

Chapter 4: Threats and Conservation

Actions Overview

This chapter presents updated information on the problems affecting Colorado's Species of Greatest Conservation Need (SGCN) and their habitats, as well as conservation actions needed to address problems and improve species' status. Current information on problems that may adversely affect SGCN or their habitats (i.e., "threats") was compiled from a number of different sources, including the 2006 SWAP, agency and partner biologists, and a variety of existing conservation assessments, conservation and management plans, CPW and CNHP databases, and published literature. There are myriad existing resources that present in-depth discussions of threats and/or needed conservation actions for many of the SGCN and their habitats. The purpose of the SWAP is not to re-create these resources. Rather, in this document we will summarize the most crucial aspects of biodiversity conservation in Colorado over the next 10 years. A list of additional resources, including management, conservation, and recovery plans, is presented in Appendix D.

This threat assessment was undertaken strictly from the perspective of wildlife conservation. Some of the identified practices are also necessary and highly valued public services and land uses – for instance, water development, residential development, recreation, mining, and agriculture. These activities provide important values and are legitimate, often vital public pursuits, from which all of society benefits. Nonetheless, aspects of some of these activities are sometimes harmful to wildlife and their habitats, which are also legitimate public values and resources; therefore, these actions pose challenges from the viewpoint of wildlife conservation. These challenges need to be identified in order to determine which are most harmful, and importantly, where opportunities for investments in remedial or preventive actions would be most effective and efficient.

Updated Lexicon for Describing Threats & Actions

As noted in the 2006 SWAP, many sources use different language to describe essentially the same threats and conservation actions. In order to maintain consistency of threats/actions descriptions across species and habitats, "taxonomies" of threats and actions were created for the 2006 SWAP, based on work by The Nature Conservancy. In the interim, a standardized lexicon has been developed by the Conservation Measures Partnership⁷ (Salafsky et al. 2008), and is

⁷ The Conservation Measures Partnership (CMP) is a joint venture of conservation organizations and collaborators that are committed to improving the practice of conservation. Each organization within CMP has biodiversity conservation as its primary goal, has a focus on field-

recommended in the 2012 Best Practices for State Wildlife Action Plans guidance (AFWA 2012). For the 2015 SWAP, we have adopted the Salafsky lexicon's classification of general threats and conservation actions (Tables 5 & 6, respectively). The database that was developed to house information on SGCN and habitats for the 2006 SWAP has been updated to reflect the new lexicon. Use of the Salafsky lexicon will position the CPW to migrate SGCN information and conservation work planning to the Miradi program, a tool also developed by the Conservation Measures Partnership, in the future if it is determined that we can improve our conservation outcomes by doing so.

The Salafsky lexicon uses a three-level categorization scheme, with each level increasingly specific (Tables 5 & 6). As explained in Salafsky et al. (2008),

*“An ideal classification for both threats and actions would be **simple** (uses clear language and examples and is understandable by all practitioners); **hierarchical** (creates a logical way of grouping items that are related to one another to facilitate use of the classification and meaningful analyses at different levels); **comprehensive** (contains all possible items, at least at higher levels of the hierarchy; consistent (ensures that entries at a given level of the classification are of the same type); **expandable** (enables new items to be added to the classification if they are discovered); **exclusive** (allows any given item to only be placed in one cell within the hierarchy); and **scalable** (permits the same terms to be used at all geographic scales)...The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. The third level, by contrast, is at a much finer scale and thus only contains some illustrative examples rather than comprehensive listings of threats and actions at this level.”*

An example of the three-level classification is:

Level 1 – Human Intrusions and Disturbance

Level 2 – Recreational Activities

Level 3 – hiking

Using this lexicon will allow for large-scale analyses (e.g., allowing federal agencies and national non-governmental organizations to assess threats across states), but it must also provide enough specificity to direct meaningful conservation action in Colorado. Thus, we have modified it to include additional Level 1 and Level 2 categories that were deemed necessary to adequately describe the situation in Colorado, and added more detailed entries in Level 3.

As with any classification method, there are various ways to categorize and “lump or split,” and all options ultimately force some degree of simplification onto very complex and inter-related issues. The Salafsky lexicon is no exception, and readers may experience a degree of discomfort with some applications of this method. We remind those readers that the SWAP is a statewide, strategic document that is intended to highlight the most significant conservation issues across

based conservation actions, and is working to develop better approaches to project design, management, and assessment. For additional information, visit <http://www.conservationmeasures.org/>.

our state. As such, it is a first step in conservation planning that is appropriately supported by a series of more in-depth species and habitat conservation plans. Existing and needed species/habitat plans are addressed in the tables and narratives that follow.

Table 5. Lexicon of threats according to Salafsky et al. 2008.

Threats marked with an asterisk (*) are not included in Salafsky et al. (2008), but we have determined that they are needed to fully express threats to SGCN in Colorado.

Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
1 Residential & Commercial Development Threats from human settlements or other non-agricultural land uses with a substantial footprint	1.1 Housing & Urban Areas Human cities, towns, and settlements including non-housing development typically integrated with housing (e.g., shopping areas, offices, schools, hospitals)	<ul style="list-style-type: none"> • Housing, urban, and ex-urban development • Hobby livestock – domestic sheep and goats associated with exurban development
	1.2 Commercial & Industrial Areas Factories and other commercial centers (e.g., manufacturing plants, military bases, power plants, train yards, airports)	
	1.3 Tourism & Recreation Areas Tourism and recreation sites with a substantial footprint (e.g., ski areas, golf courses, county parks, campgrounds)	<ul style="list-style-type: none"> • Recreation area developments
2 Incompatible Agriculture⁸ Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture and aquaculture	2.1 Annual & Perennial Non-Timber Crops Crops planted for food, fodder, fiber, fuel, or other uses (e.g., farms, plantations, orchards, vineyards, mixed agroforestry systems)	<ul style="list-style-type: none"> • Conversion to cropland • Early/often pasture and hayfield cutting (nest destruction) • Intensive agricultural operations • Loss of compatible CRP lands • Poor quality CRP lands
	2.2 Wood & Pulp Plantations Stands of trees planted for timber or fiber outside of natural forests, often with non-native species (e.g., silviculture, Christmas tree farms)	

⁸ In Salafsky et al. (2008), this threat is “Agriculture and Aquaculture.” For the purposes of this SWAP, we have changed this threat to “Incompatible Agriculture,” in recognition of the role that some agricultural lands play in providing wildlife habitat.

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Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
	<p>2.3 Livestock Farming & Ranching Domestic terrestrial animals raised in one location on farmed or non-local resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching) (e.g., cattle feed lots, dairy farms, cattle ranching, chicken farms)</p>	<ul style="list-style-type: none"> • Altered native vegetation • Decreased water quality (nutrient load from cattle) • Degradation of alpine habitats from sheep grazing & disturbance by guard dogs • Incompatible timing, intensity, duration of grazing • Range improvement operations • Reduced grass and forb diversity • Transmission of pathogens
	<p>2.4 Marine & Freshwater Aquaculture Aquatic animals raised in one location on farmed or non-local resources; also hatchery fish allowed to roam in the wild</p>	
<p>3 Energy Production & Mining Threats from production of non-biological resources</p>	<p>3.1 Oil & Gas Drilling Exploring for, developing, and producing petroleum and other liquid hydrocarbons (e.g., oil wells, natural gas drilling)</p>	<ul style="list-style-type: none"> • Altered native vegetation • Behavioral avoidance of oil/gas development & associated infrastructure • Fragmentation of native habitat due to oil/gas development & associated infrastructure
	<p>3.2 Mining & Quarrying Exploring for, developing, and producing minerals and rocks (e.g., coal mines, alluvial gold panning, gold mines, rock quarries)</p>	<ul style="list-style-type: none"> • Mining operations • Rock mining in nesting & winter habitat • Uranium mining
	<p>3.3 Renewable Energy Exploring, developing, and producing renewable energy (e.g., geothermal power production, solar farms, wind farms, birds flying into windmills)</p>	<ul style="list-style-type: none"> • Collision with wind turbines • Behavioral avoidance of renewable energy development & associated infrastructure • Fragmentation of native habitat due to renewable energy development & associated infrastructure
<p>4 Transportation & Service Corridors Threats from long narrow transport corridors and the vehicles that use them, including associated wildlife mortality</p>	<p>4.1 Roads & Railroads Surface transport on roadways and dedicated tracks (e.g., highways, secondary roads, logging roads, bridges and causeways, road kill, fencing associated with roads)</p>	<ul style="list-style-type: none"> • Collision (e.g., auto) • Fragmentation
	<p>4.2 Utility & Service Lines Transport of energy & resources (e.g., electrical and phone wires, oil and gas pipelines, electrocution of wildlife)</p>	<ul style="list-style-type: none"> • Collision (e.g., powerlines)

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Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
	4.3 Shipping Lanes (<i>not applicable to Colorado</i>)	
	4.4 Flight Paths (e.g., impacting birds)	<ul style="list-style-type: none"> • Low-flying military jets & helicopters
5 Biological Resource Use Threats from consumptive use of “wild” biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species	5.1 Control of Nuisance Species or Collecting⁹ Killing or trapping wild animals for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons	<ul style="list-style-type: none"> • Extermination / evictions in urban settings • Loss of habitat due to prairie dog control • Mortality and prey reduction through rodent control • Poisoning (indirect effect of prairie dog control)
	5.2 Gathering Terrestrial Plants Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons	
	5.3 Logging & Wood Harvesting Harvesting trees and other woody vegetation for timber, fiber, or fuel (e.g., clear cutting of hardwoods, pulp operations, fuel wood collection)	<ul style="list-style-type: none"> • Clearcutting • Even-age timber management • Removal of cavity trees • Fragmentation • Replacement of mature/old growth with younger, more even-aged stands
	5.4 Fishing & Harvesting Aquatic Resources Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution	
6 Human Intrusions & Disturbance Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources	6.1 Recreational Activities People spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons (e.g., off-road vehicles, snowmobiles, mountain bikes, hikers, skiers, birdwatchers, pets in rec areas, temporary campsites, caving, rock-climbing)	<ul style="list-style-type: none"> • Campsites and hiking • ORV trail development and use • Motorized and non-motorized recreation • Recreational caving • Rock climbing, hiking near cliffs & crevices • Trails in drainages near nests • Unregulated backcountry winter recreation

⁹ In Salafsky et al. (2008), this threat is “Hunting and Collecting Terrestrial Animals.” Salafsky’s terminology is intended to address conservation needs at a global scale, including places where hunting is not managed. For the purposes of Colorado’s SWAP, the reference to hunting in this context was deemed to be misleading and inappropriate. Thus, we have re-named this threat category.

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Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
	<p>6.2 War, Civil Unrest & Military Exercises Actions by military forces without a permanent footprint (e.g., tanks and other military vehicles, training exercises and ranges, defoliation, munitions testing)</p>	
	<p>6.3 Work & Other Activities People spending time in or traveling in natural environments for reasons other than recreation, military activities, or research (e.g., law enforcement, drug smugglers, illegal immigrants, vandalism)</p>	<ul style="list-style-type: none"> • Proximal non-recreation disturbance
<p>7 Natural System Modifications Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare</p>	<p>7.1 Fire & Fire Suppression Suppression or increase in fire frequency and/or intensity outside of its natural range of variation (e.g., fire suppression to protect homes, inappropriate fire management, escaped agricultural fires, arson, campfires)</p>	<ul style="list-style-type: none"> • Altered fire regime • Fire suppression leading to high intensity fires • Altered fire regime and juniper encroachment • Wildfires exacerbated by climate change
	<p>7.2 Dams & Water Management/Use Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities (e.g., dam construction, dam operations, sediment control, change in salt regime, wetland filling, levees and dikes, surface water diversion, groundwater pumping, channelization, artificial lakes)</p>	<ul style="list-style-type: none"> • Altered hydrological regime – dewatering • Altered hydrological regime – siltation and sedimentation • Altered hydrological regime – wetland drainage • Altered hydrological regime – altered flow and fluctuating water temperatures • Decreased water quality and/or quantity • Natural system modification (hydrological) - dam, diversion, or drop structure construction or modification • Natural system modification (hydrological) – groundwater pumping and surface water diversions • River flow management and riverbank protection • Scouring floods • Water storage • Fragmentation due to diversion structures without fish passage

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	<p>7.3 Other Ecosystem Modifications Other actions that convert or degrade habitat in service of “managing” natural systems to improve human welfare (e.g., land reclamation projects, abandonment of managed lands, rip-rap along shorelines, mowing grass, tree thinning in parks, beach construction, removal of snags from streams)</p>	<ul style="list-style-type: none"> • Altered animal community (change in predator/prey balance) • Altered animal community (loss of beaver) • Altered native vegetation (cottonwood/willow degradation) • Altered native vegetation (loss of older aspen stands) • Altered native vegetation (loss of shoreline nesting, roosting, and perching habitat) • Altered native vegetation (riparian area deforestation, denuding of wetland vegetation) • Altered native vegetation (seral stage imbalance) • Altered native vegetation (streambank cover reduction) • Cave/mine closures and grating • Fragmentation • Natural system modification - wetland filling, eutrophication, siltation
<p>8 Invasive & Other Problematic Species & Genes Threats from non-native and native plants, animals, pathogens /microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance</p>	<p>8.1 Invasive Non-Native/Alien Species Harmful plants, animals, and microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities (e.g., feral cattle, household pets, zebra mussels)</p>	<ul style="list-style-type: none"> • Invasive animals - bullfrogs • Invasive animals - European starlings • Invasive animals - white sucker • Invasive animals – aquatic predators (e.g., smallmouth bass, northern pike, walleye, burbot) • Invasive plants – tamarisk • Invasive plants – cheatgrass
	<p>8.2 Problematic Native Species Harmful plants, animals, or microbes that are originally found within the ecosystem(s) in question, but have become "out-of-balance" or "released" directly or indirectly due to human activities (e.g., overabundant native deer)</p>	<ul style="list-style-type: none"> • Habitat loss / degradation due to beetle kill • Habitat loss due to insect damage and fire • Predation and parasites
	<p>8.3 Introduced Genetic Material Human altered or transported organisms or genes (e.g., pesticide resistant crops, using nonlocal seed stock, genetically modified insects for biocontrol)</p>	<ul style="list-style-type: none"> • Invasive animals - hybridization

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	8.4 Pathogens¹⁰	<ul style="list-style-type: none"> • Loss of prairie dog colonies due to sylvatic plague • Pathogen - canine distemper • Pathogen - chytrid fungus • Pathogen - respiratory disease caused by <i>Pasteurellacea</i> and <i>Mycoplasma</i> bacteria • Pathogen - sylvatic plague • Potential for white-nose syndrome to be introduced
9 Pollution Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources	9.1 Household Sewage & Urban Waste Water Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments (e.g., discharge from municipal waste treatment plants, leaking septic systems, fertilizers and pesticides from lawns and golf-courses)	<ul style="list-style-type: none"> • Water pollution
	9.2 Industrial & Military Effluents Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments	<ul style="list-style-type: none"> • Waste or residual materials (excess sediment loads) • Waste or residual materials (mine tailings, excess sediment loads, etc.)
	9.3 Agricultural & Forestry Effluents Water-borne pollutants from agricultural, silvicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments (e.g., nutrient loading from fertilizer runoff, herbicide runoff, manure from feedlots, soil erosion)	<ul style="list-style-type: none"> • Herbicide/pesticide spraying or runoff (grasshopper control) • Herbicide/pesticide spraying or runoff and nonpoint source pollution • Nutrient loads • Pesticide spraying (prey reduction) • Poisoning (fire ant insecticides) • Reduced water quality due to herbicide/pesticide runoff
	9.4 Garbage & Solid Waste Rubbish and other solid materials including those that entangle wildlife	

¹⁰ In Salafsky et al. (2008), pathogens are not split out as a separate threat. However, there are several pathogens causing significant impacts to SGCN, and we found it useful to create an additional category for this threat.

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Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
	9.5 Air-Borne Pollutants Atmospheric pollutants from point and nonpoint sources (e.g., acid rain, smog from vehicle emissions, excess nitrogen deposition)	<ul style="list-style-type: none"> Air pollution (precipitating/concentrating on high elevation snow fields)
	9.6 Excess Energy Inputs of heat, sound, or light that disturb wildlife or ecosystems (e.g., noise from highways or airplanes, heated water from power plants, lamps attracting insects)	
10 Geological Events Threats from catastrophic geological events	10.1 Volcanoes (<i>not applicable to Colorado</i>)	
	10.2 Earthquakes/Tsunamis (<i>not likely to be applicable to Colorado</i>)	
	10.3 Avalanches/Landslides Avalanches or landslides	
11 Climate Change & Severe Weather Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation	11.1 Habitat Shifting & Alteration Major changes in habitat composition and location (e.g., desertification, tundra thawing)	<ul style="list-style-type: none"> Climate variability (intensification or alteration of normal weather patterns, e.g., droughts, tornados) Habitat shifting and alteration due to climate change
	11.2 Droughts Periods in which rainfall falls below the normal range of variation (e.g., severe lack of rain, loss of surface water sources)	<ul style="list-style-type: none"> Lack of water due to drought and exacerbated by climate change
	11.3 Temperature Extremes Periods in which temperatures exceed or go below the normal range of variation (e.g., heat waves, cold spells, disappearance of glaciers)	
	11.4 Storms & Flooding Extreme precipitation and/or wind events (e.g., thunderstorms, tornados, hailstorms, ice storms or blizzards, dust storms)	<ul style="list-style-type: none"> Climate variability (e.g., prolonged rain or hail events)
12 Organizational Capacity and Management* Inability to implement effective conservation measures due to lack of goal/policy alignment across agencies and stakeholders, lack of dedicated funding sources, institutional barriers to coordination	12.1 Lack of Coordination	

Level 1	Level 2 (general threats in Tables 7 & 8)	Level 3 – illustrative examples (specific threats in Tables 7 & 8)
	12.2 Lack of Funding	
	12.3 Lack of Common Goals	
	12.4 Confused or Gaps in Authorities	
	12.5 Legislation/Policy Changes	
13 Lack of Knowledge* Inability to determine priorities for what/when/where conservation action is needed due to poor understanding of species needs	13.1 Complete Distribution in Colorado Unknown	
	13.2 Critical Life History/Habitat Components Unknown	
	13.3 Genetic Relationship with Other Subspecies Unknown	
	13.4 Population Status Unknown	
	13.5 Population Trend Unknown	
	13.6 Response to Change, Disturbance, & Other Threats Poorly Understood	
14 Natural Factors* Life history traits that contribute to species' vulnerability and warrant management attention or influence effectiveness of potential conservation approaches	14.1 Scarcity (leading to inbreeding depression)	
	14.2 Low Annual Recruitment	
	14.3 Low Reproductive Rate	
	14.4 Nest Predation	
	14.5 Competition	
	14.6 Loss of Species from Suitable Habitat	

Overview of Threats to Biodiversity in Colorado

This section provides a very brief overview of the major threats to biodiversity in Colorado. We highlight here the primary issues related to the threats that affect many SGCN and/or are widely distributed across the state. These narratives are far from exhaustive, and are intended only as a simple synopsis to help readers understand the primary ways in which various threats interact with and on species and/or their habitats. As previously noted, many of these issues are closely related to each other, and interact in complex ways. A single threat likely has multiple adverse impacts, and each adverse impact may be coming from multiple threats. Teasing apart the cumulative effects of multiple threats for each SGCN is a dizzying task that exceeds the scope of this SWAP. Our goal here is to illuminate the most crucial conservation and research needs, and to support on-going conservation planning at more localized landscape, species and habitat-

specific scales. We have focused attention on threats that are currently known to be affecting SGCN and their habitats within Colorado, or that are considered likely to impact these resources in the foreseeable future. Many species cross state and international boundaries, especially birds. Conservation activities in other parts of these species' ranges are important, but are beyond the scope of Colorado's SWAP. Past activities that have ceased or are no longer threatening SGCN at the population level, and thus are not likely to drive conservation decisions over the next 10 years, are not considered major threats in this SWAP.

Throughout this document, threats are discussed in the order presented in the Salafsky lexicon. In the following section, threats that are not applicable in Colorado have been omitted.

1 Residential & Commercial Development

The most obvious impact of residential and commercial development is complete destruction of native habitat, as woodlands, grasslands, etc. are replaced by buildings and pavement. Other impacts include alteration of the local hydrology. One very significant impact is the damming and diversion of natural waterways to provide increased water availability for larger human populations (see following section on hydrological modification for more on this). Hard surfaces such as pavement prevent infiltration of storm water, which increases the quantity of runoff into surface creeks and streams, and decreases the augmentation of groundwater and moisture availability for plants' root zones. This runoff may be tainted by fertilizers, pesticides, motor oil, pharmaceuticals, and myriad other pollutants. Areas of residential and commercial development also change species dynamics, such as predator/prey relationships and competition among species for food/shelter resources. Examples include introduction of domestic predators (such as house cats and dogs) and increasing numbers of urban-adapted meso-predators (such as raccoons and foxes), as well as proliferation of weeds that out-compete native plant species (thus changing the food and cover resources available for wildlife). Furthermore, species that some consider pests, such as bats, prairie dogs, and predators, may be intentionally exterminated. Residential and commercial development and accompanying roads, utility corridors, and other infrastructure fragment native habitats. This can result in wildlife being confined to patches of habitat that are too small to sustain populations, and too far apart for individuals to move between. Ripple effects of growing urbanization also include increased recreational pressure on surrounding natural areas.

2 Incompatible Agriculture

2.1 Cropland

Like residential and commercial development, conversion to cropland replaces native habitats with row crops, hay fields, and so on. Agricultural fields still provide habitat components, such as food and cover, for some wildlife species. This is especially true for crop fields that are retired into the Conservation Reserve Program and seeded with seed mixes appropriate to the local native wildlife. However, activities associated with agricultural production, such as plowing, tilling, and mowing, can be fatal to species that inhabit agricultural fields. Use of herbicides, pesticides, and insecticides may kill native species outright, or have indirect impacts such as reduction in food resources (insects, seeds, etc.) that lower wildlife species' health, reproductive success, and/or ability to survive migration or winter. Perhaps most important of all, much of the water management that adversely affects many species and habitats is driven by the need for irrigation to sustain crop agriculture. Over 80% of the water delivered in Colorado goes to agricultural uses (<http://www.coloradowater.org>). Some of the same concerns for residential and commercial development relative to water quality and quantity also apply to cropland.

2.3 Livestock Farming & Ranching

Livestock farming and ranching can have positive or negative influences on habitats, depending on how it is conducted and the specific habitat in question. In extensive grasslands, such as those on Colorado's eastern plains, the ecological system has historically been maintained by grazing and browsing animals (such as bison, pronghorn, and prairie dogs), and the plant species that are typical of grasslands have evolved to withstand these pressures. Likewise, the wildlife species that live in grasslands have evolved to inhabit a variety of habitat niches created by native grazers, which historically included a mosaic of bare ground, very short grass, mid-height grass, and shrub patches. In the absence of free-ranging bison, livestock ranching is now the primary tool available to maintain the health of grassland systems. However, ranching practices often reduce the heterogeneity of this landscape matrix, such that many grasslands are now characterized by fences, homogenous structure, and reduced native species. These conditions are less suitable for many grassland species. Other ways that livestock ranching may reduce habitat suitability for wildlife include seeding of non-native pasture grasses; reduction or loss of palatable native grass and forb species; an increased percentage of unpalatable grass and forb species; and potential for degraded riparian zones (soil compaction, increased runoff leading to gullying, downcutting, lowered water table, and loss of riparian vegetation). Predator and prairie dog control is also a common component of grazing management.

Other habitats that have not evolved with grazing as a primary disturbance are more likely to experience changes in plant structure, species composition, increased soil disturbance and erosion, and/or spread of invasive weeds. For example, livestock grazing in pinyon-juniper has greatly reduced the presence and functioning of biological soil crusts, and increased the

incidence of weeds, especially cheatgrass. Proliferation of cheatgrass changes the characteristics of wildfire, with a number of consequences, including altering the density of vegetation and the ability of native plant species to regenerate. Domestic sheep grazing in the alpine can alter species composition of tundra communities.

Although some agricultural activities pose an ongoing threat to wildlife, it should be noted that ranching and farming are also critical to maintaining numerous wildlife populations.

Agricultural practices preserve open space and provide sources of concentrated food and cover that would not otherwise exist. Examples include wild ungulate use of croplands and irrigation practices that create wetlands and reservoirs. Without these contributions, it is highly doubtful that Colorado could support current populations of deer, elk, waterfowl and shorebirds or the present number of recreational fishing opportunities that now exist.

3 Energy Production & Mining

3.1 Oil & Gas Drilling

Oil and gas development involves a complex series of exploration and production activities, and includes associated infrastructure such as well pads, pipelines, and roads. The footprint of oil and gas development is dependent upon how densely pads are sited (for example, one pad per 640-acre section versus one pad per five acres or multiple pads per acre). Impacts to terrestrial wildlife include habitat conversion and behavioral avoidance of areas where humans and infrastructure are present. In addition, there may be negative impacts associated with the increased noise associated with drilling and operating wells or transfer stations. Aquatic wildlife are affected as well. A significant amount of water is used in drilling, followed by disposal of contaminated water post-drilling. Water polluted with toxic chemicals can have significant effects on a variety of species, including fish and aquatic insects, amphibians, wading birds, and riparian vegetation, among others. For those species where oil and gas is listed as a threat, the use of BMPs is likely appropriate at a site-specific scale. However, to fully mitigate these impacts, the planning, implementation, and mitigation of oil and gas activities need to be carried out at much larger scales, as appropriate to the landscape that these various species inhabit.

3.2 Mining & Quarrying

Mining and quarrying destroy habitat, and have a variety of indirect effects on wildlife. Mining can contaminate streams via leaching of newly exposed rock and chemicals associated with the mining process itself. Past mining of silver, gold, and uranium continue to negatively impact water quality of large rivers and streams. For example, the Upper Arkansas and Las Animas Rivers have elevated levels of heavy metals, which have resulted in an overall decrease in aquatic fauna, including reduced fish productivity and loss of some aquatic insect species. Sand and gravel mining operations are typically near rivers and streams, where they impact hydrologic

flow and patterns, with resultant loss or degradation of riparian vegetation, including the cottonwood galleries and understory shrubs and herbaceous plants that provide cover and food resources for wildlife. Mining for resources such as coal and molybdenum can reduce both air and water quality.

3.3 Renewable Energy

Wind, solar, geothermal, and biofuels energy production continue to grow throughout the state. While these renewable sources of energy are important to pursue for a variety of reasons, they also come with potential for adverse impacts to wildlife. Most of the wind energy development is occurring in the eastern prairie region, with consequent impacts (at least localized) on some species, especially birds and bats. Impacts include behavioral avoidance and collision with turbines. Like traditional means of energy production, all forms of renewable energy production increase habitat fragmentation with associated roads and transmission lines. Many of the same issues associated with crop agriculture also apply to biofuel production.

4 Transportation & Service Corridors

4.1 Roads & Railroads

The most significant impact of roads at a landscape scale is fragmentation of habitat. At its most basic, fragmentation refers to the change from large, contiguous areas of suitable habitat to smaller units of suitable habitat, interspersed with areas of, essentially, non-habitat (road surfaces, urban areas, and so on), as well as an overall decrease in the total amount of habitat available. The size of habitat patches, number of patches, and distance between patches that constitute fragmentation is variable, depending on the species. Fragmented habitat is also qualitatively different from non-fragmented habitat, in terms of which species are present, amount of light and moisture, relative temperature, and a host of other factors that influence whether or not a given species can continue to thrive in that place. Fragmentation from roads can be variable, depending not only on the species, but also on the size of the road, speed of traffic, and volume of traffic.

Other impacts of roads are alteration of local hydrology (quantity and flow patterns of runoff), altered rates of erosion and sedimentation in nearby waterbodies, and pollution from motor oil, gasoline, de-icing agents, and other chemicals. A related threat from roads and railroads is the potential for catastrophic spills of toxic materials. Infrastructure related to road crossings (bridges, culverts) can create barriers to fish movement. Construction and use of roads are significant vectors for weeds, and right-of-way maintenance (mowing, application of herbicides) can adversely impact native species, as well as their food and cover resources. Lastly, of course, roads can be a significant source of mortality for animals that cross roads (especially slow animals such as turtles and amphibians) or bask on roads (such as snakes and lizards). Roads can

also be a significant local source of mortality for highly mobile species such as elk, mule deer, and many smaller animal species.

4.2 Transmission & Service Lines

Impacts from transmission lines include electrocution of birds and bats, disturbance from right-of-way maintenance, introduction of vertical structure within habitats that provide perches for raptors, and introduction and spread of noxious weeds. Transmission lines can also contribute to habitat fragmentation, depending upon their density, siting, and design.

5 Biological Resource Use

5.1 Control of Nuisance Species & Collecting

Intentional control or persecution of native species that are considered pests by some people is a threat for several SGCN. Chief among these are the three species of prairie dog (black-tailed, white-tailed, and Gunnison's), as well as bats that use human dwellings and other buildings. Prairie dogs are removed for a variety of reasons, including to make way for residential and commercial development, and to improve forage availability for domestic cattle. However, prairie dogs are crucial components of ecosystems that support a myriad of other species, some of whom can not persist without the dens and prey base that prairie dogs provide. Several of the SGCN identified in this document are of conservation concern, at least in part, due to the dramatic reduction in prairie dogs.

5.3 Logging & Wood Harvesting

Like grazing, the harvesting of timber can be used as a tool for enhancing habitats, or it can pose threats to native wildlife species, depending on where, when, and how it is conducted. Use of appropriate silvicultural practices in appropriate forest types is not considered a threat to the forest type or wildlife species that occur in that forest type. Appropriate silvicultural prescriptions would be those that mimic natural disturbances in both size and scale across a given area. Wildlife species that evolved in these forested environments are resilient to disturbances that are caused by natural processes. Logging could be considered a threat when it does not mimic natural ecological disturbances in size and prescription.

6 Human Intrusions & Disturbance

6.1 Recreational Activities

Colorado residents and visitors are fortunate in the vast array of recreation opportunities our state has to offer. However, when not managed appropriately, recreationists can have significant impacts on native wildlife. Access roads fragment habitat, construction and use of trails introduce weeds, and the presence of humans and their pets can disturb wildlife, potentially

leading to abandonment of nest sites, feeding or wintering areas, and other important habitats. Hiking and climbing too close to cliff faces and edges disturbs nesting raptors, and caving can cause abandonment of bat maternity roosts and winter hibernacula. Off-road vehicles can damage stream crossings, wetlands, and vegetation; lead to increased erosion and sedimentation; spread noxious weeds; and facilitate poaching. In addition, noise, unpredictable human presence, and disturbance from motorized recreation can lead to wildlife avoiding or abandoning habitat. Any disturbance during winter (skiing, snowmobiling) that causes wildlife to flee could result in an expenditure of energy reserves needed to survive winter.

7 Natural Systems Modifications

7.1 Fire & Fire Suppression

Many of Colorado's forests and shrublands have evolved with periodic wildfires. In these ecosystems, fire maintains a heterogenous landscape (and thus a variety of habitat types) by controlling the density of trees and shrubs, creating forest openings, regenerating decadent stands, and supporting reproduction (for example, in species that require fire to germinate seeds). Historic fire regimes are out of balance across much of the American West, due primarily to a century of fire suppression. When natural wildfires are routinely put out, trees become denser and understory fuels (leaf litter, needle duff, downed woody debris, etc.) accumulate. In addition, other natural processes such as insect and disease disturbances may become unbalanced. The ultimate result of these cumulative effects is wildfire that burns hotter and faster, and is more likely to spread into the tree canopy. Wildfires that occur too frequently or burn too intensely can have catastrophic impacts on soil and water resources. Extremely high temperatures can sterilize soil, eliminating its ability to support plant regrowth. Excessive erosion can result in significant reduction in water quality, as well as restructuring of river and stream channels, which alters the types, quality, and amount of suitable habitat for aquatic species. Future threats from wildfire are expected to be exacerbated by climate change.

7.2 Dams & Water Management/Use

Dams and the management and use of water have a multitude of complex effects on wildlife and their habitats. Dams themselves replace habitat outright. The operation of dams directly affects the timing, volume, and temperature of flows, and indirectly affects many closely related habitat characteristics, including transfer of sediments, oxygen levels, support of riparian vegetation, and a host of others. The use of water involves diversions (piping water from one basin to another, irrigation canals, and so on), channelization of rivers and streams, groundwater pumping, and other means of removing water from rivers. Some of the results include, but are not limited to, flattening of the hydrograph, alteration of the quantity, duration, timing, and intensity of high or low flow events (floods, droughts), patterns of erosion & sedimentation that are incompatible with wildlife needs, and barriers to fish movement. Many riparian and wetland plants, the basis

of crucial habitat for many species of wildlife, require specific conditions to germinate, grow, and reproduce. The amount of water in surface and groundwater systems is directly related to whether or not these species can survive. Likewise, the amount of water, temperature of the water, chemical composition and clarity of water determine whether or not fish can successfully spawn, obtain sufficient food, elude predators, survive winter, and so on. Seasonal timing of when specific conditions occur (high flows, low flows, scouring floods, etc.) is also very important for aquatic and riparian species. All these habitat characteristics are either supported or degraded by the ways in which water is managed and used.

7.3 Other Ecosystem Modifications

For the purposes of this SWAP, we have used the term “other ecosystem modification” as a catch-all category when causes of stress are so multi-faceted that teasing out major contributors is uncertain, or when stresses are apparent but causes are unknown.

8 Invasives, Problematic Native Species, & Pathogens

8.1 Invasive Non-Native Species

Invasive non-native species are plants or animals that have been introduced into local ecosystems, usually as a result of human activity. Non-native species that become established are often able to out-compete native species for required resources, prey on native species, and/or hybridize with native species. This can lead to reduced abundance, altered distribution, or constricted range of native species. Other impacts could include altered food webs, reduction of reproductive success, health/vigor, and/or overwinter survival, or total elimination of native species from the area. Examples of non-native plants with significant impacts on native wildlife and their habitats include tamarisk, leafy spurge, and cheatgrass, among a host of others. Non-native animals include a variety of introduced sport fish, bullfrogs, zebra mussels, red-eared sliders, and Eurasian collared doves, among others.

8.2 Problematic Native Species

Problematic native species are those that naturally occur in an ecosystem, but have become out of balance. In the absence of native predators, elk have proliferated in some places to the point that they are degrading willow carrs and aspen stands. Species such as coyotes, raccoons, crows and ravens can also become out of balance when there are artificial food sources or a lack of top level predators that would naturally suppress populations. Insects such as mountain pine and spruce beetles are native to Colorado. These insects are a natural disturbance process that helps maintain forest ecosystems. However, a variety of factors, including increased temperature, drought, and – in some cases – fire suppression, have contributed to very severe insect outbreaks and significant tree mortality across the state. The effects of climate change can increase these threats.

8.4 Pathogens

A number of pathogens are having significant impacts on SGCN in Colorado. Sylvatic plague can greatly reduce prairie dog abundance, affecting not only the prairie dogs themselves, but also the myriad of species that use or rely on prairie dogs. Plague and canine distemper are significant problems for recovery of black-footed ferrets, a federally-listed endangered species. Chytrid fungus has been implicated in extreme declines in boreal toads, and may be related to declines in northern leopard frogs as well. Bighorn sheep are being impacted by respiratory disease caused by *Pasteurellacea* and *Mycoplasma* bacteria. Whirling disease has contributed to the collapse of wild trout populations in the western U.S. and is considered a threat to Colorado's native cutthroat trout. White-nose syndrome, a fungal disease in bats first detected in New York in 2006, has decimated some bat populations in the eastern U.S., and is moving westward. Though this disease has not yet been documented in Colorado, as of 2014 it was documented as far west as the Missouri/Kansas border. The potential exists for it to pose significant future threats to some SGCN.

9 Pollution

9.1 Household Sewage & Urban Waste Water

Housing and urban areas are a source of pollutants that enter Colorado waters. Developed areas have large coverage of impervious surface (pavement, buildings) and other land with impaired drainage that increase the amount of runoff and carry nutrients, toxic chemicals and/or sediments (e.g., discharge from municipal waste treatment plants, leaking septic systems, fertilizers and pesticides from lawns and golf-courses). These pollutants may be harmful to both aquatic and terrestrial plants and animals. Species near housing and urban areas are most likely to be impacted, but effects can be far-reaching.

9.2 Industrial & Military Effluents

Industrial and military activities can also be a source of water-borne pollutants. Resource extraction and industrial activities including mining, energy production, and manufacturing, especially those that require large amounts of water, can release nutrients, toxic chemicals and/or sediments into the water. Pollution may be incremental with cumulative effects, or accidental spills may introduce large quantities of pollutants during a single episode.

9.3 Agricultural & Forestry Effluents

Runoff of herbicide and pesticide applications in both cropland and forested areas are a primary source of water-borne pollutants from these activities. Increased sedimentation in the local watershed is also likely to result from certain tillage or lumber harvest activities.

9.5 Air-Borne Pollutants

Atmospheric deposition (air pollutants deposited to ecosystems) occurs in both wet deposition through rain, snow, cloud or fog, and as dry deposition via dust and gases. Atmospheric pollutants may come from both point and nonpoint sources (e.g., acid rain, smog from vehicle emissions, excess nitrogen deposition). Atmospheric nitrogen and sulfur deposition can change water chemistry and thereby impact aquatic vegetation, invertebrate communities, amphibians, and fish.

11 Climate Change & Severe Weather

Climate projections for Colorado are generally in agreement that the state will experience temperatures that are 2-5 °F warmer than current temperatures by mid-century¹¹. Projections for future precipitation are variable, ranging from very dry to approximately 10% wetter than current conditions. Moisture increases are more likely for winter; projections for summer precipitation are highly variable, especially for precipitation associated with monsoonal rains. Elevations below approximately 8,000 feet are likely to experience increasing amounts of annual moisture as rain rather than snow. A potential for changes in El Niño/La Niña effects may lead to extreme wet years followed by extreme dry years, which could have significant impacts to wildlife and their habitats.

As part of the SWAP revision process, we conducted a habitat-based climate change vulnerability assessment. The results of that work are summarized in Appendix F of this document. The full technical report can be obtained from CNHP or accessed online¹².

How climate change will ultimately manifest in Colorado, as well as potential impacts to wildlife species and habitats, is largely unknown at this point. To the best of our ability to estimate, we presume that some potential impacts could include those listed below. This same caveat applies to most of the climate change narrative in the species summaries that follow. Though much of this information is speculative, it represents our best professional judgment given the information available to us, until such time as more focused research results become available.

11.1 Habitat Shifting & Alteration

As temperatures increase and precipitation regimes change, suitable climatic conditions for species and/or habitats may shift in elevation or latitude. There is the potential for this to result

¹¹ The full range of projected temperature increase across all emissions scenarios at mid-century vary from 1.5 to 6.5 degrees warmer; late-century projections vary from 1.5 to 9.5 degrees warmer. See <http://wwa.colorado.edu/climate/co2014report> for the complete set of projections.

¹² http://www.cnhp.colostate.edu/download/documents/2014/CO_SWAP_Enhancement_CCVA.pdf

in different tree, shrub, and understory species dominating the landscape. In the future, we may see novel plant communities¹³ emerge or significant loss of current communities.

11.2 Drought

Drought is a natural component of the climate in the arid West, with fluctuations between wet years and dry years typical. As temperatures across Colorado warm, we may experience more frequent and intense droughts – periods in which precipitation and soil moisture is below normal – with consequent changes in which plant and animal species can survive, and an overall decrease in plant vigor. Past extreme droughts, such as those experienced in 2002 and 2012, have impacted a number of species (blue grama, spruce, lodgepole, aspen, and pinyon pine). Similar scenarios may become more familiar as climate change progresses.

11.3 Temperature Extremes

Colorado's future climate is expected to include warmer temperatures overall, as well as more frequent and/or extended periods when temperatures go above or below what we have historically considered normal. We are likely to experience more frequent and extended heat waves, and fewer cold spells of the type that control insect populations. Warmer temperatures on average, even without extremes, are likely to produce earlier snowmelt and peak runoff, more precipitation falling as rain instead of snow, increased moisture stress for some wildlife species and their habitats, and potential impacts on seed production/germination and growth of various plant species. These changes will have direct impacts on wildlife habitats, rendering some areas unsuitable for species that currently live there and providing new opportunities for other species to colonize.

11.4 Storms & Flooding

As global climate continues to change, Colorado may experience increased frequency and/or severity of extreme precipitation and/or wind events, thunderstorms, damaging hail, tornados, dust storms, and ice or snow storms. Potential effects include changes in habitats – examples include large areas of windthrow in forests and scouring of rivers and streams.

12 Organizational Capacity & Management

To appropriately manage and conserve wildlife and their habitats, it is necessary for agencies, researchers, non-governmental organizations, and others involved in this work to collaborate, share information and resources, and support each other's efforts. Lack of alignment in goals, bureaucratic obstacles to cooperation, and lack of resources are some examples of what we mean by the "threat" of organizational capacity and management. Other examples include lack of guidance or regulatory documents such as recovery plans to direct conservation action. Field

¹³ For the purposes of the SWAP, we can interpret plant communities to be roughly equivalent to habitat types.

staff workloads exceed staffing for many conservation agencies, and this forces work strategy to be reactive rather than proactive. Increasing the capacity of agencies by increasing staffing where possible, finding and developing efficiencies, and collaborating to greater extents may alleviate some of this conservation threat.

13 Lack of Knowledge

Effective wildlife management and conservation requires sufficient understanding of life history and habitat requirements, distribution, relationships among species, effects of management interventions in habitats, and so on. It is also important to understand responses of non-target species to management and conservation practices (for example, grazing prescriptions, pinyon-juniper removal). Incomplete knowledge inhibits our ability to identify and interpret potential threats and decide on appropriate course(s) of action.

14 Natural Factors

For the purposes of the SWAP, this category has been included to address issues related to conservation status or life history characteristics that contribute to vulnerability. These include scarcity, out of balance inter-species relationships such as predation and competition, and reproductive success. In many cases, threats addressed in the SWAP as natural factors are, in fact, products of a variety of interacting human impacts.

Overview of Conservation Actions

Similar to the threats descriptions in the previous section, the following narratives are intended to give readers a general understanding of the types of conservation and management activities that might be undertaken to improve the status of SGCN and their habitats in Colorado. They are not comprehensive, but they illustrate the types of strategies and actions that are proposed or suggested in the species and habitat narratives that follow, and in Tables 7 and 8. Standards and practices for conservation and habitat management are always evolving. In addition, the specifics of “who,” “how,” and so on are often highly contingent upon local conditions. Thus we do not consider the statewide SWAP to be the most appropriate venue for prescribing conservation action methods. However, to provide general guidance for project planning, we include examples of the types of activities that might be employed to achieve conservation goals, as appropriate.

Table 6. Lexicon of conservation actions according to Salafsky et al. 2008.

Actions marked with an asterisk (*) are not included in Salafsky et al. (2008), but we have determined that they are needed to fully express conservation needs in Colorado.

Level 1	Level2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
<p>1 Land/Water Protection Actions to identify, establish or expand parks and other legally protected areas</p>	<p>1.1 Site/Area Protection Establishing or expanding public or private parks, reserves, and other protected (e.g., national parks, wildlife sanctuaries, private reserves)</p>	
	<p>1.2 Resource & Habitat Protection Establishing protection or easements of some specific aspect of the resource on public or private lands (e.g., easements, development rights, water rights, instream flow rights, wild and scenic river designation)</p>	<ul style="list-style-type: none"> • Acquire conservation easement for habitat protection • Acquire water rights or instream flow rights
<p>2 Land/Water Management Actions directed at conserving or restoring sites, habitats and the wider environment</p>	<p>2.1 Site/Area Management Management of protected areas and other resource lands for conservation (e.g., site design, demarcating borders, putting up fences, training park staff, control of poachers)</p>	<ul style="list-style-type: none"> • Coordinate on ecologically sensitive design of recreational facilities • Employ grazing as a tool for compatible vegetation cover, structure, composition • Implement compatible forest management • Implement compatible grazing practices • Implement seasonal closures • Manage public use to be compatible with biodiversity • Manage to limit disturbance, especially to roost sites, maternity colonies, and hibernacula
	<p>2.2 Invasive/Problematic Species Control Controlling and/or preventing invasive and/or other problematic plants, animals, and pathogens</p>	<ul style="list-style-type: none"> • Control bullfrogs • Control non-native birds • Control non-native fish • Control non-native plants • Manage research, management, and recreation activities to control the spread of pathogens • Remove tamarisk through biological, chemical, mechanical means and prevent re-establishment • Write and/or implement integrated weed/pest management plan

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Level 1	Level 2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
	<p>2.3 Habitat & Natural Process Restoration Enhancing degraded or restoring missing habitats and ecosystem functions (e.g., creating forest corridors, prairie re-creation, riparian tree plantings, prescribed burns, breaching levees, dam removal, fish ladder)</p>	<ul style="list-style-type: none"> • Adjust operation of dam • Employ grazing as a tool for compatible vegetation cover, structure, composition • Implement streambank or in-stream restoration • Improve erosion and excess sedimentation conditions • Improve status of prairie dogs • Maintain appropriate patch size and habitat mosaic • Maintain connectivity (e.g., wildlife over/under passes, habitat corridors, fish passages) • Manage caves/mines for native bats • Re-seed native species • Restore native habitat • Restore native understory species • Restore natural fire regime • Restore riparian vegetation & hydrologic regime
<p>3 Species Management Actions directed at managing or restoring species, focused on the species of concern itself</p>	<p>3.1 Species Management Managing specific plant and animal populations of concern (e.g., harvest management of wild mushrooms, culling buffalo to keep population size within park carrying capacity, controlling fishing effort)</p>	<ul style="list-style-type: none"> • Develop and implement active disease management program • Develop proactive conservation program • Implement existing management/recovery plan • Maintain deer/elk populations within carrying capacity for healthy habitat • Reduce nest predators • Write and implement management/recovery plan
	<p>3.2 Species Recovery Manipulating, enhancing or restoring specific plant and animal populations, vaccination programs (e.g., artificial nesting boxes, clutch manipulation, supplementary feeding, disease/parasite management)</p>	<ul style="list-style-type: none"> • Maintain genetic connection/integrity within and between populations • Provide artificial nesting boxes/platforms • Reduce nest predators
	<p>3.3 Species Re-Introduction Re-introducing species to places where they formally occurred</p>	<ul style="list-style-type: none"> • Re-introduce extirpated native species • Translocate species to historic range

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Level 1	Level 2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
	<p>3.4 Ex-Situ Conservation Protecting biodiversity out of its native habitats (e.g., captive breeding, artificial propagation, gene banking)</p>	
<p>4 Education & Awareness Actions directed at people to improve understanding and skills, and influence behavior</p>	<p>4.1 Formal Education Enhancing knowledge and skills of students in a formal degree program (e.g., public schools, colleges and universities, continuing education)</p>	
	<p>4.2 Training Enhancing knowledge, skills and information exchange for practitioners, stakeholders, and other relevant individuals in structured settings outside of degree programs (e.g., monitoring workshops or training courses, learning networks or how-to manuals, stakeholder education on specific issues)</p>	<ul style="list-style-type: none"> • Educate development industries about avoiding and/or mitigating wildlife impacts • Improve communication among researchers and policy/decision-makers • Improve knowledge of species, habitats, problems, via professional meetings and other venues
	<p>4.3 Awareness & Communications Raising environmental awareness and providing information through various media</p>	<ul style="list-style-type: none"> • Implement landowner outreach/education and incentives programs • Publish educational material/sponsor educational programs to raise public awareness
<p>5 Law & Policy Actions to develop, change, influence, and help implement formal legislation, regulations, and voluntary standards</p>	<p>5.1 Legislation Making, implementing, changing, influencing, or providing input into formal government sector legislation or policies (e.g., state ballot initiatives, providing data to policy makers, zoning regulations, species protection laws)</p>	

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Level 1	Level 2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
	<p>5.2 Policies & Regulations Making, implementing, changing, influencing, or providing input into policies and regulations affecting the implementation of laws at all levels: international, national, state/provincial, local/community, tribal (e.g., input into agency plans regulating certain species or resources, working with local governments or communities to implement zoning regulations, promoting sustainable harvest on state lands)</p>	<ul style="list-style-type: none"> • Encourage use of Farm Bill programs • Establish mitigation requirements for developments • Monitor water quality standards • Promote consideration of biodiversity issues in transportation and land use planning processes • Promote zoning that concentrates use and protects habitat • Provide incentives for homeowners to increase tolerance of bats • Work with state and federal partners to limit density of oil/gas leasing and development
	<p>5.3 Private Sector Standards & Codes Setting, implementing, changing, influencing, or providing input into voluntary standards & professional codes that govern private sector practice (e.g., Conservation Measures Partnership Open Standards, corporate adoption of forestry best management practices, sustainable grazing by a rancher)</p>	<ul style="list-style-type: none"> • Implement Best Management Practices for <ul style="list-style-type: none"> ○ agricultural production ○ energy development & mining ○ forest management ○ livestock grazing ○ transportation, urban development, landscaping ○ water resource management
	<p>5.4 Compliance & Enforcement Monitoring and enforcing compliance with laws, policies & regulations, and standards & codes at all levels (e.g., water quality standard monitoring, initiating criminal and civil litigation)</p>	<ul style="list-style-type: none"> • Enforce 404 wetlands regulations • Enforce hunting, fishing, collecting regulations • Enforce state/federal/local pollution standards • Enforce wildlife and habitat protection laws • Enforce travel regulations

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Level 1	Level 2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
<p>6 Livelihood, Economic & Other Incentives Actions to use economic and other incentives to influence behavior</p>	<p>6.1 Linked Enterprises & Livelihood Alternatives Developing enterprises that directly depend on the maintenance of natural resources or provide substitute livelihoods as a means of changing behaviors and attitudes (e.g., ecotourism, nontimber forest product harvesting)</p>	
	<p>6.2 Substitution Promoting alternative products and services that substitute for environmentally damaging ones (e.g., farmed salmon as a replacement for pressure on wild populations, promoting recycling and use of recycled materials)</p>	
	<p>6.3 Market Forces Using market mechanisms to change behaviors and attitudes (e.g., certification, positive incentives, grass and forest banking, valuation of ecosystem services such as flood control)</p>	
	<p>6.4 Conservation Payments Using direct or indirect payments to change behaviors and attitudes (e.g., quid-pro-quo performance payments, resource tenure incentives)</p>	<ul style="list-style-type: none"> • Implement the NRCS Black-footed Ferret Initiative program • Implement Purchase/Transfer Development Rights program for habitat protection • Mitigate species/habitat loss (e.g., grass banking, mitigation banking, credits for off-site habitat protection)
	<p>6.5 Non-Monetary Values Using intangible values to change behaviors and attitudes (e.g., spiritual, cultural, links to human health)</p>	
<p>7 External Capacity Building Actions to build the infrastructure to do better conservation</p>	<p>7.1 Institutional & Civil Society Development Creating or providing non-financial support & capacity building for non-profits, government agencies, communities, and for-profits (e.g., creating new local land trusts)</p>	

Level 1	Level 2 (general actions in Tables 7 & 8)	Level 3 – illustrative examples (specific actions in Tables 7 & 8)
	<p>7.2 Alliance & Partnership Development Forming and facilitating partnerships, alliances, and networks of organizations (e.g., Conservation Measures Partnership)</p>	<ul style="list-style-type: none"> • Coordinate with related agencies to align goals, policies, measures of success • Coordinate with related agencies to identify and secure funding • Engage in collaborative, proactive planning and conservation programs
	<p>7.3 Conservation Finance Raising and providing funds for conservation work (private foundations, debt-for-nature swaps)</p>	<ul style="list-style-type: none"> • Provide economic assistance for private land habitat improvements and/or species conservation
<p>8 Research and Monitoring* (general actions in Tables 7 & 8)</p>		<ul style="list-style-type: none"> • Conduct primary research on species and habitat responses to changing climate • Improve understanding of species/habitat distribution (field inventory, modeling, ground-truthing) • Research critical life history/habitat components • Research population parameters and/or monitor status. • Research species/habitat response to management • Research and develop an effective plague vaccine and delivery system • Research genetic relation to other (sub)species

1 Land/Water Protection

In the conservation community, the term “protect” as applied to private land refers to the acquisition of real property interest in land or water. In other words, a protection strategy involves purchase of land, development rights, or water rights for the purpose of preventing conversion or permanent loss of habitat. Types of actions that fall under the land/water protection category including purchase of land to establish preserves, sanctuaries, or parks; conservation easements that allow some uses (such as livestock grazing) but prohibit others (such as erections of homes or infrastructure); purchase of in-stream flow or water rights (for example, to maintain sufficient water in rivers and streams to support fisheries or waterbird populations);

and purchase or transfer of development rights programs (the right to build on a specific property is sold or traded for the right to build on a different property).

Protection strategies as applied to public lands include creation of new parks, monuments, or other conservation areas from publicly owned land, as well as special area designations such as Wilderness Areas, Research Natural Areas, Special Interest Areas, and so on. Management of these lands is based on specified allowable uses and activities, with a focus on conservation of specified natural resources (e.g., species, ecosystems, ecological processes). Examples of protection strategies as employed in Colorado include creation of the Great Sand Dunes National Park and Preserve, private preserves owned by The Nature Conservancy, the myriad of conservation easements held by Colorado's land trust community, the Transferred Development Rights program in Boulder County, and Colorado Water Conservation Board's Instream Flow Program. In the case of all these protection strategies, the destruction of habitat is, in effect, prohibited by law.

2 Land/Water Management

For the purposes of the SWAP, management of land and water encompasses the majority of activities that agencies and conservationists undertake to restore, maintain, or enhance the quality and function of ecological systems. This type of strategy can be applied to any habitat, regardless of land ownership. This category includes design and implementation of human activity and land use (for example, livestock grazing practices, forest management, recreation infrastructure) in a manner that is compatible with the needs of native wildlife species. Efforts to improve habitat condition or restore ecological processes are also included. A small sample of these include: weed control; realignment and rehabilitation of trails; adjusting the operation of dams to change the amount and timing of peak flows; planting of appropriate native species where vegetation has been damaged or to establish desired habitat structure; controlled burns to prevent catastrophic wildfire or to regenerate habitat; restoration of damaged streambanks or removal of instream barriers, and many more. Many habitat restoration projects require control of non-native or problematic species. Control of non-native vegetation might involve use of herbicides, fire, grazing, biocontrol, or other acceptable practices. Control of non-native animal species may consist of activities such as manual collection/removal, chemical control, and species-specific traps. Because many control methods have potential for negative impacts on non-target, sensitive native species, extreme care should be taken in adapting methods to site-specific needs. Management strategies are usually voluntary, and though they are often prescribed in agency management plans and similar strategic documents, they are generally not required by law.

3 Species Management

Species management strategies are actions that focus on particular species, rather than on habitats or ecosystems. Examples include culling herds, controlling fishing or hunting of particular species, relocation or re-introduction of species that have been lost from historically occupied habitat, captive breeding programs, and seed or gene banking. These activities are undertaken to improve the abundance, distribution, and health of particular populations, or of a species across its range. Species management strategies are most often employed for species that are hunted or fished, or species that have suffered precipitous declines and are in danger of extinction or extirpation. Two high-profile species management programs in Colorado are the captive breeding and re-introduction of black-footed ferrets, and the re-introduction of lynx.

4 Education & Awareness

Education and awareness strategies focus on people for the purpose of improving understanding and influencing behavior (Salafsky et al. 2008). Education may refer to formal degree programs, information sharing among professionals (workshops, conferences, and training programs), or activities to raise the awareness of the general public on issues concerning threats to species/habitats. Public awareness activities may be targeted toward people with interest in a particular issue, private landowners managing large acreages or significant habitats, or policy- and law-makers with influence over species and habitats, among others. CPW is engaged with many other entities in a cooperative, collaborative effort to deploy numerous private land biologists across the state. These collaborations have occurred with CPW, Rocky Mountain Bird Observatory, Natural Resources Conservation Service, Rocky Mountain Elk Foundation, Pheasants Forever, and in the past, Colorado Watershed network.

5 Law & Policy

Law and policy strategies involve formal government, and include laws as well as policies and regulations that guide interpretation and implementation. These are actions to develop, change, influence, and implement formal legislation, regulations, and voluntary standards. Examples include the Endangered Species Act and associated take permits, and permitting for development projects under the the National Environmental Policy Act or the Clean Water Act. This category also includes activities geared toward changing existing laws and regulations, such as ballot initiatives, and enforcement of existing laws, as well as local community codes and ordinances (such as land use zoning). Implementation of voluntary industry standards in both public and private enterprise is also considered a policy strategy. Examples include commitment to the use of Best Management Practices by the transportation, energy production, mining, forestry, and

agricultural industries. Note that proper use of Best Management Practices involves the careful articulation of what these practices entail, based on the particular species, suite of species, or habitat(s) that are of concern. In many cases, Best Management Practices do not currently exist, and would need to be developed. The State of Colorado, through several agencies, has developed some BMPs, but more work remains to be done.

6 Livelihood, Economic & Other Incentives

Livelihood, economic and other incentives involves the development, implementation and evaluation of programs intended to provide incentive for conservation-minded landowners to maintain their operations while also contributing to the net conservation benefit of a species or suite of species. Incentives can be delivered in several avenues. This may include using market forces to provide a value for ecosystem services such as flood control, conservation payments as a direct payment for conservation behavior, or non-monetary values where the incentives are something other than financial. Particular examples include mitigation banking, initiatives for participation in recovery of at-risk species such as the black-footed ferret, and credits for offsite habitat protection. The U.S. Department of Agriculture provides funds for habitat improvement and other conservation measures through a number of its Farm Bill programs. Species/habitat banks and crediting programs are increasing in Colorado as methods are developed, tested, and improved. The Farm Bill and other incentive or market-based programs can offer important benefits to species that rely on privately-owned land for a significant portion of their habitat(s). Managers and conservationists can encourage use of these programs by educating landowners on opportunities available, providing technical assistance on project design and implementation, and offering guidance on application process(es).

7 External Capacity Building

External capacity building describes actions that are intended to build infrastructure to do better conservation. The partnerships required to undertake the large-scale, meaningful conservation to aid in the long-term survival of many species and habitat types is covered by this action. This may involve the creation or provision of non-financial support and capacity building for non-profits, government agencies, communities and for-profits. It may also involve the forming and facilitation of partnerships, alliances and networks of organizations, and finally may involve the raising and provision of funds for conservation work. In some cases, alignment of policies and goals across agencies, in conjunction with implementation of conservation-compatible industry practices is needed. One example of this would be conservation of prairie dogs and associated species, where collaboration among state and local agencies and private landowners are needed to maintain viable populations of prairie dog species and the SGCN for which they create habitat.

8 Research & Monitoring

Research and monitoring actions are those that collect and use scientific information to assess population status, species response to various management techniques, habitat treatments, and many other aspects of wildlife management and conservation. Long-term research and monitoring can provide important ecological insights; both are very important for the improved management of SGCN, priority habitats, and treatments intended to benefit either.