in a relatively humane death because the animals die instantly or within seconds to a few minutes. These methods, however, are also considered inhumane by some individuals. Some individuals believe any use of lethal methods to alleviate 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 nonlethal 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. With 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, agencies are challenged with conducting activities and employing methods that are perceived 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 alleviate requests for assistance to reduce damage and threats. WS-Colorado would continue to evaluate methods and activities to minimize the pain and suffering. WS' use of euthanasia methods under the proposed action would follow those required by WS' directives (WS Directive 2.430, WS Directive 2.505) and recommended by the AVMA for use on free-ranging wildlife under field conditions (AVMA 2013).

Some methods have been stereotyped as "humane" or "inhumane." However, many "humane" methods can be inhumane if not used appropriately. For instance, a cage trap is generally considered by most members of the public as "humane." Yet, without proper care, live-captured wildlife in a cage trap can be treated inhumanely if not attended to appropriately. Therefore, the goal would be to address requests for assistance using methods in the most humane way possible that minimizes the stress and pain to the animal. WS has improved the selectivity and humaneness of management techniques through research and development. Research is continuing to bring new findings and products into practical use. Until new findings and products are found practical, a certain amount of animal suffering could occur when some bird damage management methods are used in situations where nonlethal damage management methods are not practical or effective.

Overall, the management of resources, physical exclusion, or frightening devices are regarded as humane when used appropriately. Although some issues of humaneness and animal welfare concerns could occur from the use of live-capture methods, reproductive inhibitors, and repellents, those methods, when used appropriately and by trained personnel, would not result in the inhumane treatment of wildlife. Concerns from the use of those nonlethal methods would occur from injuries to animals while restrained, from the stress of the animal while being restrained, or during the application of the method. 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 action is not taken to alleviate conditions that cause pain or distress in animals. When live-capture devices are deemed appropriate, WS personnel would be present on-site during capture events or methods would be checked frequently to ensure birds captured were addressed timely to prevent injury. Although stress could occur from being restrained, timely attention to live-captured wildlife would alleviate suffering. Stress would likely be temporary.

Nicarbazin is currently the only reproductive inhibitor that is registered with the EPA for application with birds. Nicarbazin (sold under the trade name OvoControl™) can be used to reduce pigeon egg production and viability (for detailed discussion see **Chapter 2**). The use of nicarbazin would generally be considered as a humane method. Nicarbazin reduces the hatchability of eggs. Consuming bait daily did not appear to adversely affect chicks that hatched from female birds fed nicarbazin (Avery et al. 2006, Avery et al. 2008). Nicarbazin has been characterized as a veterinary drug since 1955 by the FDA treat outbreaks of coccidiosis in broiler chickens to with no apparent ill effects to chickens. Based on current information, the use of nicarbazin would generally be considered humane based on current research.

Also under the proposed action, lethal methods could also be employed to alleviate or prevent bird damage and threats, when requested. Lethal methods would include the recommendation that birds be harvested during the regulated hunting season, shooting, DRC-1339 (or Starlicide), Avitrol, and euthanasia after birds were live-captured. WS' use of euthanasia methods under the proposed action would adhere to WS' directives (see WS Directive 2.430, WS Directive 2.505). The euthanasia methods available for use under the proposed action for live-captured birds would be shooting, cervical dislocation and carbon dioxide. The AVMA guidelines on euthanasia list cervical dislocation and carbon dioxide as acceptable methods of euthanasia for free-ranging birds, which can lead to a humane death (AVMA 2013). The use of cervical dislocation or carbon dioxide for euthanasia would occur after the animal has been live-captured and away from public view. Although the AVMA guidelines also list gunshot as a conditionally acceptable method of euthanasia for free-ranging wildlife, there is greater potential the method may not consistently produce a humane death (AVMA 2013). WS' personnel that employ firearms to address bird damage or threats to human safety would be trained in the proper placement of shots to ensure a timely and quick death.

With the exception of DRC-1339, all lethal methods listed would be available under all alternatives. However, a product containing the same active ingredient, Starlicide™, is commercially available as a restricted-use toxicant for managing damage associated with starlings and blackbirds in feedlot situations (Dolbeer and Linz 2016). The active ingreditent of Starlicide™ is 3-chloro-p-toluidine hydrochloride, which is mixed into pelletized bait and sold commercially under the the name Starlicide Complete® (DRC-1339, 98% active ingredient). Starlicide Complete® can be custom mixed with livestock feed or other bait to alleviate damage in these situations (Dolber and Linz 2016). However, Starlicide Technical® can only be used by USDA WS personnel or under the direct supervision of USDA WS personnel.

After consuming bait treated with Starlicide, birds typically die 1 to 3 days later. Treatments are most successful in the winter, especially when snow is present, and alternative food sources are limited. Before treating an area, a period of prebaiting (using non-toxic bait) should be established to allow the target blackbirds and starlings to acclimate to feedling at specific bait sites (Dolbeer and Linz 2016). Bait sites are regularly monitored to ensure that nontarget birds such as native doves, passerines, and domestic poultry are not present.

DRC-1339 causes irreversible necrosis of the kidney and the affected bird is subsequently unable to excrete uric acid with death occurring from uremic poisoning and congestion of major organs (DeCino et al. 1966, Knittle et al. 1990). The external appearances and behavior of starlings that ingested DRC-1339 slightly above the LD50 for starlings appeared normal for 20 to 30 hours, but water consumption doubled after 4 to 8 hours and decreased thereafter. Food consumption remained fairly constant until about 4 hours before death, at which time starlings refused food and water and became listless and inactive. The birds perched with feathers fluffed as in cold weather and appeared to doze, but were responsive to external stimuli.

Birds ingesting a lethal dose of DRC-1339 become listless and lethargic, and normally die within 24 to 72 hours following ingestion. This method appears to result in a less stressful death than which probably occurs by most natural causes, which are primarily disease, starvation, and predation. In non-sensitive birds and mammals, central nervous system depression and the attendant cardiac or pulmonary arrest is the cause of death (Felsenstein et al. 1974).

Avitrol is a chemical method that works as a dispersing agent. When a treated particle is consumed, affected birds begin to emit distress calls and fly erratically, thereby frightening the remaining population away (see discussion in **Chapter 2**). Only a small number of birds need to be affected to cause alarm in the rest of the population. The affected birds generally die. In most cases where Avitrol is used, only a small percentage of the birds are affected and killed by the chemical, with the rest being dispersed. In experiments to determine suffering, stress, or pain in affected animals, Rowsell et al. (1979) tested Avitrol on pigeons and observed subjects for clinical, pathological, or neural changes indicative of pain or distress but none were observed. Conclusions of the study were that the chemical met the criteria for a humane pesticide. Avitrol is a restricted use pesticide that can only be used by certified applicators but would be available for use under any of the alternatives.

WS has improved the selectivity of management devices through research and development for the use of padded jaw pole traps with pan-tension devices and other modifications, lights for deterring birds from airplanes while in flight, immune-contraception drugs to reduce fertility of overabundant species, and chemical immobilization/euthanasia procedures that minimize pain. Until new findings and products are found to be practical, a certain amount of distress will occur if BDM objectives are to be met in those situations where nonlethal BDM methods are ineffective or impractical. Furthermore, if it were possible to quantify distress, it is possible that the actual net amount would be less under the proposed action (or any other alternative involving the use of lethal methods) than under the No Federal BDM Alternative since suffering experienced by domestic animals preyed upon by predators is reduced if BDM is successful in abating predation. Measures to reduce pain and stress in animals and Protective Measures used to maximize humaneness are listed at the end of this chapter.

The majority of the methods listed in Chapter 2 would be available for use under any of the alternatives. Therefore, 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.

3.3.2 Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.

Under this alternative, WS-Colorado would recommend or use only nonlethal methods for Bird Damage Management.

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Populations.

Under this alternative, WS-Colorado would not recommend or lethally take any target species because lethal methods would not be used. CPW could provide some level of professional BDM assistance for lethal activities, but this would be limited by resources such as personnel available and funding and conducted without federal assistance. It is likely that assistance would be minimal because most are federally managed birds. Nonlethal activities conducted by WS would likely intensify, but result in similar levels of nonlethal activities as conducted under Alternative 1 with similar numbers of birds hazed or captured and released or relocated.

Nonlethal harassment, could be ineffective for some bird species, in particular pigeons and raptors, and some birds would quickly become habituated to harassment techniques (*e.g.,* Canada geese), and, thus, where lethal techniques would be implemented, such as to reinforce hazing efforts, WS would continue to conduct nonlethal control but with less success. This could be ineffective, especially at airports and for crop and property protection, and resource owners could become frustrated by WS's apparent lack of success. Therefore, private entities would conduct BDM, more than under Alternative 1, but resulting in, at most, similar levels of take of target species. Additionally, many nonlethal techniques cannot be used in certain situations (use of pyrotechnics in some residential areas to move roosts and at livestock feeding facilities such as dairies where their use can cause agitation of the livestock and loss of production).

The primary difference between BDM under the current activities and that conducted by private entities would be the use of chemicals and a reduced take of migratory birds requiring a depredation permit from USFWS. Private entities would rely on Avitrol and potentially Starlicide Complete which contains the chemical in DRC-1339, to control starlings, feral pigeons, and blackbirds. Technical grade DRC-1339 is currently available for use only by WS and could not be used by the public. This would likely lead to less species being taken under this alternative with chemical BDM methods. Additionally, not all private individuals would want to obtain a depredation permit from USFWS because of the application fee and permiting process is perceived as burdonsome, and, thus, less migratory birds requiring a permit would likely be taken.

As a result, this alternative would likely lead to private entities having somewhat less impacts to target bird species populations as described under Alternative 1, especially the species controlled with DRC-1339 (starlings, blackbirds). For the same reasons shown in the population impacts analysis, it is unlikely that introduced commensal birds, native doves, blackbirds, or other target bird populations would be impacted significantly by implementation of this alternative. Impacts and hypothetical risks of illegal chemicals and other methods under this alternative as described in **Chapter 2** would probably be greater than the proposed action, similar to Alternative 3, but less than Alternative 4. Potential use of illegal methods would lead to unknown risks to target species populations. For example, the nestlings and eggs in a nesting colony of 3,000 American White Pelicans and 1,458 nests were all killed (~2,400 chicks and eggs), except 1, because a man was frustrated with pelican damage (he had suffered $20,000 in losses to crops from trampling). The Minnesota Natural Resources Department had given him little support in trying to resolve the problem. So, he decided to take matters into his own hands. These types of problems will continue to occur without sufficient support.

Issue B: Impacts of BDM on Non-target Bird Populations, Including T & E Species.

Under this alternative, WS would kill few non-target animals because lethal methods would not be used. Some nonlethal BDM methods have the potential to take non-target species such as entanglement and death in netting, but even so, non-target take would be minimal and less than under the proposed action. However, all of WS lethal and nonlethal take of non-target species from FY13 to FY17 were with methods considered nonlethal, and therefore, non-target take would not differ substantially from the current activities. Under this alternative, CPW might provide some level of professional BDM assistance with lethal control activities, but this would be limited by resources (i.e., personnel, funding, etc.) without federal assistance. CPW take of non-target species would likely be similar to WS's and be minimal, if it occurred. On the other hand, individuals and organizations whose bird damage problems were not effectively resolved by nonlethal control methods alone would likely resort to other means of lethal control such as use of shooting by private persons or use of chemical toxicants. This could result in less experienced persons implementing control methods and could lead to greater take of non-target wildlife than the proposed action. For example, shooting by persons not proficient at bird and damage identification could lead to killing of non-target birds. It is hypothetically possible that frustration caused by the inability to reduce losses could lead to illegal use of chemical toxicants which could lead to unknown impacts on local non-target species populations, including T&E species. Hazards to raptors, including Bald Eagles and falcons, could therefore be greater under this alternative if chemicals, that are less selective or that cause secondary poisoning, are used by frustrated private individuals. Therefore, it is likely that non-target take under this alternative would be greater than under the proposed action and could include T&E and sensitive species.

Issue C: Impacts of BDM Methods on Public and Pet Safety and the Environment.

Alternative 2 would not allow for any lethal methods to be recommended or used by WS. WS would only implement nonlethal methods such as harassment with shooting firearms and pyrotechnics, live traps followed by relocation, repellents (*e.g.,* methiocarb, MA, and polybutene tactile repellents), and reproductive inhibitors (nicarbazin). As discussed under Alternative 1, use of these BDM devices is not anticipated to have more than minimal risks to the public, pets, and the environment. The public is often especially concerned with the use of chemicals. The nonlethal chemicals that could be used by WS in BDM, excluding toxicants, were discussed above and not expected to impact the public, pets, or the environment. Such chemicals must undergo rigorous testing and research to prove safety, effectiveness, and low Environmental risks before they would be registered by EPA or FDA. Any operational use of chemical repellents and tranquilizer drugs would be in accordance with labeling requirements under FIFRA and state pesticide laws and regulations and FDA rules which are established to avoid unreasonable adverse effects on the environment. Following labeling requirements and use restrictions is a built-in mitigation measure that would assure that use of registered chemical products would avoid significant adverse effects on human health.

CPW would likely provide some level of professional BDM assistance with lethal control activities, but this would be limited by resources (i.e., personnel, funding, etc.) without federal assistance. The impact on human and pet health and safety from CPW activities would likely be similar to WS's and be minimal. Excessive cost or ineffectiveness of nonlethal techniques could result in some individuals or entities to reject WS's assistance and resort to lethal BDM methods. Private efforts to reduce or prevent damage would be expected to increase, resulting in less experienced persons implementing lethal BDM methods such as use of firearms and leading to greater risks than under Alternative 1. However, because some of these private parties would be receiving advice and instruction from WS, concerns about human health risks from firearms and chemical BDM methods use should be less than under Alternative 3 or 4. Commercial pest control services would be able to use Starlicide Complete (where available) which contains the chemical in DRC-1339, and Avitrol, and such use would likely occur more often in the absence of WS's assistance than under Alternative 1. Use of these chemicals in accordance with label requirements should avoid any hazard to members of the public. It is hypothetically possible that frustration caused by the inability to alleviate bird damage could lead to illegal use of certain methods such as toxicants that, unlike WS's controlled use of DRC-1339 could pose secondary poisoning hazards to pets and to mammalian and avian scavengers. Some chemicals that could be used illegally would present greater risks of adverse effects on humans, pets, and the environment than those used under the current activities alternative.

Sole Use of Hazing Techniques – Case Study

WS-Colorado recognizes that integrative, innovative, and acceptable management strategies are needed to effectively reduce human-wildlife conflicts. Usually, this involves implementing an integrated management strategy involving both lethal and nonlethal techniques. During the public comment period for this EA, the use of nonlethal methods **only** to deter Canada geese were suggested. This topic was discussed in "Section 2.5.5 Only Live Trapping and Translocation Would Be Employed Rather Than Lethal Take." However, we will further examine these issues here as presented by Holevinski et al. (2007).

Holevinski et al. (2007) evaluated a variety of nonlethal hazing techniques to deter nuisance Canada geese from using an urban and suburban site. The urban site, Brighton, New York directly bordered Rochester, encompassing 40 km^2, with a housing density of 250/km^2(Holevinski et al. 2007). The city of Brighton chose to address their nuisance Canada goose problems by developing a task force to discuss goose issues and a border collie service to haze geese at 1 public park and 2 privately-owned sites (Holevinski et al 2007). Volunteers also conducted egg-oiling programs to reduce the annual production of young. The authors importantly noted that the discharge of firearms within the city is prohibited and noise ordinances are in effect (Holevinski et al. 2007).

The suburban study site was located in Clarence, New York approximately 19.9 miles northeast of downtown Buffalo. The city encompassed approximately 85 km^2, with a population of 26,000 people, and had a housing density of 110/km^2 (Holevinski et al. 2007). Clarence, was primarily an agricultural community (52% total area) although, land was continuously being converted to residential subdivisions. Notably, these subdivision contained multiple drainage ponds which served as attractants for Canada geese. Like Brighton, Clarence participated in an egg oiling program from 2001 to 2003 and annually received a depredation permit to remove 20 nuisance Canada geese per year. Although, the study notes that Clarence received a depredation permit it does not explicitly state how many geese or if any geese were lethally removed during the study. Similarly, hunting is prohibited within Clarence in parks and residential areas, where Canada geese are causing damage (Holevinski et al. 2007).

Methods

In late June 2002 and 2003, 245 adult and 169 juvenile Canada geese were live captured at the urban site; similarly, 123 adult and 231 juvenile geese were captured at the suburban site (Holevinski et al. 2007). All geese were aged, banded (with a metal leg band), and released. Radio transmitters and red tarsal bands (with 3 letter codes) were attached to 9 female geese at each site in 2002. Twelve additional females were fitted with radio transmitters and neck bands in 2003 (7 geese Brighton and 5 females Clarence). To supplement observational data of goose movements, 118 geese in Brighton and 33 geese in Clarence were additionally collared using plastic neckbands inscribed with numeric codes.

After the summer molt, nuisance Canada goose flocks at each site were located by the triangulation of radio-marked birds. The movements of radio-marked and collared individuals during hazing periods were recorded and plotted using ArcView GIS. Hazing techniques included the use of border collies, pyrotechnics, remote-controlled boats, lasers, strobe lights, kayaks, goose distress calls, or combinations of these methods (Holevinski et al. 2007). Hazing sites at both the urban and suburban locations typically consisted of mowed lawns in close proximity to open water. Hazing techniques were evaluated at each site to determine which method could be used based on public perception, traffic considerations, town ordinances, and permission from private landowners and townships.

In 2002 and 2003, hazing activities were conducted at 5 sites in Brighton (urban) and 4 sites in Clarence (suburban). However, these activities were not conducted from August 15th to September 25th (two weeks prior to special goose hunting season) or October 25th to November 15th (first 22 days of waterfowl hunting season) (Holevinski et al. 2007). Hazing activities were conducted during the day and night and a “hazing period” was defined as the time a technique or combination of techniques were used to disperse geese from a specific location. When geese left one location and were subsequently hazed from another property, this was recorded as a separate hazing period. As hazing occurred, the authors recorded date, time, location, number of geese present, hazing technique(s) used, duration of the hazing period, and number of geese remaining after hazing ended (Holevinski et al. 2007). When these operations were conducted at night, geese were counted using spotlights when necessary. Border collies were used to haze geese between 0700 and 2000 hours. Lasers were used only between 0700 and 2000 hours due to the necessity of low light conditions for the units to operate (Holevinski et al. 2007).

Results

Nonlethal methods were used to haze geese on 378 separate occasions (**Figure 3.54**). Lasers (n=134), border collies (n=113), laser/pyrotechnics combinations (n=54), border collie and remote controlled boat combinations (n=37), and pyrotechnics alone (n=27) were the most commonly used methods (Holevinski et al. 2007). More than 90% of geese were hazed away from locations in 97% of events, border collies alone were successful in 94% of events (Holevinski et al. 2007). Laser and pyrotechnic combinations removed more than 90% of geese in only 64% of events, and pyrotechnics alone in 59% of events (Holevinski et al. 2007). The mean amount of time to successfully haze geese from a site varied based on the technique used. After the use of the provided hazing technique geese left sites at: lasers mean of 4.2 minutes (range 1-30 minutes), pyrotechnics mean of 5.1 minutes (range 1-25 min), laser and pyrotechnics combinations mean of 6.3 minutes (range 1-26 minutes), border collies mean of 6.4 minutes (range 1-30 minutes), and border collie and remote controlled boat combinations 17.5 minutes (range 1-30 minutes) (Holevinski et al. 2007).

In four separate events, hazing Canada geese with a distress call never moved geese from a location (Holevinski et al. 2007). Similarlly, three events using strobe lights were ineffective. Geese swam within 5 meters of the light without being disturbed (Holevinski et al. 2007). Hazing events using a kayak (n=4) were also unsuccessful in persuading geese to leave the water; and using a combination of pyrotechnics and kayaks (n=2) did not remove any geese during daylight hours (Holevinski et al. 2007). The authors discontinued the use of these methods and excluded them from further analysis after these events (Holevinski et al. 2007). During hazing events, the average flock size was 47 from August to September and 146 from October to November. This range was consistent between years and flock increases were attributed to fall movements of local and migrant birds (Holevinski et al. 2007).

The average distance moved by radio-marked geese from hazing sites to another location<2 hours after hazing was 0.73 miles (n=153) (Holevinski et al. 2007). Subsequently after hazing events, geese moved a mean distance of: lasers 0.67 miles, border collies 0.80 miles, laser and pyrotechnic combinations 0.44 miles, border collies and remote controlled boat combinations 0.38 miles, and pyrotechnics alone 0.33 miles (Holevinski et al. 2007). Immediately after being hazed, 80% of the time geese moved to similar conflict sites within the community and 19% of the time they moved to wetlands within the community where they were less likely to cause conflict (Holevinski et al. 2007). Of the radio-marked geese, 1% traveled to locations where hunting could occur after a hazing event (Holevinski et al. 2007).

Radio-marked geese were located 739 times, but were only hazed 378 times (51%) (Holevinski et al. 2007). The remaining 49% of goose locations were in areas where hazing was not permitted (Holevinski et al. 2007). During the study, only 23 of 30 radio-marked geese were exposed to hazing techniques. Seven of these individual birds were never located in hazing areas or died before hazing activities began.

Of the neck collared geese, 122 of 151 (80%) were observed during the hazing periods near hazing sites (Holevinski et al. 2007). The remaining 29 (20%) were never seen after being collared. Only 64 of 1,600 observations (4%) of neck collared geese occurred in areas that were open to hunting (approximately 3.1 to 18 miles away) (Holevinski et al. 2007).

Mortality

Only 13.6% of adult geese (n=338), 7.5% of juveniles (n=400), and 8.0% of radio-marked adult birds banded at hazing sites were harvested during open hunting seasons during the two year study

(Holevinski et al. 2007). Of 46 geese harvested by hunters, 41 were recovered <31 miles from the hazing sites, and 5 were recovered out of state (Holevinski et al. 2007).

Summary

Holevinski et al. (2007) concluded that hazing had an impact on the localized movements of Canada geese, but it did not cause geese to permanently move from the study sites (Holevinski et al. 2007).

Similar to other studies, the distance geese moved in response to hazing primarily depended on flock size, frequency and predictability of the stimulus, and site conditions (Holevinski et al. 2007, Madsen and Fox 1995, Sherman and Barras 2004, York et al. 2000). Sherman and Barras (2004) found that geese hazed with lasers moved <1.2 miles from urban sites in Ohio; and even with intensive hazing (24 hours/day) post molting geese moved only 2.1 ± 0.12 miles (York et al. 2000). Furthermore, although some geese moved 2.2 miles away from the study sites and into hunting areas, in larger metropolitan areas, were Canada goose conflict sites are farther from agricultural fields, foraging flights and subsequent exposure to hunting may not occur (Holevinski et al. 2007).

Overall, the authors state that the success of a Canada goose hazing program depends on the perspectives and roles of people in the community (Holevinski et al. 2007). They further state that landowners that want geese removed from their property may consider a hazing program successful if geese simply move onto a neighboring property. However, local officials who receive complaints on a town- or city-wide basis, would label a program unsuccessful if geese simply moved to similar locations within the community and continued to cause problems (Holevinski et al. 2007). While hazing geese to alternative sites may have short-term benefits, this does not control the increasing numbers of geese (Holevinski et al. 2007). The authors state that "some type of direct removal (e.g., hunting, summer roundups) is required for population management of resident goose flocks" (Holevinski et al. 2007).

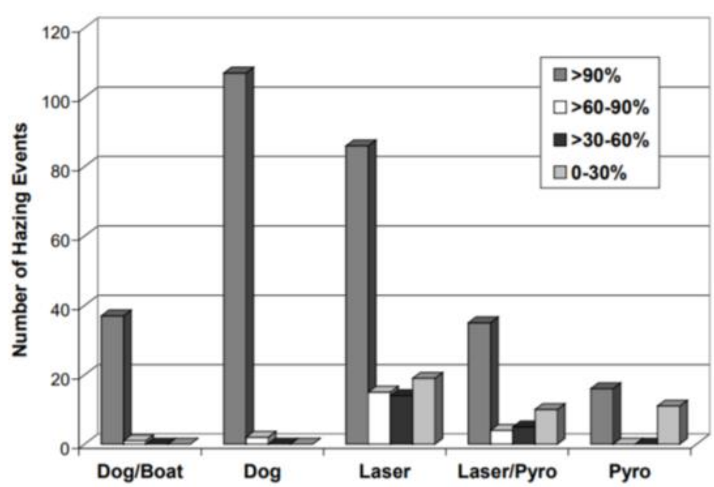


Figure 3.54. Percentage of resident Canada geese removed during each hazing event with border collie and remote-controlled boat combinations (Dog/Boat), border collies (Dog), lasers (Laser),

laser and pyrotechnic combinations (Laser/Pyro), and pyrotechnics (Pyro) in Brighton and Clarence, New York, 2002 and 2003. From Holevinski et al. 2007.

Issue D: Impacts of BDM on Sociocultural Resources.

Some people who oppose lethal control of wildlife by government but are tolerant of government involvement in nonlethal BDM would favor this alternative. Persons who have developed affectionate bonds with individual wild birds would not be affected by WS's activities under this alternative because the individual birds would not be killed by WS. However, other private entities would likely conduct similar BDM activities as those that would no longer be conducted by WS which means the impacts would then be similar to the current activities alternative. Also, private entities are not required to perform similar environmental planning and analysis as WS-Colorado or obtain public input into management plans. There will be some increased sense by the public of not being informed before damage management actions are implemented since private entities are often not required by federal or state law to inform the public.

Under this alternative, WS would be restricted to nonlethal methods only. Nuisance pigeon problems would have to be resolved by nonlethal barriers and exclusion methods. Assuming property owners would choose to allow and pay for the implementation of these types of methods, this alternative would result in nuisance pigeons and other birds relocating to other sites where they would likely cause or aggravate similar problems for other property owners. Thus, this alternative would most likely result in more property owners experiencing adverse effects on the aesthetic values of their properties than the current activities alternative. Many of the current materials used for barriers (netting, metal flashing, wire, etc.) could, in some cases, reduce the aesthetic property value.

Thus, it is anticipated that bird populations would not be impacted under this alternative, but some people may have more problems with bird damage than under the proposed action.

Issue E: Humaneness and Animal Welfare Concerns of Methods.

Selectivity of BDM methods is related to the issue of humaneness in that greater selectivity results in less perceived suffering of non-target animals. The selectivity of each method is based, in part, on the skill and discretion of the WS employee in applying such methods and on specific measures and modifications designed to reduce or minimize non-target captures. The humaneness of a given BDM method is based on the human perception of the pain or anxiety caused to the animal by the method. How each method is perceived often differs, depending on the person's familiarity and perception of the issue as discussed in **Chapter 1**. The selectivity and humaneness of each alternative is based on the methods employed and who employs them under the different alternatives. Schmidt and Brunson (1995) conducted a public attitude survey in which respondents were asked to rate a variety of WDM methods on humaneness (1=not humane, 5= humane) based on their individual perceptions of the methods. Their survey found that the public believes that nonlethal methods such as animal husbandry, fences, and scare devices were the most humane and the use of traps, snares, and aerial hunting was the least humane. Many other WS EAs (WS 1999, 2001, 2006, 2008) have discussed how selective each of the methods used in Colorado to take target animals was and information on their humaneness.

BDM conducted by private individuals could be less humane than BDM conducted under the regulations of federal BDM. BDM methods used by private individuals may be under recognized, particularly, those that are used illegally. Members of the public that perceive some BDM methods as inhumane would be less aware of BDM activities being conducted by private individuals because private individuals would not be required to provide information under mandatory policies or regulations similar to those applied to WS. Thus, the perception of inhumane activities could be reduced, although the actual occurrence of BDM and associated inhumane activities may increase.

The No Federal Program Alternative would likely result in more negative impacts with regard to humaneness than the current program. The other alternatives analyzed in this EA were also analyzed in prior WS environmental documents (WS 1996, 1998, 1999, 2001) and found to lie between the Current Program and No Federal Program Alternatives. These will not be discussed further. However, humaneness is a concern of WS and is a criteria used to help determine the appropriate Protective Measures to maximize method selectivity and humaneness. The current program conducted by WS has taken minimal numbers of non-target species from FY13 to FY17, with most of these being unintentionally live trapped during trapping and translocation projects. For FY13 WS had 2 species that were non-target takes: Black-billed Magpie (1) and Red-winged Blackbirds (13). In FY14, WS had 3 species that were non-target takes: House Sparrows (1), European Starlings (22), and Common Raven (1). For FY15, WS had 1 species that was a non-target take: Gadwall Duck (1). In FY16, WS had 2 species that were non-target takes: Common Raven (2) and Gadwall Duck (1). And finally, for FY17 and FY18, WS had 0 species with non-target take. Review of U.S. Department of the Interior Geological Survey, Breeding Bird Survey (BBS) data indicate that 2005-2015 population trends for target species taken by WS remain similar to those reported in the EA (Sauer et al. 2017). Thus, WS's Protective Measures have been very effective at minimizing the take of non-targets.

In 2017, USDA WS conducted a series of risk analyses on wildlife damage management activities conducted by USDA WS personnel. These analyses include an introductory chapter (Chapter I, WS 2017c) which addresses employee and public safety. Other chapters address specific tools used by Wildlife Services, and address employee and public safety related to the use of those tools. These include: corral traps (WS 2017d), box traps (WS 2017d), walk-in and swim-in traps (WS 2017d), Decoy and bait station traps (WS 2017d), Swedish goshawk traps (WS 2017d), purse traps (WS 2017d), nest box traps (WS 2017d), drive/herd traps (WS 2017d), foot snares or foot nooses (WS 2017e), firearms (WS 2017 h), carbon monoxide (WS 2017j), and nets (WS 2017k). Similar risk analyses of 24 other USDA WS methods have not yet been finalized, but are in progress. See WS (2017c) for the complete list.

These WS risk analyses have generally found that methods used by USDA WS often include some inherent risk, and cite appropriate measures to mitigate the risks to employee and human health and safety, as well as other environmental factors, and humaneness. These measures are generally already incorporated by USDA WS and WS-Colorado; however, if these risk analyses determine that additional mitigation measures are warranted, WS-Colorado will implement those measures as applicable. WS (2017c) found an annual average of 59 field injuries to USDA WS employees nationwide. The majority of these were minor injuries, including strained muscles/ligaments (35%), compression/contusion injuries (15%), and laceration/puncture wounds (13%). Together, these minor injuries accounted for 63% of injuries.

Humaneness, as perceived by the livestock industry and pet owners, requires that domestic animals be protected from predatory birds because humans have bred many of the natural defense capabilities out of domestic animals. Predators frequently do not kill larger prey animals quickly, and will often begin feeding on them while they are still alive and conscious (Wade and Bowns 1982). The suffering apparently endured by livestock and pets damaged in this manner is unacceptable to many people.

Thus, the decision-making process involves tradeoffs between the above aspects of pain and humaneness. Objective Protective Measures to minimize impacts from this issue must consider not only the welfare of wild animals, but also the welfare of humans and domestic animals if damage management methods were not used. Therefore, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal. People may perceive the humaneness of an action differently. The challenge in coping with this issue is how to achieve the least amount of animal suffering within the constraints imposed by current technology and funding.

3.3.3 Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.

Under this alternative, WS-Colorado would not conduct operational BDM activities in Colorado. If requested, WS-Colorado would provide affected resource owners and managers with technical assistance information only (lethal and nonlethal).

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Populations.

Despite no direct involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. **Chapter 2** contains a thorough discussion of the methods available for use in managing damage and threats associated with birds. With the exception of Mesurol (EPA No. 56228-33) and DRC-1339, all methods listed in the Appendix could be available under this alternative, although not all methods would be available for direct implementation by all persons because several chemical methods are only available to those persons with pesticide applicator licenses. Although DRC-1339 is only available for use by WS, a product containing the same active ingredient, Starlicide, is commercially available as a restricted-use pesticide for managing damage associated with starlings, red-winged blackbirds, common grackles, and brown-headed cowbirds at livestock and poultry operations. Management actions taken by non-federal entities would be considered the *environmental status quo*.

The number of birds lethally taken under this alternative would likely be similar to slightly lower than other alternatives. Lethal take of birds could continue to occur either without a permit (if those species are non-native), during hunting seasons, under depredation orders, or through the issuance of depredation permits by the USFWS or CPW. WS-Colorado's involvement would not be additive to take that could occur since the individual requesting WS-Colorado's assistance could conduct bird damage management activities without WS' involvement.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent bird damage as permitted by federal, state, and local laws and regulations or those persons could take no action. Therefore, bird populations in Colorado would not be directly impacted by WS activities implementing technical assistance only.

With the oversight of the USFWS and CPW, it is unlikely that bird populations would be adversely impacted by the implementation of this alternative. Management actions could be undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by other entities such as the USFWS and CPW. If operational assistance is not provided by WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and threats could lead to illegal take which could lead to real but unknown effects on other wildlife populations. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Issue B: Impacts of BDM on Non-target Bird Populations, Including T & E Species.

Despite no direct involvement by WS-Colorado in resolving damage and threats associated with birds in the state, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. Lethal take could continue to occur either without a permit (if those species are non-native), during hunting seasons, under depredation orders or through the issuance of depredation permits by the USFWS or CPW. Nonlethal methods have the potential to inadvertently disperse non-target wildlife while lethal methods have the potential to inadvertently capture or kill non-target wildlife. Management actions taken by non-federal entities would be considered the *environmental status quo*.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent bird damage as permitted by federal, state, and local laws and regulations or those persons could take no action. Therefore, non-target populations would not be directly impacted by WS from activities implementing technical assistance only.

If operational assistance is not provided by WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and threats could lead to illegal take which could lead to real but unknown effects on other wildlife populations. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Potential impacts to non-target species, including threatened and endangered species from the recommendation of methods by WS under this alternative would be variable. If methods were employed as recommended by WS and according to label requirements, in the case of chemical methods, potential risks to non-targets would likely be low and similar to the proposed action. WS' involvement would not be additive to take that could occur since the individual requesting WS' assistance could conduct bird damage management activities without WS' involvement. However, if methods were not employed as recommended or methods that are not recommended are employed, potential impacts to non-targets are likely to be higher.

Issue C: Impacts of BDM Methods on Public and Pet Safety and the Environment.

Despite no direct involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. With the exception of Mesurol (EPA No. 56228-33) and DRC-1339, all methods listed in **Chapter 2** could be available under this alternative, although some methods would only be available to those persons with pesticide applicator licenses. Although DRC-1339 is only available for use by WS, a product containing the same active ingredient, Starlicide, would be available. Private efforts to reduce or prevent damage would be expected to increase, and would likely result in less experienced persons implementing chemical or other damage management methods which may have a greater risk to human and pet health and safety than under Alternative 1. Ignorance and/or frustration caused by the inability to reduce losses could lead to illegal use of toxicants by others which could lead to unknown impacts to humans. Potential impacts to human health and safety from the recommendation of methods by WS under this alternative would be variable. If methods were employed as recommended by WS and according to label requirements, in the case of chemical methods, potential risks to human health would likely be low and similar to the proposed action. However, if methods were employed without guidance from WS or applied inappropriately, the risks to human health and safety could increase.

Issue D: Impacts of BDM on Sociocultural Resources.

Since birds could continue to be taken or dispersed under this alternative, despite WS' lack of involvement, the ability to view and enjoy birds would likely be similar to the other alternatives. The lack of WS' involvement would not lead to a reduction in the number of birds dispersed or taken since WS has no authority to regulate take or the harassment of birds. The USFWS and CPW have management authority over birds and would continue to adjust all take levels based on population objectives for those bird species in the state. Therefore, the number of birds lethally taken annually during hunting seasons, under depredation orders, or through the issuance of depredation permits would be regulated and adjusted by the USFWS and CPW. Under this alternative, those individuals experiencing damage could and likely would continue to employ both lethal and nonlethal methods, despite WS' lack of involvement. Therefore, the impacts to the aesthetic value of birds would be similar to the other alternatives. Impacts would only be lower than the proposed action alternative if those individuals experiencing damage were not as diligent in employing methods as WS would be if conducting operational assistance. If those people experiencing damage abandoned the use of those methods then birds would likely remain in the area and available for viewing and enjoying for those people interested in doing so.

Also, private entities are not required to perform similar environmental planning and analysis as WS-Colorado or obtain public input into management plans. There will be some increased sense by the public of not being informed before damage management actions are implemented since private entities are often not required by federal or state law to inform the public.

Issue E: Impacts of Bird Damage Management on Humaneness and Animal Welfare Concerns.

Despite no direct involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. The issue of humaneness of methods under this alternative is likely to be perceived as similar to humaneness issues discussed under the proposed action. This perceived similarity is derived from WS' recommendation of methods that some consider inhumane. WS would not directly be involved with damage management activities under this alternative. However, the recommendation of the use of methods would likely result in the requester employing those methods. Therefore, by recommending methods and thus a requester employing those methods, the issue of humaneness would be similar to the proposed action.

WS would instruct and demonstrate the proper use and placement of methodologies to increase effectiveness in capturing target bird species and to ensure methods are used in such a way as to minimize pain and suffering. However, the efficacy of methods employed by an individual would be based on the skill and knowledge of the requester in resolving the threat to safety or damage situation despite WS' demonstration. Therefore, a lack of understanding of the behavior of birds or improperly identifying the damage caused by birds along with inadequate knowledge and skill in using methodologies to alleviate the damage or threat could lead to incidents with a greater probability of being perceived as inhumane. In those situations, the pain and suffering are likely to be regarded as greater than those discussed in the proposed action alternative.

Those people 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 or 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. Similar to Alternative 3, it can be difficult to evaluate the behavior of individual people and determining what may occur under given circumstances. Therefore, only the availability of WS' assistance can be evaluated under this alternative since 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 methods would be applied as humanely as possible 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, then the issue of method humaneness would be of greater concern since pain and distress of birds would likely be higher.

3.3.4 Alternative 4: No Federal WS-Colorado Bird Damage Management.

This alternative consists of no federal BDM by WS-Colorado.

Issue A: Impacts of Bird Damage Management Activities (BDM) on Target Bird Populations.

Under this alternative, WS-Colorado would not be involved with any aspect of bird damage management. All requests for assistance received by WS-Colorado to resolve damage caused by birds would be referred to the USFWS, CPW, CDA, and/or private entities.

Despite no involvement by WS-Colorado in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. Similar to Alternative 2, with the exception of Mesurol and DRC-1339, all methods listed could be available under this alternative, although not all methods would be available for direct implementation by all persons because several chemical methods are only available to those persons with pesticide applicators licenses. Although DRC-1339 is only available for use by WS, a product containing the same active ingredient, Starlicide, is commercially available as a restricted-use pesticide for managing damage associated with starlings, red-winged blackbirds, common grackles, and brown-headed cowbirds at livestock and poultry operations.

Lethal take of birds could continue to occur either without a permit (if those species are non-native), during hunting seasons, under depredation orders or through the issuance of depredation permits by the USFWS or CPW. The USFWS issues permits for those species of birds protected under the MBTA while CPW issues permits for those species of birds including game birds protected under state law.

Under this alternative, property owners or managers may have difficulty obtaining permits to use lethal methods. As detailed above in Alternative 1, the USFWS requires that permittees contact WS to obtain a recommendation (technical assistance) for how to address bird damage as part of the permitting process. Under this alternative, WS would not perform this function. However, the USFWS needs professional recommendations on individual damage situations before issuing a depredation permit for lethal take and the USFWS does not have the mandate or the resources to conduct damage management activities. Therefore, state agencies with responsibilities for migratory birds would likely have to provide this information. If the information were provided to USFWS, they could review the application and make a determination as described in Alternative 1.

The number of birds lethally taken under this alternative would likely be similar or slightly less to the other alternatives. WS' involvement would not be additive to take that could occur since the persons requesting WS' assistance could conduct bird damage management activities without WS' involvement.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent bird damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Management actions could be undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by other entities such as the USFWS and CPW. If operational assistance and technical assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. This may occur if those persons or organizations providing technical assistance have less technical knowledge and experience managing wildlife damage than WS. Illegal, unsafe, and environmentally unfriendly actions could lead to real but unknown effects. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Issue B: Impacts of BDM on Non-Target Bird Populations, Including T & E Species.

WS would not be involved with any aspect of bird damage management. Therefore, WS would have no direct impact to non-targets or threatened and endangered species under this alternative. All requests for assistance received by WS to resolve damage caused by birds would be referred to the USFWS, CPW, CDA, and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. Lethal take of birds could continue as stated under Alternative 2.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent bird damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Potential impacts to non-target species, including threatened and endangered species would be variable under this alternative. If operational assistance and technical assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. Illegal, unsafe, and environmentally unfriendly actions could lead to real but unknown effects on non-target species. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003). However, if appropriate operational assistance and technical assistance was provided by persons knowledgeable and experienced in managing wildlife damage, the risks would be similar to Alternative 2.

Issue C: Impacts of BDM Methods on Public and Pet Safety and the Environment.

Under this alternative, WS would not conduct any lethal removal of birds nor would WS-Colorado perform any harassment of blackbirds, geese, raptors, herons and other birds. Persons who have developed affectionate bonds with individual wild birds would not be affected by WS under this alternative. However, other private entities would likely conduct similar BDM activities as those that would no longer be conducted by WS which means the impacts would then be similar to the current activities alternative. If frustrated individuals could not stop damage, they may cause more harm to birds and therefore, could impact aesthetics for some individuals.

Under this alternative, the lack of WS support in BDM in reducing nuisance pigeon and other bird problems where droppings cause unsightly messes would mean aesthetic values of some affected properties would continue to be adversely affected if the property owners were not able to achieve BDM some other way. In many cases, this type of aesthetic "damage" would worsen because property owners would not be able to resolve their problems and bird numbers would continue to increase.

Issue D: Impacts of BDM on Sociocultural Resources.

Under this alternative, WS would not be involved with any aspect of bird damage management. Therefore, WS would have no direct impact to human health and safety under this alternative. All requests for assistance received by WS to resolve damage caused by birds would be referred to the USFWS, CPW, CDA, and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent bird damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Potential impacts to human health and safety would be variable under this alternative. If operational assistance and technical assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. Illegal, unsafe, and environmentally unfriendly actions could lead to real but unknown effects on health and safety. However, if appropriate operational assistance and technical assistance was provided by persons knowledgeable and experienced in managing wildlife damage, the risks would be similar to Alternative 2.

Also, private entities are not required to perform similar environmental planning and analysis as WS-Colorado or obtain public input into management plans. There will be some increased sense by the public of not being informed before damage management actions are implemented since private entities are often not required by federal or state law to inform the public.

Issue E: Humaneness and Animal Welfare Concerns of Methods.

Despite no involvement by WS in resolving damage and threats associated with birds, those persons experiencing damage caused by birds could continue to alleviate damage by employing both nonlethal and lethal methods. Those methods would likely be considered inhumane by those persons who would consider methods proposed under any alternative as inhumane. The issue of humaneness would likely be directly linked to the methods legally available to the public since methods are often labeled as inhumane by segments of society no matter the entity employing those methods. A method considered inhumane would still be perceived as inhumane regardless of the person or entity applying the method. However, even methods generally regarded as being humane could be employed in inhumane ways. Methods could be employed inhumanely by those people inexperienced in the use of those methods or if those people were not as diligent in attending to those methods.

The efficacy and therefore, the humaneness of methods would be based on the skill and knowledge of the person employing those methods. A lack of understanding of the target species 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 alleviate damage and threats caused by birds. Therefore, those methods considered inhumane would continue to be available for use under this alternative. If those people experiencing bird damage apply those methods considered humane methods as intended and in consideration of the humane use of those methods, then the issue of method humaneness would be similar across the alternatives. If those persons experiencing bird damage were not provided with information and demonstration on the proper use of those methods and employed humane methods in ways that were inhumane, the issue of method humaneness could be greater under this alternative. However, the level at which people would apply humane methods inhumanely under this alternative based on a lack of assistance is difficult to determine and could just as likely be similar across the alternatives.

3.4 Evaluation of Alternatives to Meet the Goals and Objectives of USDA-WS and WS-Colorado.

The goals and objectives of USDA-WS and WS-Colorado are to provide services to reduce threats to human health and safety, reduce damage to resources, property, and protect wildlife when requested, within the constraints of available funding and workforce. Throughout this EA, these goals and objectives have been discussed as they related to WS-Colorado BDM and are summarized in **Tables 3.87, 3.88,** and **3.89**. In these tables, each Alternative is evaluated for how it meets each goal and/or objective. Of the four Alternatives evaluated, the chosen Alternative ("Preferred Alternative") meets the most goals and objectives while minimizing any negative environmental impacts, as evaluated in relation to the e*nvironmental status quo*.

WS follows CEQ regulations implementing the NEPA (40 CFR 1500 et seq.), USDA (7 CFR 1b) and USDA-APHIS Implementing Guidelines (7 CFR 372) as part of the decision-making process. Cumulative impacts, as defined by the CEQ (40 CFR 1508.7), are impacts to the environment that results from the incremental impacts 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.

Under the Proposed Action/No Action alternative (Alternative 1) WS would respond to requests for assistance by: 1) taking no action, if warranted, 2) providing technical assistance to property owners or managers on actions they could take to reduce damage or threats of damage, or 3) provide technical assistance and operational assistance to a property owner or manager experiencing damage or threats of damage. Under this alternative, WS would be the primary agency conducting operational assistance. However, other federal, Colorado and private entities could also be conducting bird damage management activities.

WS-Colorado does not normally conduct operational damage management activities concurrently with other public (federal or state) entities in the same area but these activities may occur at adjacent sites within the same period. However, WS-Colorado may conduct damage management activities concurrently in the same area that private entities such as commercial pest control companies are conducting similar activities. The potential cumulative effects analyzed below could occur because of A) the aggregate effects of WS' activities along with the activities of other entities and individuals either over a short or extended period of time or B) because of the aggregate effects of WS' activities over a short or extended period. Through ongoing coordination and collaboration between WS, the USFWS, and CPW, the activities of each agency and the take of birds during hunting seasons, under depredation orders or depredation permits would be available. Damage management activities would be monitored to ensure they are within the scope of analysis of this EA.

Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).

Under Alternative 1, all of the goals and objective of USDA-WS and WS-Colorado discussed would be met. The efficiency in achieving these goals is largely dependent on the performance of WS-Colorado BDM at a future time and place. Therefore, we cannot state with certainty that these goals *will* be accomplished. However, this Alternative provides the most efficient and reliable framework for accomplishing these goals and objectives. In the past, these goals and objectives were met in the past.

Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.

Under Alternative 2, WS-Colorado would be able to meet some of the goals and objectives with limitations. Although WS-Colorado would be able to respond to requests for assistance associated with bird damage, it would not be performed as efficiently as under Alternative 1. Since nonlethal methods would only be provided, a reduced number of personnel would be responding to requests for assistance, and this personnel would likely not be able to conduct as many site visits as performed under Alternative 1. Timely requests for assistance would be limited by a lack of support staff. Additionally, requests for help involving lethal BDM would need to be referred to other entities and/or individuals. Human health and safety would not be provided to the extent in Alternative 1 and airport programs using WS-Colorado assistance would likely be forced to conduct lethal management on their own or hire additional contractors. Furthermore, livestock, agricultural, and other resource managers would either need to contract lethal BDM work through another entity or individual or take it upon themselves to perform the work. Under this alternative, the amount of non-target take has the potential to increase in the public sector as individuals attempt to conduct lethal BDM without the professional support or assistance of WS-Colorado.

Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.

Under Alternative 3, the number of WS-Colorado personnel would likely be reduced; and the work would include a reduced amount of field work. Due to a lack of personnel, WS-Colorado would not be able to respond adequately to all bird damage or threats of damage under this alternative. In only providing technical assistance for bird damage management, many of the operational support staff positions would no longer be needed (cooperators currently funding for these positions) and thus, would be unable to provide operational assistance to airports, livestock producers, agricultural producers, property owners, natural resource managers etc. WS-Colorado employees would only be able to respond to BDM requests for assistance by telephone and workshops. However, the inability to physically visualize and observe bird damage would limit the effectiveness of these responses. Additionally, due to a reduction in staff, technical assistance could be delayed.

WS-Colorado would be limited in our ability to resolve bird damage under Alternative 3 and would be unable to protect: 1) human and pet health and safety, 2) livestock and agriculture, 3) natural resources, or 4) property. WS-Colorado would still be able to provide some level of effective technical assistance to the state, but the lack of operational staff would severely limit the scope of this work.

Although, non-target take by WS-Colorado would be minimized under this alternative, a moderate increase in non-target take is anticipated to occur in the public-sector due to less experienced and in some cases, less professional persons or entities performing BDM. This increase of private sector non-target take under Alternative 3 would likely not result in significant negative impacts on non-target species populations but would be higher than those experienced under Alternative 1.

Alternative 4: No Federal WS-Colorado Bird Damage Management.

Under Alternative 4, WS-Colorado would not be able to respond to damage or threats of damage associated with birds. We would also not be able to alleviate or resolve BDM requests for assistance related to 1) human and pet health and safety, 2) livestock and agriculture, 3) natural resources, or 4) property.

WS-Colorado would not take any non-target species under this alternative, but a moderate increase in non-target take is anticipated in the private sector due to increased BDM activities being conducted by less experiences, and in some cases less professional, entities and individuals. WS-Colorado would not be able to limit this non-target take by providing technical assistance. The quality of technical assistance available to the public would be greatly diminished, because state and federal agencies, and private nuisance wildlife control officers and companies have limited knowledge about bird damage management. Private entities/individuals would likely use other lethal and nonlethal methods that are less selective for BDM and would likely cause an increase in non-target take. The level of non-target take is likely to be higher than Alternative 1, and WS-Colorado would not be able to achieve our goal of minimizing non-target take in the state.

3.5 Summary of Cumulative Impacts

Under Alternatives 1 and 2, there would be no significant negative direct, indirect, or cumulative impacts on the issues analyzed in this EA: target species populations, non-target species populations, public and pet safety and the environment, sociocultural issues, and humaneness and animal welfare concerns.

Under Alternatives 3 and 4, there would be no significant negative direct, indirect, or cumulative impacts on target species populations, non-target species populations, public and pet safety and the environment, sociocultural issues, and humaneness and animal welfare concerns. However, under Alternatives 3 and 4, there would likely be major negative impacts to the public and pet safety and the environment due to increased non-target capture, increased use of more dangerous methods by less experienced personnel; increased risk of wildlife strikes; and increased damage due to birds.

Differences would occur among the alternatives regarding the amount of target bird species and non-target bird species take, but those differences would not result in significant impacts to statewide numbers of any of these species analyzed in this EA, under any of the Alternatives. This includes the likely direct, indirect, and cumulative impacts under each Alternative.

From an environmental impact perspective, Alternative 1 and 2 would both be acceptable. From an economic impact perspective, only Alternative 1 is acceptable, because bird damage would increase under the other three Alternatives. From a societal perspective, each of the Alternatives would be acceptable, depending on an individual's values, attitudes, and beliefs. From a natural resource management perspective, only Alternative 1 would preserve wildlife biodiversity due to an overabundance of adaptable or invasive bird species.

Alternative 1, the continuation of the current WS-Colorado BDM program, is the Alternative which best accomplishes the goals and objectives of USDA-WS and WS-Colorado. And it is the only Alternative which is likely to accomplish them all. It is therefore the Preferred Alternative based on the analyses in this EA.

Under Alternative 1, past, present, and reasonably foreseeable future actions would not result in cumulatively significant negative environmental impacts on any of the issues analyzed in detail in this EA: target species populations, non-target species populations, public and pet safety and the environment, sociocultural issues, and humaneness and animal welfare concerns. These actions would also result in non-cumulative negative impacts on any of the other issues considered. All WS-Colorado BDM activities under this Alternative will comply with relevant laws, regulations, policies, orders, and procedures (including ESA, MBTA, and FIFRA). When finalized, this EA will remain valid until WS-Colorado and other appropriate agencies determine that new actions or new alternatives, having substantially different environmental effects, must be analyzed; or until changes in environmental policies, the scope of the WS-Colorado BDM activities, or other issues trigger the need for additional NEPA analysis. This EA will be periodically reviewed for its continued validity, including regular monitoring of the impacts of WS-Colorado activities on populations of both target and non-target species, and will be updated as needed.

Table 3.87. USDA Wildlife Services-Colorado: Summary of the Environmental Impact of Alternatives by Issues.

Issue	Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Impacts of BDM on Target Bird Populations	WS-Colorado's impacts would be localized, temporary, and of low magnitude; Non-WS entities would have a minimal role under this Alternative.	WS-Colorado would have minimal to no impacts; Impacts by non-WS entities would increase.	WS-Colorado would have no impacts; Impacts by non-WS entities would be greater than under **Alternatives 1** and **2**.	WS-Colorado would have no impacts; Impacts by non-WS entities would be the greatest under this Alternative.
Impacts of BDM on Non-target Bird Populations, Including T&E Species.	WS-Colorado's impacts if any, would be exceptionally limited. Non-WS entities would have minimal to no involvement under this Alternative.	WS-Colorado would have less impacts than **Alternative 1**; Impacts by non-WS entities would increase.	WS-Colorado would have no impacts; Impacts by non-WS entities would be greater than under **Alternatives 1** and **2**.	WS-Colorado would have no impacts; Impacts by non-WS entities would be the greatest under this Alternative.
Impacts of BDM on Public and Pet Safety and the Environment.	WS-Colorado's impacts, if any, would be of very low magnitude; Many of the impacts seen in the private sector would be equal to those seen in WS-Colorado BDM because NWCOs have similar safety protocols for protecting the public, pet safety, and the environment.	Impacts by WS-Colorado would be less than **Alternative 1**; Impacts by non-WS entities would increase.	WS-Colorado would have minimal to no impacts; Impacts by non-WS entities would be greater than under **Alternatives 1** and **2**.	WS-Colorado would have no impacts; Impacts by non-WS entities would be the greatest under this Alternative.
Impacts of BDM on Sociocultural Resources.	WS-Colorado must consider impacts and has greatest coordination with other government entities under this Alternative; Non-WS entities are not required to consider impacts and are not required to coordinate with other government entities.	Impacts by WS-Colorado would be greater than under **Alternative 1** due to less effective methods; Impacts by non-WS entities would increase, but the increase would vary depending on voluntary community coordination.	WS-Colorado would have minimal to no impacts; Impacts by non-WS entities would be greater than under **Alternatives 1** and **2**.	WS-Colorado would have no impacts; Impacts by non-WS entities would be the greatest under this Alternative.
Impacts of BDM on Humaneness and Animal Welfare Concerns of Methods.	WS-Colorado would be perceived to have the greatest impact under this Alternative; Non-WS entities would have less impacts.	Impacts by WS-Colorado would be minimal in comparison to **Alternative 1**; Impacts by non-WS entities would be	WS-Colorado would have minimal to no impacts; Impacts by non-WS entities would be greater than under **Alternatives 1** and **2**.	WS-Colorado would have no impacts; Impacts by non-WS entities would be the greatest

Issue	Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
		greater than under **Alternative1.**		under this Alternative.

Table 3.88. How would the four Alternatives be likely to meet the goals of WS-Colorado, as described in this Environmental Assessment?

Goals	Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Provide WS-Personnel Safety	Meets	Meets	Meets	Not applicable
Respond to All Requests for Assistance associated with Bird Damage	Meets	Somewhat meets, but not as well as **Alternative 1.**	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Respond in a Timely Manner to Requests for Assistance	Meets	Somewhat meets, but not as well as **Alternative 1.**	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Resolve or Alleviate Bird Damage	Meets	Somewhat meets, but not as well as **Alternative 1.**	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Manage Risks to Human and Pet Health and Safety	Meets	Somewhat meets, but not as well as **Alternative 1.**	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Resolve, Alleviate, or Manage Bird Damage and Threats to Agriculture	Meets	Somewhat meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Resolve, Alleviate, or Manage Bird Damage and Threats to Livestock	Meets	Somewhat meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet

Goals	Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Resolve, Alleviate, or Manage Bird Damage and Threats to Natural Resources	Meets	Somewhat meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Resolve, Alleviate, or Manage Bird Damage and Threats to Property	Meets	Somewhat meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Reduce the Risk of Bird Strike Hazards at Airports	Meets	Somewhat meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet
Prevent Bird Damage When Feasible	Meets	Does not meet	Does not meet	Does not meet
Minimize Non-target Take	Meets	Meets, but not as well as **Alternative 1**.	Somewhat meets, but not as well as **Alternatives 1** and **2**.	Does not meet

Table 3.89. WS-Colorado: Examination of Alternative with Project Objectives.

Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Objective 1. Professionally and proficiently respond to all requests for BDM assistance or threats of damage associated with bird species, using the integrated BDM approach and the WS Decision Model. BDM must be consistent with all applicable Federal, State, and local laws, WS polices and directives, cooperative agreements, MOUs, and other requirements as provided in any decision resulting from this EA.			

Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Meets all components of objective.	Meets components of objective but may be less proficient than Alternative 1 when lethal BDM is deemed immediately necessary.	Meets components of objective except for proficiency and some partner agency policies for MOUs for integrated BDM.	Does not meet objective.
Objective 2. Implement integrated BDM so that cumulative impacts do not negatively affect the viability of any native bird species populations.			
Meets objective.	Meets objective if other entity can conduct lethal damage management when needed.	Meets objective if other entity can conduct lethal damage management when needed. Experience in lethal damage management may be difficult to find.	Does not meet objective.
Objective 3. Ensure that actions conducted for BDM fall within the management goals and objectives of applicable wildlife damage management plans or guidance as determined by the jurisdictional, state, tribal, or Federal wildlife damage management agency.			
Meets objective.	Meets objective except where nonlethal methods are inappropriate according to partner agency management objectives, plans, or guidance. May be limited public participation in plans.	Meets objective except where lethal integrated BDM is indicated in partner agency management objectives, plans, or guidance. May be limited public participation in plans.	Does not meet objective or not applicable. May be limited or no public participation in plans.
Objective 4. Minimize impact on target and non-target species populations by using the WS Decision Model to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.			

Alternative 1: Continue the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action).	Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only.	Alternative 3: WS-Colorado Provides Technical Assistance Only for Bird Damage Management.	Alternative 4: No Federal WS-Colorado Bird Damage Management.
Meets objective.	Meets objective under the constraints of the alternative.	Meets objective under the constraints of the alternative.	Fails to meet objective under the constraints of the alternative.
Objective 5. Incorporate the use of effective new and existing nonlethal and lethal technologies, where appropriate, into technical and direct assistance.			
Meets objective.	Meets objective except if lethal methods must be used.	Meets objective except for lethal technologies.	Does not meet objective.
Objective 6. Ensure that actions conducted for BDM align with local community stakeholder objectives and management goals using the most effective means while complying with federal, state, and local rules and regulations regarding public and pet safety, environmental protection, sociocultural impacts, humaneness and animal welfare concerns.			
Meets objective.	Meets objective under the constraints of the alternative, except some socio-cultural and animal welfare goals may be minimized due to private sector inexperience or lack of information.	Meets objective under the constraints of the alternative, except some socio-cultural and animal welfare goals may be minimized due to private sector inexperience or lack of information.	Does not meet objective or not applicable.

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CHAPTER 5: LIST OF PREPARERS AND PERSONS CONSULTED.

Name	Organization and Title
Emily L. Blizzard	**USDA WS-Colorado** *Staff Wildlife Biologist*
Martin S. Lowney	**USDA WS-Colorado** *State Director*
Kendra B. Cross	**USDA WS-Colorado** *District Supervisor*
Mike Green	**USDA WS-OSS** *Environmental Coordinator*
Creed Clayton	**USFWS-Ecological Services Colorado** *Wildlife Biologist*

CHAPTER 6: PUBLIC COMMENTS AND RESPONSES.

WS-Colorado received 554 comment letters that contained a combined total of approximately 1,000 individual comments. Many of these comments were identical or substantially similar, so "like" comments were grouped together. Below, we have summarized the comments into 19 individual comments and provided responses to them. All of the comments we received were either outside the scope of the EA, were adequately addressed in the Draft EA, or have been addressed more clearly in this Final EA. WS-Colorado has provided responses to the substantive comments in the section below.
Below, comments are provided in bold, and our response is provided below the comment in normal font (*i.e.*, not bold).

1. **We received numerous comments on the draft EA which are categorically outside the scope of the EA.**

   Comments on topics outside the scope of the EA include; comments opposing or supporting certain actions or alternatives without providing any further context, decisions regarding state laws, hunting regulations in Colorado, providing habitat for wildlife, migratory bird population management in the U.S, Canada goose feces disposal/cleanup in parks, providing goose meat to low income families, inspection of meat processors, policy changes regarding decline of bird populations, and other land management decisions that WS-Colorado has no regulatory authority over.

2. **Commenters submitted numerous research articles without any context or explanation of why WS-Colorado should consider them.**

   WS-Colorado reviewed and considered all of the literature that was provided by the commenters. Some of the literature included was already cited in the EA, to the extent that they were new to WS-Colorado; if they did not add anything substantive to the analyses in the EA, then WS-Colorado did not cite them but, included that literature in the project record. Other literature that was provided and not cited in the EA were opinion articles and articles that were outside of the scope of the EA.

3. **Commenters claim that WS-Colorado is not transparent regarding information that is available to the public on WS-Colorado's BDM operations and that WS is noncompliant with requests for information.**

   WS-Colorado disagrees with this comment. WS-Colorado has made this EA available to the public, agencies, tribes, and other interested or affected entities for review and comment prior to making and publishing the decision as discussed in section *1.9.5* of the EA. WS posts annual Public Data Reports on the Wildlife Services website and information is also made available to the public through the FOIA process.

4. **Commenters claim that the BDM methods used by WS-Colorado are not best management practices with emphasis on nonlethal methods.**

   WS-Colorado disagrees with this comment. WS-Colorado fully analyzed a nonlethal BDM only alternative in the EA (Alternative 2). For further information on best management practices and use of nonlethal methods refer to EA sections *1.9.7 How Does this EA Relate to Site-Specific Analyses and Decisions, Using the WS Decision Model?, 2.7 How Do WS-Colorado Personnel Select a BDM Strategy Using the WS Decision Model?, 2.8 What Are the Integrated Wildlife*

Damage Management Strategies that WS-Colorado Employs?, 2.9 Bird Damage Management Methods Available for Preventing, Reducing, and Alleviating Damage and Threats Associated with Birds in Colorado.

5. **Commenters claim that WS-Colorado failed to evaluated novel or new methods including (nicarbazin, anthraquinone), nonlethal methods in the EA.**

   WS-Colorado disagrees with this comment. Information regarding these methods are thoroughly discussed in the EA in section *2.9.5 Lethal Methods That May Be Used, 3.3.1 Alternative 1: Continuing the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action). Issue E: Impacts of Bird Damage Management on Humaneness and Animal Welfare Concerns., 2.5.2 Short Term and Long-Term Population Suppression., 3.3.2 Alternative 2: Nonlethal Bird Damage Management by WS-Colorado Only. 3.2 Analysis of Methods.*

6. **Commenters claim that DRC-1339 used for BDM by WS-Colorado are mobile and persistent in the soil and water which poses a threat to nontarget species.**

   WS-Colorado disagrees with this comment. WS-Colorado abides by all of the label restrictions, state laws and local laws, and WS-Directive 2.401 when applying DRC-1339. Additional information is provided on pesticide use in EA sections *2.4.3 Issue C: Impacts of Bird Damage Management on Public and Pet Safety and the Environment. 2.4.2 Issue B: Impacts of Bird Damage Management on Non-target Bird Species, Including T & E Species. 2.4.4 Issue D: Impacts of Bird Damage Management on Sociocultural Issues. 2.14 Protective Measures. 3.2 Analysis of Methods. 3.3 Environmental Consequences and Cumulative Impacts of Issues Analyzed In Detail for each Alternative*.

7. **Commenters claim that WS-Colorado fails to analyze cumulative impacts of BDM on bird populations because the scope of the analysis is only within the state of Colorado.**

   WS-Colorado disagrees with this comment. As discussed in section *1.9.4* of the EA; Lead agencies have the discretion to determine the geographic scope of their analyses under the NEPA. As discussed in *Section 1.9.1* of the EA; WS-Colorado has considered both the proposed action and the geographic area involved and has determined that the preparation of this EA to address WS-Colorado' BDM activities on a statewide basis for the state of Colorado is the appropriate approach to take. Wildlife populations, with the exception of T&E species, are monitored over large geographic areas (*e.g*., Central Flyway, Biological Conservation Regions, state of Colorado) and smaller geographic areas (*e.g.*, zones/units). For a detailed description of cumulative impacts refer to *section 3.3* of the EA (Environmental Consequences and Cumulative Impacts of Issues Analyzed in Detail for each Alternative).

8. **Commenters provided reference to the study titled: North America Has Lost Nearly 3 Billion Birds Since 1970 was published in the journal, Science (Sept. 2019). Commenters posted concerns about loss of biodiversity and extinction and that the proposed action would accelerate negative effects on bird populations.**

   WS-Colorado does not manage bird populations or have regulatory authority over bird populations in the state of Colorado or in the United States. WS-Colorado included an additional study: Rosenberg et al. 2019, information in Natural Factors that Limit Bird Populations in section *3.1.7* of the EA. For detailed information on bird population impacts refer to EA sections *3.1.7 Potential Biological Removal for Local Populations., 2.6.5 WS-Colorado's Impact on Biodiversity, and 3.5 Summary of Cumulative Impacts*. WS-Colorado has determined that the proposed actions will not have a significant impact to any of the species population discussed in the EA.

9. **Commenters requested that WS-Colorado needs to provide data for 2019 Canada goose BDM in the EA.**

   WS-Colorado is not required to include this data because the project occurred outside of the years covered in this analysis. However, WS-Colorado agrees that this is important information to include, so WS Colorado will provide the updated Canada goose data from 2019 in the Decision Document for this EA. Additionally, the 2019 data was added to Section 3.3.1. WS-Colorado at any time may start or initiate a new project. New projects are covered under the existing EAs and actions analyzed.

10. **Commenters claim that the EA is not based on scientifically supported data that demonstrates that management actions are needed.**

    WS-Colorado disagrees with this comment. For a detailed description of the need for BDM action, refer to all of *Section 1.5 At What Point Do People or Entities Request Help with Managing Wildlife Damage?, 2.8.4 Community Based Decision Making., 2.9 Bird Damage Management Methods Available for Preventing, Reducing, and Alleviating Damage and Threats Associated with Birds in Colorado., 2.9.1 Nonlethal Methods That May Be Used., 1.1 1.1 Purpose and Need, 1.2 1.2 In Brief, What is this Environmental Assessment About?, 1.7 What are the Needs for the WS-Colorado Bird Damage Management Activities?, 2.4.1 Issue A: Impacts of Bird Damage Management Activities on Target Bird Populations., 2.5.5 Only Live Trapping and Translocation would be Employed Rather Than Lethal Take., and 2.5.2 Short Term and Long-Term Population Suppression., and 3.3 Environmental Consequences and Cumulative Impacts of Issues Analyzed in Detail for each Alternative. 2.7 How Do WS-Colorado Personnel Select a BDM Strategy Using the WS Decision Model?, 2.8 What Are the Integrated Wildlife Damage Management Strategies that WS-Colorado Employs?* In addition, WS-Colorado cited more than 600 scientific publications to produce this environmental assessment.

11. **A commenter claimed that wintering geese move between breeding grounds in Canada and overwintering areas in the U.S., but do not nest in Colorado or the lower 48 states and that they are protected under the MBTA.**

    WS-Colorado disagrees with this statement. There is a difference between the subspecies of resident geese and migratory geese. Resident Canada geese are present in Colorado throughout the year and nest and breed in Colorado. For additional information on this topic refer to EA section *3.3.1 Alternative 1: Continuing the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action)* Specifically, Canada geese sections. The USFWS provides WS-Colorado to take many species of birds that are protected under the MBTA that cause damage or pose a threat of damage to aviation safety, agriculture, natural resources, human health and safety, and property.

12. **Commenters claim that WS-Colorado proposed action violates MBTA and animal protection laws.**

    WS-Colorado disagrees with this comment. WS-Colorado is a non-regulatory agency. Take permits are issued for BDM to WS-Colorado by Federal regulatory agencies. For detailed information on this topic refer to EA *sections 1.15 What Are the State of Colorado's Authorities and Objectives for Managing Bird Damage? 1.16 How Does WS-Colorado Work with State,* *County, and local Governments? 1.17 How Does WS-Colorado Work with Federal Agencies? 1.6 What is the Precedence for WS Performing BDM in Colorado?*

13. Commenters questioned the rationale for including several different species in the EA.

WS-Colorado thoroughly explains the rationale for including each species in the EA in the following sections of the EA: *1.7 What are the Needs for the WS-Colorado Bird Damage Management Activities?, 2.13 Basic Bird Species Information., 3.1 The Analysis: How are Bird Estimates Determined?, 3.3 Environmental Consequences and Cumulative Impacts of Issues Analyzed In Detail for each Alternative.* *it should be noted that **Ch. 3** examines the bird species involved in BDM activities in Colorado. Species with a take of less than 10 on average over 5 fiscal years are not examined in detail. This holds true for lesser species involved in BDM such as orioles and hummingbirds. Both species have been involved in aircraft strikes.

14. A commenter claimed that Canada geese, specifically those that are found in Denver's parks, can effectively be managed using nonlethal methods only.

WS-Colorado disagrees with this comment. WS-Colorado recognizes that integrative, innovative, and acceptable management strategies are needed to effectively reduce human-wildlife conflicts. Usually, this involves implementing an integrated management strategy involving both lethal and nonlethal techniques. During the public comment period for this EA, the use of nonlethal methods **only** to deter Canada geese were suggested. This topic was discussed in "*Section 2.5.5 Only Live Trapping and Translocation Would Be Employee Rather Than Lethal Take*." However, WS-Colorado thoroughly explains the use of nonlethal methods only in the EA in the following sections of the EA: *3.3.2 Alternative 2: Nonlethal Methods Only> Sole Use of Hazing Techniques – Case Study.*

Overall, the authors state that the success of a Canada goose hazing program depends on the perspectives and roles of people in the community (Holevinski et al. 2007). They further state that landowners that want geese removed from their property may consider a hazing program successful if geese simply move onto a neighboring property. However, local officials who receive complaints on a town- or city-wide basis, would label a program unsuccessful if geese simply moved to similar locations within the community and continued to cause problems (Holevinski et al. 2007). While hazing geese to alternative sites may have short-term benefits, this does not control the increasing numbers of geese (Holevinski et al. 2007). The authors state that "some type of direct removal (e.g., hunting, summer roundups) is required for population management of resident goose flocks" (Holevinski et al. 2007).

For the last 15 years, Denver Parks and Wildlife have solely used nonlethal methods to address damage associated with Canada geese in Denver Parks. Denver parks and Wildlife, along with other state and federal agencies (e.g. CPW and USFWS), similarly have data on Canada goose management activities that have historically been conducted in Denver and throughout Colorado during this period. Additionally, it should be noted that WS Colorado makes the final decisions on what methods to be used based on the WS Decision Model and consultation with the landowner and manager. WS-Colorado's analysis would include nonlethal methods.

15. Commenters questioned the rationale for WS-Colorado choosing lethal methods over nonlethal management for Canada geese in Denver's Parks.

WS-Colorado makes the final decisions on what methods to use based on the WS Decision Model and consultation with the landowner and manager. WS-Colorado's analysis would include nonlethal methods. In many situations, such as the Denver Parks Canada goose project, using only nonlethal methods has proven to be ineffective. Therefore, lethal methods are used to effectively manage the BDM situation. WS-Colorado thoroughly explains the rationale for including each species in the EA in the following sections of the EA: *1.5 At What Point Do People or Entities Request Help With Managing Wildlife Damage?, 2.8.4 Community Based Decision Making., 2.9 Bird Damage Management Methods Available for Preventing, Reducing, and Alleviating Damage and Threats Associated with Birds in Colorado., 2.9.1 Nonlethal Methods That May Be Used., 1.1 Purpose and Need., 1.2 In Brief, What is this Environmental Assessment About?, 1.7 What are the Needs for the WS-Colorado Bird Damage Management Activities?, 2.4.1 Issue A: Impacts of Bird Damage Management Activities on Target Bird Populations., 2.5.5 Only Live Trapping and Translocation would be Employed Rather Than Lethal Take., 2.5.2 Short Term and Long-Term Population Suppression.,* and *3.3 Environmental Consequences and Cumulative Impacts of Issues.*

16. **Commenters quoted the draft EA as stating "According to the 2019 EA, the need for bird damage management, including lethal management actions, is justified due to "gradual urbanization" which "led to fundamental land use changes across Colorado, especially along the Front Range" leading to "increased human/wildlife interactions."**

    The statement quoted by the commenter has been misquoted or misunderstood. It reads in the document: "*As human populations encroach, fragment, and or destroy wildlife habitat, human-wildlife interactions will continue to increase in both frequency and magnitude (Soulsbury and White 2015). Not surprisingly, at a local and state level, as wildlife populations increase in abundance due to low numbers of natural predators, a lack of hunting, excellent breeding habitat conditions, habituation to human disturbance, abundant food resources, augmented survival rates of offspring, and longer life-spans than those normally seen in rural areas, Colorado residents will continue to request assistance in resolving human-wildlife conflicts (Adams and Lindsey 2010). Within Colorado, the population has increased from 1.32 million (1950) to 5.7 million (2019) with an average of 52 people per square mile (World Population Review 2019). This gradual urbanization, has led to fundamental land use changes across Colorado, especially along the Front Range,* ***and has the potential for*** *increased human/wildlife interactions; justifying the need for WDM*."

17. **Commenters raised concerns over the Environmental Protection Agency (EPA) Vasquez Boulevard and Interstate 70 site as a Superfund site and ramifications for Canada geese from those sites being processed for human consumption.**

    WS-Colorado added the EPA Superfund site map and description into *3.3.1 Alternative 1: Continuing the Current Integrated Approach to Managing Bird Damage (Proposed Action/No Action)> Issue C: Impacts of Bird Damage Management Methods on Public and Pet Safety and the Environment*. As discussed in **Chapter 2 -** *Protective Measures*, WS-Colorado would bury or incinerate Canada geese living in areas potentially polluted by mining operations, smelting, or where glycol ponding occurs. This would include within Superfund areas and any resident geese removed from water sources within 2 miles of a water feature (where geese reside) within the Superfund site.

18. **Commenters suggested additional nonlethal methods for managing Canada geese in Denver Parks. Other methods suggested included: Park Cleaning Machines, Clean Up Companies, Goosinator, Volunteer hazing programs, Dock or Residential Units, Habitat Management, and Modification.**

The use of Park Cleaning Machines, Clean Up Companies, Goosinator, Volunteer hazing programs, Dock or Residential Units are outside the scope of this EA. The EA lists methods that are used by WS-Colorado. WS-Colorado does not have the authority to make decisions for cooperators as to what methods they will or will not use. However, WS-Colorado does make the final decision on what methods to use based on the WS Decision Model and consultation with landowners and managers. WS-Colorado's analysis would include nonlethal methods. In many situations, such as the Denver Parks Canada goose project, using only nonlethal methods has proven to be ineffective in managing the BDM situation. See *response 13* above.

19. **Commenters asked for an extension of the public comment period on the EA by a minimum of 30 days.**

WS-Colorado evaluated the request to extend the comment period on the environmental assessment "Bird Damage Management in Colorado." Comment periods on environmental assessments are typically 30 days. WS-Colorado granted 39 days to accept comments from the public, with the comment period closing October 25, 2019. There was no unusual circumstance, such as an extended holiday season during the comment period that would affect the public's ability to comment. The proposed actions are narrow, confined to one state, and do not warrant an extended comment period in addition to the 39 days granted.

WS-Colorado continued to work with all parties interested in providing comments on the EA and provided guidance on how to submit public comments. WS-Colorado values the public's input by all parties, appreciated all comments submitted, and integrated substantive public comments.

APPENDIX A. SECTION 7 CONSULTATION

USDA

United States Department of Agriculture

Animal and Plant Health Inspection Service

Wildlife Services

Western Region

Colorado State Office

12345 W. Alameda Parkway, Suite 204
Lakewood, CO 80228

(303) 328-9041 Phone

(303) 328-9047 Fax

October 12, 2018

U.S. FISH AND WILDLIFE SERVICE

☐ NO CONCERNS
☒ CONCUR NOT LIKELY TO ADVERSELY AFFECT
☐ NO COMMENT

[signature] 12/18/18
WESTERN COLORADO SUPERVISOR (DATE)

Ann Timberman
U. S. Fish and Wildlife Service, Ecological Services
445 West Gunnison Ave, Suite 240
Grand Junction, CO 81501

Dear Ann:

The Wildlife Services Colorado program (WS-Colorado) of the United States Department of Agriculture, Animal and Plant Health Inspection Service requests an informal Section 7 Consultation for federal listed threatened and endangered species in Colorado for a bird damage management (BDM) program to protect aviation safety, property, threatened and endangered species, species of management concern, grain and other agricultural crops, and human safety. We are preparing an environmental assessment to examine issues, alternatives and environmental consequences of BDM to protect these resources. The WS-Colorado Program most recently completed a Section 7 consultation for predator damage management (PDM) in 2016 and the WS-Colorado programmatic in 2011. The enclosed analysis includes references to previous informal Section 7 consultations, portions of the environmental assessment to provide scope and effect, and an appendix with descriptions of methods that would be used during BDM.

WS-Colorado is a federal program within the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) national program with responsibility to manage wildlife damage to protect agriculture, human health and safety, natural resources and property. WS is the federal agency authorized by Congress to protect American resources from damage associated with wildlife. This authority is provided by The Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 8351), commonly referred to as the Animal Damage Control Act. This responsibility is conducted under the Act of March 2, 1931, as amended in 1987 (Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 8353). The program manages damage by providing technical assistance, operational management, educational programs, and liaison with state and federal regulatory agencies for permits, technical information, and seminars and workshops. Activities conducted by WS-Colorado are closely aligned with management goals of the Colorado Department of Agriculture (CDA), Colorado Parks and Wildlife (CPW), and the U. S. Fish and Wildlife Service (USFWS).

WS-Colorado has been conducting BDM activities in Colorado since 1964 when BDM was requested at cattle feedlots in eastern Colorado, urban bird roosts in Denver, Grand Junction and other cities in 1965, and blackbird damage to corn in 1966. These wildlife damage management activities continue to change and evolve to reflect societal values and minimize impacts to people, wildlife and the environment. Moreover, the science of wildlife management continuously progresses as new information becomes available in scientific publications. We continuously review and incorporate this new information into program activities and research conducted by the National Wildlife Research Center, the research branch of Wildlife Services. BDM is very complex, often brings strong emotional response from the public and can take years to produce observable effects. In many urban and suburban environments, Bird Damage Management (BDM) is considered a contentious issue among public stakeholders. While one group may advocate for the use of alternative management methodologies, such methods may be less effective, harmful to the environment, or harmful to shared natural resources. Additionally, some of these conflicts among user groups may be harmful to some threatened or endangered species within the state.

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