PEOPLE AND PREDATOR SERIES

COLORADO WOLVES

INFORMATIONAL PACKAGE

CENTER FOR COLLABORATIVE CONSERVATION

WARNER COLLEGE OF NATURAL RESOURCES
COLORADO STATE UNIVERSITY

THE CENTER FOR HUMAN-CARNIVORE COEXISTENCE

COLORADO STATE UNIVERSITY EXTENSION

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PREFACE

The Center for Human-Carnivore Coexistence (CHCC) at Colorado State University, in collaboration with the CSU Center for Collaborative Conservation and CSU Extension, have developed educational materials entitled the People and Predator Series.

The Center for Human-Carnivore Coexistence and the Center for Collaborative Conservation are housed within the Warner College of Natural Resources at CSU.

The People and Predator Series provides scientific information on the interactions between humans and carnivores. It includes information on a wide range of topics, including carnivore ecology, wildlife and livestock management, economics, and social dimensions of living with predators. Information Sheets are available to the public as publications through CSU Extension.

The first installment of the People and Predator Series is on Colorado Wolves, published in June 2020. This series provides science-based information regarding the potential restoration of wolves in Colorado. The series has undergone extensive review by scientists both within and CSU.

Included herein are the 12 Information Sheets that comprise the Colorado Wolves series. These Information Sheets are intended to educate the public and inform science-based policy but are not intended to state a position on any particular policy decision.

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Wolf Taxonomy and Biology

Information Sheet 8.002 People and Predator Series | Colorado Wolves

By the Center for Human-Carnivore Coexistence (5/20)

Taxonomy of gray wolves

Taxonomy refers to the hierarchical naming and grouping of living organisms based on their physical and genetic characteristics. Taxonomy is a system invented by people and can be confusing. Most species can be distinguished by their physical appearance. Other species can look very similar and be genetically different. Some species can look different but still breed with each other. The taxonomy of gray wolves (*Canis lupus*) is complicated and the subject of ongoing debate among scientists.[1-5] Since 1993 , five subspecies have been recognized in North America.[6]

Subspecies are the taxonomic rank below species. Typically, a subspecies lives in a separate area than the rest of the species and has different physical or genetic traits. Subspecies have a third part added to their scientific name. For instance, the Mexican gray wolf (*Canis lupus baileyi*), which lives in the southwest United States, is the rarest subspecies of gray wolf.[7]

The number and geographic boundaries of gray wolf subspecies in North America have not been fully resolved. For example, some scientists consider wolves in parts of the eastern Great Lakes into Canada as a distinct species – the eastern wolf (*Canis lycaon*).[8-9] Others think these wolves are not a distinct species but rather hybrids between gray wolves and coyotes.[10]

Red Wolf (*Canis rufus*)

The red wolf (*Canis rufus*) lives in the southeastern United States.[11] Genetic evidence suggests red wolves are more closely related to coyotes than gray wolves.[3] But, red wolves living in the wild today are considered distinct from both coyotes and gray wolves (notice the different species name – *rufus* versus *lupus*). Current evidence supports red wolves as a distinct species.

Biology of Gray Wolves

Gray wolves are the largest wild members of Canidae, the dog family.[12-14] Coyotes, foxes, and

Key Points

- Taxonomy, the naming and grouping of living organisms, is complicated for wolves. Five subspecies of gray wolf (*Canis lupus*) are currently recognized in North America, including the Mexican wolf of the southwestern U.S. The red wolf (*Canis rufus*) of the southeastern U.S. is considered a distinct species.
- Gray wolves, the largest wild canine, are social animals that can live in a variety of habitat types, wherever there is enough prey and where they are tolerated by humans.
- Gray wolves have been eliminated from much of their former range. Today, about 300,000 wolves occur globally, including 60,000 in Canada, 7700-11,200 in Alaska, and about 6000 in the lower 48 U.S. states.

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domestic dogs are other species in that family. Female wolves typically weigh 60 to 100 pounds, and males 70 to 115 pounds. Wolves are social and live in groups called packs, which typically include a breeding pair, their offspring, and other adults that may or may not be breeders. In the Rocky Mountains, packs average about 10 wolves in areas with little human impact, such as National Parks. Outside of parks, pack size is often less due to legal hunting, poaching, and livestock control. Wolf packs live within territories, which they defend from other wolves. Territory sizes range from 50 to over 1,000 square miles, depending on factors such as prey availability and human presence on the landscape.

Wolf pack

Wolves sexually mature at age two and can reproduce most of their lives. Under natural conditions, average wolf lifespan is about 5-6 years. In human-dominated landscapes, lifespan is less, with most mortality due to humans.[15] Wolves can live up to 14 years, although this is rare.

Wolves typically mate in January through March and sometimes mate for life. After a gestation period of about two months, four to six pups are born in early spring and are cared for by the entire pack. By seven to eight months, pups are almost fully grown and begin traveling with adults. A maturing wolf may stay with the pack and attempt to gain a breeding position. More often, it may leave to try to find a mate and start a new pack.

Wolf with pups

Gray wolves use many different habitat types, from Arctic tundra to forests, grasslands, and deserts wherever there is enough prey and where they are tolerated by humans. In the western United States, the best habitat for wolves is on public lands where both these needs are met. In the Rocky Mountains, wolves feed on a variety of prey, primarily elk, but also deer and occasionally moose. In Yellowstone National Park, elk make up about 90% of their diet. Wolves also eat small mammals, insects, and berries.

How many wolves live in the wild?

Historically, the gray wolf was the most widely distributed land mammal on earth, other than humans.[16-17] They lived through most of the Northern Hemisphere. Due to habitat loss and

predator control programs, wolves were eliminated through much of their former range. Today, they inhabit parts of North America, Europe, and Asia. About 300,000 wolves occur globally.[16]

In North America, gray wolves once ranged from Alaska and Canada to Mexico, occupying most of North America. Wolves were eliminated from the lower 48 U.S. states, except in northeastern Minnesota and Isle Royale National Park, Michigan.[17] Wolves have since recovered in some areas. Today, they occupy only 15% of their historic range in the lower 48 states.[18]

Currently, over 60,000 gray wolves live in Canada and 7700-11,200 live in Alaska.[19] About 6000 inhabit the lower 48 states. This includes about 4000 wolves in the western Great Lakes states of Michigan, Minnesota, and Wisconsin. About 2,000 wolves live in the northern Rocky Mountain states of Idaho, Montana, and Wyoming. Smaller numbers of wolves live in the Pacific Northwest, including Washington, Oregon, and Northern California.[20] A group of up to 6 wolves was confirmed in northwest Colorado in 2020, and an additional lone wolf was confirmed in north-central Colorado near Walden in summer 2019.[21-22]

The Mexican gray wolf was reintroduced to Arizona, New Mexico, and northern Mexico starting in the late 1990's. At least 160 Mexican gray wolves now live in the wild in the U.S.[7] A small and unknown number of Mexican wolves are free-ranging in northern Mexico.

The red wolf is one of the world's most endangered large carnivores, listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN).[23-24] Red wolves were reintroduced into eastern North Carolina starting in the late 1980's.[11] Currently , about 40 red wolves live in the wild.

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Wolves in Colorado: History and Status

By the Center for Human-Carnivore Coexistence (5/20)

The history and current status of wolves in Colorado

The gray wolf is native to Colorado.[1-3] Historically, wolves were distributed in Colorado throughout all major habitat types. During the latter half of the 1800s, hunters decimated wolf prey such as bison, elk, and deer. By the early 1900s, less than 1000 elk remained in Colorado[3], compared to over a quarter million elk today.[4] At the same time, domestic livestock were increasing in numbers, providing an alternative prey source for wolves. Because wolves killed livestock and game, by the mid-1940's, wolves were eradicated from Colorado by shooting, trapping, and poisoning.[5-7] Similarly, government sponsored predator control eliminated wolves throughout most of the western United States. Wolves were restored to Yellowstone National Park in the mid 1990's and over the ensuing decades Colorado Parks and Wildlife is aware of a few lone wolves that have made it to Colorado.[8] These wolves died from vehicle collisions, shooting, or poisoning, or they simply disappeared. It is possible, if not likely, that other wolves have made their way into Colorado and have not been observed.

More recently, a lone wolf was confirmed in north-central Colorado near Walden in July 2019.[6] This male wolf had a radio-collar that showed it came from west-central Wyoming. In January 2020, a group of up to 6 wolves was confirmed in Moffat County in northwest Colorado.[9] These wolves likely migrated from a nearby state, perhaps Wyoming. It is uncertain if they will stay in Colorado.

Wolf tracks observed by Colorado Parks and Wildlife in January 2020 in northwest Colorado. Photo by Colorado Parks and Wildlife.

Wolves are currently listed as "endangered" under federal and state law (see *Wolf Policy Information Sheet*). The federal law protecting wolves is the U.S. Endangered Species Act (ESA). The state law is Colorado's Nongame, Endangered, or Threatened Species Conservation Act. For endangered species, federal law takes precedence over state law. Thus, wolves that arrive in Colorado are under the management authority of the U.S. Fish and Wildlife Service and not Colorado Parks and Wildlife.[6] The ESA makes it unlawful to harm, harass, or kill a wolf, except if there is an immediate threat to human safety.

Key Points

- The gray wolf is native to Colorado but was eradicated from the state by the mid-1940s.
- Colorado still has suitable habitat for wolves, including a sufficient prey base and extensive public land.
- A few individual wolves have arrived in Colorado during the past two decades and a small group currently lives in the state, but it is unclear if and when Colorado would have a self-sustaining viable population of wolves. Reintroducing more wolves would reduce uncertainty and increase the likelihood of a viable population.

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Can Colorado still support wolves?

Although wolves were eliminated from the state in the 1940s, Colorado still retains suitable habitat for wolves.[10-13] Wolves can live in a variety of habitat types and can persist where there is enough prey and they are tolerated by humans. In the western United States, the best habitat for wolves is on public lands where both these needs are met (see *Wolf Taxonomy and Biology Information Sheet*).

Prey abundance is one of the best predictors of where wolves can live, and Colorado supports a sufficient prey base for wolves.[10] If wolves re-establish in Colorado, either naturally or through reintroduction, it will likely initially be on the Western Slope (see *Wolf Policy Information Sheet*). As such, elk and mule deer would be the primary prey. Over 430,000 mule deer live in the state.[14] Colorado also supports over 280,000 elk, the largest elk population of any state.[4] The largest big game herds occur on the Western Slope (see *Wolves, Big Game, and Hunting Information Sheet*).

Colorado also has over 24 million acres of public lands, mostly federally owned.[15] Of all the U.S. states, Colorado ranks 11th in total acres of federal land. This includes over 3.5 million acres of federally protected wilderness, ranking 6th among all U.S. states.[16] Most of these public lands are in western Colorado (Figure 1).[17] Because public lands, especially wilderness areas, have less human disturbance, these areas would likely serve as important habitat for wolves.

Multiple scientific studies have concluded that Colorado can sustain a population of wolves.[10-13] A study published in 1994 indicated that Colorado could support over 1000 wolves.[11] A study published in 2006 predicted that, after forecasting increased human population growth and road development, Colorado could support at least 400 wolves by 2025.[13] Another study published in 2017 identified western Colorado as prime for wolf restoration.[10] Updated studies are necessary to estimate how many and where wolves could live in Colorado both now and into the future.

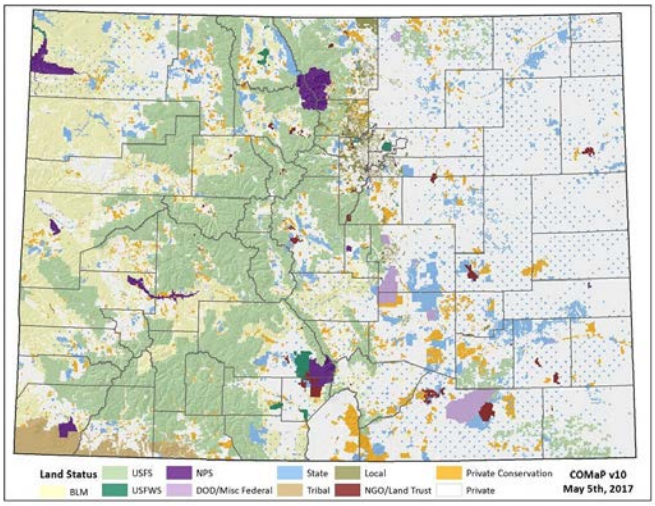

Figure 1. Colorado land ownership. Most public land is federal, and most is in western Colorado. Reprinted from Colorado National Heritage Program.[17]

Ultimately, people will determine where wolves can live.[10] Wolves once were the most widely distributed land mammal worldwide. Today, they inhabit parts of North America, Europe, and Asia. As long as people tolerate them, wolves can persist in regions with many people.[10, 12] For example, over 2,300 wolves live in Minnesota[18], a state with 5.6 million people and an average population density of 71 people per square mile.[19] About 850 wolves live in Wisconsin[18], a state with 5.8 million people and an average population density of 107 people per square mile.[19] For comparison, Colorado has 5.8 million people and an average population density of 56 people per square mile.[19] Colorado's population is heavily concentrated in the Front Range, with only about 10% of residents living in the Western Slope. As another comparison, over 11,000 wolves now live in Europe, including near large cities. This is about twice as many wolves as the 6000 wolves that now live in the lower 48 U.S. states.[10] Europe is half the area of the lower U.S. with twice the average human population density.[20]

The best habitat for wolves in Colorado would be public lands where there is abundant prey and open space and less potential for conflict with people.[12] Much of the more remote public lands, particularly wilderness areas, are at higher elevations. In some areas, wolf prey like elk and deer seasonally migrate to lower elevations during winter. This includes private lands in valley bottoms, which can be productive[21] and a refuge from hunting and thus attractive to wildlife.[22] If wolves follow their prey to private lands, this would increase the risk of conflict with people and livestock. Conversely, grazing of livestock on public land where wolves reside would also increase the risk of conflict. A variety of strategies are available to prevent and reduce such conflicts (see *Wolves and Livestock Information Sheet* and *Wolves and Human Safety Information Sheet*).

Wolves currently live in Colorado, so why do some people still want to reintroduce more wolves?

An important conservation goal for endangered species is that they recover to form a self-sustaining and viable population.[13] A viable population has sufficient numbers and geographic distribution such that it can persist over the long-term. The wolves currently in northern Colorado - a single group of six wolves and another lone wolf - are not a sustainable viable population over the long-term. These wolves are at risk. They might be killed or disappear, as has happened to other wolves that have migrated to Colorado.[8] Also, while protected in Colorado, wolves that cross into Wyoming have no legal protection in most of the state.[23] Further, unpredictable events like disease can quickly eliminate such a small group of wolves, and these few animals contain a limited gene pool which can reduce the chance of long-term persistence. Thus, it is uncertain if the wolves currently in Colorado will grow to form a viable population in the state. It is also unclear if and when a viable population would arise from continued colonization from nearby states. Reintroducing wolves would greatly reduce both sources of uncertainty.

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Wolf Policy

By the Center for Human-Carnivore Coexistence (5/20)

Gray Wolves and the Endangered Species Act

The gray wolf was listed as an Endangered Species under the U.S. Endangered Species Preservation Act of 1966 and legally protected under the Endangered Species Act (ESA) of 1973.[1] The U.S. Fish and Wildlife Service (USFWS) is responsible for the management and eventual recovery of threatened and endangered species, including wolves. To help recover gray wolves, the USFWS and the National Park Service reintroduced them into Idaho and Yellowstone National Park in the mid-1990s. The reintroduction was successful and the wolf population grew and expanded (see *Wolves, Big Game, and Hunting Information Sheet*). Today, about 2,000 wolves live in the northern Rocky Mountain states of Idaho, Montana, and Wyoming.[2] Smaller numbers of wolves live in the Pacific Northwest, including Washington, Oregon, and Northern California (see *Wolf Taxonomy and Biology Information Sheet*). Because of this population growth, over the past decade, gray wolves were removed ("delisted") from the endangered species list in Montana, Idaho, Wyoming, eastern Oregon and Washington, and parts of Utah. Due to their abundance, wolves in Alaska were never added to the endangered species list. But in many other states - including Colorado and the Great Lakes states - wolves are still federally listed as an Endangered Species.

Gray Wolf

The USFWS now considers wolf populations stable and healthy throughout their current range.[1] They have concluded that the gray wolf is not in danger of extinction and thus has recovered from endangered status. As a result, in March 2019, USFWS proposed to remove all gray wolves (except for the Mexican gray wolf subspecies, *Canis lupus baileyi*) in the continental United States from protection under the ESA.[3] This policy decision, if finalized, would turn management of gray wolves back to individual state wildlife agencies.

The USFWS proposal to delist gray wolves does not include the separate listing of the Mexican gray wolf under the ESA. Because of their rarity, Mexican gray wolves are protected as a separate subspecies and would remain listed under the ESA. Similarly, the red wolf (*Canis rufus*), a distinct species that lives in the southeastern United States, would remain listed as endangered under the ESA.[4]

The USFWS proposal to delist the gray wolf in the continental U.S. was reviewed by an independent panel of scientists that provided comments and criticism on USFWS's

Key Points

- The gray wolf is currently federally listed as endangered under the U.S. Endangered Species Act (ESA) in most of the lower 48 U.S. states. The U.S. Fish and Wildlife Service (USFWS) has recently proposed to remove ("delist") all gray wolves (except the Mexican gray wolf subspecies) from protection under the ESA.
- Ballot Proposition 114 is a citizen-initiated measure scheduled for the Colorado ballot on November 3, 2020. Under the Proposition, the Colorado Parks and Wildlife Commission would be required to develop a science-based plan to restore gray wolves and oversee wolf restoration and management.
- Until the USFWS proposed delisting rule is finalized, any wild gray wolves in Colorado are still endangered under the ESA. Consequently, USFWS, and not Colorado Parks and Wildlife, has management authority of such wolves.

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assumptions, arguments, and conclusions.[5] The timeline and fate of the proposed delisting is unclear. If the delisting is finalized by the government, it is likely that it will be challenged in court. Until the proposed rule is finalized, gray wolves will remain listed as an Endangered Species in Colorado under the ESA.

Ballot Proposition 114 (formerly 107)

Ballot Proposition 114 is a citizen-initiated measure scheduled for the Colorado ballot on November 3, 2020.[6] A Proposition is proposed legislation that is voted on by the public. If approved by voters, the Proposition becomes law.

Under the Proposition, the Colorado Parks and Wildlife Commission would be required to:

- Develop a plan to restore gray wolves in Colorado using the best scientific data available.
- Hold statewide hearings to obtain public input.
- Take the steps necessary to begin reintroduction of wolves by December 31, 2023 on designated lands west of the Continental Divide.
- Oversee gray wolf restoration and management.
- Distribute state funds to assist livestock owners in preventing and resolving conflicts between wolves and livestock.
- Distribute state funds to pay fair compensation to livestock owners for losses caused by wolves.
- Not impose any restrictions on private landowners regarding land, water, or resource use.

The Commission is a governor-appointed board of 11 citizens that oversees Colorado Parks and Wildlife (CPW), a state agency. The mission of CPW is to "perpetuate the wildlife resources of the state, to provide a quality state parks system, and to provide enjoyable and sustainable outdoor recreation opportunities that educate and inspire current and future generations to serve as active stewards of Colorado's natural resources."[7]

Proposition 114 was approved for circulation on June 21, 2019. On December 10, 2019 proponents of the Proposition submitted 215,370 signatures of registered Colorado voters to the office of the Colorado Secretary of State to place wolf restoration on the Fall 2020 state-wide ballot. The Colorado Secretary of State's office announced on January 6, 2020 that the measure received enough signatures to make the November 2020 ballot.

The public has a range of feelings about the provisions in Proposition 114 that can vary by stakeholder group (see *Public Perspectives on Wolves and Wolf Reintroduction Information Sheet*). If Proposition 114 is supported by voters, participatory processes that involve diverse stakeholders with conflicting views in respectful dialogue and shared decision-making can lead to better, longer-lasting outcomes for all sides (see *Dialogue and Social Conflict about Wolves Information Sheet*).

Who has management authority over wolves in Colorado?

Any wild gray wolves in Colorado are still considered endangered under the ESA. Consequently, USFWS and not CPW, has management authority of such wolves.[8] Under the ESA, harming, harassing, or killing a wolf is a federal crime. Recently, a group of up to six wolves was confirmed in northwest Colorado.[9] An additional lone wolf was confirmed in north-central Colorado near Walden (see *Wolves in Colorado: History and Status Information Sheet*). These wolves have the full protection of the ESA.

If ballot Proposition 114 passes in November 2020, CPW will be mandated to develop and oversee a plan to reintroduce and manage wolves in Colorado. If wolves are still listed as endangered under the ESA, a permit for reintroduction would be required from the USFWS.[8] If the permit is secured, CPW would then be responsible for developing and implementing the wolf reintroduction and management plan.

Under this scenario, these reintroduced wolves might be designated as an "Experimental, Non-Essential Population" under the "10(j) rule" of the ESA.[10] The U.S. Congress added the 10(j) rule to the ESA to help relieve landowner concerns that reintroductions might result in restrictions on use of private, tribal, or public land. The ESA restricts "take" of endangered species. As defined under the ESA, "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[11]

The 10(j) rule relaxes the "take" prohibitions for an endangered species. This would provide CPW, other agencies, and landowners more management flexibility with reintroduced wolves. For example, if authorized in the permit, wolves that come into conflict with livestock could potentially be removed or killed. USFWS used this provision to reintroduce gray wolves to Yellowstone National Park, Mexican gray wolves to Arizona and New Mexico, and red wolves to North Carolina. USFWS also has used this provision to restore other endangered species.

What is the current policy of Colorado Parks and Wildlife towards wolves in Colorado?

In 2004, a collaborative working group convened by CPW provided recommendations for managing wolves that migrate into Colorado.[8,12] The resulting document dealt exclusively with natural recolonization and did not address the potential for active reintroduction by wildlife managers. The working group recommended that naturally migrating wolves be able to live "with no boundaries" where they find habitat in the state. The group also recommended that wolves be managed with both lethal and non-lethal methods to avoid conflicts with people, livestock, and big game. In 2005, the Colorado Parks and Wildlife Commission affirmed its support of the working group's recommendation.[13] In 2016, the Commission considered the issue of wolf reintroduction and adopted a formal resolution opposing intentional release of wolves into Colorado.[8,13] Neither the Commission nor CPW has adopted a formal resolution or position on Ballot Proposition 114.[14]

What is the Mexican gray wolf and how does it relate to wolf recovery in Colorado?

The Mexican gray wolf is the rarest subspecies of gray wolf in North America.[15] Mexican wolves differ from other gray wolves in genetic and physical traits and are the smallest subspecies in North America.[16] The Mexican gray wolf was included in the initial listing of the gray wolf under the ESA. In 2015, it was listed and protected separately from the rest of gray wolves as an endangered subspecies.

Mexican Wolves

The historical range of Mexican gray wolves includes Mexico, southeastern Arizona, southwestern New Mexico, and parts of western Texas.[17] It does not include Colorado. Mexican gray wolves were reintroduced to Arizona, New Mexico, and northern Mexico starting in the late 1990's. Recovery efforts are ongoing. As of January 2020, a minimum of 160 wild Mexican gray wolves now live in the southwest U.S.[15] The subspecies may be removed from the endangered list when there is an average of at least 320 wolves in the U.S. and 200 in Mexico over an eight-year period.

Some scientists have warned against recovering the Mexican gray wolf outside its historical range.[18] If Mexican wolves disperse north, including into Colorado, it would likely lead to interbreeding with other subspecies of gray wolves recolonizing southward. Such hybridization could make it more difficult to preserve the unique Mexican gray wolf subspecies, as directed under the ESA. This is especially true as long as the Mexican gray wolf population is very small because interbreeding could more easily swamp their unique genetic traits. Also, because northern subspecies are typically larger, they might dominate breeding opportunities and further increase the odds of hybridization. To keep Mexican gray wolves within their historical range, federal policy mandates that if animals leave the reintroduction zone in Arizona and New Mexico, they are recaptured and returned to the area.

However, once the Mexican wolf population is large enough to accept new genetic material, occasional

genetic interchange with northern subspecies could be beneficial.[16,19] Wolves can travel long distances and there was almost certainly some interbreeding between Mexican wolves and other subspecies in the past. Once the Mexican wolf populations is sufficiently large, limited genetic exchange can help increase genetic diversity. This can improve population health and allow adaptation to changing environments.

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Wolves and Human Safety

By the Center for Human-Carnivore Coexistence (5/20)

Are wolves dangerous to humans?

The perception of wolves as a danger to people has a long history in human society. In reality, the risk of wolves attacking or killing people is low. Wolves typically avoid people, buildings, and roads and encounters are rare.[1] For example , a study published in 2002 reviewed wolf-human interactions in Alaska and Canada, where over 60,000 wolves live.[2] Between 1900 -2000, a 100-year period, the study found only 16 cases where wild, healthy wolves bit people. In six cases, bites were severe. No bites were life-threatening. Another 12 cases involved aggression by known or suspected rabid wolves. In North America, there are no documented accounts of humans killed by wild wolves between 1900-2000.[2-4]

Worldwide, in those rare cases where wolves have attacked or killed people, most attacks have been by rabid wolves.[4,5] Wolves are unlikely to be a long-term reservoir host for rabies, but they can catch it from other species (see *Disease Information Sheet*).[5] Most incidents of rabies occur in other wildlife such as raccoons, skunks, foxes, and bats.[6] A decrease in the incidence of rabies worldwide has led to the decrease in the number of rabid wolf attacks.[4]

Little Red Riding Hood
Illustration by J. W. Smith

Another factor associated with wolf attack is habituation - losing fear of humans.[4] Habituation can occur when wolves are fed by people or within some protected areas. Wolf attacks have also occurred when wolves are provoked, such as when humans trapped or cornered them or entered a den with pups. Attacks are also associated with highly-modified environments, for example where there is little to no natural prey and when wolves are dependent on human food sources.[4]

Key Points

- Like many large carnivores, wolves are generally afraid of humans and will avoid people, buildings, and roads if possible.
- The risk of wolves attacking or killing people is low. As with other wildlife, it is best not to feed wolves and to keep them at a respectful distance.
- Wolves may kill pets if they encounter them, although such events are infrequent. To reduce the chance of conflict with dogs, avoid turning dogs loose in areas with wolves, and keep dogs leashed or under voice control.

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There also have been recent reports of wolves attacking people.[7] Wolves may have killed a Canadian man in 2005.[8] Wolves killed a woman jogging alone in a remote part of Alaska in 2010.[9] In summer 2019, a wolf attacked a tent camper in Banff National Park.[10] Such encounters foster the perception that wolves are far more dangerous to humans than they are.[7] Attacks are still exceedingly rare. For example, no wolf has attacked a human in Yellowstone National Park since wolves returned in 1995.[11] Yellowstone receives 4 million visitors per year, including tent campers.[12] About 100 wolves live in Yellowstone and are exposed to people, with few issues.[11]

Overall, wolves represent little threat to humans, unless people habituate them by providing them with food.[2-4, 7, 11] As with other wildlife including other carnivores such as bears, it is best not to feed wolves and to keep them at a respectful distance.

Are wolves dangerous to pets?

Wolves may kill pets if they encounter them, as can other large carnivores such as mountain lions and coyotes. The most common conflicts between wolves and pets involve domestic dogs.[5, 13-15] Like other wild carnivores, wolves will guard their territories. Unleashed dogs that roam into wolf territories might be considered as intruders or competitors. Wolves are likely most aggressive near their den or rendezvous ("meeting") sites and when protecting recent kills.

Wolves killing dogs, however, is infrequent.[13] Typically, most dogs killed by wolves are hunting dogs in pursuit of wildlife such as bears, mountain lions, and wolves themselves.[5, 13-15] In some areas, the risk of wolf attacks on dogs is a source of conflict between wolves and hunters and can be an important motivation for the illegal killing of wolves. Wolves typically avoid residential areas and are thus less of a threat to dogs there.

There are ways to reduce the chance of conflict between wolves and dogs.[16-18] Wolves are generally afraid of people and will avoid them, so staying as close to dogs as possible will make it less likely that wolves will attack dogs. Hunting with dogs is inherently risky in wolf country. Avoidance of wolves is the best way to minimize conflict. If you hunt with dogs in wolf country, learn to recognize wolf sign such as scat, tracks, and howls. If you see or hear sign, don't turn your dogs loose. Bells or beepers on dogs might also help protect dogs. For hikers in wolf country, dogs should be leashed or under strict voice control. This will not only protect dogs, but also protect the wildlife that dogs might chase, disturb, or kill.[19]

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Ecological Effects of Wolves

By the Center for Human-Carnivore Coexistence (5/20)

What is a Trophic Cascade?

Predators at the top of the food chain are known as apex predators. They can cause ecological effects that ripple through an ecosystem. These are called "trophic cascades". A growing number of studies globally have documented trophic cascades generated by apex predators.[1] Apex predators such as large carnivores are some of the first animals to decline or disappear when they share landscapes with people. Large carnivores are particularly susceptible because of their naturally low numbers, wide ranges, and active predator control by people. Their loss can have cascading effects that alter aquatic and terrestrial systems throughout the world.[2]

What are the ecological effects of wolves?

In short, it's a complicated story with no simple answers.[3,4] Multiple scientific studies have suggested that wolves, as apex predators, can have substantial ecological effects. Most such studies have been conducted in national parks such as Yellowstone and Isle Royale in the U.S. and Banff and Jasper in Canada.

In Banff National Park, development and human activity around the town of Banff kept wolf density low.[5-6] Farther from town, wolf density was higher. When researchers compared low and high wolf density, they found fewer wolves led to increased elk numbers and greater browsing on willows and aspen (Figure 1). This in turn reduced habitat quality for songbirds and beavers.

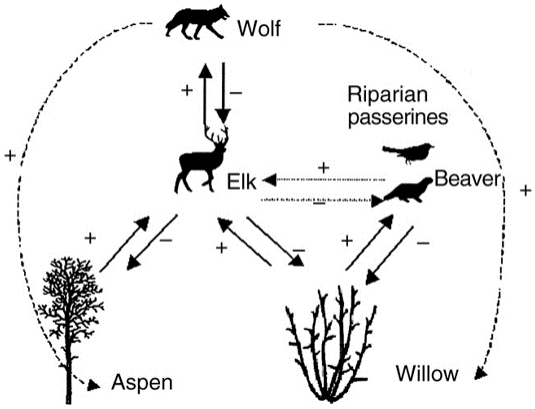

Figure 1. Simplified trophic cascade caused by wolves in Banff National Park. Reprinted from Hebblewhite et al. 2005

Another study took place in Jasper National Park.[7] Scientists used historical records on wolf and elk numbers to suggest that elimination of wolves in the mid-1900's led to increases in elk browsing and declines in aspen. Wolf recovery in the late 1960s apparently reduced elk use and allowed aspen to regrow.[7]

On Isle Royale National Park in North-western Lake Superior, a research project ongoing for over 60 years has documented a unique predator-prey relationship between wolves and moose.[4] Wolves are the only predator and primary cause of death for moose, which represent 90% of wolf diet. Wolf predation is an important influence on moose populations, indirectly impacting

Key Points

- Wolves can generate trophic cascades – ecological effects that ripple through an ecosystem. In places like Yellowstone National Park, wolves have likely contributed to willow and aspen recovery and overall habitat diversity by reducing overbrowsing by elk.
- Wolves are likely not solely responsible for the changes in the Yellowstone ecosystem. Additional factors such as drought, harsh winters, other predators, and human hunting may have also helped reduce the Yellowstone elk herd and transform the ecosystem.
- Predicting the ecological effects of wolves is complicated, with no simple answers. Ultimately, if restored to Colorado, wolves might generate noticeable ecological effects where they occur in high enough densities for long enough time. In areas with lower densities of wolves, ecological effects will be less evident.

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vegetation by altering moose browsing.[4] However , since wolves colonized Isle Royale around 1949, the effects of wolves have varied over the years. Wolves have had strong effects during some periods but weaker influence during others. This is primarily because wolf numbers have fluctuated over time due to a variety of reasons, including prey abundance, weather, and disease.

Yellowstone National Park has been a focus of many studies on the ecological role of wolves. Elk represent about 90% of wolf diet in this area.[4,6] Since the reintroduction of wolves in 1995, the elk herd in Yellowstone's northern range has declined substantially. This has led some researchers to infer that wolves caused the decline.[1,8,9] Wolves also can change the behavior of elk, causing them to move more and use habitat differently by seeking more cover.[10-12] As in other parks, studies conclude that wolf predation can contribute to willow and aspen recovery, and overall habitat diversity, by reducing overbrowsing by elk, benefiting songbirds and beavers.[1,8,10,11] Some studies also contend that willow and aspen recovery might change the flow of streams[13-15], a topic that has gained considerable media attention.[16] Other studies suggest that wolves can reduce coyote populations[17] and thereby increase survival of pronghorn fawns upon which coyotes prey.[18] Wolves also can benefit scavengers that feed on wolf kills such as bears, ravens, and eagles.[6,19]

However, some researchers have questioned if wolves are solely responsible for the changes evident in the Yellowstone ecosystem since wolves were reintroduced 25 years ago.[3,4] They conclude that additional factors such as drought, harsh winters, other predators (bears and mountain lions), and human hunting also contributed to the decline of the Yellowstone elk herd. Experimental studies have not found strong evidence that wolves alone are driving regrowth of willow and aspen by changing elk behavior.[20, 21] Additional experimental evidence suggests that a reduction in overbrowsing alone is not sufficient to recover willows along some small streams.[22] The overall benefit of wolves to scavengers also has also been challenged.[3] Wolves eat most of the animals they kill, leaving scavengers the leftovers. Also, if wolves reduce prey numbers, fewer animals would die on their own and be available for scavengers to eat.

Overall, such studies emphasize that understanding trophic cascades in large complicated ecosystems is challenging.[3,4] Although loss of predators can cause ecosystem-level impacts[2], reintroduction of carnivores, including wolves, doesn't always fully restore degraded ecosystems.[23] In general, sweeping claims about trophic cascades caused by wolves are context-dependent and sometimes exaggerated.

What ecological effect might wolves have in Colorado?

The ecological effects of wolves are difficult to predict, particularly outside of national parks.[3,4] In parks such as Yellowstone, wolves and their prey are typically protected from many human disturbances, such as hunting, predator control, and habitat loss. Within parks, wolves are more likely to occur in abundant, stable populations. This likely increases their ecological effects. Outside of parks, wolves are often more heavily impacted by people and their density is often lower. This might lessen their ecological effects.[3]

Ultimately, if restored to Colorado, wolves might generate ecological effects where they occur in high enough densities for long enough time. Wolves are more likely to cause ecological effects when they contribute to local reductions in prey populations, working in concert with other factors that also limit prey, such as adverse weather, habitat decline, other predators, or human hunting. In other areas with lower densities of wolves, the ecological effects of wolves will be less evident.

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Wolves, Big Game, and Hunting

By the Center for Human-Carnivore Coexistence (5/20)

Impacts of Wolves on Big Game and Hunting

The impact of wolves on elk, deer, and other big game is complicated. Wolves chase down their prey and often target old and weak animals that might have otherwise died from starvation or disease.[1] Also, the hunting success rates for wolves are low. Typically, over 80% of hunting attempts end unsuccessfully.[2] Under such conditions, wolves alone are unlikely to reduce big game populations.

Wolves can contribute to local declines in the number of prey. This is more likely when harsh weather, other predators (e.g., bears, cougars, coyotes), or human hunters also kill animals.[1] Wolves also can make big game more wary, move more, and use habitat differently by seeking more cover.[3] This would make hunting more challenging in some areas. Similarly, human hunters can also alter movement and habitat use of big game.[4]

Elk and Wolves in the Northern Rocky Mountains

In states with wolves, abundant big game and hunter harvests can still occur. Such is the case for many states with wolves including Alaska; the Great Lake States of Minnesota, Wisconsin, and Michigan; and the northern Rocky Mountain States of Wyoming, Montana, Idaho. In much of the northern Rocky Mountains, including in Yellowstone National Park, elk are the primary prey of wolves.[5] Elk post-hunt population sizes[6-9] (Figure 1) and hunter harvest of elk[10-13] (Figure 2) in Wyoming, Montana, and Idaho have not declined since wolves were reintroduced starting in 1995. Note that these estimates of population sizes are made after the hunting season, representing the number of elk available after hunters had the opportunity to hunt.

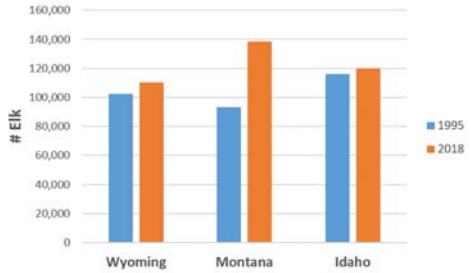

Figure 1. Post-hunt elk population sizes in northern Rocky Mountain States since wolf reintroduction. Data compiled from state wildlife agencies.[6-9]

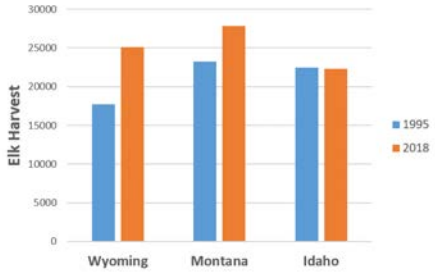

Figure 2. Elk harvest in northern Rocky Mountain States since wolf reintroduction. Data compiled from state wildlife agencies.[10-13]

Key Points

- Colorado supports an abundant prey base for wolves. This includes over 430,000 mule deer and 280,000 elk, the largest elk population of any state. The largest mule deer and elk herds occur in western Colorado.
- If occurring in high enough population numbers for enough time, wolves in Colorado might locally impact some big game herds and hunting opportunities. This is more likely if wolf predation acts with other factors that limit prey such as severe winters.
- At a statewide level, wolves are unlikely to have a major impact on overall big game populations or hunting opportunities in Colorado based on evidence from northern Rocky Mountain states.

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Montana provides a useful case study. At a statewide level, elk population sizes[7] (Figure 3) and elk harvested by hunters[11] (Figure 4) have been stable since 2004 despite a rapid increase of wolves until around 2013.[14] Wolf hunting was allowed in Montana starting in 2009.

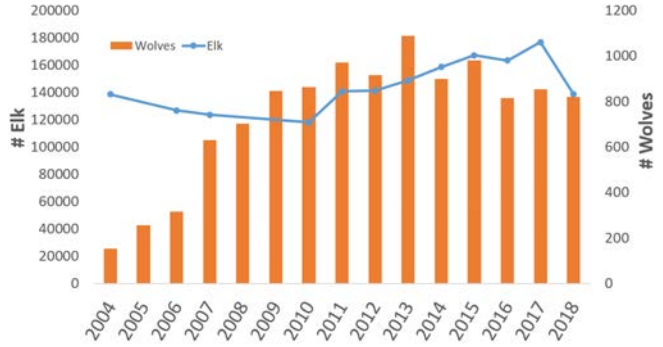

Figure 3. Montana elk and wolf population sizes. Data compiled from Montana Fish, Wildlife & Parks.[7,14]

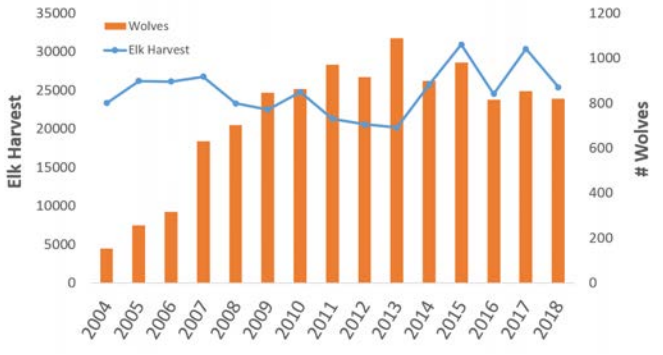

Figure 4. Montana elk harvest and wolf population size. Data compiled from Montana Fish, Wildlife & Parks.[11,14]

However, wolves do not occur across all of Montana. The most appropriate comparison is in regions where both wolves and elk interact. Wolves live in the western part of Montana (purple circles in Figure 5).[14] Elk are distributed farther east than wolves, into central Montana (green shading in Figure 6).[7]

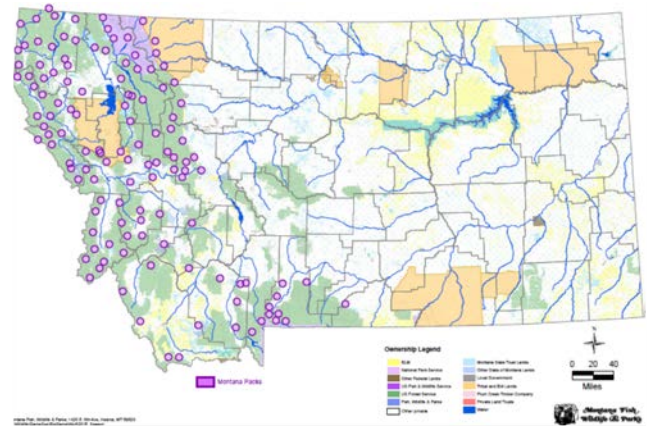

Figure 5. Montana wolf pack locations. Reprinted from Montana Fish, Wildlife & Parks.[14]

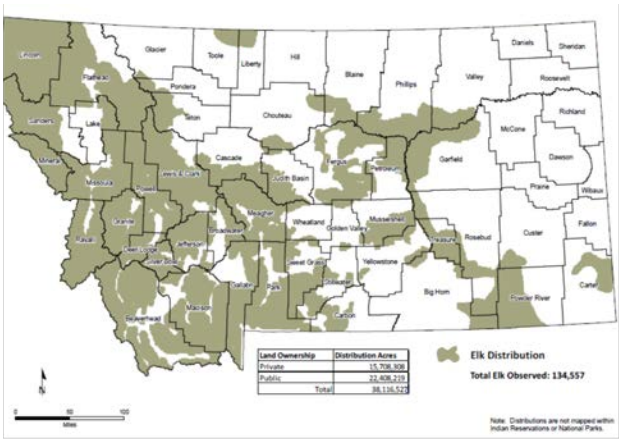

Figure 6. Montana elk herd locations. Reprinted from Montana Fish, Wildlife & Parks.[7]

In western Montana, where both wolves and elk live, elk harvest by hunters has been steady or increasing in many places.[15] Elk population sizes are at or above objectives set by the state game agency in most hunting districts in the state (red and green in Figure 7).[7] This includes areas with wolves, including near Yellowstone in the southwest corner of the state. Yet in other areas, elk numbers have declined, due in part to wolf predation.[15] Some elk hunting districts are currently below population objectives set by the state (yellow in Figure 7).

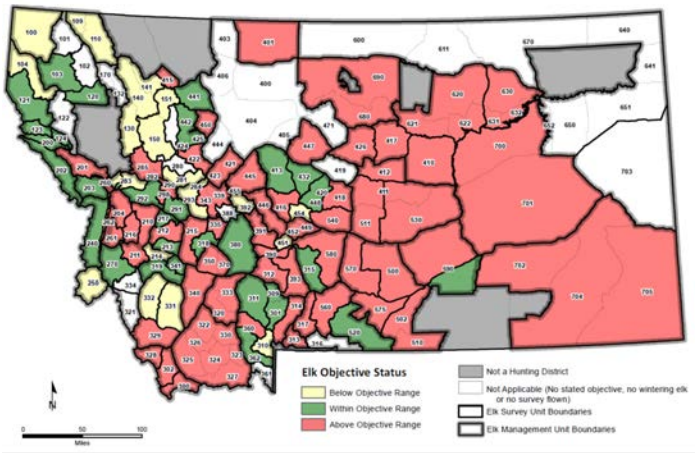

Figure 7. Montana elk population objectives by hunting district. Red above objective; Green within objective; Yellow below objective. Reprinted from Montana Fish, Wildlife & Parks.[7]

Similarly, in Idaho, elk herds currently are within or above management objectives in 17 of 22 elk management zones.[8] However, some elk herds are below population objectives. This is the case in the Lolo Zone in northern Idaho. According to Idaho Department of Fish and Game, wolves and other predators have contributed to local declines of elk

herds, along with habitat degradation and harsh winters. In response, the agency has conducted regulated hunting and targeted control efforts to reduce wolf populations in the area.[16] In Wyoming, most elk herds also are above population objectives. In 2019, Wyoming Game and Fish estimated that elk populations are 29% above objective for those herds it counts.[6]

Mule Deer and Wolves in the Northern Rocky Mountains

Hunter harvest for mule deer also has been relatively stable over the past 10 years in Wyoming[10], Montana[11], and Idaho.[12] Compared to elk, however, mule deer are more often below population objectives set by state wildlife agencies. This in part reflects a decline in mule deer populations in recent decades throughout the Rocky Mountain West. This decline is thought to be driven by a combination of factors. Loss and degradation of habitat due to residential and energy development, invasive weeds, and encroaching tree cover are important. Weather, including severe winters and drought, also impact mule deer. Other factors, including disease, competition with elk, hunting, and predation may also contribute to localized declines. Wolves eat mule deer and can impact populations in some situations. However, the quantity and quality of habitat, more than predation, typically determine how many mule deer can be supported on a landscape.[17-18]

Moose and Wolves in the Northern Rocky Mountains

Moose are relatively recent arrivals to parts of the U.S. Rockies.[19-25] Moose likely immigrated from Montana and Idaho to Wyoming in the 1850's. Restrictions on moose hunting, forest fire suppression, and predator control programs led moose to become abundant in the northern Rocky Mountains by the mid-late 1900s. Historically, moose were rare in Colorado, with only a few stray animals wandering in from Wyoming.[23-25] These strays were probably just transient animals seeking new habitats, but they never came in large enough numbers to establish a stable population. A moose population was established in Colorado with the introduction of moose into north-central Colorado in the late 1970s. Additional moose were reintroduced to the Creede area in south-central Colorado between 1991-1993 and to the Grand Mesa in west-central Colorado between 2005-2007.[25] Since then, populations have increased to nearly 3000 moose.

Moose populations have declined over the past 30-40 years through much of the U.S. The exact causes are unknown. Similar to mule deer, the decline is likely due to a variety of factors. These include habitat loss and degradation, wildfires, human development, parasites, and predation. Climate may also limit moose. Moose are adapted for cooler conditions. But, in the lower U.S., they are living in a warming climate at the southern edge of their natural range.

In the northern Rocky Mountains, predation of moose calves by grizzly bears, black bears, and wolves may contribute to moose declines. However, in Wyoming, low pregnancy rates and malnourishment were the primary limits on moose populations.[22] Also, moose are declining in areas where wolves are rare or absent. This includes southwestern Wyoming and other regions of the West. Wolves are not the primary cause of moose decline across their range. Habitat quantity and quality, including healthy willow and aspen communities, strongly influence moose populations.[21]

Potential Impacts of Wolves in Colorado

Overall, the effect of wolves on big game populations and hunting opportunities is complex. Sweeping generalizations are difficult. Ultimately, if occurring in high enough population numbers for enough time, wolves in Colorado might contribute to local reductions of some big game herds in some areas, especially in combination with habitat degradation, other predators, and human hunting. If so, this might reduce hunting opportunities for some herds.[26] Big game herds that are small or isolated might be more susceptible to wolf predation impacts. However, overall, based on evidence from northern Rocky Mountain states, wolves will likely have a relatively low impact on big game and hunting at a statewide level.

If wolves re-establish in Colorado, either naturally or through reintroduction, it will likely be initially on the Western Slope. As such, elk and mule deer would be the primary prey. Colorado supports a sufficient prey base for wolves.[27] Over 430,000 mule deer live in the state.[28] Colorado also supports over 280,000 elk, the largest elk population of any state.[28] The largest big game herds occur on the Western Slope. Colorado Parks and Wildlife (CPW) considers some elk herds as overabundant.[29] In 2018, 19 of the state's 42 elk herds (45%) exceeded population objectives set by CPW. 18 of the 42 herds (43%) were within 10% of their target population objective. CPW has been actively working to reduce overpopulated elk herds to limit damage to crops and livestock forage. In FY2018, CPW paid out $95,755 in claims due to elk damage. In this context, if wolves help reduce overabundant elk herds causing damage, this might be viewed as beneficial. Only 4 (10%) out of the state's 42 elk herds were below objective targets in 2018. In particular, herds in the southwest corner of the state have been recently declining. Long-term drought and increasing human development are likely contributing causes.

As in the northern Rocky Mountains, mule deer in Colorado are more often below population objectives than elk.[29] In 2018, 10 out of 54 deer herds (19%) exceeded their population objective by more than 10%. In FY2018, CPW paid out $28,660 in claims due to deer damage. 25 out of 54 deer herds (46%) were below their population objective targets.

Ultimately, wildlife managers have a variety of tools to manage predators, big game, and hunter harvest. One tool is regulated harvest of both predators and big game. Harvest can be manipulated to achieve management objectives for predator and prey populations. Harvest of wolves in Colorado would be possible only if they are no longer protected under the U.S. Endangered Species Act and are classified as a game species by Colorado Parks and Wildlife. Also, habitat quality is often more important than predation in driving population dynamics of big game, including in Colorado.[17,30-31] Thus, another management tool to ensure thriving herds and hunting opportunities is to improve big game habitat. This can include habitat restoration to improve forage quality. Reducing habitat degradation due to human development is also important. Scientific monitoring of populations of both predators and big game can ensure that the numbers of predators and prey has achieved the desired balance.

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COLORADO STATE UNIVERSITY EXTENSION

Wolves and Disease

By the Center for Human-Carnivore Coexistence (5/20)

How might wolves affect chronic wasting disease in elk and deer in Colorado?

Chronic wasting disease (CWD) is a contagious and fatal neurological disease found in deer, elk, and moose. It is caused by the transmission of an abnormal protein called a prion. CWD is relatively widespread in Colorado.

Mule deer herd

Wolves are predators that chase prey. Wolves tend to target slower, more vulnerable individuals, including sick and diseased animals.[1,2] One study developed a mathematical model predicting that selective predation by wolves would result in a more rapid decline in CWD in deer compared to hunting by humans.[3] The model suggested that wolf predation may help limit CWD. There has been no field study to test this prediction. However, wolf predation has been shown to help control disease (tuberculosis) in wild boar in Spain.[2]

Insight can be gained from other predators. Studies in the Front Range of Colorado showed mule deer killed by mountain lions were more likely to be infected with CWD than mule deer killed by hunters.[4] This suggests that mountain lions select infected animals when targeting adult deer. Such selective predation by mountain lions, however, did not limit CWD transmission in deer populations with high infection rates.[5] Unlike wolves who run when hunting, mountain lions are considered "ambush" predators that sit and wait for prey to pass. Such predatory behavior might make them less likely to detect sick animals compared to wolves.[5]

When carnivores eat infected prey, CWD prions can remain infectious in carnivore feces.[6] But, canines appear to be naturally resistant to prions.[7] We there - fore would not expect the number of prions to increase in their digestive tracts. In fact, CWD prions may be degraded as they pass through the digestive system.[6] While predation may not eliminate CWD from deer or elk populations, predators that selectively prey on infected animals would be expected to reduce the number of infections. This would be more likely in areas where wolves are well-established.

What is hydatid disease and can wolves spread it to humans?

Hydatid disease is caused by tapeworms in the *Echinococcus* genus.[8 - 12] *Echinococcus* tapeworms require two hosts to complete their lifecycle.

Key Points

- Chronic wasting disease (CWD) is a contagious and fatal neurological disease found in deer, elk, and moose in Colorado. Selective predation by wolves on sick and diseased animals may help limit CWD in big game, but no field study has tested this prediction.
- Hydatid disease is caused by the *Echinococcus* tape- worm. Canines such as wolves, coyotes, foxes, and domestic dogs are the definitive host, and ungulates such as deer, elk, moose, and domestic livestock are intermediate hosts. In rare circumstances humans may be infected by accidently ingesting eggs, but direct human infection from wolves is extremely unlikely.
- Dogs and wolves are closely related and also can share many of the same parasites and diseases. Dogs are much more likely to infect wolves than vice versa.

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Definitive hosts support adult tapeworms. Domestic dogs and wild canines (e.g., coyotes, foxes, and wolves) are definitive hosts. Intermediate hosts support the immature (cyst) form of the tapeworm. Several species can be intermediate hosts, including small mammals (e.g., rodents) and ungulates (hoofed animals), including both wild ungulates (e.g., deer, elk, moose) and domestic livestock (e.g., sheep, pigs etc.).[8,9]

Tapeworm cysts in moose lung. Photo by Alaska Department of Fish and Game

Tapeworms need both the definitive and intermediate hosts to complete their life cycle (Figure 1). The adult tapeworm lives within the intestines of the canine and releases eggs into the environment via canine feces. The intermediate host then ingests the eggs by eating contaminated vegetation. The cycle is completed when a canine eats the infected organs of an intermediate host.

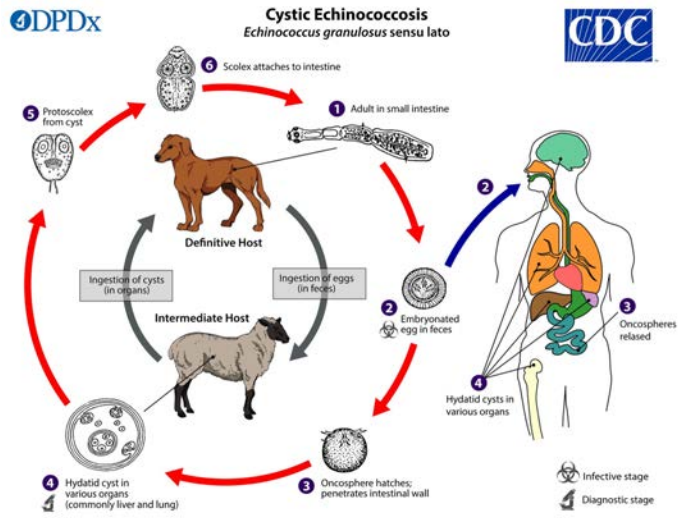

Figure 1. Echinococcus life cycle for domestic cycle of tapeworm infection, including domestic dogs and domestic livestock. Reprinted from Center for Disease Control.[12]

North America has multiple wild and domestic cycles of tapeworm infection. The wolf/ungulate wild cycle has been documented since the early 1900s.[8-10] The species of tapeworm most commonly found in wolves is *Echinococcus canadensis*. Recently, *E. canadensis* was confirmed as regularly cycling in wolves and wild ungulates in western North America, with infections present in 30-60% of wolves tested.[9,10] *E. canadensis* has been documented in Colorado.[11] In 2017, a hydatid cyst was identified in a Colorado moose. This case occurred in the apparent absence of resident wolves, suggesting other canids may have been involved. In 2020, *E. canadensis* eggs were identified in feces from gray wolves that migrated into northwestern Colorado.[11]

Humans may be infected from accidentally ingesting tapeworm eggs. Infections are typically from the species of tapeworm (*E. granulosus*) in the domestic cycle between dogs and livestock (often sheep or pigs; Figure 1).[8,10,12] People are infected from interaction with working or companion dogs with eggs in their feces or on their paws or fur. However, human infection is rare in North America. There have been no documented human cases of hydatid disease originating from within the United States for several years, although some people have acquired infection traveling abroad.[8]

Direct human infection from wolves is therefore extremely unlikely. Also, the hydatid disease caused by *E. canadensis* is considered relatively benign in comparison to those infections arising from the domestic cycle between dogs and livestock.[8,10]

There are several basic precautions that can minimize the risk of human infection. Avoid touching or handling feces of wild canines. Hunters should wear gloves when field dressing carcasses and wash hands thoroughly. Contact with or consumption of the hydatid cysts in the organs of ungulates can be a source of infection to domestic dogs. To minimize risk of infection, dog owners should prevent their dogs from consuming ungulate carcasses and should regularly deworm their dogs.

Can wolves and domestic dogs transmit diseases to one another?

Dogs and wolves are closely related and can share many of the same parasites and diseases.[13] Dogs are much more likely to infect wolves than vice versa. Dogs are the world's most common carnivore[14] and typically greatly outnumber wolves.[15,16] Thus, diseases can be maintained in dog populations and can then spill over to wolves.[13] Also, diseases in wolves and dogs can occur in other wildlife, which often outnumber wolves too. So, the risk of dogs being infected by wolves is low.

Wolves that are deliberately released during restoration programs are typically vaccinated against common canid diseases and treated with antiparasitic drugs. Such was the case for wolves restored to Yellowstone National Park.[17] Upon release, wolves therefore should be healthy, but can subsequently contract diseases and parasites when exposed in their new environment.

Rabies, parvovirus, and distemper can be particularly impactful to wolves. Rabies is a fatal viral disease that infects the central nervous system.[18] Rabies has occurred sporadically in wild wolves globally.[13] It is rare in North American wolves, with only infrequent accounts in Alaska and Canada.[19,20] When rabies outbreaks do occur, it can result in local declines in wolf numbers.[13,19-21] However, wolves are unlikely to be a long-term reservoir host for rabies.[13] Most incidents of rabies occur in other wildlife such as raccoons, skunks, foxes, and bats.[13,18] Wolves can contract rabies from other species, including dogs. For example, dogs appear responsible for transmitting rabies to endangered Ethiopian wolves.[14,22,23] This caused massive outbreaks in the wolf population.

Distemper and parvovirus ("parvo") are contagious viral diseases that can infect both wolves and dogs.[24,25] Parvovirus is primarily spread from direct contact and contaminated feces. Distemper is typically spread through airborne exposure from sneezing or coughing. Dogs can transmit these diseases to wolves.[13,26] For example, an outbreak of parvovirus in wolves in Isle Royale National Park likely came from dogs.[27,28] Distemper outbreaks in Ethiopian wolves also likely originated with dogs.[22,23] Distemper and parvovirus also have been detected in wolves in Yellowstone, Banff, and Jasper National Parks.[29-31] However, dogs are likely not playing an important role in these areas. Rather, the diseases are likely circulating in other wild carnivores (e.g., raccoons, skunks, coyotes, and foxes) in and around the Parks.

External parasites can also infect both wolves and dogs.[13] For example, wolves in Alaska have been infected by lice introduced by dogs.[32] Dog lice can impact the health of individual wolves but is not considered a threat to wolf populations. Sarcoptic mange – a skin disease caused by parasitic mites - can also infect both wolves and dogs. However, there is no indication of transmission of mange between dogs and wolves.[13] Rather, wolves are more likely to be infected from wild canids, such as foxes, coyotes, and other wolves.[17,33,34] Mange outbreaks can cause local declines in wolf populations.

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COLORADO STATE UNIVERSITY
EXTENSION

Wolves and Livestock

By the Center for Human-Carnivore Coexistence (5/20)

What are the potential impacts of wolves on livestock in Colorado?

Impacts to livestock from wolves creates costs borne by livestock producers (*see Wolf Economics Information Sheet*). Calculating these costs, including mortality from wolf predation and other indirect impacts, is challenging. Part of the problem is not knowing exactly how many livestock are killed by wolves each year. For example, in the Northern Rocky Mountain states of Montana, Idaho, and Wyoming, the U.S. Fish and Wildlife Service (USFWS) confirmed a total of 136 cattle (both adults and calves) and 114 sheep (adults and lambs) killed by wolves in 2014.[1] In contrast, the National Agricultural Statistics Service (NASS) reported 2,835 cattle and 453 sheep killed by wolves in the same region and year.[2,3] The USFWS data are underestimates because they don't include livestock that are killed by wolves but are never found or reported.[4,5] The NASS numbers are based on a self-reported survey of livestock producers and do not include verification of kills. This leaves the accuracy of the NASS data in question, and the reports likely overestimate the number of livestock killed by wolves.[6]

One way to estimate impact of wolves on the livestock industry is to calculate the proportion of livestock killed by wolves out of the total number of livestock in counties with wolves. Using

USFWS data of confirmed wolf kills[1] and NASS data of number of cattle[2], the calculated percentage of cattle killed by wolves in the Northern Rocky Mountain states is under 1%. However, this calculation ignores livestock that are not vulnerable to predation (e.g., in feedlots or on range where wolves do not occur) and thus likely underestimates the percentage. Nonetheless, the available data suggest that mortality caused by wolves is a small economic cost to the livestock industry as a whole.[7]

However, in addition to mortalities, producers can also suffer indirect losses such as stress, sickness, and reduced weight gain and pregnancy rates when wolves scare, chase, or attack livestock.[8 - 11] The indirect effect of wolves on livestock is not well studied so estimating the extent of indirect losses is difficult. Costs could be considerably higher when including unseen deaths, indirect losses, and expenses for producers to deter wolves or to seek compensation (*see Wolf Economics Information Sheet*).[9] Indirect losses might be more likely on ranches where wolves are already killing cattle.[10]

Although wolf depredation on cattle and sheep accounts for less than 1% of the

Key Points

- Impacts to livestock from wolves creates costs borne by livestock producers, including mortality from wolf predation and other indirect impacts. These costs are unevenly distributed and localized, with some producers suffering greater losses than others. Although wolf depredation is a small economic cost to the livestock industry as a whole, the impacts to individual producers can be substantial.
- On rare occasions wolves only eat a portion of what is killed. Such events can have negative economic impacts and reinforce negative perceptions towards wolves. They are therefore important to minimize and prevent.
- Wildlife managers and livestock producers have a variety of management tools to reduce conflict with wolves. This entails alterations in livestock practices and/or efforts to manage wolves. Both non-lethal and lethal tools can be effective and used proactively to prevent conflict or reactively after conflict has occurred.

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annual gross income from industry-wide livestock operations in the Northern Rocky Mountains, these costs are unevenly distributed and localized, with some producers suffering greater losses than others.[7,12] For those impacted by wolf predation, the economic and emotional impacts can be substantial. Both direct and indirect losses could significantly affect the livelihood of individual ranchers operating on thin profit margins in volatile markets. At a stakeholder workshop in February 2020, ranchers shared their belief that wolf reintroduction poses a threat to rancher's security regarding their livelihood and way of life.[13]

Understanding why some producers are more vulnerable to wolf predation and others are not is an active area of research.[14] The answer likely includes where livestock are grazed (some areas have more wolf activity than others); the type of livestock (sheep are more vulnerable than cattle); the type of operation (e.g., cow/calf versus stocker); range versus pasture operations; and how much the livestock are protected.

Do wolves sometimes kill more prey than they can eat?

On rare occasions predators kill many animals in excess of their food needs and only eat a portion of what is killed. This is sometimes called surplus killing, excess killing, or partial prey consumption.[15 - 21] This behavior has been documented in a wide variety of predators, including wolves, foxes, weasels, bears, shrews, spiders, and insects.[19] One of the better-known examples of partial prey consumption involves grizzly bears catching salmon, only eating the eggs and other select body parts, and discarding most of the remaining fish. Bears do this when there are so many fish that are easy to catch they can consume only the most nutritious and calorie rich parts of each caught fish.

For wolves, this type of predation event can occur on native ungulates such as deer, moose, or caribou[17-19] and livestock such as sheep.[7] It is generally believed that the vulnerability of the prey plays a large role in excess killing. For example, a study in Minnesota found that after an unusually severe winter, white-tailed deer were in very weak condition and for a few weeks wolves killed deer at much higher rates than normal and only partially consumed the carcasses.[18] Like the bear example, wolves were likely trying to maximize their energetic gain and taking advantage of a short period when their prey was vulnerable.

Surplus killing on livestock may be more frequent than on wild prey because livestock are typically more vulnerable to predation.[7] One study found that in the Northern Rocky Mountains from 1987-2003, wolves excessively killed sheep but not cattle. On average there were about 3 surplus killing events on sheep per year and an average of 8.85 sheep killed per attack.[7] Compared to cattle, sheep and goats are thought to be more vulnerable because of their smaller size, fewer defenses (e.g., horns), and their tendency to occur in flocks that can supply large numbers of concentrated prey. Another factor is that corrals and other enclosures for livestock can make it easier to catch multiple livestock.[21]

Although uncommon, such events can have negative economic impacts for producers. Such events can also be viewed as needless killing, reinforcing negative perceptions towards wolves. They are therefore important to minimize and prevent using approaches described below.

What management tools are available to reduce livestock conflict with wolves?

Wildlife managers use a variety of strategies to prevent or reduce livestock conflict with wolves. Some tools are reactive, meaning management occurs after the conflict happened. Other tools are proactive, meaning management occurs prior to conflict. Management actions are often situation-dependent and involve an integrated approach, combining both lethal and non-lethal methods.

Lethal methods can include regulated hunting (proactive) or targeted removal (reactive). Regulated hunting of wolves can limit wolf populations.[22 - 25] Lethal removal of wolves in reaction to conflict, for example killing livestock, can be effective if targeted to the correct individuals.[26 - 28] Some studies have suggested that lethal removal of wolves only temporarily reduces depredation and actually may eventually increase conflicts.[29 - 31] For example, one study concluded that killing wolves may displace depredations to neighboring properties.[31] Another study reported that lethal removal might increase depredations the following year as new wolves breed and fill vacancies[29], although these conclusions were contradicted when other researchers re-analyzed these data.[32]

Proactive non-lethal tools can help prevent conflict. Such tools often focus on modifying wolf, livestock, and/or human behavior to minimize encounters.[26, 33-35] For example, physical or psychological barriers or scare tactics can be established to try to ward off wolves and other predators. These include fencing, fladry (flagging), lights, and sound devices, which rely on novelty and are effective at least temporarily.[36] Livestock guardian dogs also can deter wolves, although wolves also can kill guard dogs and thus finding the right breed and number of guard dogs is important.[37] Wolves also tend to avoid humans, so people accompanying livestock (e.g., herders, range riders, or scouts) can reduce encounters and also help manage herds proactively.[38] Modifying livestock management practices can help,[26, 33, 39] particularly during calving or lambing when animals are most vulnerable. For example, grazing strategies can be altered to avoid wolves, for instance by moving livestock away from known wolf dens. Removal of carcasses of livestock that have died can also be useful, as carcasses attract wolves and other predators. Such non-lethal tools entail costs in terms of time, labor, and money that need to be considered if they are to be implemented.

Fladry

For all of these strategies the scale and the context will determine whether or not they are effective. For example, fladry is only appropriate for small pastures, guard dogs are only effective if they are large enough or in a big enough group to deter wolves, and livestock that are spread widely across a landscape are more difficult to protect.

Local communities can apply combinations of strategies and tools. For example, the ranching community in the Blackfoot Valley of Montana uses a collaborative, grass-roots approach to reduce conflicts with predators through proactive strategies.[39] They remove and compost livestock carcasses, fence calving areas, and employ wildlife technicians to monitor livestock and wolves. This has helped reduce both the number of livestock and wolves killed in the community. The program is funded from a combination of sources, including governmental agencies, private foundations, corporations, and individual donations.[40]

In addition, producers can be financially compensated for livestock lost to wolves (*see Wolf Economics Information Sheet*).[7 - 9, 41, 42] Such programs are often underutilized by producers. These compensation programs have also been criticized for their high costs and burden of proof to verify kills, inadequate funding

to fully compensate for losses, and lack of incentives to prevent conflict. Alternative incentive models, where producers are paid to coexist with wildlife, including carnivores, are being proposed as we learn from ongoing programs.[41, 43] These models are commonly referred as “payment for ecosystem services”.

Several useful manuals exist to help landowners with approaches to reduce conflict between livestock and wolves.[44 - 46] These documents review in more detail the variety of tools and best management practices available to reduce and even prevent livestock losses to predators.

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Wolf Economics

Information Sheet 8.012 People and Predator Series | Colorado Wolves

By the Center for Human-Carnivore Coexistence (6/20)

Estimating the value of wolves

Comparing costs and benefits of different options is often helpful for making decisions about how we manage natural resources. But how do we estimate a value for something not found in markets? For example, water flowing in our rivers is valued for its aesthetic attributes, boating and fishing, and to provide habitat for endangered fish. Water is also a critical resource for growing crops, for industry, for washing dishes, and to water lawns. Some uses of water, like irrigating crops or use in our homes, have markets where prices indicate their value. Other uses, like floating down a river in your personal kayak, may not have markets that indicate their economic value. Likewise, we know wolves provide both benefits that are valued in the market, like the price of a wolf pelt, and benefits that don't have a market value, like their contribution toward balancing eco-systems.

To be able to compare benefits and costs, we have to convert them into common units (that is, dollars), including those that do not have a market value. Economists have several ways to calculate non-market values.[1,2] The types of market and non-market values referred to in this Information Sheet are:

- *Consumptive use value* – Consumptive uses reduce the quantity of a resource. For example, hunting wolves would produce economic benefits to those reliant on the hunting industry, but would reduce (consume) the wolf population. Likewise, predators like wolves will reduce consumptive use values (a cost) when they consume big game that others want to hunt.
- *Non-consumptive use value* - Non-consumptive uses do not diminish the quantity or value of a resource. For example, viewing or snapping a picture of a wolf is non-consumptive, because the number of wolves is not affected by the economic activity. Video or printed photos for nature programs are examples of non-consumptive uses.
- *Existence and bequest value* – Some people would be willing to donate or allow their tax money to be used to protect wolves and other carnivores, even if they would never get a chance to see them in person. They would pay for their existence, and to make sure the resource is there for future generations.

Benefits

No studies in Colorado have measured the economic benefit of wolves, but we can look at the consumptive use, non-consumptive use, and existence/bequest values found in research about other states or regions for some insight.

Key Points

- The cost of wolves includes weight and death losses to livestock producers, lost hunting and recreation opportunities, and costs for monitoring and management.
- Benefits include consumptive use (e.g., state and private returns from wolf hunting, if allowed), non-consumptive use (e.g., tourism to view wolves), and existence and bequest values (the value to just know wolves exist and will be there for future generations).
- The benefits of wolves would apply broadly to people in Colorado, but costs will fall disproportionately on relatively few, especially livestock producers and potentially those reliant on the big game hunting industry. Careful planning and discussion about how to mitigate losses from wolves, manage wolf populations, and compensate people for losses can be aided by extensive experience in other states.

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Consumptive use values - Wolf hunting is now allowed in much of the Northern Rocky Mountains (NRM), which generates revenues that would be considered consumptive use. For example, the sale of licenses for hunting and trapping wolves in Montana tops $400,000 per year.[3] Plus, hunters spend money for travel, housing, food, and equipment, generating income for hotels, restaurants, and hunting guides. Some ranchers may be able to offset losses associated with wolves by providing access to their property and services (guiding, housing) to people that hunt wolves, if and when hunting is allowed in Colorado. For example, some private ranches in Colorado[4a] charge from $2,400-2,950 per hunter, in groups of [4-6], for private elk and deer hunts (up to $90,000 per ranch). An Idaho outfitter[4b] offers wolf hunting on Idaho ranches for $3,800 for a single hunter. The potential for revenues based on consumptive uses is clearly present in Colorado.

Non-consumptive use values - Wolves provide opportunities for people to view, film, photograph, listen to, or otherwise experience wolves in their natural habitats. Tourists flock to Yellowstone National Park for a chance to see wolves. When first introduced into Yellowstone National Park in 1995, economists estimated that visitor use would increase by 5% for out-of-area residents and 10% for local residents.[5] Ten years later, economists confirmed that visitation was as predicted and that wolf-related visitation produced $47 million annually in travel expenditures in Idaho, Montana, and Wyoming.[6,7]

Wolf watchers in Yellowstone National Park. Photo courtesy of National Park Service.

Today, guided hiking to view wolves in Yellowstone costs $600 to $900 per day, depending on the size of the group, and a six-day 'wolf vacation' goes for $1,950 per person.[4c] The benefit of wolf-related tourism in Colorado may be more limited than the unique wolf viewing opportunities in Yellowstone's northern range, which has high wolf density, radio-collared wolves, outstanding viewsheds, and good access via paved year-round roads. However, Colorado is also a top tourist destination and many of its citizens would likely benefit from developing a wolf-related tourism industry.

Existence and bequest values – Few studies have estimated the existence value of wolves. One study estimated that existence value from introducing wolves in northern Yellowstone was $11 million per year when adding together everyone's willingness to pay in the United States.[7] Existence values can be compared to the costs of introducing wolves, along with other benefits and costs, to help policy makers manage natural resources. If benefits outweigh costs, society gains by introducing wolves. Existence values will likely be important in Colorado too, but a specific study would be required to know how much.

Costs

Many costs accompany coexistence with wolves. Some are more difficult to value than others. Costs generally fall into three main categories: personal impacts, commercial production, and public management.

Personal impacts occur when people's lives are personally changed in some meaningful way. For example, although the risk of wolves attacking people is low (see *Wolves and Human Safety Information Sheet*)[8], people who fear wolves might alter their recreation plans. There are no known studies about the costs of personal impacts, but anecdotal Information can show what these costs might be. For example, parks and governmental agencies post warnings about the risk of wolf attacks when hiking, especially with dogs.[9] Although rare, people have been bitten, have experienced standoffs with wolves on the trail, and have even been chased away from campsites.[10] These potential negative encounters almost certainly lead some people to curtail their recreational activities, but studies would be required to confirm their true impacts.

Costs to commercial production - Another potential cost of wolves is reduced income for some Colorado

businesses, primarily hunting and ranching. At a local level in states with strong wolf populations, elk numbers are stable or increasing in many areas where wolves and elk interact, but they have declined in others.[11] At the statewide level, the number of elk harvested by hunters has not declined in the Northern Rocky Mountains (NRM), despite increases of wolves (see *Wolves, Big Game, and Hunting Information Sheet*). An economic analysis in Montana concluded that, overall, wolves have not had a significant economic effect on elk harvest in the state.[12] Rather, demand for hunting shifted from the southwest region near Yellowstone to areas farther away from where wolves were first introduced. Based on the few studies that are available, hunting-related benefits in Colorado are not likely to decline substantially overall. However, at a local level, where wolves contribute to declines in big game herds and hence hunting opportunities, this would result in a cost to those reliant on hunting to support their livelihoods.

The largest commercial cost is from wolves harassing and/or killing livestock. The economic cost of livestock killed by wolves is determined by multiplying the number of animals lost times fair market value. However, counting these losses is difficult because the exact number of livestock killed by wolves is not known (see *Wolves and Livestock Information Sheet*). For example, the U.S. Fish and Wildlife Service (USFWS) confirmed a total of 136 cattle (both adults and calves) and 114 sheep (adults and lambs) killed by wolves in 2014 in the NRM.[13] In contrast, the National Agricultural Statistics Service (NASS) reported 2,835 cattle and 453 sheep killed by wolves in the same region and year.[14,15] The USFWS data are underestimates because they don't include livestock killed by wolves but are never found or reported, whereas the NASS numbers are likely overestimates because they are based on self-reported surveys of livestock producers and do not include verification of kills. Thus, these vastly different estimates of the number of livestock killed by wolves makes it difficult to calculate the precise cost of wolf depredation. What is known is that the proportion of livestock killed by wolves is low, and mortality caused by wolves is a small economic cost to the livestock industry as a whole.[16]

Although wolf depredation on cattle and sheep accounts for less than 1% of the annual gross income from livestock operations in the Northern Rocky Mountains[16], these costs are unevenly distributed and localized (see *Wolves and Livestock Information Sheet*). As such, low average industry-wide costs could mask high costs for some individual producers. Studies show that producers that experience predation are more likely to continue to so.[17] Furthermore, several studies show that costs could be many times higher when including unconfirmed deaths and indirect losses such as lower market weights, reduced conception rates due to stress, and producer mitigation costs to deter wolves or to seek compensation.[16-20] For example, one study found that calves in herds that experienced predation were 22 lbs. lighter and, when added across all calves in those herds, accounted for a greater loss than confirmed depredations.[17] Other studies found unverified and indirect losses to be at least 6 times that of verified losses.[18-19] A later study found that these estimates of unaccounted losses may be overstated.[21] Clearly, more research is required to know exactly how much producers might lose if wolf populations expand in Colorado.

Cost of public management – The government also incurs costs to manage wolves. State government monitors wolves, prepares reports, and manages hunting licenses. The federal government also monitors and manages wolves where they are endangered. The government also provides compensation payments through federal, state, and county programs, as do some non-governmental agencies. The USFWS estimated that, in 2015,

almost $6.5 million was spent on managing wolves by state, federal, and tribal agencies in a region composed of northern Wyoming, Montana, North Dakota, the Idaho panhandle, Washington and Oregon.[13]

Fiscal analysis of Ballot Proposition 114 (see *Wolf Policy Information Sheet*) forecasts annual costs to the state of Colorado of $350,000-450,000 for the first 2 years of the planning phase of wolf reintroduction.[22] Costs are expected to increase as the plan is implemented and wolves are reintroduced. Future costs will depend on the details of the plan that is developed by Colorado Parks and Wildlife.

Compensation

Government agencies and private organizations offer a variety of programs to compensate producers for livestock lost to predators, including wolves.[20,23] Defenders of Wildlife, for example, operated a trust to pay for livestock losses for nearly 25 years starting in 1987.[24] Most states have created separate programs for wolves and receive federal grants to help with the cost. Wyoming paid about $170,000 in 2018 for livestock killed or injured by wolves[25], which is a typical amount for western states. The USDA Farm Services Agency's Livestock Indemnity Program will reimburse 75% of the value of killed livestock.[26]

Studies show that livestock producers underuse these programs and often do not like the way they are operated.[16,23,27-31] Primary problems include high costs and burden of proof to verify kills. Producers that use the USDA Livestock Indemnity Program, for example, sometimes find that they receive only a portion of their costs and with a significant wait time. Another criticism is inadequate funding to fully compensate for unverified kills or indirect losses. Some states do pay based on a compensation ratio meant to account for unverified kills and indirect losses. For example, Washington state pays 2 to 1 for confirmed damages[32], whereas Wyoming pays up to 7 to 1.[20] As discussed above, there is a great degree of disagreement among studies about actual losses. If the wolf population expands in Colorado, determining these values will be important for producers and the efficacy of wolf management in the state.

The value and structure of compensation programs has been widely discussed in the literature. One study[20] looked at over 100 programs around the world and found five reasons for compensation programs: 1) to reduce retaliatory or preventative killing of predators; 2) to improve producer attitudes toward predators; 3) to improve compliance with suggested conflict avoidance/reduction schemes; 4) to assist the economic sustainability of large ranches that have potential to coexist with predators (thereby preventing conversion of these lands to residential development); and 5) to improve economic equity (i.e., fairness) by distributing the costs of carnivore conservation among a larger group and not solely on affected producers. Studies show, however, that compensation programs do not necessarily change ranchers' attitudes towards carnivores.[23,30] Also, most do not offer incentives for producers to take preventative measures to avoid conflict.[27,28,30,31] Some solutions have been proposed in the scientific literature. For example, some have suggested that instead of paying ranchers for losses, we should be paying them to coexist with wolves.[27, 34, 35] This idea, and others, need to be considered thoroughly if Colorado is to have a fair and effective program.

Currently, Colorado Parks and Wildlife (CPW) does not have the authority to compensate ranchers for livestock losses caused by wolves.[36,37] Proposition 114 mandates that, if wolves are reintroduced, producers receive fair compensation for livestock depredation by wolves (see *Wolf Policy Information Sheet*).[38] Costs for compensation are to be borne by CPW's wildlife cash fund, derived from hunting and fishing licenses, unless the wildlife cash fund can't fully pay for such expenses.[37] The details of the compensation process are yet to be determined but

will depend on the restoration plan developed by CPW, in cooperation with other governmental agencies, private citizens, and organizations.[36, 37]

Conclusions

It is difficult to make precise estimates of economic costs and benefits of wolves in Colorado. Based on past research and experience in other states with wolves, Colorado citizens could benefit from consumptive use (e.g., hunting wolves), non-consumptive use (e.g., tourism related to viewing), existence value, and bequest values for future generations. But, at what cost? The benefits were estimated to be about twice the costs where wolves were first introduced into Yellowstone and northern Idaho,[7] but could be different in Colorado. In addition, the size of the benefits or costs may not be the most important issue. Costs will fall disproportionately on livestock ranchers and potentially those reliant on the big game hunting industry. The distribution of who pays these costs, versus who gets the benefits, presents a significant social and political challenge. This challenge can be met, and potential social conflict reduced, if Colorado maintains a productive dialog with those most affected by wolf reintroduction (see *Dialogue and Social Conflict Information Sheet*). This process can be aided by the experiences of other states that have dealt with similar situations.

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Public Perspectives on Wolves and Wolf Reintroduction

By the Center for Human-Carnivore Coexistence (5/20)

Attitudes Towards Wolves and Wolf Reintroduction in the US and Beyond

Public opinion surveys have been used by social scientists to study the attitudes of the general public and specific stakeholder groups towards wolves and wolf reintroduction. These surveys have found that public attitudes towards wolves are on average positive[1,2] and have become more positive across the past several decades.[1] However, these attitudes can vary significantly by experience with or proximity to wolves, stakeholder groups, and demographics.[2-5] A 2014 survey of U.S. residents found 61% of respondents had positive attitudes towards wolves.[1] Across 38 quantitative public opinion surveys conducted between 1972 and 2000 in the U.S., Canada, and Europe, an average of 51% of all respondents had positive attitudes towards wolves and 60% had positive attitudes towards wolf reintroduction.[2] Across these studies, attitudes towards wolves were associated with a variety of different demographic characteristics, such as age, income, and urban/rural residence.[2]

Studies suggest that attitudes towards wolf reintroduction are influenced by individuals' beliefs about the right for wolves to exist as well as their emotional responses to wolves.[6,7] People often have strong emotions towards wolves because wolves are seen as representative of broader societal-level conflicts, such as clashes between urban and rural values and the struggle among different stakeholder groups for a say in decision-making about wildlife management (see *Dialogue and Social Conflict about Wolves Information Sheet*).[8,9] Studies have also found that proximity to wolves can influence attitudes. In particular, people living in areas with wolves tend to have more negative attitudes towards wolf conservation than people living outside these areas.[2,4] This effect may be due to both direct[5] and indirect experiences with wolves[4] (e.g., interactions with other people about wolves). An exception is Yellowstone National Park, where visitors from the local area supported wolf reintroduction more than out-of-area visitors.[10] These local residents stand to gain substantially from tourism, which may influence their views.[10]

A 2011 study on willingness to coexist with large carnivores in communities in Washington, Idaho, and Montana where wolves are present provides further insight on public perspectives towards wolves.[11] Interviews with community residents indicated that social group (e.g.,

Key Points

- Public attitudes towards wolves and wolf reintroduction are generally positive in the U.S., including Colorado, but can vary by demographics, geography, and stakeholder groups. Both online and mail surveys conducted over the last few decades have found consistent support for wolf reintroduction among a majority of Colorado residents on the Eastern Plains, Front Range, and Western Slope.
- Perceived positive impacts of wolves include the ability of wolves to restore balance to ecosystems and improve the environment, emotional and cultural connections to wolves, wolf viewing opportunities, and moral arguments for wolf restoration (e.g., "it's the right thing to do").
- Perceived negative impacts include ranchers incurring costs from wolves preying on livestock, reduced deer and elk populations and hunting opportunities, and threats to the safety of people and pets.

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tribal members, ranchers, non-ranchers), historical context, and management policies influenced attitudes towards wolves. Tribal members were more willing to coexist with wolves, due to their view that living with carnivores is an important part of their cultural heritage. Ranchers felt particularly strongly about the need for lethal control of large carnivores such as wolves, but attitudes about the need for lethal control varied depending on how long wolves have been present on the landscape. Community members in Montana and Idaho with past experience living with wolves more frequently discussed strategies to adapt ranching practices to minimize livestock depredation by wolves. In contrast, a community in Washington where wolves had recently colonized more frequently discussed lethal control of wolves as a strategy to reduce conflict. Communities reported a higher degree of acceptance of wolves where there was a perceived ability to control wolves through management actions. Community members' perspectives towards wolves were also influenced by whether they felt understood by society and were able to have a voice in decision-making about wolves, pointing to the need for an inclusive process for making policy and management decisions (see *Dialogue and Social Conflict about Wolves Information Sheet*).

There is mixed evidence on the impact of economic incentives and other management strategies for minimizing human-wolf conflict on public attitudes towards wolves (see *Economics of Wolves in Colorado Information Sheet*).[12] A 2004 study in Sweden found that livestock producers who received subsidies for predator-proof electric fencing tolerated wolves better than those who did not.[13] However, economic incentives and wolf management strategies- including legalized predator killing- do not always increase tolerance.[12,14,15] For example, a 2001 study in Wisconsin found that livestock producers who were compensated for wolf depredation were not more tolerant than producers who were not compensated for their livestock losses due to wolves.[14]

Overall Support for Wolf Reintroduction in Colorado

In Colorado, multiple studies have found an overall high level of public support for wolf reintroduction. A 2019 online survey conducted by Colorado State University (CSU) researchers found that 84% of the 734 residents surveyed would vote for wolf reintroduction (see Figure 1).[16] People who took the survey represented the Colorado population in terms of age and gender and results were weighted to be representative of region (Eastern Plains, Front Range, and Western Slope). Survey respondents had no knowledge of the survey topic before agreeing to take the survey for pay, so there's no reason to believe wolf-advocates were over-represented in the survey. Online recruitment may, however, create some bias towards individuals with high technology awareness.

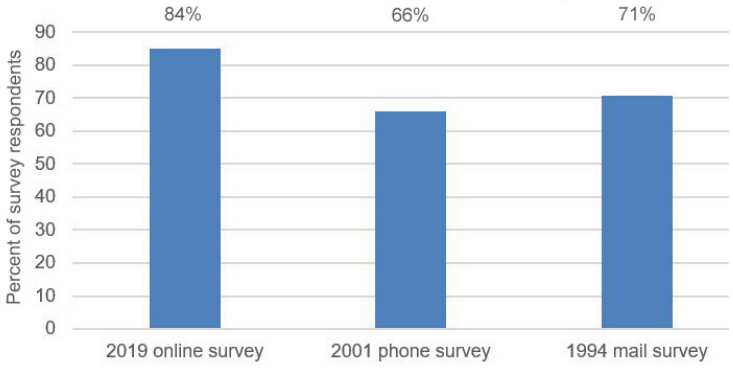

Figure 1: Proportions of Colorado residents indicating they would vote in favor of wolf reintroduction from a 2019 online survey[16] , a 2001 phone survey[18] , and a 1994 mail survey[17] .

The level of support identified in the 2019 survey was an increase in support from a mail survey conducted by CSU researchers in 1994, which found that 71% of the 1,452 residents surveyed would vote for wolf reintroduction.[17] The 2019 findings also showed a higher level of support compared to a phone survey conducted in 2001, which found that 66% of 500 Colorado residents surveyed were supportive of reintroduction[18] (Figure 1). The 2019 and 1994 surveys measured public support by asking residents if they would vote for or against wolf reintroduction without providing any detailed information about wolves and wolf reintroduction. The 2001 survey measured public support before and after providing persuasive arguments for and against wolf reintroduction but found that persuasive arguments had little impact on support.[18]

Support for Wolf Reintroduction in Colorado by Geography and Stakeholder Groups

Surveys reveal that while support for wolf reintroduction is highest among the urban and Front Range population in Colorado, the majority of rural residents also support reintroduction.[16,18] The 2019 survey found that 85% of Front Range residents, 80% of Western Slope residents, and 79% of Eastern Plains residents would vote in favor of wolf reintroduction (see Figure 2).[16] The 2019 survey also found that 83% of those from rural areas and 66% of those who strongly identified as hunters would vote for wolf reintroduction. Prior surveys in Colorado have found similar trends. The 1994 survey found that 74% of Eastern Slope residents would support wolf reintroduction compared to 65% of Western Slope residents.[17] The 2001 survey, which included residents from Colorado, New Mexico, and Arizona, also found support was highest among urban residents (73%), but the majority of hunters (59%) and people from rural areas (60%) still supported wolf reintroduction.[18]

Evidence on rancher perspectives towards wolf reintroduction in Colorado is mixed. The 2019 survey found that 70% of people who strongly identified as ranchers would vote for wolf reintroduction.[16] The 2001 survey found that 44 % of ranchers supported wolf restoration, with an increase to 52% after hearing arguments favoring restoration.[18] During a stakeholder workshop on wolf reintroduction hosted by CSU researchers in February 2020, ranchers attending indicated that they were opposed to wolf reintroduction in Colorado because they felt wolves posed a threat to ranchers' livelihoods (see *Dialogue and Social Conflict about Wolves Information Sheet*). They also believed that the initiative to reintroduce wolves was failing to give recognition to their previous conservation efforts.[19] Overall, further research is needed to fully understand the diversity and prevalence of various rancher perspectives towards wolves and wolf reintroduction.[19]

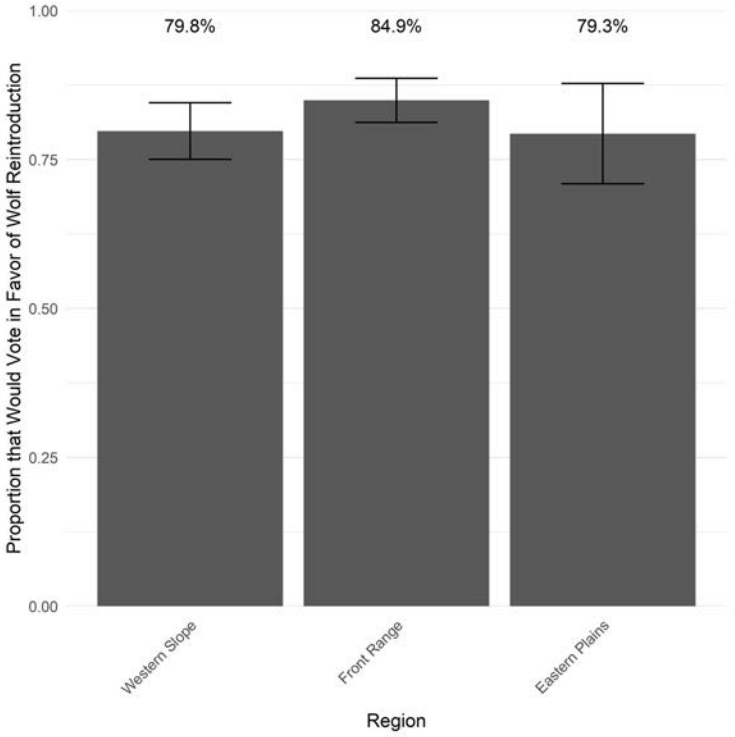

Figure 2: Proportion of survey respondents across three regions of Colorado who said they would vote in favor of wolf reintroduction.

Reasons for Public Support and Opposition to Wolf Reintroduction in Colorado

Surveys, interviews, and stakeholder workshops have identified numerous perceived positive and negative impacts of wolves and reasons why people support or oppose wolf reintroduction in Colorado. These perceptions are not always supported by data tracking the ecological and economic impacts of wolves (*see other Information Sheets*).

Perceived positive impacts of wolf reintroduction mentioned by 2019 survey respondents include the ability of wolves to restore balance to ecosystems and improve the natural environment; the opportunity to view wolves in the wild; emotional and cultural connections to wolves; enhanced tourism opportunities; a reduction in pest populations; and a

perceived moral obligation to restore species that once lived in the state.[16] Furthermore , at the February 2020 stakeholder workshop, representatives of some environmental groups discussed how they supported wolf reintroduction because they believed it is the first time their values related to wolf conservation are being recognized in decision-making (see *Dialogue and Social Conflict about Wolves Information Sheet*). They felt they had not received recognition in the past by the state legislature or state wildlife agencies.[19]

Perceived negative impacts of wolf reintroduction mentioned by the 2019 survey respondents include threats to people and pets, loss of hunting opportunities, and potential wolf attacks on livestock.[16] Similarly, the 1994 survey found that negative attitudes towards wolf reintroduction were associated with beliefs that wolf reintroduction would result in ranchers losing money, wolves wandering into residential areas, and large losses in deer and elk populations.[17] During the February 2020 stakeholder workshop, those opposed to reintroduction indicated their belief that the effort to reintroduce wolves was part of a broader trend of society not recognizing their value and contributions to society as well as a pending threat to their economic viability.[19]

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Moral Arguments Related to Wolf Restoration and Management

By the Center for Human-Carnivore Coexistence (6/20)

Moral arguments are arguments that something is "good," "bad," "right," or "wrong." They are often used to justify positions both for and against wolf restoration. A recent online survey of Coloradans found that respondents identified moral arguments as reasons for supporting wolf reintroduction. These included beliefs that: wolf reintroduction is the right thing to do; wolves deserve to live where they once thrived; reintroduction would make up for the past wrong of deliberately extirpating wolves from the state; and humans should fairly share the landscape with other animals like wolves.[1] Beliefs that link humans and other species are common in Native American worldviews. Native people in support of wolf restoration might argue that there is a balance in the natural world and reintroducing wolves would return some of that balance.[2] Many of these reported beliefs also relate to Aldo Leopold's land ethic, which advocates that people should respect their community and expands the definition of community beyond humans to include other parts of the Earth, such as animals, plants, and water.[2,3] Leopold argues that an action is morally right when it preserves the integrity, stability, and beauty of the biotic community. Wolf reintroduction is therefore often justified using this land ethic, as it is seen by some as an effort to enhance the integrity of the biotic community (see *Ecological Effects of Wolves Information Sheet*).[4] Environmental philosophers have also made the moral argument that reintroducing wolves to their native habitat is right because it would enhance the wilderness character of an area, promoting connections between people and wilderness.[5] Finally, some use the moral argument that the ballot initiative in Colorado to reintroduce wolves is good because it is a democratic process for ensuring the majority of public's values are adequately considered in decision-making about wildlife.[1]

Moral arguments have also been used to oppose reintroduction. Some people argue that reintroducing wolves is not ethical if individual reintroduced wolves would be hunted or die from human-wolf conflicts.[6] Additionally, media coverage of wolf reintroduction in Colorado often includes the moral argument that the ballot initiative for wolf reintroduction wrongly imposes the will of the urban majority on the rural minority in the state, who would have to live with the potential negative impacts of wolves (e.g., livestock depredation; see *Wolves and Livestock Information Sheet*).[1] There is opposition to reintroduction on moral grounds among Indigenous people, too. Native Americans have always been active stewards of the land, but some believe that we should

Key Points

- Moral arguments—arguments that something is "right" or "wrong"—are invoked on both sides of the debate about wolves. Moral arguments touch on some of our most deeply held values.
- Moral arguments for wolf reintroduction include: wolves deserve to live where they once thrived, humans should share the land with and respect members of the biotic community such as wolves, and wolves enhance the wilderness character of natural areas. A moral argument against wolf reintroduction is that it is imposing the will of the majority of Coloradans on rural Coloradans who have to live with the potential negative impacts of wolves.
- Different values associated with wildlife lead to different moral arguments for or against killing wolves as a management tool.

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not directly interfere with nature. These people might say we should support the land's healing and natural processes, but we don't have the right to decide when or how the land heals, or what comes back.[2]

Moral arguments are also used to justify positions for and against regulated hunting of wolves and the killing of "problem" wolves that come into conflict with people. Some argue that killing native predators such as wolves may not be ethically justified.[7,8] Instead, they advocate for the use of preventative management strategies that minimize conflict between humans, livestock, and wolves, reserving killing wolves as a last resort.[7,8] Such people have been classified as "mutualists" or as having a "biocentric" view towards nature[9,10] , a view that was both preceded by and informed by Native worldviews.[2] They believe that animals have rights to respectful treatment and should not be managed solely as a resource to be used by humans.[10,11] A recent study found that approximately 35% of Colorado residents can be classified as mutualists and that the majority of Coloradans do not support killing wolves as a management tool (Figure 1).[11] Those with more mutualist values often point to research suggesting that higher animals experience similar emotions to humans.[12] They also feel that while the benefits of killing animals to populations, ecosystems, and society are often uncertain, the negative impacts of killing on the individual animal being targeted are certain.[8,13] Individuals with this perspective may also be skeptical of intensive wildlife management in general, believing that people should manage wild animals less and their own behavior more.[14] Social science research suggests that modernization has led to a growing percentage of the US population with this more "mutualist" view towards animals.[10,11]

On the other hand, individuals with more "traditional" or "domination" views towards wildlife believe that wildlife should be used as a resource for humans.[10,11] They believe that killing and hunting wildlife are morally justified if they further human interests and enjoyment. Traditionalists also support wildlife management to maintain ecosystem balance and species diversity.[9-11] Individuals with this viewpoint argue that death and predation are natural components of ecosystems[9] and that humans are morally justified in killing wildlife to maximize benefits for both humans [10,11] and ecosystems.[9] Research finds that approximately 28 % of Coloradans have these more traditional values towards wildlife.[11]

Moral arguments touch on some of our most deeply held values. Diverse moral arguments drive the debate and social conflict over wolves, but in the end policy will demand compromises on all sides. Participatory processes that involve stakeholders in shared dialogue and decision-making are crucial to ensure stakeholders and policy-makers understand and consider the diversity of moral arguments underlying policy debates (see *Dialogue and Social Conflict About Wolves Information Sheet*).

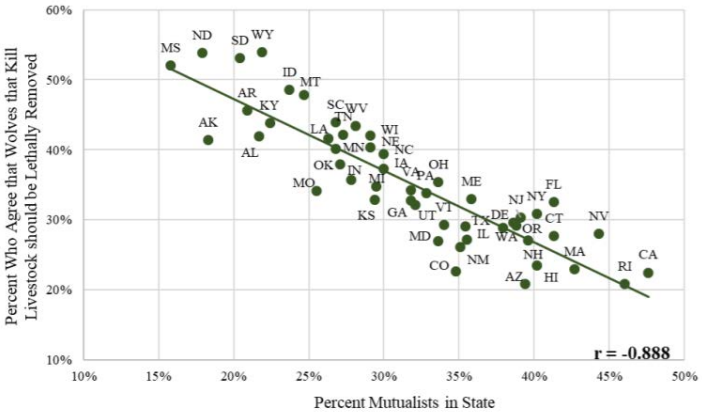

Figure 1: Percent of mutualists in each state, compared to the percent who agree that wolves should be killed for predating on livestock, from Manfredo et al. (2020)[11]

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COLORADO STATE UNIVERSITY
EXTENSION

Dialogue and Social Conflict about Wolves

By the Center for Human-Carnivore Coexistence (5/20)

What can we do to have better dialogue about a topic as controversial as wolves?

Talking with friends, neighbors, co-workers, land managers, policy makers, and the general public about critical issues is normal and necessary. Talking about the future of wolves in Colorado is no different. Having a dialogue with others about these critical issues is important because people often prefer getting information about natural resource management issues through discussions with people they know.[1]

Talking about sensitive topics with others can be difficult, however. Numerous *cognitive biases* we all have operating in our subconscious minds can limit our ability to learn and share new information that will lead to better decisions for ourselves and our communities.[2] For example, one type of bias can cause us to favor information that conforms with our existing beliefs and ignore new information.[3] Most of us think of ourselves as moral and capable.[4] When we hear something that threatens our self-image, we tend to ignore or fight the new information.[2,4]

Our hesitancy to accept new information can also be caused by biases related to the media we select and our social groups.[5] For example, we often choose to follow media outlets that we expect will provide interpretations and information that align with the beliefs of our social group.[5] We are also often influenced by political operatives and lobbyists to believe that scientific uncertainty about an issue is greater than it actually is.[6] Our beliefs about an issue are strongly influenced by what we think others in our social group believe.[7] Furthermore, we can misgauge the beliefs of others in our group based on a powerful spokesperson in that group.[8]

Cognitive biases can cause us to make poor assumptions about others, increasing conflict and preventing productive dialogue on controversial topics. Often we see other's biases while underestimating our own.[9] Many of us tend to believe we see an issue objectively while others do not.[10] This tendency causes us to assume people who disagree with us must be uninformed, irrational, or biased.[10] We may also assume that a person's actions are primarily explained by their values and character, rather than by the situation they are in, leading us to negatively interpret the other person's words and actions.[2,11]

Key Points

- Natural human biases may lead people to make inaccurate and damaging assumptions about other's perspectives. Using established techniques to overcome these biases can help us have better conversations.
- Social conflict is driven by biases, different attitudes and misinformation. At a deeper level, social conflict is fueled by basic human values and needs.
- Traditional ways of dealing with natural resource conflicts like public meetings and comment periods are insufficient for reducing social conflict. Rather, more participatory processes are needed that involve stakeholders in dialogue and shared decision-making.

For example, people may assume someone else would kill a wolf because that person doesn't value wolves, when in reality that person may only kill a wolf under certain circumstances to protect their livelihoods.

For many of us, it can be challenging to be open to new information and viewpoints, so how can we engage in meaningful dialogue about wolves in Colorado? Here are some tips that can help us overcome our biases:

- Sometimes showing people information that contradicts their viewpoint may cause them to cling more tightly to it, particularly if their identity is challenged.[12] Encouraging others to think about their important values before receiving new information can reduce their defensiveness and increase their acceptance.[4,13] So, before talking about wolves , try talking with the other person about land, water, home, family, recreation and other important values.
- Framing an issue in terms of what the other person cares about is more likely to result in your audience engaging with a message or new information.[14] When talking about wolves, consider that your audience may care specifically about wolves, or they may care more about wilderness, hunting, ranching, or recreation. Try asking how wolves relate to those things.
- People are more likely to respond positively to a request when the requester first provides a kind gesture.[15] So, consider first saying something positive and respectful about the other person's point of view related to wolves before presenting new information or arguments.
- In some cases, highlighting the scientific consensus around an issue (i.e., the number of scientists agreeing or studies agreeing with a finding) in conversations can increase acceptance of this information.[6] For example, if someone is concerned about the threat of wolves to human safety, you can point out that data on wolf attacks indicates the risk of wolves attacking or killing people is very low (see *Wolves and Human Safety Information Sheet*). Furthermore, sharing the large number of others who have a belief can increase acceptance of that new belief.[7, 14]
- If you perceive misinformation in what you are hearing, try discussing logical inconsistencies in misleading communications.[6] Logical inconsistencies around wildlife issues can arise when "fake experts" convey the impression of knowledge or expertise without possessing any relevant expertise. Try discussing the problem of "fake experts" in general before sharing any specific information about issues related to wolves.

In simple terms, some basic rules we all know can guide our conservations. When you enter a conversation, don't just try to convince. Instead, balance your desire to convince others with trying to learn and understand. Talk less. Listen more and listen carefully. Humbly ask questions to understand the other person's views. Have empathy for others.

What drives social conflict over wolves and how can we do better?

The topic of wolves is contentious and can create social conflict among ranchers, hunters, environmentalists and other groups.[16,17] Social conflict occurs when groups struggle over power and diverse values. Sometimes it includes people purposefully trying to prevent opposing groups from achieving their goals. Social conflict can inhibit effective management and can result in negative outcomes for people and wildlife.[18]

The social conflict over wolves in Colorado is driven in part by different attitudes and beliefs about wolves and the effects they may or may not have on ecosystems and people. Social conflict is also driven in part by unresolved debates about natural resource management and the deeper values that wolves symbolize.[17-19] For

example, long-standing conflicting views about public land management exacerbates the debate about wolves. Also, many environmental groups advocate so strongly for wolf reintroduction because wolves have become symbolic of the broader fight to preserve and make amends with wilderness.[16] On the other hand, interview-based research has found that opposition to wolves, particularly among many ranchers and rural communities, is driven in part by wolf conservation being symbolic of the many social trends perceived as economically and culturally threatening.[17,18]

At a stakeholder workshop held in Glenwood Springs, Colorado in February 2020, participants from environmental NGOs, state agencies, a sovereign Native American nation, and ranching and hunting groups discussed the deeper values behind the social conflict over wolf reintroduction in Colorado.[20] Participants shared that the debate goes beyond the pending ballot proposition to reintroduce wolves to the state. Rather, the debate includes deeper, more long-standing issues. These include conflicting views over how public lands should be managed, different cultural values of wildlife, and the impacts of changing demographics and values on more traditional ways of life.[20] Workshop participants identified many ways wolves in Colorado may positively or negatively affect their fundamental values and needs. Some groups, such as some ranchers and hunters, believed the ballot initiative to reintroduce wolves was part of a broader trend of society not recognizing their value and contributions to society as well as a pending threat to their economic viability. Individuals representing ranching interests discussed how they believe the initiative to restore wolves was failing to give recognition to their previous conservation efforts. On the other hand, environmentalists supporting wolf reintroduction expressed their belief that the ballot initiative is the first time their values related to wolves are being recognized in decision-making. They believed they had not received recognition in the past by the state legislature or state wildlife agencies. The discussion highlighted why the debate over wolf reintroduction and management can become so contentious and emotional, including feelings of betrayal. It is not just about wolves, but about people feeling that their fundamental values, needs, and identities are being threatened or ignored.

Traditional public engagement processes typically rely on public hearings and comment periods. These processes are insufficient for such value-based conflict and can exacerbate, rather than reduce, social conflict.[21] This is because they tend to focus on biology, economics, and other technical fixes while ignoring more fundamental, non-material social and psychological unmet needs. Other approaches are needed. Participatory processes that involve diverse stakeholders with conflicting views in respectful dialogue and shared decision-making can lead to better, longer-lasting outcomes for all sides.[22,23] These processes involve stakeholder workshops and meetings in which stakeholders share their diverse values and needs and help develop management plans that address these needs. To be effective, workshops and meetings should be part of a multi-layered process that addresses the deeper-rooted value-based conflict, finds common ground, and creates mutually acceptable solutions.[23] These processes can enhance empathy and build trust between groups with different perspectives. In so doing, they can facilitate the development of collaborative solutions that are more widely accepted by the public.[22,23]

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