Chapter 8
Impacts of Expanding Introduced Mountain Goats

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Range Expansion

In three quarters of a century, the approximate span of one human lifetime, the number of mountain goats living in the Greater Yellowstone Area increased from no known individuals to about 2,355 in 2014. Mountain goats first appeared in the area through the relocation of 157 individuals to various mountain ranges in efforts by state agencies to increase hunting opportunities for large game (see chapter 2). These relocations began in the 1940s and continued to the early 1970s. From release sites on the periphery of the area, mountain goats began colonizing and expanding their range into the core. While the speed of the expansion has been modest since the initial introductions, the increase in their distribution and abundance has been steady and is ongoing. For example, aerial counts of mountain goats within or near the boundary of Yellowstone National Park increased from 24 in 1997 to 178 in 2009 and 209 in 2014. The current distribution of mountain goats encompasses all the mountain ranges of the northern portion of the Greater Yellowstone Area, as well as the Snake River and, most recently, the Teton Range in the southern portion of the area.

Mountain goats in the area have repeatedly demonstrated an aptitude to disperse across unsuitable habitats, such as low elevations and forested areas, to access and colonize new areas. There are extensive unoccupied, but suitable, mountain ranges such as the southern Absaroka and Wind River ranges in Wyoming. As a result, there is strong likelihood that mountain goat distributions will continue to expand unless managers employ specific actions to curtail their population growth and dispersal. Because of the strong potential for mountain goats to continue expanding their range, and their designation as a non-native species in the area, some natural resource agencies have raised concerns that they may be detrimental to native bighorn sheep. Mountain goats could compete for forage and space, transfer disease-causing pathogens, and negatively affect native plants in subalpine and alpine plant communities. (Laundré 1990, Varley 1996, Lemke 2004, DeVoe et al. 2015, Flesch et al. 2016, Lowrey et al. 2017, National Park Service 2018b)

Range Overlap with Native Bighorn Sheep

Mountain goats and bighorn sheep use similar habitats and share native ranges outside of the Greater Yellowstone Area, primarily in inland mountains west of the continental divide from the northern United States to central Alberta and British Columbia, Canada. The ability of both mountain ungulates to share these ranges and maintain healthy populations is likely due to differences in their selection of seasonal home ranges and habitat types and foods within home ranges. The historic absence of mountain goats in the Greater Yellowstone Area since the Pleistocene may have enabled native bighorn sheep to broaden their range more than would be possible in the presence of mountain goats. Under this scenario, stronger levels of overlap in resource selection and competition would occur where colonizing mountain goats infringe on habitats occupied by bighorn sheep. Within the Greater Yellowstone Area, the welfare of bighorn sheep is of concern to wildlife managers due to substantial historical population declines across most of their range, a consequence of market hunting, habitat loss, and diseases introduced by domestic livestock (see chapter 2). Mountain goats also have the same lethal respiratory diseases that affect bighorn sheep and can transfer these pathogens to them, as has been documented in regions outside of the Greater Yellowstone Area (see chapter 6). The area hosts many isolated populations of bighorn sheep, some of which continue to experience periodic die-offs and poor recruitment from disease, as well as one of the most robust core ranges of bighorn sheep in North America that is largely absent of mountain goats. For these reasons, the continued increase in distribution and abundance of mountain goats poses potential for substantial negative impacts to bighorn sheep populations in the Greater Yellowstone Area. (Adams et al. 1982, Gross 2001, Courtemanch 2014, Wolff et al. 2016, Lowrey et al. 2018a)

Competition for limited resources, such as food, water, minerals, or winter range, can drive one species to dominate over another through aggressive displacement behavior or the exploitation (use) of shared limited resources. In the Front Range of Colorado, researchers observed over 100 interactions between non-native mountain goats and native bighorn sheep and concluded that 37% resulted in the apparent deterrence of bighorn sheep from a resource, such as mineral or foraging sites. However, most interactions were benign with no or only a modest response of bighorn sheep to the presence of mountain goats. Within the Greater Yellowstone Area, we have observed both species bedded, apparently amiably, within 10 yards (9 meters) of each other! We also have photos from remote cameras showing both species appearing to wait their turn to access a salt bait.

While both species broadly overlap in the area, it is unclear how often direct interactions occur. Studies evaluating the direct exploitation of shared limited resources and the effects on both mountain ungulates do not exist. However, comparisons of seasonal diets and habitat attributes have provided insight into the potential overlap in resource use. Separate studies of mountain goat and bighorn sheep diets have found strong overlap in use of forage resources, with both species relying on similar

A bighorn sheep ram appearing to wait for a pair of mountain goats to finish their turn at a bucket of salt (hidden behind the rock pile) in the Gallatin Range of Montana. Exploitation of limited resources by mountain goats may have negative impacts to bighorn sheep. However, it is unclear how often direct interactions cause displacement and whether these interactions have an impact on bighorn sheep populations. Photo by Bob Garrott, Montana State University.

proportions and species of grasses and forbs during the summer and winter. However, in shared ranges within the Greater Yellowstone Area, summer diet overlap was substantially lower, with a greater reliance on forbs by mountain goats and grasses by bighorn sheep. While studies in the northeast portion of Yellowstone National Park found greater overlap in fall diets, the two mountain ungulates used distinctive feeding sites, only overlapping use in these feeding sites by 30%. Scientists need more information about dietary overlap between the two mountain ungulates to draw reliable conclusions. (Laundré 1994, Varley 1996, Reed 2001)

While seasonal ranges of introduced mountain goats and native bighorn sheep overlap considerably in portions of the Greater Yellowstone Area (see chapters 3 and 4), comparisons of habitat and home range attributes can provide insights into potential competition. A recent study based on global positioning system (GPS) collar locations in the northeastern portion of the Greater Yellowstone Area, where mountain goats and bighorn sheep have shared home ranges in the same areas for approximately 50 years, found strong similarities in selection for habitat attributes during both summer and winter and, therefore, limited evidence of seasonal partitioning or separation. The strongest differences included slope, with steeper slopes selected more strongly by bighorn sheep during the summer and by mountain goats during the winter. Bighorn sheep avoided canopy cover more strongly during both seasons and tended to occur at lower elevations during winter. However, these differences did not result in complete spatial separation between the two species. (Lowrey et al. 2018b)

Although there appear to be some differences in diet that may reduce the frequency and magnitude of competitive interactions, the seasonal habitats and home ranges of mountain goats and bighorn sheep in the Greater Yellowstone Area are similar enough that the spatial overlap between the two species will likely continue to increase as ranges and numbers of mountain goats expand. Differences in the timing of resource use by each species, as well as the relative abundance of forage and contiguous habitat available across much of the mountain environments in the Greater Yellowstone Area, may lessen competitive interactions and associated effects. We note that numbers of both species increased during the period of mountain goat expansion. However, expanding mountain goats may negatively affect bighorn sheep on shared winter ranges or other areas where these resources are less available or contiguous, particularly if increases in interactions between the two species result in the transmission of respiratory diseases to bighorn sheep. Additionally, given that populations of bighorn sheep and mountain goats in separate geographic areas have strong dietary overlap, it remains uncertain whether mountain goats will adversely affect bighorn sheep once they completely colonize the area and the process of partitioning occurs. (Laundré 1994, Varley 1996, Reed 2001, Flesch et al. 2016, Butler et al. 2017, Lowrey et al. 2018b)

Potential Impacts to Native Plant Communities

Native plant communities may be sensitive to activities such as bedding, grazing, trailing, and wallowing (dust baths) by non-native mountain goats. In Olympic National Park, high numbers of mountain goats on summer ranges caused substantial declines in subalpine and alpine plant cover and diversity with detrimental impacts to several rare plant species. Moreover, mountain goats increased bare soil and the abundance of plants that proliferate in disturbed areas. The deposition of nitrogen into the soil from urine and feces of mountain goats may alter rates of nitrogen cycling in subalpine and alpine communities. However, scientists have not detected substantial impacts of mountain goats on plant communities in the Greater Yellowstone Area, even in regions where mountain goats have been present for approximately half a century.

In alpine regions of the northeastern portion of Yellowstone National Park, an area with such a history of mountain goat presence, a study found minimal impacts of mountain goats on native plant species. Biologists documented decreased plant cover, increased bare soil, and increased soil nitrogen in areas of high mountain goat use, but these effects were restricted to the tops of ridgelines. The lack of substantial impact may be due to the relative abundance of forage and habitat for mountain goats in the region. The effects of mountain goats may be more substantial in areas where resources are limited, such as on winter ranges or in areas with low forage availability. Additionally, the resiliency of native plant communities in the Greater Yellowstone Area to mountain goat presence may be due to adaptations to grazing from a suite of native animals such as chipmunks *Neotamias minimus*, yellow-bellied marmots *Marmota flaviventris*, elk, and bighorn sheep, a species never present in the subalpine and alpine communities of Olympic National Park. Given the relatively rapid increases of mountain goats observed in recent years, for example in Grand Teton National Park, additional monitoring and research will help to understand their effects on local and regional alpine and sub-alpine communities. (Houston et al. 1994, Aho 2012)

Potential for Continued Range Expansion

Mountain goats likely will continue to expand their distribution into unoccupied mountainous regions of the Greater Yellowstone Area. A recent study found that nearly all areas annually surveyed had increasing numbers of mountain goats and high kid to adult ratios, a factor characteristic of robust, healthy populations. The strongest rates of population growth occurred in areas mountain goats had most recently colonized. This pattern of high growth rates at the front of the range expansion is characteristic of trends observed in other populations of introduced ungulates. When first introduced, the relatively few individuals and abundant resources can lead to large population increases. When numbers of animals increase to the point that available resources in an area cannot support them, some individuals may move to new areas where resources are not limiting, and competition is low. Population growth rates in these new, unoccupied areas are often unbounded for a time until numbers increase to the capacity of the area to support them.

In the Greater Yellowstone Area, the slowly expanding front of the mountain goat range has now encompassed 43% of previously unoccupied areas of suitable habitat, leaving a substantial (2,367 square miles; 6,131 square kilometers) portion of suitable habitat currently unoccupied. Predictions indicate the entire area could support about 5,330 to 8,850 mountain goats if they eventually occupy all suitable habitat (4,149 square miles; 10,745 square kilometers). This level of abundance is about 2½ to 4 times the 2014 estimate of 2,355 mountain goats in the area. However, the eventual abundance of mountain goats in the Greater Yellowstone Area may be constrained by the availability of winter range and competition with other ungulates. While some of the unoccupied areas of suitable habitat are disjunct from each other, dispersing individuals likely do not require contiguous mountain habitats to colonize new areas. The Gallatin Range in the northwestern portion of the Greater Yellowstone Area supports a robust mountain goat population that likely established from animals dispersing from the neighboring Madison Range to the west or the Bridger Range to the north. These movements would have required travel across densely forested or low-elevation valleys. Observations of dispersal movements over a low-elevation prairie landscape in central Montana further suggest that the lack of contiguous suitable habitat will not prevent continued range expansion in the area. (Williams 1999, DeVoe et al. 2015, Flesch et al. 2016)

Mountain goats have already colonized most suitable habitat in Yellowstone National Park, the Snake River Range of Idaho and Wyoming, and the northern portion of the Greater Yellowstone Area, including the northern Absaroka Mountains (see figures 3 and 4 in chapter 2). The remainder of suitable habitat that is currently unoccupied or in the process of becoming colonized includes the southern Absaroka Range south of the North Fork of the Shoshone River (26% of the total suitable habitat in the Greater Yellowstone Area), Wyoming Range (15%), Wind River Range (10%), Teton Range (5%) in Grand Teton National Park, and Gros Ventre Range (3%). The potential for competition with bighorn sheep and the

A large group of non-native mountain goats on the Beartooth Plateau in Wyoming. Mountain goat populations are robust in portions of the Greater Yellowstone Area and there is a strong likelihood of continued range expansion throughout the unoccupied regions. Photo by Steve Ard, Tracker Aviation, Inc.

transmission of respiratory pathogens between bighorn sheep and mountain goats in these unoccupied areas is a concern to managers. Native herds of bighorn sheep occupy a substantial portion of these areas and 75% of the currently occupied bighorn sheep range occurs within areas defined as suitable summer habitat for mountain goats. Both the southern Absaroka (south of North Fork Shoshone River) and Wind River Ranges support the Greater Yellowstone Area's largest core regions for bighorn sheep while the Teton Range supports one of the area's smallest and most isolated native populations of bighorn sheep. The southern Absaroka Range, comprising the largest amount of suitable habitat for mountain goats, is at the beginning stages of colonization with only single and small groups of mountain goats recorded. In the adjoining Absaroka Mountains to the north, mountain goats are well established and likely the primary source of dispersing individuals to this region. (DeVoe et al. 2015, Flesch et al. 2016, Lowrey et al. 2018b)

The Teton Range is also experiencing colonization of mountain goats, with the first individuals observed in the late 1970s. These individuals were dispersers from the established population introduced in the Snake River Range of Idaho in the late 1960s and early 1970s. From the late 1970s through the early 2000s, sightings of mountain goats in the Teton Range were sporadic and thought to represent transient individuals. However, from 2008 onwards, biologists at Grand Teton National Park consistently documented adult females with dependent young, signaling that breeding was occurring within the park. Since then, the population has grown steadily and, during the most recent aerial survey in December 2018, biologists counted 88 mountain goats. Presently, most mountain goat activity occurs between Cascade and Snowshoe canyons on the east side of the Tetons within Grand Teton National Park, although biologists have observed mountain goats at the north and south ends of the range as well as the western portion on the Caribou-Targhee National Forest. Based on monitoring of radio-collared mountain goats within Grand Teton National Park, productivity and survival of adult females have been high and all evidence suggests the population was rapidly growing. The predicted amount of suitable habitat available within the Teton Range can support about 250 to 400 mountain goats, a number that is 2.5 to 4 times higher than current population estimates. If left unmanaged, the mountain goat population could colonize all suitable habitats throughout the Teton Range. (Whitfield 1983, Hayden 1984, Laundré 1990, DeVoe et al. 2015, Wyoming Game and Fish Department 2018)

Complexities of Managing Mountain Goats

The management of mountain goats in the Greater Yellowstone Area is complex and challenging. Mountain goat populations overlap multiple federal and state jurisdictions, each with differing missions and mandates. Thus, their management requires close coordination between these agencies (see chapter 9). Sixty-seven percent of lands are managed by the federal government, including 48% by the Forest Service (including 11 wilderness areas), 11% by the National Park Service, 7% by the Bureau of Land Management, 0.5% by the Fish & Wildlife Service, 0.1% by the Bureau of Reclamation, and 0.2% by other federal land managers. Private entities own 27% of lands in the Greater Yellowstone Area, with state agencies (4.2%), Native American tribes (1.8%), and non-governmental agencies (0.03%) managing the rest. The primary agencies involved in the management of mountain goats and their habitat include the National Park Service (Yellowstone and Grand Teton national parks), state wildlife management agencies (Idaho Department of Fish and Game; Montana Fish, Wildlife and Parks; Wyoming Game and Fish Department), and the Forest Service (Beaverhead-Deer Lodge, Bridger-Teton, Caribou-Targhee, Custer Gallatin, and Shoshone national forests). (McIntyre and Ellis 2011)

Each agency approaches its responsibility from the standpoint of its own management policies and with different objectives. National Park Service management policies call for the management of exotic, non-native species that do not meet a park purpose. This management could include eradication if control is prudent and feasible and the exotic species interferes with natural processes and the perpetuation of natural features, native species, or natural habitats. The National Park Service has begun removing introduced mountain goats from Olympic National Park in Washington and Grand Teton National Park in Wyoming. Yellowstone National Park has conducted research to determine potential impacts on native plant and animal resources but is not considering a capture and removal program at this time due to the large number of mountain goats involved and significant social, funding, and logistical obstacles. (Houston et al. 1994, National Park Service 2006, Aho 2012, White et al. 2013, National Park Service 2018a,b)

Generally, state management objectives are to sustain populations in suitable habitats while providing a conservative harvest. The Wyoming Game and Fish Department is interested in maintaining mountain goat populations in areas with minimal impact to native bighorn sheep. However, they would like to discourage further expansion by mountain goats into native bighorn sheep populations. The establishment of hunting districts for mountain goats may slow their spread through the rest of the Greater Yellowstone Area, but consistent hunting pressure will be needed to reduce mountain goat abundance. The Forest Service classifies bighorn sheep as a sensitive species on all the National Forest System lands in the area. This designation requires supervisors to maintain viable populations in identified planning units and generally gives them priority for conservation over non-native species such as mountain goats. (U.S. Department of Agriculture, Forest Service 2005)

The interests of hunters and wildlife viewers play an important role in the management of mountain goats by state agencies and the Forest Service, whereas the conservation of native species and communities is a priority for the National Park Service. The challenge in managing introduced mountain goats in a complex administrative landscape like the Greater Yellowstone Area, where a single mountain goat population may occur within several jurisdictions, stems from striving to integrate competing management perspectives and public demands with consideration of the local context. For example, in Wyoming, wildlife managers employ different options for two populations of mountain goats that overlap with bighorn sheep. Bighorn sheep that reside in the Absaroka Mountains share the same respiratory pathogens as mountain goats in that area so disease is less of a concern. In contrast, disease testing suggests lethal pathogens typically associated with pneumonia are not present in bighorn sheep in the Teton Range, even though the likely source population of mountain goats was exposed. In addition, Wyoming Game and Fish Department managers can achieve management goals for mountain goat abundance and distribution through managed hunting in the Absaroka Mountains outside of Yellowstone National Park, while that approach is less effective in the Teton Range because the majority of mountain goats reside within Grand Teton National Park. Therefore, this situation necessitates a very active role of the National Park Service to address mountain goat numbers in the Teton Range, which they have undertaken. Compared to Yellowstone National Park, the number of mountain goats in Grand Teton National Park is also relatively low and, therefore, preventing further expansion of goats would involve the removal of fewer animals, which may be more socially acceptable and reasonable to fund. (Flesch et al. 2016)

As introduced mountain goats continue to expand in the Greater Yellowstone Area, the agencies entrusted with managing them will face additional challenges and difficult decisions, in part because of the complex administrative landscape. With flexibility in management and consideration of region-specific ecological situations, mountain goats can have a place in the area but will be highly managed to preserve native species and communities.

Future Management of Mountain Goats

Managers intentionally introduced mountain goats into previously unoccupied habitats of the Greater Yellowstone Area to provide hunting and viewing opportunities.

This management approach is not favored today, and there are reasons to actively manage or discourage their expansion. However, it is important to recognize that conservation and perpetuation of mountain goats in areas with minimal conflicts with native species may be desirable for some management agencies. For example, areas like the Snake River Range in Idaho and Wyoming have a long history of mountain goat presence with little to no overlap with native herds of bighorn sheep. The Idaho Department of Fish and Game and the Wyoming Game and Fish Department manage for the perpetuation of robust mountain goat populations in these areas for public hunting and viewing opportunities.

However, in areas where impacts of mountain goats on native species may be substantial, management of mountain goats is, and will likely continue to be, more direct and active. This is particularly true in regions where managers are concerned about the welfare of important bighorn sheep populations. Many of the strategies for managing mountain goats across the Greater Yellowstone Area attempt to reduce the opportunities for mountain goats to use or become established in areas occupied by native bighorn sheep. For example, the population of bighorn sheep in the Teton Range is especially sensitive due to its constricted range, small size, unique genetic and behavioral adaptations, and susceptibility to pneumonia-causing pathogens. Although mountain goats have been in the Teton Range for nearly four decades, recent evidence of breeding has prompted Grand Teton National Park, in coordination with the Wyoming Game and Fish Department and the Forest Service, to initiate plans for reducing or eliminating the potential for mountain goats to overlap with bighorn sheep. (Wyoming State-wide Bighorn-Domestic Sheep Interaction Working Group 2004, Butler et al. 2017, National Park Service 2018b)

The Absaroka Range provides another example of the strong emphasis on bighorn sheep conservation in management plans for mountain goats. The entire range supports one of the largest and most robust populations of bighorn sheep in the continental United States, with an estimated 4,000 animals spread in herds across the landscape. These core native herds were never extirpated or supplemented to increase their numbers and are home to over 85% of the bighorn sheep that reside in Wyoming. The southern portion of the Absaroka Range supports approximately the same abundance of bighorn sheep as predicted for mountain goats, an estimated 1,395 to 2,315 animals. The Wyoming Game and Fish Department places the highest priority on the native herds of bighorn sheep across the entire Absaroka Range. Management of these native herds attempts to maintain the unique genetic and behavioral adaptations that bighorn sheep possess in these areas. Therefore, the Wyoming Game and Fish Department has implemented liberal mountain goat hunting seasons in the Absaroka Range outside of Yellowstone National Park. The Colorado Division of Wildlife and Parks uses a similar management approach to discourage mountain goats from colonizing important bighorn sheep habitat. (Wyoming Statewide Bighorn Sheep-Domestic Sheep Interaction Working Group 2004, Colorado Division of Wildlife 2009, Wolff et al. 2016, Lowrey et al. 2018b)

Although managers have achieved many successes, setbacks and failures have stymied restoration efforts for several bighorn sheep populations. This is clearly illustrated by the fact that range-wide translocation of over 21,500 bighorn sheep associated with restoration efforts has ultimately resulted in a current population of only 50,000 animals. As a result, there is more emphasis on maintaining existing populations, especially large groups of populations such as those in the Greater Yellowstone Area. Many of these populations have a portfolio of diverse migratory patterns that may be difficult to recreate using translocation. This effort will require assessing and making management decisions related to acceptable risk regarding pathogen transfer, competition with mountain goats and domestic livestock, increasing human developments and activities within bighorn sheep habitats, and potential habitat and environmental modifications that climate change may exacerbate. (Wild Sheep Working Group 2012, Lowrey et al. 2019)

Furthermore, a substantial proportion of bighorn sheep in the Greater Yellowstone Area occupy high-elevation winter ranges as an integral component of their seasonal habitats. Bighorn sheep that rely on these winter ranges are dependent upon a very delicate interplay of dry, windblown, snow-free ridges that exist through mid- to late winter followed by movements to gradually opening areas as snow melts at lower elevations. Increasing temperatures at these high elevations during winter could disrupt this balance by creating freeze-thaw cycles that render forage unavailable and/or produce a mismatch in the timing of movements to lower-elevation areas in spring. Such developments could result in habitats being able to support fewer bighorn sheep and have population-level impacts. Such impacts may worsen in the presence of competitors, such as mountain goats. (Courtemanch et al. 2017)

Disease-related mortality is an all too common component of bighorn sheep populations. Efforts to understand the disease ecology of bighorn sheep are essential for maintaining or recovering bighorn sheep populations. Increased knowledge of pathogen transmission between bighorn sheep, mountain goats, and domestic livestock, as well as transmission within bighorn sheep populations and pathogen persistence once introduced into populations, is necessary for identifying options to manage disease and minimize mortality. In addition to disease, continued research and monitoring of bighorn sheep and mountain goat populations through time as their distribution, population dynamics, and habitats change is necessary to make informed management decisions in the future. In addition, in the Greater Yellowstone Area, continued coordination and collaboration on research and management among various federal, state, and tribal agencies is indispensable to accomplish these goals.

Conclusions

Managers intentionally introduced mountain goats into the Greater Yellowstone Area during the 1950s to1970s to provide hunting and viewing opportunities.

Since these introductions, mountain goat populations have grown to over 2,000 individuals in approximately 43% of the suitable habitat. However, there may be several reasons to intentionally manage or discourage their expansion. Although biologists have not detected significant impacts to native flora in the area from mountain goats, there is potential for them to affect native bighorn sheep populations through competition and transmission of disease-causing pathogens. It is highly probable that mountain goats will continue to expand throughout the area and infringe on habitats occupied by bighorn sheep. The Greater Yellowstone Area could potentially support up to nearly 9,000 mountain goats if they colonize all available habitat, the large majority of which is in habitats occupied by bighorn sheep. Even if there are low levels of shared resource use between mountain goats and bighorn sheep, it seems doubtful that this many mountain goats would not have adverse impacts on the almost 6,000 bighorn sheep that currently reside in the area.

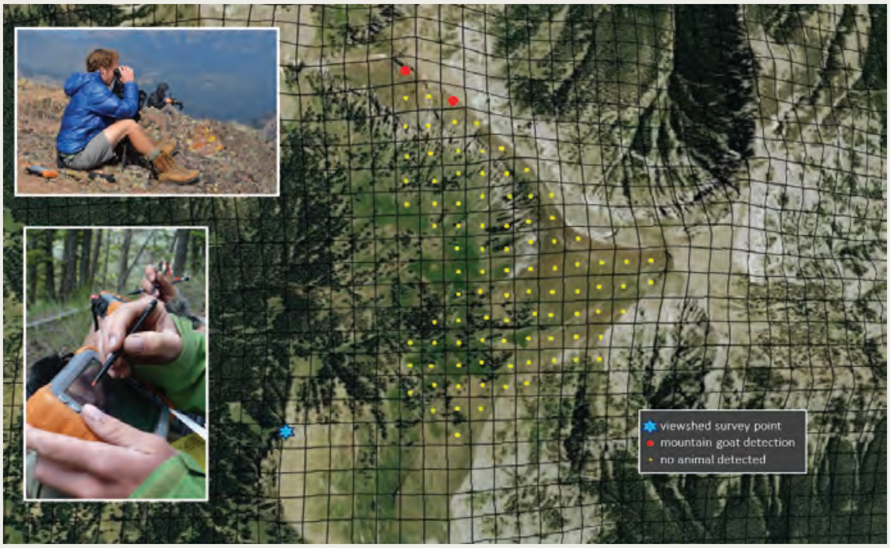
Nonetheless, it is important to recognize and appreciate how mountain goats are perfectly suited for the mountainous habitats of the Greater Yellowstone Area and that mountain goats are highly regarded in many regions of the area by wildlife watchers and hunters. Given the complex ecological, jurisdictional, and social landscape in the area, there is not one single solution for managing mountain goats throughout the area. In areas where mountain goats minimally conflict with native species, namely bighorn sheep, there may be reason to promote their conservation. As mountain goats continue to expand in the Greater Yellowstone Area, the need for continued cross-jurisdictional coordination and collaboration in both research and management will be necessary to accomplish objectives of the myriad agencies that align with social desires in the area. Continued monitoring of populations through time and research focused on disease ecology for the two mountain ungulates are necessities to inform management decisions in the future. (DeVoe et al. 2015, Lowrey et al. 2018b)

How We Learn: Impacts of Mountain Goats

Owing to the inclination of mountain goats and bighorn sheep to inhabit some of the most rugged and remote terrain of the Greater Yellowstone Area, designing and conducting rigorous studies to understand the ecology of these mountain ungulates is a challenging endeavor. Not only do such studies often require long, large elevation-gain approaches on foot or expensive aerial flights to access their habitat, but just observing the highly mobile animals amidst ledges and cliffs or underneath forest canopies poses an additional impediment to obtaining good information on mountain ungulates. To overcome these challenges and gain insight into the potential exploitative competition from overlap of home ranges and resource use by mountain goats and bighorn sheep, researchers in the Greater Yellowstone Area have employed several innovative techniques for collecting information on movement patterns, distributions, and resource selection. One method is the use of VHF and GPS collars placed on captured animals, which have provided a wealth of ecological information (see chapters 3 and 4). The use of this technology is highly desirable; however, they are costly to deploy across large areas of the Greater Yellowstone Area landscape. A more cost-efficient and entirely non-invasive method of collecting information on mountain ungulates includes the use of camera traps. The ability to collect broad spatial data is limited by this method, however, due to the restricted locations camera traps need to be placed to be most effective.

Another alternative is the use of occupancy methods, whereby biologists address the limitations of animal detections by recording both the presence and absence of animals in an area. For example, aerial surveys often record only the location of animals where the observers looked. However, if observers do not record the sites where they looked and did not see animals, they do not know if the animal was absent

A camera placed at a high-elevation site in the northern Beartooth Range captures a group of bighorn rams followed by a group of mountain goats less than 24 hours later, demonstrating how camera traps can be used to capture overlap of resource use between the two mountain ungulate species. Photos by Doug McWhirter, Wyoming Game and Fish Department.



Example of occupancy survey methods for understanding fine-scale habitat selection of mountain ungulates from a study completed in the Greater Yellowstone Area (DeVoe et al. 2015). Two independent observers were placed at each viewshed survey point and simultaneously recorded both detections and non-detections of mountain ungulates in a survey viewshed of 100 meter by 100 meter grid cells. These methods allow estimation of fine-scale habitat selection corrected for poor detection of mountain ungulates on complex and difficult to survey landscapes. Photos by Jesse DeVoe, Montana State University.

or went undetected. Occupancy studies take advantage of the additional 'absence' information, as well as data collected from a second, independent observer, to make improved inferences of species habitat selection and distributions. Biologists used this method recently in the Greater Yellowstone Area to understand summer habitat selection and predict the potential expansion and abundance of mountain goats in uncolonized areas. Equipped with binoculars, spotting scopes, and ruggedized field tablets, researchers backpacked into mountain ungulate terrain and visited numerous survey points from which two independent observers surveyed view sheds of 100 meters by 100 meters (109 yards by 109 yards) grid cells (visible on the field tablets). To estimate habitat selection by mountain goats, biologists recorded the presence or absence of mountain goat groups in each grid cell and related this information to remotely sensed habitat attributes. They modeled these habitat selection relationships across the entire Greater Yellowstone Area and combined the results with estimates of abundance from areas in the Greater Yellowstone Area fully colonized by mountain goats to estimate the total number of mountain goats the entire area could support. While highly informative, these methods are time and energy consuming, not only due to accessing rugged and remote terrain (multi-day trips are essential), but also collecting both presence and absence information requires greater effort than presence-only information. (DeVoe et al. 2015)

A bighorn sheep ram atop a seemingly insurmountable rock pillar. Photo by Randy Ilg.

Chapter 9
Current Management

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Jurisdictions and Mandates

The North American Model of Wildlife Management is premised on the public ownership of wildlife, which is not the case in most of the world where wildlife is owned by private landowners or governments. With some exceptions, the primary legal authority and management responsibility for sustaining wildlife populations is entrusted to state agencies governed by commissions which, in the Greater Yellowstone Area, include the Idaho Department of Fish and Game, Montana Department of Fish, Wildlife and Parks, and the Wyoming Game and Fish Department. Federal land management agencies such as the Forest Service and the Bureau of Land Management are responsible for managing wildlife habitat and fulfilling other multiple use objectives within their jurisdictions. Also, the Fish and Wildlife Service works with state, federal, and tribal agencies and private landowners to recover federally designated threatened and endangered species, coordinates management of migratory birds that seasonally cross jurisdictional boundaries and manages habitats through their wildlife refuge system. In addition, the National Park Service has responsibility for the management of wildlife and habitat within Yellowstone and Grand Teton national parks. This arrangement of jurisdictions with variable responsibilities with respect to wildlife and their habitats necessitates a collaborative approach to management. (Organ et al. 2012)

With respect to state wildlife agencies, management usually entails the establishment of specific objectives and management activities that direct populations toward those objectives. In the case of large ungulates, this includes managing population sizes through hunting, habitat enhancement, landowner agreements, and other actions. Many states have species-specific management plans that detail these objectives and management actions. (Idaho Department of Fish and Game 2010, Montana Fish, Wildlife and Parks 2010)

A somewhat different approach is employed on National Park Service lands, where populations can fluctuate more in response to competition, forage availability, predation, and weather, with less human intervention. As an example, hunting in Yellowstone National Park was prohibited by Congress in 1894 (16 USC 26). While desirable non-native species may be included in the management objectives of state agencies, National Park Service policy recommends the management of non-native species that interfere with native wildlife or their habitats, up to and including eradication, if such control is prudent and feasible. (National Park Service 2006)

Although management mandates vary among agencies and jurisdictions, there is much overlap of shared goals, including conserving or recovering sustainable populations of wildlife and their habitats while maintaining the public trust by basing decisions on reliable information and reducing property damage and human injury. As a result, migratory populations, like many of the ungulate herds in the Greater Yellowstone Area, require a coordinated approach to management.

Population Management

Management can be broadly defined as the process of dealing with or controlling things or people. Ungulate management is most often the latter, and may mean increasing, decreasing, or maintaining the size of a wildlife population, which is primarily accomplished through controlling people (in this case, hunters). State wildlife agencies, with public involvement, usually establish some sort of population objective, which is often

Surveying for bighorn sheep on winter range with a helicopter in Montana. Photo by Mark Gocke, Wyoming Game and Fish Department.

a combination of biological and social capacities, and which can be used as a measure of success and provide agency accountability. Monitoring populations provides indicators used to assess whether established objectives are being met. This monitoring can include periodic "trend counts," population estimates derived from sampling the population and applying statistical analyses, or other attributes such as ram to ewe ratios or success rates of hunters (see chapter 7).

A concept referred to as adaptive management is often used in population management due to unpredictable environmental variation, difficulties in collecting data, and the need to make assumptions regarding the drivers of population dynamics in the absence of complete and detailed site-specific information. Adaptive management is a continual process of evaluation and adjustment that includes determining an objective, applying a management action, measuring progress towards achieving the objective, and adjusting subsequent management actions. A prerequisite of population management is understanding the dynamics of a population, or factors responsible for its growth or decline, so appropriate measures can be taken to manage toward objectives. Sometimes monitoring information is enough to gain this understanding, but often more detailed knowledge is required, which can be provided through specific research as part of the adaptive management process. (Walters 1986, Riley et al. 2003)

Hunting is the primary tool used to meet population objectives and, as traditionally applied to both bighorn sheep and mountain goats in the Greater Yellowstone Area, has been quite conservative. Bighorn sheep hunting usually involves limited numbers of hunters and is focused on adult males. In Montana, hunter harvest of bighorn sheep ewes is applied in specific areas to maintain densities below a given threshold, often the forage capacity of that specific winter range, to prevent excessive winter mortalities and minimize the risk of disease outbreaks. The ability to offer ewe licenses exists in Wyoming and Idaho but has not been implemented in a substantial way. In contrast to male-only harvest in bighorn sheep, either-sex hunting of mountain goats (adopted primarily due to difficulty distinguishing males and females) is the norm to control or reduce mountain goat numbers.

Another way of managing populations is to remove the annual increase created by the birth and recruitment of young animals by capturing and translocating individuals. Bighorn sheep and mountain goats have traditionally been captured using drop nets, corral traps, chemical immobilization and, more recently, aerial net-gunning operations. For example, the size of the Whiskey Mountain bighorn sheep herd in Wyoming was controlled for many years through the capture and relocation of 75 to 100 bighorn sheep each year (1,574 total from 1964 to 1990), which had the additional benefit of restoring or supplementing other bighorn sheep populations. Similarly, from 1989 to 1997 a total of 46 mountain goats were removed from the Snake River Range herd in Idaho to prevent the population from growing beyond its' carrying capacity. In some areas, extenuating circumstances such as a lack of hunter access create situations where translocations are employed out of necessity. (Idaho Department of Fish and Game 2019)

Habitat Management

While population management is important, no species can persist without habitat. Land management agencies bear responsibility to maintain habitats for native species and, in some cases, desirable non-native species (see chapter 3). This usually means managing land uses such as oil and gas development, road building, timber harvesting, livestock grazing, and recreation to minimize impacts on wildlife resources as much as possible. In the case of livestock grazing, the land management agency may also consider the effects of diseases introduced from livestock as an impact on the persistence of certain wildlife species, as in the case of domestic sheep grazing and potential pathogen transmission risk to bighorn sheep (see chapter 6).

In addition to habitat protection, land management agencies also can enhance habitats with prescribed fire, managed wildfire, timber harvest, and herbicide treatments.

Mountain ungulates are captured through a variety of techniques, from (clockwise from upper left) net-gunning from a helicopter, drop nets, darting with immobilization drugs, and self-triggered net/mesh traps. Photos by Mark Gocke, Wyoming Game and Fish Department (upper left, lower right), Richard Horst (upper right), and Doug McWhirter, Wyoming Game and Fish Department (lower left).

Bighorn sheep feeding in habitat recently burned by wildfire. Burned areas offer highly nutritious forage and high visibility and are sought out by bighorn sheep. Photo by Mark Gocke, Wyoming Game & Fish Department.

Bighorn sheep are grazers that prefer open habitats with high visibility, so fire and mechanical treatments that remove vision-obstructing trees and shrubs and increase the production of preferred forage grasses are beneficial. Depending upon the goal, herbicides can be used to remove shrubs to achieve the same response, or to discourage the establishment of undesirable weeds like cheatgrass that often follow disturbances like wild or prescribed fires. (Risenhoover and Bailey 1985, Festa-Bianchet 1988)

Disease Management

Bighorn sheep and mountain goats are susceptible to pneumonia and, therefore, disease prevention and management is an important undertaking (see chapter 6). Knowing what respiratory pathogens exist in a herd is valuable, and this information is gathered from periodic disease surveillance. Knowledge of existing pathogens is also important from a restoration standpoint because new pathogens can be introduced when translocating animals. (Besser et al. 2012b, Cassirer et al. 2017a)

Bighorn sheep are generally susceptible to common pathogens harbored by domestic sheep and goats, so minimizing the potential for pathogen transmission from domestic sheep and goats to bighorn sheep is an objective for wildlife managers. Considerable efforts are expended to avoid commingling using intensive and collaborative approaches to administering domestic sheep grazing allotments and negotiating waivers (with financial compensation) of specific grazing allotments. Even though primarily benefitting bighorn sheep, such "buy-outs" have also helped individual permittees experiencing depredations from recovered large carnivores such as grizzly bears and wolves. However, the reduction of domestic grazing opportunities from public lands is a very controversial issue, with involuntary actions often litigated. (Schommer and Woolever 2008, Wild Sheep Working Group 2012)

The concern over pathogen transmission is great enough that state wildlife agencies may cull individuals showing signs of diseases such as pneumonia from a bighorn herd in the hope of removing infected animals and minimizing the spread of disease. The lethal removal of bighorn sheep observed commingling with domestic sheep or goats is another tactic used to minimize pathogen transfer and the spread of disease. The concern is these bighorn sheep may become infected, return to their herd of origin, and introduce new pathogens to the remainder of the herd and initiate a disease outbreak. In very specific cases, domestic sheep producers have been given the authority to lethally remove bighorn sheep if they appear among their domestic sheep. If a domestic sheep is wandering or left after others have been brought off grazing allotments, state wildlife agencies may occasionally be given permission from the owner to remove that animal. As one might imagine, lethally removing someone's private property is a task handled very delicately. In some cases, ownership cannot easily be established, and responses are limited. Idaho Code Title 25, Chapter 23 and Montana MCA 81-4-6 and MCA 81-4-2 address disposition of stray livestock and Wyoming has adopted a feral, or "stray" livestock statute (§11-48-102) that establishes a protocol for removing such animals if they pose disease risks.

To find collaborative solutions to address overlap or commingling between domestic and wild sheep and the resulting pathogen transmission concerns, a diverse group of stakeholders in Wyoming developed a Statewide Bighorn Sheep-Domestic Sheep Interaction Plan. This plan prioritizes the state's bighorn sheep herds with respect to their origin and importance, with core native herds receiving the highest level of protection, and translocated herds receiving less emphasis. As part of this plan, there is also agreement on how these issues will be addressed and, most importantly, encouragement to continue communication among all interested parties. To define areas of concern for pathogen transmission risk, the Forest Service developed a computer model that quantifies the relative risk of contact between bighorn sheep and domestic sheep grazing allotments on public lands. The resulting information serves as a starting point for discussions on how to reduce that risk.

(Wyoming Statewide Bighorn Sheep-Domestic Sheep Interaction Working Group 2004, O'Brien et al. 2014, U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management 2015)

Other prevention options such as identification and removal of chronically infected pathogen "carriers" and vaccines could have benefits, although field administration in wild, remote settings where bighorn sheep exist could prove problematic. Vaccines or the administration of antibiotics to domestic sheep may eventually prove more feasible, although increased costs are still likely. Prevention of commingling currently remains the most effective means of minimizing the risk of pathogen transmission.

Funding

Most federal funding for ungulate management comes from congressionally appropriated taxpayer dollars. State agency work is largely funded through hunting license sales and the Federal Aid in Wildlife Restoration Act. Often referred to as the Pittman-Robertson Act, this excise tax on arms and ammunition is used to fund wildlife surveys and research, acquisition and improvement of wildlife habitat, translocations, acquisition and development of public access, and hunter safety programs.

Funding for state management of mountain ungulates is often limited, as agency revenues generated by hunting license sales for these species do not cover the cost of annual population and disease monitoring, let alone intensive research projects or translocation efforts. Programs that generate more hunting revenue, like mule deer or elk, often subsidize the management costs of mountain ungulates, and are generally focused on funding population monitoring efforts. Funding is also generated by the limited special auction or raffle of bighorn sheep and mountain goat hunting licenses. Montana offers one Governor's license for bighorn sheep while Wyoming offers five Governor's licenses for bighorn sheep. Idaho offers two special tags, one available for auction and the other available through a lottery. Although the number of licenses and how the money is funneled into management varies, the money raised can be significant.

The single Montana Governor's bighorn sheep license has sold for as much as $480,000. Montana and Wyoming also offer mountain goat raffles, which generate considerable, but less, funding than bighorn sheep tags ($10,000 to $15,000).

Another source of funding for mountain ungulate management and research efforts are conservation groups such as the Wild Sheep Foundation and their network of chapters and affiliates. Similarly, the Rocky Mountain Goat Alliance dedicates their efforts to mountain goats. In addition, businesses such as Canon USA, Inc. and private donors sometimes provide substantial donations for mountain ungulate research and restoration through foundations and partnership organizations such as Yellowstone Forever and the Grand Teton National Park Foundation. Large, long-term efforts like bighorn sheep and mountain goat research in the Greater Yellowstone Area require support from a broad coalition of funding sources.

Bighorn Sheep Management

Efforts to re-establish Rocky Mountain bighorn sheep populations (not to be confused with the desert bighorn sheep subspecies) have largely been successful and numbers range-wide have increased from an estimated 10,000 in 1960 to approximately 50,000 in 2017. Most of this increase has been the result of translocations. Between 1920 and 1990, the states of Wyoming, Montana, and Idaho translocated almost 3,000 bighorn sheep within their borders, imported another 300 bighorn sheep, and provided over 600 bighorn sheep to restoration efforts in other states. West-wide, there have been almost 1,500 translocations involving 21,500 bighorn sheep. (Buechner 1960, Wild Sheep Working Group 2015)

These translocations were largely conducted with relatively small numbers of bighorn sheep, and oftentimes with only one release site; usually low-elevation winter ranges due to their accessibility during winter when bighorn sheep are easier to capture. The resulting reestablished herds often reside in relatively homogeneous groups and tend to become sedentary compared to their migratory predecessors. Such restorations leave populations extremely susceptible to disease, weather, and predation influences. Even today, over 50% of bighorn sheep populations in Idaho, Montana, and Wyoming contain less than 100 individuals. (Jesmer et al. 2018)

Recent work has shown the importance of geographically distributed metapopulations (group of connected populations) in the Greater Yellowstone Area. Animals spread throughout suitable habitats and exhibiting a broad range of behavioral traits, such as migration strategies, provide resilience in the face of disease epidemics or severe weather events. Similar examples come from the world of caterpillars and salmon, where such diversity of behaviors has been termed a "portfolio" effect. This term, taken from the world of financial investments, represents the notion that it is best not to have all your eggs in one basket, but instead, to have a diverse portfolio (see chapter 4). (Schindler et al. 2015a, Lowrey et al. 2019)

If a metapopulation is lost, can it be recreated? One management experiment in southwestern Montana is attempting to create a metapopulation using a series of within -mountain range transplants. Along the southwestern face of the Madison Range, there were at least five known, historic bighorn sheep winter ranges. However, bighorn sheep were extant on only two of these five as of 2013. One of these winter ranges had recovered from an all-age, disease-related die-off to record numbers. Biologists created a proposal to move bighorn sheep from this highly-populated winter range to one of the ranges where bighorn sheep had been extinct for at least the past 50 years, with the hope of re-establishing bighorn use of the area. Transplanting bighorn sheep from local source herds has several advantages, including little or no risk of introducing new pathogens (which can occur if another herd is used), familiarity with ecological (habitat) conditions, and retained knowledge of migration behaviors and predator communities. Recent work in the Madison Range indicates there is potential habitat for two to four times the number of bighorn sheep that currently exist, suggesting habitat is not limiting for bighorn sheep and further encouraging this sort of method for re-establishing a metapopulation. (Butler et al. 2018, Lula et al. 2020)

To test this re-establishment plan, biologists moved 97 bighorn sheep over a series of three transplants to a release site approximately 14 airline miles (22 kilometers) north of the capture site. The bighorn sheep were let out of a trailer immediately into their new landscape and showed highly variable individual exploratory behaviors, colonizing the expected winter range and five additional sub-drainages. Most ewes chose low-elevation winter ranges, but some chose high-elevation winter ranges. While some transplanted bighorn travelled nearly 40 miles (64 kilometers) away to join other herds, others remained at the release site a variable number of months, some nearly two years. The released bighorn did show a higher mortality rate than resident bighorn, which was expected as they adjusted to their new landscape. Renewed knowledge of new areas of the Madison Range should now have been thoroughly "injected" into these bighorn sheep, and the extent to which they use them has yet to be determined. Currently, it appears bighorn sheep have remained at the transplant site after each release, gradually rebuilding use through the survival and reproduction of those bighorn sheep from prior years' transplants. (Singer and Gudorf 1999, Cunningham et al. 2018, Lula et al. 2020)

The result of such population conservation and restoration efforts is the increased ability to provide viewing experiences and hunting opportunities for bighorn sheep and mountain goats. Wildlife viewing is a major attraction for visitation to the Greater Yellowstone Area, with tourism contributing substantial economic benefits to communities in the region. For example, more than 4 million people visited Yellowstone National Park during 2019 and spent almost $507 million in communities near the park, which supported about 7,000 jobs and had a cumulative benefit of about $642 million to the area's economy. Similarly, 3.4 million visitors to Grand Teton National Park in 2019 spent almost $630 million in local gateway communities, supporting about 8,640 jobs with a cumulative benefit of $796 million added to the economy. These economic benefits stem, in large part, directly from the preservation of abundant populations of wildlife that often can be viewed and photographed from roads. More than 95% of visitors to the park participated in wild-

A photographer viewing and photographing bighorn sheep. Bighorn sheep often spend the winter in valley bottoms, and are especially accessible during this time. Photo by Kenneth R. Whitten.

A hunter glassing for a bighorn ram in mid-September in the alpine sheep habitats typical of the Greater Yellowstone Area. Photo by Craig Sax, Wyoming Game and Fish Department.

life viewing during their visits, which exceeded geyser viewing (87%), hiking (39%), camping (27%), and fishing (13%). (Duffield et al. 2000a,b; Manni et al. 2007, Resource Systems Group 2017, Cullinane Thomas and Koontz 2020)

In addition to viewing, over 400 people get the very coveted opportunity to hunt bighorn sheep each year in Idaho, Montana, and Wyoming, which results in approximately 350 rams taken annually, with 158 of these coming from the Greater Yellowstone Area in 2018. The odds of drawing a bighorn sheep license vary from state to state and area to area, but in 2018 almost 50,000 people applied for the 436 available bighorn sheep licenses in Idaho, Montana, and Wyoming (0.9% drawing odds). In a novel way to provide sheep hunting opportunities, certain bighorn sheep hunting districts in Montana have unlimited (one per hunter) licenses available and harvest is managed through a quota system: once the quota is met the district closes upon 48 hours' notice. Quotas in these areas are usually low, generally two to three bighorn sheep rams. Such conservative harvest management contrasts with species such as elk, which exceed 80,000 animals harvested each year among the three states. Although perhaps difficult for some to understand, hunting engenders respect and appreciation for the hunted species and ensures support for their persistence and conservation of their habitats.

Mountain Goat Management

Although there is prehistoric evidence of mountain goats in the Greater Yellowstone Area, they are generally considered a non-native species. Native species evolved in, or migrated to, an area with no human intervention and are particularly adapted to habitats found there. Conversely, non-native species were either intentionally or accidentally introduced to an area by human activities. Although disagreement exists over whether non-native species threaten the natural environment and under what circumstances, there is potential for non-native species to out-compete, transmit pathogens, and adversely affect native species. (Sagaff 2005, Simberloff 2005)

Capturing and translocating mountain ungulates is difficult but was even more of an epic adventure in the 1940s. These images depict efforts to establish mountain goats in the Greater Yellowstone Area, and involved horse-packing and rafting animals from trap sites to where they could be loaded onto trucks, driven as close to the release site as possible, and then taken by mule-drawn wagons the rest of the way. Photos courtesy of Montana Fish, Wildlife and Parks.

Mountain goat populations increased through translocations into previously unoccupied habitat in the Greater Yellowstone Area. A total of 17 translocations involving 157 mountain goats occurred (14 releases of 145 mountain goats in Montana and 3 releases of 12 mountain goats in Idaho), and have resulted in a current population of about 2,100 mountain goats, and a broad expansion of their distribution. The translocations of mountain goats in Montana were monumental efforts that included corral traps, pack horses, rafts, and mule-drawn wagons to get animals from their source population in the Sun River area of northwestern Montana to the mountain ranges of the Greater Yellowstone Area (see chapter 2). (Hayden 1984, Cote and Festa-Bianchet 2003, Lemke 2004, McWhirter 2004, Whittlesey et al. 2018, Whittlesey and Bone 2020)

Although responses vary geographically and through time, when compared with bighorn sheep, mountain goat translocations in the Greater Yellowstone Area have been considerably more successful, even with very few founding individuals. As stated earlier, a total of 21,500 bighorn sheep have been translocated that have resulted in a current total range-wide population of 50,000 while 145 mountain goats released into the Greater Yellowstone Area created a current population of 2,100 mountain goats. Another way to look at this is bighorn sheep translocations have produced a 2 to 1 "return on investment" while mountain goats have produced a 15 to 1 return. This may merely reflect the disease sensitivities of bighorn sheep compared to mountain goats, or that bighorn sheep are more of a metapopulation-oriented species, which is difficult to maintain or create in today's landscape.

Even though mountain goats were intentionally introduced into previously unoccupied habitat to provide hunting and viewing opportunities, there may be reasons to intentionally manage or discourage their expansion. Mountain goats and bighorn sheep can harbor the same lethal respiratory pathogens. They also exhibit substantial overlap in their use of habitats and forage species, which can have adverse impacts if both species are trying to share very restricted high-elevation winter ranges.

Research has shown the potential for as many as 5,372 to 8,918 mountain goats in occupied bighorn sheep habitats around the Greater Yellowstone Area. Even if there is some level of shared resources, it is doubtful there could be this many mountain goats and not have adverse impacts on the almost 6,000 bighorn sheep that currently reside in the region. (DeVoe 2015, Wolff et al. 2016, Lowrey et al. 2018a)

Descendants of mountain goats introduced in the Absaroka and Madison mountain ranges of Montana have almost completely colonized suitable habitat within Yellowstone National Park. Mountain goats are breeding and at relatively high abundance (more than 200) in the northeast and northwest portions of the park, with suitable, continuous habitat along the eastern and western boundaries. With more than 600 goats in and adjacent to Yellowstone National Park, mountain goats will likely continue to occupy these habitats and disperse into and out of the park for the foreseeable future. National Park Service (2006) policy allows for the removal of non-native species that interfere with native wildlife or habitats if such control is prudent and feasible. Eradication or control programs to substantially reduce mountain goats would involve intrusive and costly aerial and ground operations in hazardous mountainous terrain for multiple years. Also, many park staff and visitors consider mountain goats valuable, charismatic components of the ecosystem, making the removal or killing of mountain goats in the park a highly sensitive issue. (Schullery and Whittlesey 2001, Lemke 2004, DeVoe 2015, Flesch et al. 2016)

Other national park units are approaching the management of exotic or non-native mountain goats differently in response to specific situations such as the number of animals, geography and proximity to a source population, and threats occurring in each unit. For example, in Rocky Mountain National Park and Dinosaur National Monument, where breeding populations of mountain goats are not established but occasionally appear, protocols developed in cooperation with the states of Colorado and Utah direct the removal of mountain goats as soon as possible after they are detected. In 2018, Olympic National Park began implementing a mountain goat management plan, aimed at removing all mountain goats from the park. The need for removal stems from concerns about mountain goat impacts on sensitive vegetation communities as well as safety concerns following the fatal goring of a park visitor in 2010. Grand Teton National Park has initiated the removal of mountain goats from the park to reduce the potential for disease transmission and competition for space and forage between mountain goats and a small native population of bighorn sheep that is struggling. Park staff want to protect other park resources and values from a growing and expanding mountain goat population. (National Park Service 2016, 2018a,b)

Mountain goats originally translocated into the Snake River Range of Idaho from 1969 through 1971 were first seen in Wyoming on a tributary of the Snake River Canyon in 1975, followed by an observation on Teton Pass in 1977, and another in Grand Teton National Park in 1979. Observations within Grand Teton National Park were relatively sporadic until nannies with kids were first observed in 2008, representing the establishment of a breeding population. The population has dramatically increased since then, with numbers of mountain goats seen during annual aerial surveys surpassing that of bighorn sheep by 2018, with each estimated to consist of approximately 100 individuals. Bighorn sheep in the Tetons are a core native herd that has never been extirpated or supplemented and, with other core native herds in the Absaroka Mountains, northern Wind River Mountains, and the Gros Ventre and Hoback River drainages, are the highest priority bighorn sheep herds in the state to the Wyoming Game and Fish Department.

Although once containing a migratory population segment, bighorn sheep in the Tetons are now restricted to subsisting year-round on high-elevation ranges above 8,500 feet (2,590 meters). Although past concerns regarding pathogen transfer from domestic sheep have been resolved through the retirement and relocation of domestic sheep grazing, current impacts include conifer encroachment into preferred habitats as a result of fire suppression and disturbance from backcountry recreation.

The expansion of mountain goats into bighorn sheep habitats, especially restricted high-elevation winter ranges, creates concern over competition for forage and space as well as risk of pathogen transfer from mountain goats to bighorn sheep. As a result, and even though it may be difficult and costly to implement, Grand Teton National Park has initiated efforts to remove mountain goats from the Tetons, using a combination of both lethal and non-lethal techniques. (Whitfield 1983, Whitfield and Keller 1984, McWhirter 2004, Wyoming Statewide Bighorn Sheep-Domestic Sheep Interaction Working Group 2004, Courtemanch 2014, National Park Service 2018b)

At least in Wyoming, work has shown that bighorn sheep in the Absaroka Mountains already share all lethal pathogens of concern with mountain goats, and so disease risk is perhaps less than that in the Tetons where bighorn sheep have not been exposed to these pathogens. Also, the proportion of bighorn sheep habitat potentially affected by mountain goats in Yellowstone National Park is relatively minor compared with that outside the park. This coupled with the fact that the abundance and distribution of mountain goats outside of Yellowstone can be controlled through hunting seasons means the Wyoming Game and Fish Department can achieve management goals more completely through managed hunting in the Absaroka Mountains than in the Tetons. (Lowrey et al. 2018b)

Therefore, the Wyoming Game and Fish Department has determined where to manage for abundant mountain goats and where to manage for low densities or prevent their expansion altogether. Long-occupied habitats in the Beartooth and Snake River ranges will continue to be managed for robust mountain goat populations, while very liberal hunting seasons for mountain goats have been implemented in the Teton and Absaroka mountains. The Colorado Division of Wildlife and Parks has a similar management approach where mountain goat colonization of high-priority bighorn sheep habitats is actively discouraged. Idaho and Montana both have native populations of mountain goats, some sympatric with bighorn sheep, but do not prioritize one over the other. (Colorado Division of Wildlife 2009)

Even though mountain goats are considered non-native, and significant concerns exist regarding their potential impacts on bighorn sheep, they provide substantial wildlife viewing and hunting opportunities. Seeing mountain goats is the highlight of many road trips along the Beartooth Highway between Red Lodge and Cooke City, Montana. Given their limited allocation, mountain goat hunting licenses are highly sought after, with drawing odds usually around 1.0%. Recently, statewide mountain goat harvests have averaged about 30 mountain goats per year in Wyoming, 46 mountain goats per year in Idaho, and 180 mountain goats annually in Montana, with 161 of these mountain goats harvested within the Greater Yellowstone Area in 2018. However, in Montana about 86% of the mountain goat harvest currently comes from introduced populations, a complete reversal of situations 50 years ago. (Smith and DeCesare 2017)

Conclusions

Both bighorn sheep and mountain goats are fascinating mountain ungulates well adapted to the remote and rugged habitats they occupy. During European settlement of the west, bighorn sheep fared better in the Greater Yellowstone Area than in most places, and although their numbers were reduced, they were never extirpated. Bighorn sheep fared better in rugged, mountainous areas throughout the ecosystem because of the limited areas suitable for agriculture and other major habitat modifying human activities, public ownership of the vast majority of the habitat, and administrative and regulatory statutes such as designated wilderness areas and national parks that emphasize maintaining natural ecosystems and the wildlife that reside in them. As a result of managed hunting, habitat management, and minimizing disease transmission risks from livestock, these herds today are widely distributed throughout the vast wild, mountainous country in the region, and represent some of the largest metapopulations of bighorn sheep currently in existence. Translocation efforts have reestablished some populations

Moutain goat juvenile, or kid, practicing what it will spend most of its life doing, climbing on rocks. Photo by Mark Gocke.

that were extirpated, but generally with lackluster results as most populations remain relatively small, and exhibit limited migratory behaviors. Maintaining robust metapopulations of bighorn sheep where they exist is undoubtedly the best approach to the persistence of bighorn sheep on the landscape, as re-creating metapopulations is not easily achieved. Preliminary evidence from the Madison Range of Montana, however, shows promise that inter-range translocations can be used to expand seasonal habitats and migrations of bighorn sheep and perhaps create heterogeneity of behavior and functioning metapopulations while minimizing risk of introducing lethal bacterial pathogens.

Unlike bighorn sheep, mountain goats were not present when the Greater Yellowstone Area was settled by Euro-Americans but were introduced in the last century. They expanded and provide exceptional viewing and hunting opportunities throughout the region but have also created concerns over potential impacts to native bighorn sheep populations in some locations. Acknowledging appreciation of a mountain ungulate such as the mountain goat, while recognizing and addressing the potential adverse impacts of their expansion is a delicate balancing act. Wildlife managers are familiar with these questions of balance and are often faced with making decisions that consider biological realities and social preferences and tolerances. Making decisions that are bound to be unpopular with some people is to be expected in an arena where so many people care about wildlife and wildlands.

How We Learn: Translocation of Mountain Ungulates

Recovering populations of locally extirpated wildlife is oftentimes achieved by translocating animals into once occupied, but currently vacant, habitats. The use of this technique is largely how Rocky Mountain bighorn sheep numbers increased in western North America from a low of less than 25,000 animals to approximately 50,000. Sometimes these efforts intentionally place species that did not previously reside in an area into new habitats, expanding their distribution or initiating populations well outside their native ranges, as was the case with mountain goats in numerous western states, including the Greater Yellowstone Area of Idaho and Montana.

The capture and translocation of mountain ungulates is time intensive and very costly, so assessments of potential release sites to ensure the success of the reintroduced (or introduced) population is a necessity. These assessments include habitat evaluations, consideration of competition and disease transmission with existing wildlife populations and domestic animals, and the acceptance or tolerance of landowners if private lands are potentially affected.

Animals must first be captured, which with bighorn sheep and mountain goats is usually done in the winter because they tend to be at lower elevations and more accessible. Snow and colder temperatures also help with heat stress induced by being restrained and handled by humans. Capture operations generally cease prior to the onset of spring, as the stress of capture can be harmful to females in the latter stages of pregnancy. Translocation efforts most often target adult females, as they contribute the most to population increases. Hopefully, the females will be pregnant because giving birth in their new home encourages them to remain in the area and add to the growth of the population. Of course, males are needed for breeding to occur in the new population, but only a handful are needed to serve this purpose.

The bighorn sheep on the left were captured with a drop net in the Madison Range of Montana and released in the same mountain range to expand the population into suitable, but unused, habitat. The bighorn sheep on the right were captured via helicopter net-gunning, loaded into trailers for transport, and released the next day in an entirely different mountain range in Wyoming. Photos by Richard Horst (upper left), Doug McWhirter, Wyoming Game and Fish Department (upper right), Stan Harter, Wyoming Game and Fish Department (lower right), and Julie Cunningham, Montana Fish, Wildlife and Parks (lower left).

To minimize the time being handled, every effort is made to release animals as quickly as possible into their new home. Once they are released it is very important to monitor the population to determine if the translocation has been successful or, if not, why. Each effort informs subsequent translocations and hopefully increases the likelihood of the animals thriving in their new landscapes.

The conservation of wildlife rarely occurs without citizens encouraging decision-makers at every level of government to make it a priority. Wildlife management in mixed ownership landscapes such as the Greater Yellowstone Area requires a considerable amount of cooperation, coordination, and compromise. As a result, achieving a balance of biological and social wants and needs is an art as much as science. Ensuring support for wildlife management requires the engagement of many stakeholders and the coordination of many agencies and individuals. This involves meetings among cooperating agencies on items from shared data collection efforts, cooperative research projects, and habitat enhancement projects.

Even though most agencies are guided by statutory and regulatory obligations, much is left up to the desires of the public, who own the wildlife and the lands on which they reside. This requires processes by which the public can express those desires, such as commenting on National Environmental Policy Act (NEPA) documents for federal agency actions such as prescribed burns to improve habitat or industrial development projects that have the potential to negatively impact wildlife habitat. Similarly, state wildlife agencies gather public input on population management objectives and specific hunting season proposals.

Mountain goat searching for food in Sheepeater Canyon, Yellowstone National Park. Photo by Jacob Frank, National Park Service.

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“The chapters in this Greater Yellowstone Mountain Ungulate Project book, written by an incredibly-talented team of skilled and experienced wildlife biologists, provide a fascinating glimpse into the past, present and future of one of the most special places on Earth, the Greater Yellowstone. Wildlife management is not an easy task. Wildlife and land/resource management professionals need to look back, carefully mine and consider historical data and recorded observations, and develop their best recommendations going forward. I can only express my sincere gratitude and appreciation for the talented biologists who took on this monumental effort. The Greater Yellowstone will benefit from their dedication and efforts.”

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