Idaho Mountain Goat Management Plan

2019-2024

Prepared by **IDAHO DEPARTMENT OF FISH AND GAME**

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Executive Summary

Mountain goats (*Oreamnos americanus*) are an iconic alpine species; highly valued by both hunters and non-hunters. These striking, white animals are found in the most rugged mountains across the state. Hunters and other outdoor recreationists alike enjoy watching these sure-footed animals balance on cliff ledges and forage in alpine meadows.

Idaho Department of Fish and Game (IDFG) was established to preserve, protect, perpetuate, and manage all of Idaho's fish and wildlife. Idaho's prior mountain goat management plan (IDFG 1990) addressed vulnerability of mountain goats to overharvest, protection of habitat by reducing new roads and trails, and translocation of mountain goats into suitable ranges.

This plan is designed to provide guidance to IDFG staff to manage Idaho's mountain goat habitat and populations over the next 6 years. The plan directs IDFG to sustain or increase mountain goat populations across the state. To accomplish this goal, IDFG has identified statewide management direction and strategies, as well as specific strategies for each Population Management Unit (PMU). IDFG will engage partners interested in mountain goat management, including hunters, federal and state agencies, conservation organizations, tribes, and other interested individuals and groups. Partnerships can help IDFG accomplish goals to maintain sustainable populations, healthy habitat, and hunting opportunity.

The draft mountain goat management plan was available for comment on the IDFG website for 26 days. IDFG solicited and received feedback from USFS and neighboring state wildlife agencies. We received 155 on-line submissions, with 80 people providing written comments which were evaluated and summarized (Appendix D). We incorporated changes based on comments.

Mountain goats live in isolated, high-elevation areas with harsh weather conditions. They will forage in meadows and forests, but prefer to be close to rocky cliffs. Availability of high-quality habitat limits mountain goat distribution in Idaho. Most threats impacting mountain goats are direct threats to their habitat or indirect threats that cause them to leave preferred habitat. Habitat alteration caused by actions, such as road building, mining, or changing climate, may reduce amount of currently available limited habitat. Mountain goats are susceptible to disturbance by recreational activities, both motorized and non-motorized, and may abandon preferred, high-quality areas because of disturbance.

Historically, there were many more mountain goats in Idaho than there are today. Open seasons with unlimited tags through the 1950s reduced mountain goat populations in many areas. Increasingly conservative hunting season structure with controlled hunts has helped stabilize some populations, but others continue to decline. Some mountain goat populations translocated into unoccupied areas quickly increased and provided new hunting and viewing opportunities. Other translocations failed to establish or increase populations.

Idaho offers few mountain goat tags; tags are highly sought after and demand has increased over time. Hunters may harvest only 1 mountain goat in Idaho in their life. Mountain goats are polygamous, so more harvest can be placed on males than females. However, male mountain goats cannot be harvested at rates as high as other ungulates, such as deer (*Odocoileus* spp.) and elk (*Cervus elaphus*), because they live in low-density populations isolated from one another.

Small populations are inherently susceptible to random events, such as a severe winter or wildfire, which means some of Idaho's mountain goat populations may decline despite harvest. Furthermore, adult females generally do not bear kids until they are 4–5 years old. This low reproductive rate means populations grow slowly. Mountain goat populations are very sensitive to female harvest. More hunting opportunity can be offered when hunters select billies instead of nannies. This mountain goat management plan presents harvest guidelines based on a population model to help wildlife managers determine appropriate harvest levels based on population size, kid:adult ratios, and percent females in the harvest. These harvest guidelines are intended to maintain and increase mountain goat populations while offering maximum hunting opportunities.

Statewide mountain goat management direction includes:

- Provide maximum harvest opportunity possible while maintaining stable to increasing mountain goat populations statewide.
- Continue to offer controlled hunts and work with hunters to reduce harvest of nannies.
- Increase our knowledge of mountain goat survival, recruitment, habitat use, genetics, and impacts of disease, habitat changes, and recreational activities.
- Collaborate with land management agencies to incorporate conservation measures which benefit mountain goats in land use and resource management plans.
- Improve quality of mountain goat population monitoring data to better evaluate population trends.
- Create guidelines for mountain goat translocations in Idaho.

Mountain Goats CCBY IDAHO FISH AND GAME

Table of Contents

Table of Contents *cont.*

List of Figures

List of Tables

Introduction

Mountain Goat CCBY IDAHO FISH AND GAME

Mountain goats are found only in North America. They select steep slopes and adjacent alpine areas, typically occupying subalpine and alpine habitats where trees are either absent or scattered (Smith 1978). Habitats selected by mountain goats are often characterized by harsh climate with frequent strong winds, significant snow accumulation, and snowpack that persists >8 months annually (Figure 1).

Males, females, and offspring are typically referred to as billies, nannies, and kids. Both genders have horns and most horn growth occurs during the first 3 years. Adult males are generally 10–30% larger, appear stockier or heavier in the chest and shoulders, and have beards that are heavier and broader than those of adult females (Brandborg 1955, Houston et al. 1989).

Breeding season occurs between early November and mid-December (Geist 1965) followed by a gestation period of approximately 180 days. Although nannies in some populations reach sexual maturity at age 2 and produce their first kid at age 3 (Peck 1972, Stevens 1980, Bailey 1991), most nannies do not have their first offspring until 4-5 years old (Adams et al. 1982, Swenson 1985, Festa-Bianchet et al. 1994, Côté and Festa-Bianchet 2001, Hamel et al. 2006). This delay in breeding dramatically reduces potential for rapid growth in most mountain goat populations (Lentfer 1955, IDFG 1990). High mountain goat densities can lead to cascading effects on population dynamics, including prolonged reproductive intervals of 2–3 years, delayed breeding, and reduced kid survival and recruitment rates. Twinning rates are generally low (2% in Alberta; Festa-Bianchet et al.1994), but can be higher in expanding or introduced populations with high quality habitat (Holroyd 1967, Hibbs et al. 1969, Houston and Stevens 1988). A twinning rate of 22% was documented in the introduced Palisades population during the early 1980s (Hayden 1989).

Mountain goat kids are precocious and begin to forage and ruminate within days after birth (Brandborg 1955, Chadwick 1983). Nursery groups (females and their offspring, including yearlings) are formed when kids are approximately 2 weeks old. During this period, 2-year-old billies usually leave nursery herds and remain solitary or form small groups. Kids remain with their mothers through their first winter, and although presence of the mother is thought to increase survival of kids, orphaned kids can survive (Foster and Rahs 1982). After sexually maturity, reproductive success generally increases until peaking at 8 years (Stevens 1980, Smith 1984, Bailey 1991).

Nursery groups typically move greater distances daily (2–5 km) than males (<1 km/day) (Singer and Doherty 1985, Côté and Festa-Bianchet 2003). Seasonal movements may result in animals moving to lower elevations at or just above tree-line or slopes with southern exposures during winter (Brandborg 1955, Hjeljord 1973, Smith 1976, Rideout 1978, Smith 1978). In summer, males may venture into forested areas away from steep slopes to feed, while females and kids usually feed on or in immediate proximity to steep slopes used to escape potential predators.

Documented predators of mountain goats include grizzly bear (*Ursus arctos*), mountain lion (*Puma concolor*), gray wolf (*Canis lupus*), and golden eagle (*Aquila chrysaetos*). Other potential predators and observed scavengers are coyote (*Canis latrans*), bald eagle (*Haliaeetus leucocephalus*), wolverine (*Gulo gulo*), and black bear (*Ursus americanus*) (Festa-Bianchet and Côté 2008). Of all age classes, kids are most likely impacted by predation. Mountain goat kids are more susceptible to predation when foraging on open slopes and avalanche chutes, or when separated from or abandoned by nannies. However, overall annual survival in kids is 64%, higher than documented in other ungulate species (50%) (Festa-Bianchet and Côté 2008). Predation also occurs on adults, mainly during dispersal events and on mountain goats >8 years old (Festa-Bianchet and Côté 2008).

Most mountain goat mortality occurs between autumn and spring, similar to other ungulate species in Idaho (White et al. 2011). The extremely steep, rocky habitats mountain goats inhabit are treacherous, and mountain goats of any age can die from falls or in avalanches (Festa-Bianchet and Côté 2008, White et al. 2011). Mountain goat survival declines with increasing winter snowfall and increasing summer temperatures (White et al. 2011). Severe winters decrease kid survival and negatively impact reproduction (Vogel et al. 1995). Deep snow limits mountain goat mobility and ability to acquire limited food resources. Expending additional energy during severe winters can increase mortality due to malnutrition, particularly when individuals enter winter in poor body condition (Forsyth et al. 2005). Above average summer temperatures can cause heat stress in mountain goats as they forage and accelerate desiccation of forage plants (White et al. 2011).

Mountain goats are intermediate browsers, primarily feeding on grasses and alpine shrubs during summer and autumn. They select plants based on high nutrition value and availability of minerals, such as sodium. In areas where grasses are covered by snow, mountain goats readily switch to a diet of browse, including mountain mahogany (*Cercocarpus ledifolius*) and conifers (*Picea englemannii, Abies lasiocarpa*). Mosses and lichens may also be consumed where available (Côté and Festa-Bianchet 2003). Smith (1976) reported a correlation between female nutrition and kid:nanny ratios, and Bailey (1991) reported availability of summer forage was related to pregnancy rate. Winter forage is critical to adult over-winter survival and fetal development (Fox et al. 1989).

The mountain goat is recognized as a Species of Greatest Conservation Need, priority Tier 3, in the Idaho State Wildlife Action Plan (SWAP, IDFG 2017). The Action Plan is the state's guiding document for managing and conserving species before they become too rare and costly to protect. Proactive guidance in SWAP promotes recovery efforts and appropriate land-use measures, and builds and strengthens partnerships to conserve Idaho's wildlife heritage.

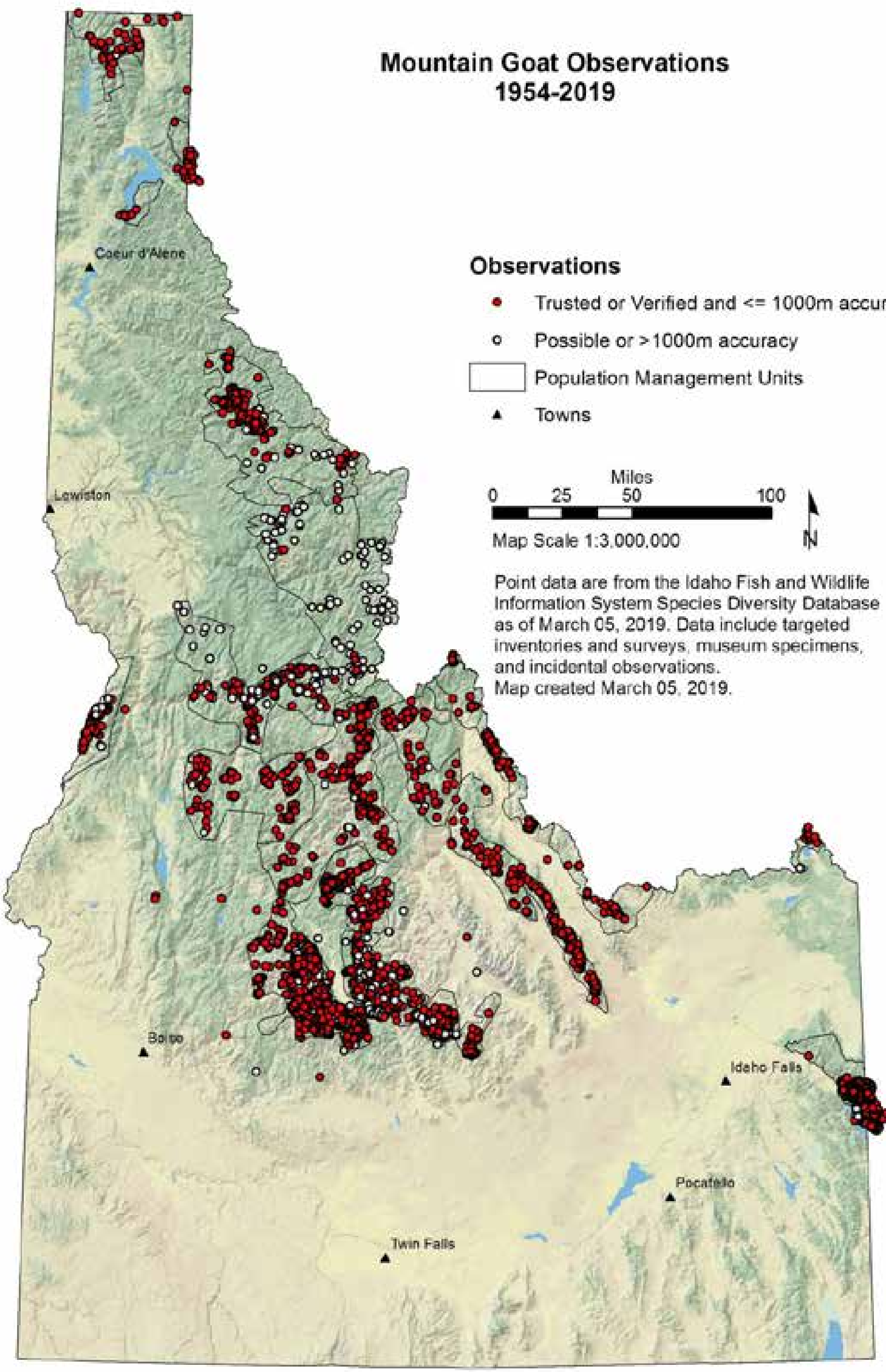

Figure 1. Known mountain goat locations in Idaho, 1954–2019.

Mountain Goat Management Plan (1990) Goals and Accomplishments

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Goals and Accomplishments

Idaho's most recent plan (1990) provided direction for mountain goat management and research from 1991 through 1995. IDFG made progress on 1990 goals:

1. In areas of suitable habitat, mountain goat herds will be managed through maintenance of conservative harvest strategies and an active translocation program.

   - Mountain goats have been managed under the harvest strategy outlined in the last plan. Harvest rates typically remained below 5% for all herds. Nannies with kids have remained unavailable for hunter harvest. For more than a decade, we have provided mountain goat hunters with information about the importance of identifying and targeting billies for harvest. Females have comprised approximately 30% of statewide harvest since the last plan.
   - Since 1990, IDFG has translocated 120 mountain goats into 6 different populations. Mountain goats were trapped from productive herds in Snow Peak (GMU 9), Black Mountain (GMU 10), Seven Devils (GMU 18), Palisades (GMU 67), and moved to Lower Salmon (GMUs 15 and 20), Middle Fork of the Salmon (GMU 27), Panther Creek (GMU 28), and Selkirks (GMU 1). Mountain goats were also translocated from Utah to the Lemhi Range (GMU 29).

2. Seek an understanding of population dynamics of mountain goats, i.e., what removal is allowable from rapidly growing vs. stable populations.

   - The population modeling effort completed for the current mountain goat planning process examined effects of different harvest rates on declining, stable, and increasing populations. Higher harvest rates are possible when female harvest is reduced. Populations with high reproductive rates can sustain higher harvest rates.

3. Maintain or increase current recreational opportunity.

   - A variety of recreational opportunities are available in Idaho including hunting, wildlife watching, and photography. Controlled hunt tag numbers have been reduced from 79 in 1991 to 50 in 2017 due to declining populations in some areas.

4. Sample mountain goats for parasites, bacterial, and viral diseases to increase our understanding of epidemiology of wildlife disease outbreaks.

   - Mountain goats turned in for necropsy and hunter harvested mountain goats have been sampled opportunistically for parasites and bacterial and viral pathogens. Mountain goats captured for research or translocations have also been sampled.

Habitat

Habitat was described by Caughley and Sinclair (1994) as the suite of resources (e.g., food, shelter, etc.) and environmental conditions that determine presence, survival, and reproduction of a population. Mountain goats have adapted to exploit an ecological niche in Idaho and other parts of North America that generally requires cliffs and other rugged topography. Physical characteristics of these habitats are more important than vegetation found within them (IDFG 1990). These habitats are rare, and are generally associated with extreme conditions of temperature, precipitation, soils, and growing-season length.

Mountain goats inhabit alpine and subalpine regions of the most rugged mountains in Idaho. One limiting factor in mountain goat distribution is availability of high-quality winter range. Winter ranges are composed of cliffs and high alpine ridges where deep snow does not accumulate, thus providing access to winter forage. Because physical characteristics are more important than vegetative characteristics, habitat generally cannot be treated to produce quality winter habitat. This situation makes management and conservation of quality winter range crucial to maintaining current populations and distribution of mountain goats in Idaho. Winter-range habitats are found in relatively isolated areas of the Panhandle, central Idaho, Hells Canyon, and the Snake River Range (Figure 2).

Most mountain goat habitat in Idaho occurs on lands managed by the United States Forest Service (USFS). Management of USFS lands provides opportunities for multiple uses where appropriate. However, conflicting interests compete for land that currently provides quality habitat for mountain goat populations. Disturbance and development of mountain goat habitat will result in fewer mountain goats in Idaho. Therefore, IDFG's coordination with land management agencies to identify and evaluate potential threats and enable more informed land- management decisions is important to mountain goat management.

Food Habits

Mountain goats are intermediate browsers (Hofmann 1989) because they eat a variety of forages, including mountain mahogany, conifers, sedges, rushes, mosses, lichens, and grasses. Their diets vary by season and between populations (Brandborg 1955, Laundrè 1994, Harris et al. 2017). A summary of 10 studies showed summer diets of mountain goats averaged 52% grass, 30% forb, and 16% shrubs, but shifted to 60% grass, 8% forb, and 32% shrubs in winter (Laundrè 1994). Variability between populations is large and mountain goats generally eat what is available. Laundrè (1994) reported percentage of grass in summer diets, for example, varied from 11% to 97%, and summer shrub consumption varied from 0% to 79%. Winter diets also show high variability.

Carrying capacity of alpine and subalpine habitats is limited and mountain goats can deplete food resources (Reed 1983). Alpine environments have a short growing season and vegetation can become scarce, especially if mountain goat numbers are high. Alpine vegetation also takes longer to recover from overgrazing than that in lower-elevation habitats. Winter-range habitat is most vulnerable because mountain goats concentrate into smaller areas during winter (Vogel et al. 1995).

Mineral Licks

Mountain goats have been observed traveling several miles to use artificial and natural mineral licks. Use of mineral licks appears to peak during summer months (Brandborg 1955, Rice 2010). Mountain goats use licks because minerals are limited in vegetation of alpine habitats and eating spring vegetation decreases sodium retention (Hebert and Cowan 1971, Feldhamer et al. 2003). Although there is no evidence artificial sources of salt satisfy any physiological requirements

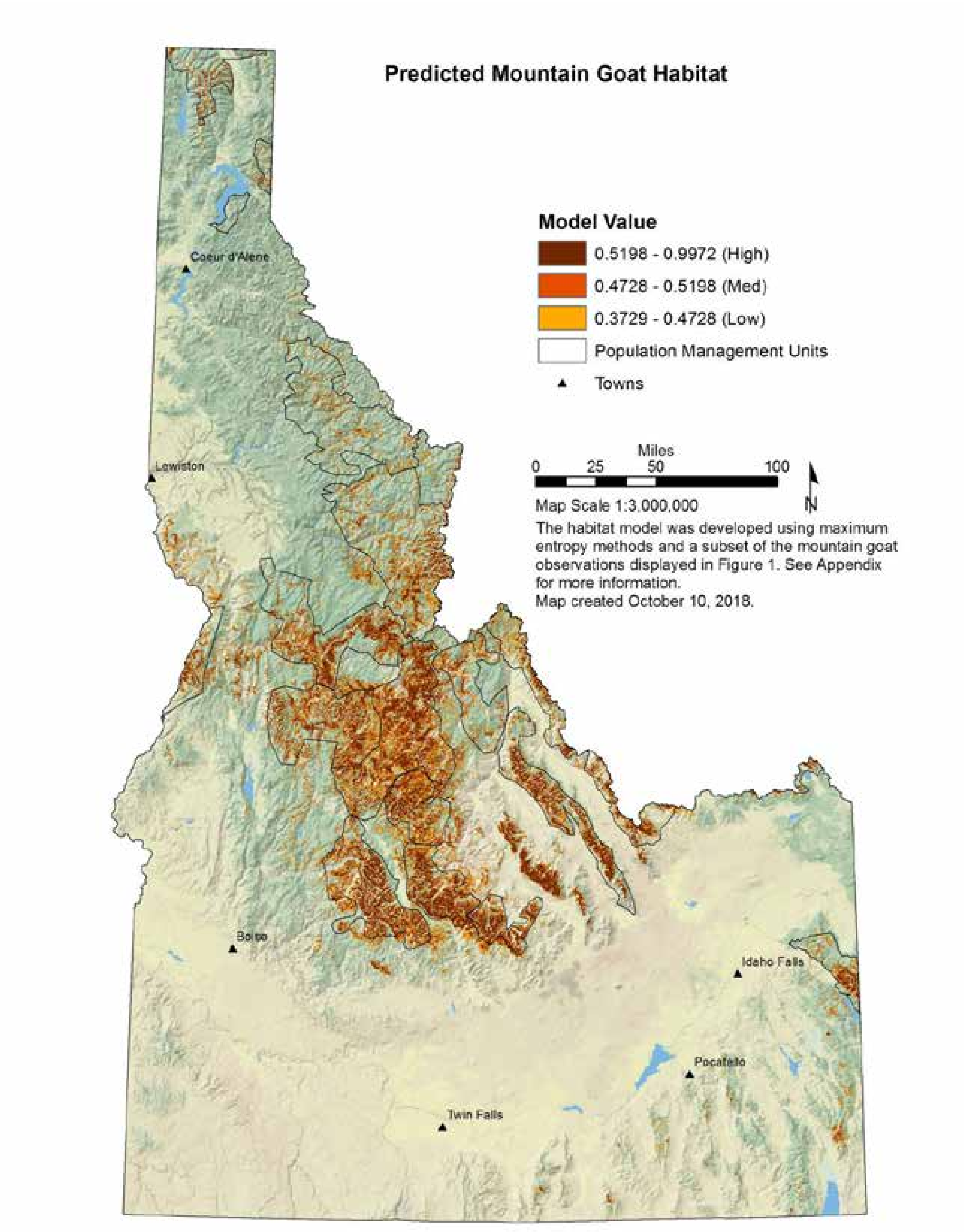


Figure 2. Predicted mountain goat habitat using maximum entropy model based on known locations (see Appendix C for modeling methods).

(Brandborg 1955), mountain goats appear to have an appetite for mineral deposits, as evidenced by their willingness to expend energy, cross dangerous terrain, and tolerate interspecific and intraspecific aggression near licks (Feldhamer et al. 2003). Mountain goat populations that use artificial sources of salt have a higher prevalence of some infections and diseases (Samuel et al. 1975).

Impacts to Mountain Goat Habitat

Most threats facing mountain goats in Idaho are either direct threats to their habitat or indirect threats that could cause them not to use available habitat (Festa-Bianchet and Côté 2008). For example, road construction, timber harvest, mining, power infrastructure, oil and gas extraction, climate change, wildfires, and fire suppression are direct threats to mountain goat habitat and are likely to negatively affect nearby mountain goat populations. Fire suppression could negatively affect mountain goat habitat by preventing late-successional forest from being converted to early successional stages, thereby reducing forage. Conversely, forest fires might temporarily remove components of plant communities mountain goat populations rely on (e.g., mountain mahogany).

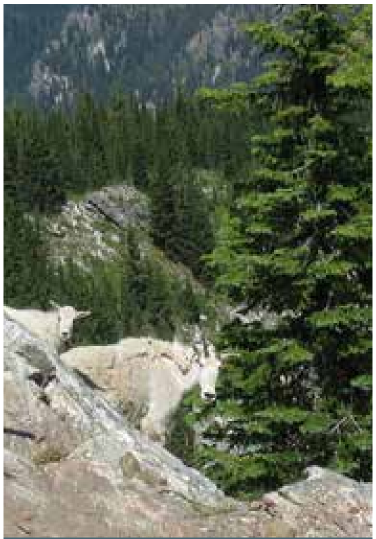
Other threats to mountain goat populations indirectly result in habitat loss by reducing effectiveness of habitat or by causing mountain goats to abandon parts of their range or reduce use of portions of their range. These indirect effects can reduce amount of forage available and increase vulnerability of mountain goats to predators and human disturbance. For example, Joslin (1986) determined kid production and survival were negatively correlated with seismic surveys in Montana.

Recreation

Human disturbance to mountain goats via recreational activities can occur in all seasons and by various forms, including all-terrain vehicles (ATVs), motorcycles, helicopters, unmanned aerial vehicles (drones), snowmobiles, snow bikes, backpacking, and backcountry skiing. Negative effects of these disturbances on mountain goats, particularly from helicopters, have been well documented (Côté 1996, Hurley 2004, Goldstein et al. 2005, Côté et al. 2013, Richard and Côté 2016). Other research addressing non-aircraft disturbance (Varley 1998, St-Louis et al. 2013) documented negative effects similar to that of aircraft disturbance. These disruptions may result in a variety of negative impacts, including habitat abandonment, changes in seasonal habitat use, alarm responses, lowered foraging and resting rates, increased rates of movement, and reduced productivity (Pendergast and Bindernagel 1976, MacArthur et al. 1979, Foster and Rahs 1985, Hook 1986, Joslin 1986, Pedevillano and Wright 1987, Dailey and Hobbs 1989, Frid 1997, Duchense et al. 2000, Phillips and Alldredge 2000, Dyer et al. 2001, Frid 2003, Gordon and Wilson 2004, Keim 2004).

Areas used by nursery groups (nannies with kids) and wintering areas are of particular concern in relation to recreational impacts (Hurley 2004). Nursery groups typically occupy habitat optimal for kid survival (Fournier and Festa-Bianchet 1995). In addition, nannies are sensitive to disturbance during kidding and post-kidding periods due to energy requirements of giving birth and lactation (Penner 1988). Hurley (2004) recommended helicopter activity should not occur within 1.5 km of occupied winter range from 15 November to 30 April and nursery group areas from 1 May to 30 June. Reproductive success and population viability of a herd hinges on health and success of these nursery groups.

Summer recreation, such as heli-hiking, heli-touring, motorcycle and ATV riding, and backpacking, are increasing in popularity. Favorite destinations for these activities are often high-quality mountain goat habitat. Activities creating the greatest amount of disturbance are motorcycle and ATV use. St-Louis et al. (2013) found almost one-half of encounters between ATVs and mountain goats resulted in moderate to strong disturbance. Increased vigilance and fleeing behavior caused by this disturbance may have a significant impact on access to quality forage resources, particularly for nursery groups during a critical period of the year. Non-motorized activities, such as backpacking and



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mountain biking may disturb mountain goats, but are less likely to generate the moderate to strong disturbance associated with motorized disturbance due to reduced noise. Another summer activity that may be a source of disturbance is endurance trail races (Newsome 2014). In 2018, there were at least 5 different races, with ≤200 participants per race, which passed through occupied mountain goat range in Idaho over 3 or more days.

Winter is a time of profound nutritional deprivation for mountain goats (Chadwick 1983, Fox et al. 1989, Shackleton 1999). Deep snow reduces food availability and increases energy expenditure (Dailey and Hobbs 1989). Mountain goats often constrain their movements and occupy small home ranges during winter (Schoen and Kirkoff 1982, Smith 1982, Keim 2003). Winter range is important to long-term survival of mountain goats and should be identified and managed to reduce disturbance to mountain goats.

Heli-skiing has been identified as an important disturbance factor affecting mountain goat populations (Goldstein et al. 2005, Cadsand et al. 2013). Heli-skiing is a relatively new and increasingly popular winter-recreation activity in Idaho that occurs in occupied and potential mountain goat range. A comprehensive assessment of winter recreation impacts, including heli-skiing, on wolverines in Idaho revealed the previously unknown extent and intensity of backcountry winter recreation (Heinemeyer et al. 2017). In addition, cat-skiing, snowmobiling, snow biking, and non-motorized backcountry skiing are increasingly popular among outdoor adventure enthusiasts. Rapidly expanding and innovative technology has resulted in lighter equipment and more powerful machines, allowing more people to access remote alpine environments with increasing frequency. In addition, as climate changes and traditional recreation areas receive less snow, more recreation activity and pressure will be placed on higher elevation, remote habitat typically favored by mountain goats.

Several studies have indicated ungulates do not become habituated to repeated, cumulative aerial disturbance, even over multiple years of the same disturbance (Bleich et al. 1994, Frid 2003). Fleeing from disturbance and vigilance can increase with repeated exposure to human disturbance, resulting in sensitization rather than habituation to human presence (Frid and Dill 2002). The long-term result of repeated disturbance by helicopters, snow machines, snow bikes, ATVs, hikers, cross-country skiers, or even logging or road building may be displacement from important winter and nursery areas, which could subsequently lead to declines in mountain goat populations.

Because wheeled and over-snow vehicles are more accessible to recreationists than helicopters or other aircraft, expansion of motorized roads and trails has the highest potential to damage and reduce quality of habitat. Increased ease of access to mountain goat habitat also impacts hunting opportunity. Festa-Bianchet and Côté (2008) reported hunting seasons have been closed in Alberta because they were easily accessible to hunters. In areas that are easier to access, Idaho may change tag allocations and hunt area boundaries to manage harvest. Mountain goats are particularly vulnerable to overharvest and are thought to be the only North American ungulate to be extirpated from parts of their range through regulated hunting (Kuck 1978, Glasgow et al. 2003).

Habituation

Mountain goats normally flee from human disturbance and may experience detrimental effects to habitat use and survival. However, there are situations where a few mountain goats have become habituated to humans and pose a threat to human safety. Habituation can result when humans intentionally feed mountain goats, allow mountain goats to approach too closely or lick salt off of their skin, or when mountain goats seek minerals created from human urine deposits. Once mountain goats become accustomed to acquiring food or salt from people, they can become aggressive, actively approach hikers, and become dangerous.

Two separate interactions occurred on Scotchman Peak trail in northern Idaho. Two hikers had encounters with aggressive mountain goats in 2015, which required medical attention from a bite and goring. This followed a well-publicized incident in Olympic National Park in Washington in 2010 where a male hiker was fatally gored in the leg by a mountain goat on a popular trail (Tsong 2010). Aggressive behavior by this and other mountain goats on the same trail had been reported by Olympic National Park visitors for 2 summers prior to the fatal encounter. In Idaho, encounters like these are limited to very popular, heavily used trails in mountain goat range. However, if trail distribution and use in mountain goat habitat increase, more of these incidents may occur.

Some national forests, national parks, and states are increasing outreach to alert hikers to potential problems and providing simple steps to prevent conflicts with mountain goats. Following conflicts on Scotchman Peak trail in 2015, Friends of the Scotchman Peaks Wilderness trained trail ambassadors to talk to hikers on the trail about safe and ethical behavior in mountain goat country. Since that time, there have been no additional human injuries on Scotchman Peak trail and more hikers are behaving appropriately by keeping their distance and actively encouraging mountain goats to move away.

Projected Changes to Idaho's Climate

Alpine species are often described as indicators of climate change, as they can be especially vulnerable due to limited range size, geographic isolation, and unique adaptations to alpine habitats which are already sensitive in nature (see Johnston et al. 2012, Frederick 2015). For mountain goats in particular, current research suggests habitat selection and survival are directly related to changes in both temperature and precipitation; changing climatic conditions may have both beneficial and detrimental effects (e.g., White et al. 2011, DeVoe et al. 2015, White et al. 2018).

Mean annual temperature in Idaho increased approximately 0.2° C (0.4° F)/decade since 1975. Summer and winter temperatures are increasing more than during other seasons; daily minimum temperatures are rising faster than daily maximums, extreme heat waves are becoming more common, and growing season is lengthening (Kunkel et al. 2013, Abatzoglou et al. 2014, Klos et al. 2014). Precipitation patterns have been more variable, but appear to trend toward increasing spring and winter precipitation with decreases in proportion of precipitation falling as snow, particularly at low- to mid-elevations (Kunkel et al. 2013, Abatzoglou et al. 2014, Klos et al. 2014). Based on current trends, projected changes over the next 50–70 years include progressively hotter, drier summers, and warmer, wetter, but less snowy, winters in the state (e.g., Kunkel et al. 2013, Wang et al. 2016). However, estimating these trends in alpine habitats is challenging due to substantial fine-scale variability in both temperature and precipitation, particularly in complex terrain. In addition, observation records at upper elevations are often sparse and not fully representative of current conditions (e.g., Ford et al. 2013, Silverman and Maneta 2016, Nadeau et al. 2017).

Assuming a business-as-usual emission scenario (Representative Concentration Pathway [RCP] 8.5), mean annual temperatures in Idaho's mountain goat PMUs are predicted to increase 3.5–3.9° C (6.3–7.0° F) by mid-century (as compared to 1961–1990 baseline), with summer temperatures rising fastest (4.1–4.4° C [7.3–8.0° F]), particularly for Sawtooth, White Cloud, and Pioneer PMUs (Wang et al. 2016, Table 1). These increases are expected to be accompanied by greater overall variability (e.g., record cold temperatures even as record highs become increasingly frequent) (Meehl et al. 2009). For example, while central Idaho may not experience a significant increase in number of extreme heat days (i.e., max. >35° C [95° F]), number of extreme cold days (i.e., min. <-12° C [10° F]) are expected to significantly decrease (Kunkel et al. 2013). By mid-century, projected increases in mean annual precipitation range from 15 mm to 83 mm (0.6–3.3 in) in mountain goat PMUs. While all PMUs are projected to experience decreases in summer rainfall and increases in winter rainfall, those in Panhandle and Clearwater Regions are projected to undergo the greatest degree of change in both seasons. Similarly, proportion of precipitation falling as snow is projected to decline in all PMUs (-0.4 m to -2.1 m [-1.3 to -6.9 ft], with the most substantial changes occurring in Cabinet, Black Snow, and Selkirk PMUs. Although model agreement for temperature projections is robust, particularly in early and mid-century, models of precipitation projections are much more variable, resulting in less certainty.

Climate: Predicted Effects on Mountain Goats

Ability of mountain goats to adapt to ongoing and projected climate changes is uncertain. Increases in temperature appear to strongly influence mountain goat populations. Warmer spring and summer temperatures negatively affect over-winter survival and juvenile growth, presumably due to direct effects on energy balance and thermoregulatory stress, as well as indirect effects on plant nutrition, availability, and phenology (e.g., Pettorelli et al. 2007, Hamel et al. 2009, Frederick 2015). During hot summers, mountain goats are susceptible to heat stress and they will seek shade or snow patches to stay cool, which can result in reduced time foraging. Warmer summer temperatures can also accelerate vegetation drying and senescence, thus reducing high-quality forage needed to produce adequate fat stores. Conversely, reductions in winter snowfall may increase over-winter survival by increasing access to food resources and reducing costs of locomotion (White et al. 2011). End-of-century projections suggest, at least in coastal Alaska, negative effects of increased summer temperatures will outweigh positive impacts of reduced snowfall (White et al. 2018, Figure 3).

Whereas mountain goat distribution will likely continue to be dictated by availability of steep escape terrain in the near term, changes in temperature and precipitation patterns may further impact individual populations by mid-century. Projected decreases in snowfall may increase availability of quality winter range that does not accumulate deep snow. Declines in amount or duration of snowpack may also

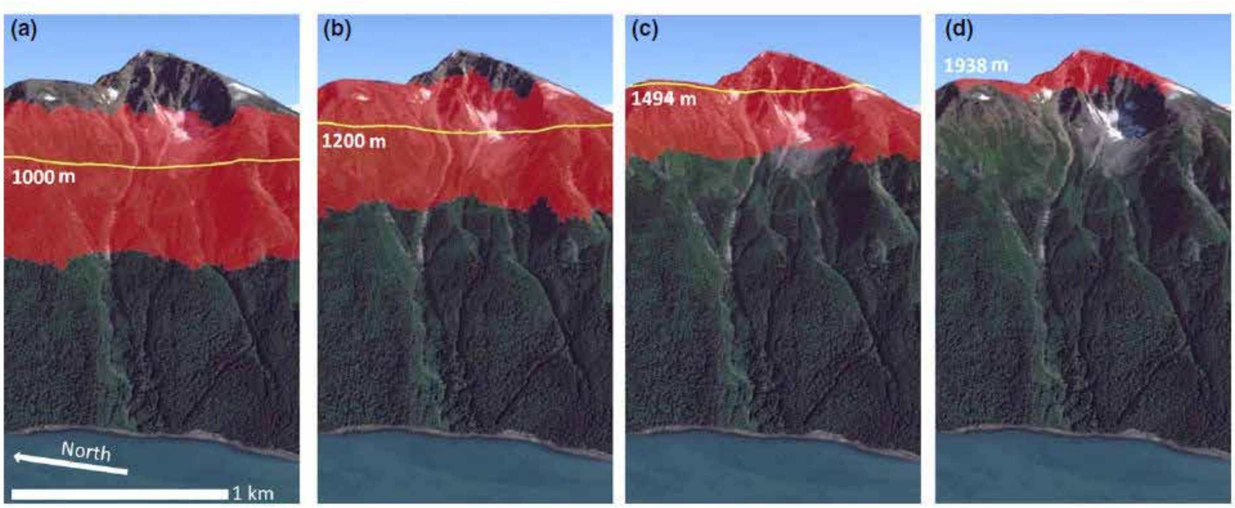

Figure 3. Predicted changes in mountain goat summer habitat distribution in southeastern Alaska by 2085 under 4 climate change scenarios: (a) current distribution (2005–2015 baseline), (b) best-case scenario, (c) intermediate scenario, and (d) worst-case scenario (adapted from White et al. 2018).

improve dispersal ability (e.g., Poole et al. 2009). However, alpine habitat is already limited in extent and, although largely in public ownership and protected as wilderness in Idaho, it could become more scarce. Modeling efforts in both coastal Alaska and Washington Cascades suggest mountain goat ranges will shrink (up to 86% under some scenarios), becoming more fragmented and isolated by end of the century (Figure 3, Johnston et al. 2012, White et al. 2018). A similar pattern could be expected for mountain goats in Idaho given they already occur at the highest elevations available across the majority of the state, particularly in Panhandle, Clearwater, and Southwest regions. As temperatures rise, mountain goats can adapt behaviorally by altering daily elevational movements and foraging times to select microsites providing cooler or warmer conditions as necessary (DeVoe et al. 2015, Frederick 2015). Perhaps, as Flesch et al. (2016) argue, they possess sufficient physiological and ecological plasticity to deal with projected changes in climate. That said, Idaho populations are small and fragmented, with low intrinsic productivity, highly variable juvenile and yearling survival, and population

Table 1. Baseline and projected mean summer (Jun-Aug) temperature and total annual snowfall for mountain goat Population Management Units (PMUs) in Idaho. Baseline data represent mean values for 1961–1990. Projected values are based on an ensemble of 10 general circulation models under a "business-as-usual" emission scenario (Representative Concentration Pathway [RCP] 8.5). Total annual snowfall was calculated from modeled precipitation-as-snow values following White et al. (2018). Original data are from ClimateWNA at a 1-km spatial resolution (Wang et al. 2016).

PMU	Acres	Elevation range (m)	Summer Temperature (°C)			Snowfall (m)		
			1961–1990	RCP 8.5, 2050s	Change	1961–1990	RCP 8.5, 2050s	Change
Black Snow	1,016,457	483–2,401	15.0	19.2	4.2	3.3	1.8	-1.6
Cabinet	69,577	708–2,131	13.4	17.5	4.1	4.9	2.8	-2.1
Seven Devils	118,646	348–2,632	17.2	21.5	4.3	1.6	0.9	-0.6
Lemhi	563,923	1,249–3,708	12.9	17.3	4.4	1.9	1.4	-0.5
Upper South Fork	709,080	862–2,951	12.1	16.4	4.3	3.4	2.5	-0.9
Lochsa-Selway	1,328,637	520–2,828	13.8	18.0	4.3	3.3	2.0	-1.3
Lost Trail	314,292	1,089–3,153	14.4	18.7	4.3	2.1	1.5	-0.6
Lower Salmon	870,195	492–2,718	13.4	17.7	4.3	2.7	1.8	-0.9
Middle Fork	1,067,488	836–3,059	13.6	17.9	4.3	2.7	1.9	-0.8
Palisades	216,186	1,546–3,044	14.7	19.0	4.4	2.3	1.6	-0.7
Panther Creek	465,216	933–3,031	15.1	19.4	4.3	1.6	1.1	-0.5
Pend Oreille	64,747	627–1,946	15.4	19.5	4.1	2.4	1.2	-1.2
Pioneer	236,432	1,866–3,634	11.6	16.0	4.4	2.7	2.2	-0.5
Sawtooth	717,234	1,292–3,268	13.3	17.7	4.4	3.7	2.5	-1.2
Selkirk	312,841	525–2,346	13.0	17.1	4.1	3.9	2.5	-1.4
South Beaverhead	250,837	1,896–3,471	12.8	17.1	4.3	1.5	1.1	-0.4
Targhee	40,175	1,977–3,173	12.4	16.6	4.2	3.5	2.9	-0.6
Yankee Fork	355,871	1,471–3,145	12.5	16.8	4.4	2.6	1.9	-0.7
White Cloud	387,876	1,716–3,586	11.9	16.3	4.4	3.1	2.4	-0.7

declines in some PMUs. These characteristics, combined with low to moderate levels of genetic diversity (see Population Monitoring, page 17), suggest a low adaptive capacity (Beever et al. 2016). A better understanding of ecology, behavior, and physiology of mountain goats with respect to temperature thresholds, as well as complex interactions between temperature and precipitation at high elevations, is needed to fully understand and appropriately manage populations under changing climatic conditions.

Habitat Management and Restoration

High-quality mountain goat habitat includes a combination of cliffs, steep slopes, and alpine ridges. Additionally, to support healthy mountain goat populations, this terrain must also be remote, in suitable climates, and relatively free from disturbance. Conservation of existing quality mountain goat habitat should be one of the highest priorities for managers. Specifically, proactively managing access and travel will be critical to protecting mountain goat populations. Identifying, mapping, and monitoring quality mountain goat habitats are essential to protecting currently occupied ranges, as well as identifying potential habitats. Because mountain goat habitats are scattered throughout Idaho, migration and dispersal corridors should be documented and conserved. Although there appears to be no physiological requirements for mineral licks (Brandborg 1955), Glasgow et al. (2003) reported licks appear to be important for many populations. Conservation of mineral licks and trails mountain goats use to access them should be a priority.

Manipulations of mountain goat habitats should be carefully considered. Altering plant communities to increase early successional stages may benefit mountain goats in some areas, but these habitats are vitally important because of their physical attributes and care should be taken to avoid disturbance of mountain goats in those areas. Habitat manipulations in areas of late-successional forests that resulted from fire suppression would be most likely to benefit mountain goats.

Management Direction – IDFG will collaborate with land management agencies (e.g., USFS) to incorporate habitat protection and mitigation measures and strategies in land use and resource management plans.

Strategy – Place conservation of existing quality mountain goat habitat as high priority for habitat management.

Strategy – Identify critical areas, including occupied winter ranges and nursery group areas.

Strategy – Identify and evaluate potential threats to mountain goat habitat and coordinate with land managers (e.g., USFS, Bureau of Land Management [BLM], Idaho Department of Lands [IDL]) and recreation groups to address those activities.

Strategy – Work with land managers (e.g., USFS, BLM, IDL) and recreation groups to minimize impacts of disturbance in mountain goat habitats by developing best-management practices for recreational activities, including over-snow recreational activities and helicopter-based recreation, by 2022.

Strategy – Develop a plan to identify and prioritize research needs for all Idaho mountain goat populations before 2020. Develop proposals for prioritized projects that identify number and type of radio-collars necessary to answer research questions. These projects could include efforts to radio-collar adult mountain goats to examine habitat use and movement patterns where this need is identified as a priority. Use survival and movement data from radio-collared mountain goats to provide insight into effects of recreation.

Management Direction – IDFG will work to better delineate seasonal distribution and movement patterns of mountain goats.

Strategy – Develop a plan to identify and prioritize research needs for all Idaho mountain goat populations before 2020. Develop proposals for prioritized projects that identify number and type of radio-collars necessary to answer research questions. These projects could include efforts to radio-collar adult mountain goats to examine habitat use and movement patterns where this need is identified as a priority.

Strategy – Use point data collected from radio-collared mountain goats to develop and refine occupancy maps of summer and winter habitats by 2024.

Management Direction – IDFG will work with land management agencies and other entities to develop education material describing safe and ethical behavior in mountain goat country.

Strategy – Produce a brochure and video describing how mountain goats become habituated to humans and how to avoid conflict while recreating in mountain goat habitats by 2020. Provide this information to the public on IDFG's website.

Strategy – Assist with volunteer or trail ambassador programs that patrol trails and educate hikers where there exists high potential for conflict. Prioritize initial outreach efforts in Scotchman Peak trail area in 2020.

Strategy – Design and install signage conveying the same message contained in the brochure and video at 10 trailheads that intersect occupied mountain goat range by 2022. Prioritize trailheads based on historical and current human-mountain goat conflicts.

Management Direction – IDFG staff will work to better understand existing and potential effects of changing climate, specifically changes in severity of winter and summer temperatures, on mountain goat recruitment rates, survival, and distribution, as well as alpine habitat responses.

Strategy – Identify and support collaborative research among partners, standardization of methods, and development of opportunities focused on identifying and understanding changes in climatic conditions that could affect mountain goat populations.

Strategy – Work with university researchers to develop climate models at appropriate scales for management of mountain goats in Idaho.

Strategy – Engage land management agencies (e.g., USFS) in collaborative efforts to address direct and indirect threats, such as road building, mining, and impacts from recreational activities, to mountain goat populations that may compound effects of climate change.

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Health and Disease

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Several parasitic, bacterial, and viral pathogens have been documented in mountain goats in Idaho, but we have not detected any population-level impacts of disease on Idaho mountain goats.

Respiratory Disease

Pasteurella spp. and *Mycoplasma ovipneumoniae* (Movi) have been documented in Idaho mountain goats sampled between 1989 and 2017, but no negative effects on populations have been detected. Research conducted in the East Humboldt Mountain Range of Nevada detected a population decline and attributed increased mortality and low kid recruitment to bacterial pneumonia (Wolff et al. 2014, Wolff et al. 2016, Anderson et al. 2016, Blanchong et al. 2018). Subsequent analysis showed bighorn sheep (*Ovis canadensis*) and mountain goats living in the same area had the same strain type of Movi, highlighting potential for disease transmission between mountain goats and bighorn sheep.

Bacterial pathogens associated with population-limiting pneumonia in bighorn sheep have been detected in mountain goats. How this may impact bighorn sheep and mountain goats living with, or adjacent to, each other remains unclear, but implications of pathogen transfer between bighorn sheep and mountain goats should be considered by managers when evaluating translocations and management of overlapping populations (Wolff et al. 2016, Anderson et al. 2016, Blanchong et al. 2018, Lowrey et al. 2018). Molecular strain-typing suggests domestic and wild goats and sheep can exchange pathogens and analysis of potential impacts to mountain goats should be a priority (Wolff et al. 2014). Determining management actions requires research addressing effects of pneumonia on mountain goat populations, particularly where bighorn sheep populations are overlapping. Observations referenced above suggest exposure of mountain goats to domestic livestock (i.e., domestic sheep [*Ovis aries*], domestic goats [*Capra hircus*], llamas [*Lama glama*]) may pose a risk to mountain goats and to overlapping or adjacent bighorn sheep populations.

Other Parasites and Pathogens

Gastrointestinal parasites, ticks, and lungworm (*Protostrongylus* spp.) have been detected in Idaho mountain goats. These pathogens were generally thought to have negative impacts on individuals, but not to cause population level declines (Côté and Festa-Bianchet 2003). *Coccidia* spp. is the most commonly detected macroparasite that typically infects the small intestine and may negatively impact juvenile animals. Other parasites documented in Idaho mountain goats include ticks (*Dermacentor* spp., *Otobius* spp.), lungworm, roundworms (*Nematodirus* spp., *Trichuris* spp.), strongyles, and cestodes. One female mountain goat from Sawtooth PMU was found to have *Echinococcus* *granulosus* hydatid cysts, the first record of this parasite and in this host species in Idaho (Foreyt et al. 2009).

Blood samples indicate most mountain goat populations in Idaho have some level of exposure to numerous bacterial and viral pathogens, including Anaplasmosis, Bovine Viral Diarrhea, Bovine Respiratory Syncytial Virus, Infectious Bovine Rhinotracheitis Virus, *Haemophilus somnus*, and Parainfluenza Virus 3. Some of these pathogens are likely circulating within mountain goat populations, but some may be exchanged with other wildlife or domestic livestock.

Contagious ecthyma is a highly contagious Parapox virus also called sore mouth, orf, and pustular dermatitis (Merwin and Brundige 2000) that has yet to be documented in Idaho mountain goats. Severe cases can involve sores and scabs, primarily on eyes, ears, mouth, muzzle, and udder. Outbreaks in mountain goats in other areas have resulted in deafness, blindness, and death (Samuel et al. 1975, Hebert et al. 1977, Zarnke 2000). A higher prevalence of infection has been observed in mountain goat populations that use artificial sources of salt (Samuel et al. 1975). Contagious ecthyma can be transmitted to humans from direct contact with affected domestic and wild animals as well as from skinning and dressing affected carcasses (Smith et al. 1982).

"Contagious ecthyma in a mountain goat" ©Tom Thorne and Beth Williams Image Gallery, Wildlife Disease Association

Unlike most large ungulates, but similar to reindeer (*Rangifer tarandus*, Palmer et al. 2004), mountain goats appear to be susceptible to West Nile virus (WNV). Seven of 12 captive mountain goats in a zoo in Nebraska died of encephalitis caused by WNV in 2002. Predicted warmer summer temperatures in Idaho could increase range of mosquitos carrying WNV. No reports of WNV in free-ranging mountain goats are known, but because the disease has been documented in all 44 counties in Idaho, WNV should be investigated as part of on-going health evaluations of mountain goats.

At least 2 mycobacterial diseases have been documented in mountain goats. Johne's disease, caused by *Mycobacterium avium paratuberculosis*, is a chronic condition that usually involves the gastrointestinal tract. Johne's disease has been reported in mountain goats in southern Colorado (Williams et al. 1979). Bovine tuberculosis, caused by *M. bovis*, has been documented in captive mountain goats in a zoo (Oh et al. 2002).

Trace Elements

Poor nutrition can predispose animals to disease. Immune function can be compromised by inadequate caloric intake or by deficiency or imbalance in specific nutritional components, including trace elements such as selenium and vitamin E (Kahn 2005). In Idaho, few populations have been sampled for evaluation of trace mineral levels. Of those tested, levels of most trace minerals are considered adequate based on accepted normal values for domestic goats and sheep, with the exception of below-normal levels of selenium in Seven Devils PMU. Trace mineral evaluations on additional populations within the state are needed to determine whether low levels of selenium or other minerals are potentially affecting population performance.

Other disease issues may be present or of concern in mountain goats and should be addressed when they become apparent or problematic based on information provided by IDFG staff or necropsy examinations. Possible changes in disease exposure due to changes in habitat use, population connectivity, management activities, climate, new pathogens and parasites, etc. emphasize importance of health monitoring to allow for early response to disease issues if needed.

Management Direction – IDFG will increase knowledge of mountain goat health and disease status in Idaho by collecting and analyzing more data to create population infection and exposure profiles.

Strategy – Continue sampling hunter harvested mountain goats for health data surveillance.

Strategy – Develop a health testing protocol by 2019 to use when mountain goats are captured.

Strategy – Collect reported sick and dead mountain goats for necropsy and collection of biological samples.

Strategy – Collect and bank mountain goat DNA from captured, necropsied, and harvested animals for future research.

Management Direction – IDFG will work to improve understanding of effects of disease on mountain goat populations.

Strategy – Work with universities and other management agencies to study effects of respiratory disease on mountain goats and subsequent threats to bighorn sheep populations.

Strategy – Work with universities and other management agencies to study possible health effects of mountain goat exposure to domestic livestock. Begin with compiling and analyzing available data from Idaho and other states, focusing on pathogens that could impact mountain goats at a population level. Complete initial compilation of available data by 2020.

Management Direction – IDFG will create guidelines for health monitoring associated with mountain goat translocations in Idaho by 2020.

Strategy – Assess risk of mountain goat translocations to health of resident mountain goats, bighorn sheep, or other wildlife populations.

Strategy – Develop a protocol for health testing prior to any translocation for source populations and recipient populations (if a population will be augmented).

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Population Monitoring

Mountain goat population monitoring is an important part of management. Data on abundance, distribution, and herd composition all help to inform management decisions. However, these data can be difficult to obtain because monitoring mountain goat populations is particularly challenging. Mountain goats are broadly distributed, occur at very low densities, often consist of small groups, and inhabit remote, rugged terrain, including several federally designated wilderness areas. Few populations have been well-studied. Consequently, seasonal movements and distributions are not fully understood. In addition, most mountain goat populations in Idaho contain <150 individuals. Thus, missing a few animals or groups during surveys can dramatically alter population estimates. Furthermore, herd composition is difficult to acquire during aerial surveys because genders appear similar.

Aerial Surveys

IDFG began conducting aerial surveys for mountain goats in the late 1940s (IDFG 1949), generally via fixed-wing airplanes and incidentally to elk and deer surveys. Prior to that, annual estimates of mountain goat numbers by the USFS across 10 national forests provided the only available records from approximately 1917 through 1950 (Brandborg 1955). Brandborg (1955) organized the first mountain goat project in Idaho, documenting life history, distribution, and population size in the Bitterroot Mountains, Selkirk Mountains, and along Salmon River. Shortly thereafter, regions around the state began directed surveys of mountain goat populations. Mountain goat population data was collected using a variety of techniques across Idaho over the last 60 years. Biologists used ground counts, fixed-wing aircraft flights, helicopter surveys, and helicopter mark-recapture studies to assess mountain goat populations. These include mountain goat-targeted surveys as well as mountain goat observations incidental to surveys for other species. Most surveys occurred during spring or winter, but many have also been conducted in summer and autumn.

Not all populations of mountain goats in Idaho are surveyed. Priority is given to PMUs where hunts are offered. Many surveys are conducted in conjunction with elk and deer surveys to decrease cost. On average, aerial surveys are conducted every 5 years in PMUs where hunts occur. Survey duration is 1–6 days depending on size of the PMU. Most surveys are performed using a helicopter with 2 observers and all areas thought to hold mountain goats in a given population's range are flown once. Observers record number of mountain goats, age (kid, yearling, adult) and gender (when possible) of individuals, and habitat type. Efforts are made to collect data quickly to ensure survey efficiency and minimize disturbance to mountain goats. Surveys provide minimum counts rather than population estimates because a mountain goat sightability model has not been fully developed. Surveys typically occur in winter in much of Idaho. However, most surveys in Upper Snake Region are conducted during summer. Surveys are scheduled to occur when sightability is likely highest based on habitat and seasonal movement patterns of mountain goats. Winter surveys are preferably flown within a few days of a fresh snow to help track mountain goats. If fresh tracks are observed, they are typically followed until mountain goats are found. Population level reproductive success is derived from ratio of kids to adults.

Exploring methods to estimate mountain goat populations is an IDFG priority. One potential method is a sightability model specific to helicopters. This method has been successfully used to estimate elk and deer populations since the 1980s. Sightability data for mountain goats were collected using 20 radio-collared mountain goats in the northern Lemhi Range (GMU 29) during 9 aerial surveys from 2008 to 2010. Model variables included habitat, vegetative cover, snow cover, level of snow tracking conducted, group size, and activity. Crude observation rates of groups averaged 85% (83–89%) in 2008, 74% (70–80%) in 2009, and 82% in 2010 (IDFG 2008, IDFG 2009, IDFG 2010). Observation rates in the Lemhi Mountains fall near the upper end of the range of mountain goat sightability estimates developed in other areas. Observation rates averaged 46% in coastal Alaska (Smith and Bovee 1984), 68% in west-central BC (Cichowski et al. 1994), 67% in east-central BC (Poole et al. 2000), 70% (range 55–84%) at Caw Ridge in Alberta (Gonzalez-Voyer et al. 2001), and 63% in southeastern BC (Poole 2007). Washington recently developed a regression-based sightability model with an average sightability of 85% (Rice et al. 2009), but surveys were conducted in summer and applicability to winter surveys will have to be evaluated. A sightability model has not been fully developed for use in Idaho.

Another technique to estimate animal populations is through mark and recapture or resight (Williams et al. 2002). In 1999, IDFG biologists began a mark-resight study in GMU 18 (Pauley and Crenshaw 2006). Mountain goats were marked with recreational paintball equipment fired from a helicopter. Biologists subsequently conducted resight surveys, recorded number of marked and unmarked mountain goats observed, and used that information to calculate Lincoln-Peterson population estimates. In 2000, biologists marked mountain goats in GMU 10 using similar methods, but with addition of a second marking occasion and resight survey (Pauley and Crenshaw 2006). Estimated abundance for GMU 18 was 171 (95% CI 109–321) and 196 (95% CI 165–245) mountain goats in 1999 and 2000. Estimated abundance in GMU 10 was 97 (95% CI 74–143) and 96 (95% CI 81–128) in April and May 2000. Initial sighting probability for undisturbed mountain goats during this project was 0.59 (SE = 0.068). The effort was repeated in 2002 and 2007 in GMU 18 and in 2002, 2005, and 2010 in GMU 10. This mark-resight method is expensive, labor intensive, and causes biased estimates due to avoidance behavior because it requires repeated surveys in the same area.

Ground Surveys

IDFG has also explored ground surveys to estimate mountain goat densities. Ground surveys have been conducted for many years across several regions in Idaho. Ground surveys may provide more accurate composition information than aerial surveys because surveyors can often observe animals for longer periods and mountain goats are generally unaffected by observer presence (Belt 2010). Additionally, Belt (2010) showed density estimates were higher for ground surveys than for aerial surveys. However, there are some disadvantages as well. Detection probability may be an issue for ground-based, volunteer surveys (Belt 2010). This issue could potentially be overcome with increased site visits,

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but this method still lacks power to detect a 30% reduction in abundance over 10 years (Belt 2010). Another drawback to ground surveys is the logistical requirement of much time and many observers.

To continue investigating alternatives to helicopter surveys, IDFG initiated a graduate research project at University of Montana in 2017. The objective of this project is to test effectiveness of remote cameras and 2 ground-survey techniques for estimating occupancy and abundance of mountain goat populations. These methods will be combined with recently developed statistical models with the goal of improving precision and reliability of these techniques. The project is being conducted in the Palisades portion of the Snake River Range and completion is expected by 2020.

Survival and Movements

Survival, habitat use, dispersal rates, and dispersal distances of mountain goats in Idaho are poorly understood. The most reliable data of this type are usually derived from individuals marked with radio-collars. Radio-locations of mountain goats in Idaho are limited to 12 individuals in Palisades PMU and 3 small groups of translocated mountain goats in GMUs 20 and 29. Translocated mountain goats were released into unoccupied habitat that historically held mountain goats or to augment existing populations. Data from recently translocated mountain goats likely does not represent true survival or movements of established populations. In addition, small sample sizes of radio-collared individuals in these PMUs are not adequate to produce survival estimates for an entire population.

Genetic Diversity

Mountain goats are polygynous, where only a few males do most breeding, and generally live in small, isolated populations, and are therefore, susceptible to inbreeding (Mainguy et al. 2009). As a result, mountain goat populations display low to moderate levels of genetic diversity. In Idaho, many mountain goat populations occur on isolated mountain ranges, which may limit dispersal opportunities across intervening valleys, resulting in isolation and reduced gene flow between herds (Shafer et al. 2011). Because mountain goats in Idaho occur on the periphery of the species' range, and in isolated areas with small population sizes, they have lower levels of genetic diversity compared to counterparts in core range (Shafer et al. 2011).

In Washington, genetic diversity was higher where alpine habitats were larger and more connected, but declined toward the southern periphery of their range, where alpine habitat was less abundant and more fragmented (Shafer et al. 2011, Parks et al. 2015). Inability of mountain goats to move between herds may further erode genetic diversity and limit ability of populations to recover (Parks et al. 2015). In small, isolated populations in Alberta, low genetic diversity (heterozygosity) has been associated with reduced juvenile survival (Mainguy et al. 2009). Ortego et al. (2011) observed a decline in genetic diversity in this same mountain goat herd, despite increasing population size. Higher heterozygosity was documented in offspring of individuals migrating to this herd, suggesting an increasing population size inadequately compensated for a small effective population size, and immigration was critical to increase genetic diversity. Isolated populations of mountain goats on the periphery of their range may be at risk of low genetic diversity due to effects of genetic drift and inbreeding (Frankham 1997). Inbreeding depression often significantly affects birth weight, survival, reproduction, and resistance to disease, predation, and environmental stress (Keller and Waller 2002). Retention of gene flow among increasingly fragmented habitat patches is necessary to sustain populations sensitive to inbreeding (Keller and Waller 2002). Small populations are more vulnerable to extinction when they suffer from inbreeding depression or loss of adaptive variation (Lynch et al. 1995).

Maintaining migration corridors and landscapes permeable to individual movements increases effective population size, genetic diversity, and adaptive potential, while providing movement routes for mountain goats to respond to climate change (Sexton et al. 2011). Distance to neighboring escape terrain and landscape changes (agricultural valleys, roads, housing) can limit gene flow (Parks et al. 2015). Considering current landscape changes, limited gene flow from mountain goat immigration into isolated populations may be insufficient to counterbalance consequences of low genetic diversity (Parks et al. 2015).

Gene flow is limited in many mountain goat populations, and further genetic work is necessary to determine negative impacts from founder effects, bottlenecks, and inbreeding. Short-term management of populations at fewer than several hundred individuals virtually guarantees a need for more intensive management for future survival (Lynch et al. 1995). Population augmentation via translocation may be a viable alternative to increase genetic diversity in isolated mountain goat herds in Idaho.

Management Direction – IDFG will improve quality of mountain goat data to better evaluate population trend and viability.

Strategy – Develop a monitoring plan for population surveys that provides for periodic assessments of population status and distribution by 2022. Survey methods may include helicopters, double-observer ground counts, camera-trap surveys, or other methods.

Strategy – Develop a plan to identify and prioritize research needs for all Idaho mountain goat populations before 2020. Develop proposals for prioritized projects that identify number and type of radio-collars necessary to answer research questions. These projects could include efforts to radio-collar adult mountain goats to examine distribution, increase survey efficiency, and estimate adult survival where these needs are identified as a priority.

Strategy – Develop new aerial survey instructions for each PMU, complete with maps of survey areas and instructions on how each region conducts their survey.

Strategy – Develop a consistent, statewide datasheet for mountain goat surveys prior to next scheduled surveys in 2019.

Strategy – Add historical population survey data to 2019 PR report.

Management Direction – IDFG will examine roles of immigration and emigration in populations with a meta-population structure.

Strategy – Develop a plan to identify and prioritize research needs for all Idaho mountain goat populations before 2020. Develop proposals for prioritized projects that identify number and type of radio-collars necessary to answer research questions. These projects could include efforts to radio-collar adult mountain goats to examine habitat use and movement patterns where this need is identified as a priority. Analysis of movement patterns could provide insight into connectivity between populations.

Strategy – Use banked mountain goat DNA to examine connectivity between mountain goat populations. A minimum of 20 samples per population will be needed for an initial analysis of connectivity. IDFG will continue to collect DNA to meet minimum sample-size needs.

Management Direction – IDFG will work to maintain genetically viable mountain goat populations across their range in Idaho.

Strategy – Secure additional funding for non-traditional mountain goat genetic monitoring (e.g., DNA from fecal pellets or hair).

Strategy – Collect and bank mountain goat DNA from captured, necropsied, and harvested animals.

Strategy – Use banked DNA to establish a baseline of genetic diversity in Idaho's mountain goats. Use this information to devise protocols and genetic "triggers" that would indicate augmenting populations with decreasing genetic diversity may be necessary.

Harvest Management

Mountain goat hunting can be an exciting and challenging adventure because mountain goats live in steep, rocky terrain in subalpine and alpine habitats that are difficult to access. Nonetheless, populations are susceptible to overharvest due to delayed sexual maturation, low productivity, and potential for high natural mortality in adults. However, conservative harvest strategies and improved population monitoring will hopefully help maintain this unique opportunity in Idaho for generations to come.

Hunter with Mt. Goat CCBY IDAHO FISH AND GAME

Historical Harvest and Management

Mountain goat harvest peaked in the 1960s and declined as mountain goat populations declined. General season hunts in the 1950s were all converted to controlled hunts by 1967, and tag numbers were reduced through the following decades. For example, in 1963 Idaho offered 7 general-season hunts (over-the-counter tags) and 28 controlled hunts with 192 tags, resulting in a harvest of 171 mountain goats. Controlled hunt permit numbers increased until 1974 when 303 tags were offered. Mountain goat populations decreased under these levels of harvest, some substantially. In response to declines, a more conservative approach to harvest was adopted. All subsequent Idaho mountain goat management plans included a goal of increasing populations. To achieve that goal, tag numbers were decreased and some hunts were closed. Since 1991, IDFG has offered 75-day hunting seasons running from 30 August to 12 November. In 2017 Idaho offered 21 controlled hunts with a total of 50 tags; 35 mountain goats were harvested. Chances of drawing a tag for these hunts ranged between 2% and 17%.

The 1991–1995 IDFG mountain goat plan (IDFG 1990) established criteria for a minimum population size of 50 prior to opening a mountain goat hunt and an annual harvest rate ≤5% of the non-kid segment (IDFG 1990). Harvest has typically been in the 2–4% range for most hunted populations, which is similar to neighboring states and provinces. This harvest regime has been in place since 1990 and many populations have been stable or declined under this harvest scenario. Exceptions include introduced populations, such as the Palisades population, which increased with similar harvest rates. Additionally, from the 1960s until the early 2000s mountain goats were translocated into vacant habitat or used to augment populations perceived to be suppressed, but success has been limited (Harris and Steele 2014).

Monitoring of low density mountain goat populations has complicated harvest management (see Population Monitoring, page 17). Idaho plans to conduct aerial surveys on most hunted populations every 5 years. These surveys provide a minimum count, kid:adult ratio, and distribution information. However, complication arises because kid:adult ratios observed from a helicopter are quite variable. Potential causes include kid sightability being even more variable than adult sightability, highly stochastic kid survival and therefore recruitment, or some combination thereof. Therefore, population surveys generate minimum known population estimates, and, if conducted near the time animals are recruited, a minimum known number of kids recruited.

Current Regulations

Mountain goats are a "once-in-a-lifetime" species, meaning hunters can legally harvest only 1 in their lifetime in Idaho. Bag limits are either gender, except nannies accompanied by kids cannot be harvested. Idaho requires a mandatory check; hunters must check their mountain goat at an IDFG office where horn length, horn annuli (age), and gender are recorded. In addition to lifetime harvest restriction, application rules and eligibility for controlled hunts are designed to further improve drawing odds. A hunter cannot apply for most other big game controlled hunts the same year they apply for a mountain goat hunt (exceptions include unlimited tag hunts and extra antlerless deer and elk hunts). Additionally, if a hunter draws a tag and does not harvest an animal, they must wait 2 years before they can reapply.

Population Dynamics

Hamel et al. (2006) modeled mountain goat population dynamics and potential impacts of harvest for 12 populations in Jasper National Park, Alberta. The authors used vital rates (birth rates as well as survival rates for both genders and different age demographics) measured on the Caw Ridge population to inform their model. All 12 populations were surveyed annually or biennially from 1973 to 2003 (Gonzalez-Voyer et al. 2001) and these demographic data were used to develop and validate their model. Additionally, they conducted a sensitivity analysis to determine how different vital rates influence rate of population change.

Population projections for 8 of 12 populations were similar to observed values from aerial surveys, but 2 were overestimated and 2 were underestimated, likely due to different survival or birth rates. Sensitivity analysis indicated survival of females ≥5 years produced the largest impact on population growth, and proportional change in population growth due to adult survival was 1.5 times greater than that of recruitment. Modeled harvest scenarios indicated nonselective annual harvest rates >1% of mountain goats ≥2 years were not sustainable for some populations. The authors produced a comparison of 4 population sizes harvested at various rates and displayed 20-year simulated population growth rates and probabilities of extinction at 40 years for managers to use as guidelines (Hamel et al. 2006).

Modeling Effect of Harvest on Idaho's Populations

We assumed Idaho's mountain goat populations experience similar population dynamics and survival rates as populations studied in Alberta. Thus, we used models from Hamel et al. (2006), but varied recruitment and harvest rates to better represent the range in variability in these rates for Idaho's populations. The large impact of adult female harvest on mountain goat populations is not surprising given low recruitment rates and average age at first reproduction for females (4.7 years; Adams et al. 1982, Swenson 1985, Festa-Bianchet et al. 1994, Côté and Festa-Bianchet 2001, Hamel et al. 2006). Although the model selects gender of harvested individual randomly, most hunters target males. Nonetheless, average statewide harvest of females was 33% between 1990 and 2017. Within individual hunt areas, female harvest ranged 0–92% over the same time period. Additionally, many populations have sustained a harvest rate of 2–4% for the last 30 years and they appear stable. Therefore, we present harvest tables as a reference for all managed populations in Idaho, including introduced populations that might have higher reproductive rates and a larger range of population sizes than modeled in Hamel et al. (2006).

Similar methods to Hamel et al. (2006) were used to produce harvest simulations and generate a set of harvest tables that allow for a wider range of recruitment rates (kid:adult ratios), population size, and proportion of females in the harvest. While generating harvest tables, output was organized to closely mimic data currently collected by IDFG. Vital rates were used to run 2-Stage and 12-Stage models from Hamel et al. (2006, with similar assumptions), but we allowed female harvest to vary (for 12-Stage models) between 10% and 50% (in 10% increments) and only harvest whole animals (i.e., for a population of 50, a harvest rate of 2% = 1 animal and 4% = 2 animals). Fecundity (number of young surviving to become a yearling) was varied by establishing 3 levels, one higher and one lower than used by Hamel et al. (2006) (0.25, 0.40 and, 0.54). Fecundity of 0.25 closely corresponds to 10 kids per 100 adults (~ 1 Jun) and levels of 0.40 and 0.54 roughly correspond to kid:adult ratios of 15:100 and 21:100. Population sizes from 50 to 250, in increments of 50, were used to approximate the range of population sizes currently in Idaho; populations <50 would not be hunted. All simulations were run 1,000 times to generate probabilities of 10% and 25% declines over 20 years (see Appendix A for a more detailed description and R code for simulations). Probabilities of 10% and 25% declines were included in harvest tables for manager consideration of acceptable risk over the next 20 years given most population growth rate values were at or near stable ($\lambda \approx 1$).

Justification for Harvest Guidelines

This plan identifies guidelines for mountain goat harvest. Justification for each guideline is explained below.

Guideline 1: Allow harvest on populations with average recruitment rates of ≥15 kids:100 adults.

In the 2-Stage model (simplest model), we varied kid:adult ratios, population size, and harvest levels (because this model includes only adults and kids, gender of harvest is a random event). A population of 100 mountain goats with 1% harvest will decline 3.8% annually when kid:adult ratios are 10:100, but will increase 2.5% and 7.7% annually when ratios are 15:100 and 21:100. At recruitment levels equivalent to 10 kids:100 adults, all populations show declines, even in absence of harvest. Decreasing population growth rate regardless of population size at a kid:adult ratio of 10:100 is the reason 12-stage models were not run with the low recruitment rate. This illustrates risk of harvesting populations which are experiencing low recruitment (Figure 4).

Guideline 2: Allow harvest in populations of ≥100 mountain goats.

In absence of hunting, a population of 50 mountain goats has a 27% probability of declining 10% in 20 years and 5% probability of declining 25% in that same time frame. Table A-1 (Appendix A) illustrates how stochastic small populations can be, even with a recruitment rate of 15 kids:100 adults and no harvest. Table A-2 (Appendix A) illustrates the impact of adding harvest of 1 individual (2% harvest rate) on that same population. Probability of a 10% decline over 20 years increased to 55% and probability of a 25% decline increased to 29%.

Hamel et al. (2006) reported the greatest effect on population growth was variability in female survival. The only source of mortality that can be easily influenced is harvest. Regardless of population size, increase in percent female harvest has similar negative impacts on population growth (Figure 5). Population growth rate for a population of 100 mountain goats with

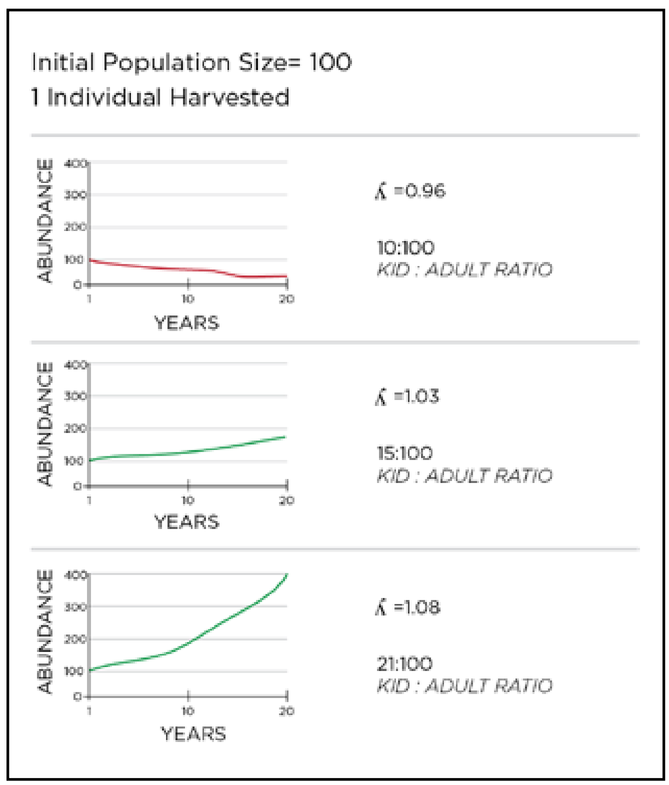

Figure 4. Results of 2-Stage model with various kid:adult ratios for a population of 100 with 1% harvest (with random selection of harvested gender of adult) showing change in abundance over time.

2% harvest rate and 50% of harvest being female is the same as a 4% harvest rate and 20% females in the harvest for the same population (Figure 6). This relationship illustrates the need to track female harvest rate through time at a population level to manage harvest. Further, this comparison demonstrates how a reduction in female harvest can lead to more hunting opportunity while maintaining stable or increasing populations. For example, if exclusive harvest of males was possible, all populations would undergo positive growth rates, even for harvest rates up to 5% (Appendix A, Table A-14).

Hunters with Mt. Goat CCBY IDAHO FISH AND GAME

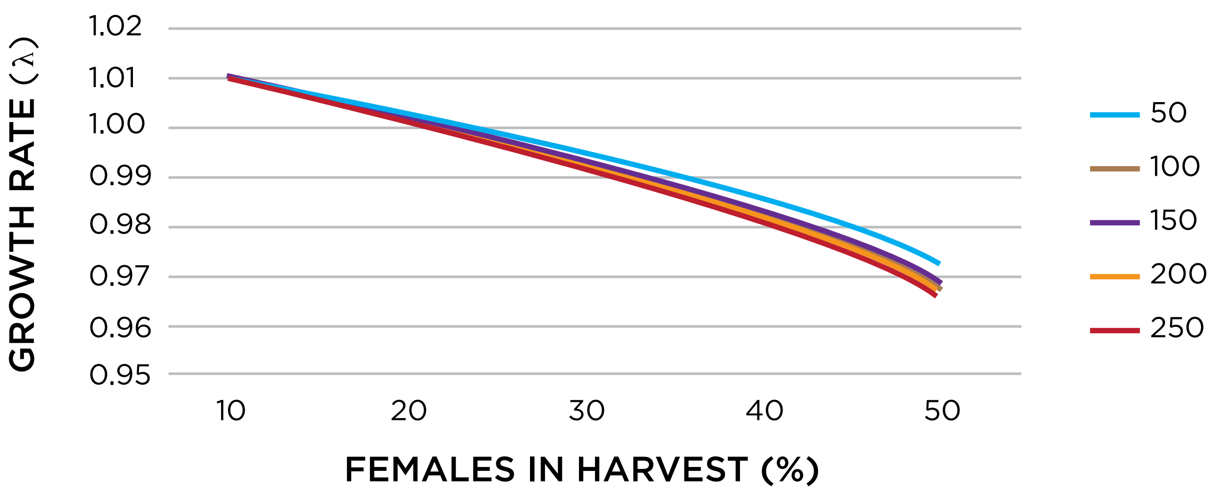

Figure 5. Population growth rates of various sized mountain goat populations with a 4% harvest rate and a range of percent females in the harvest.

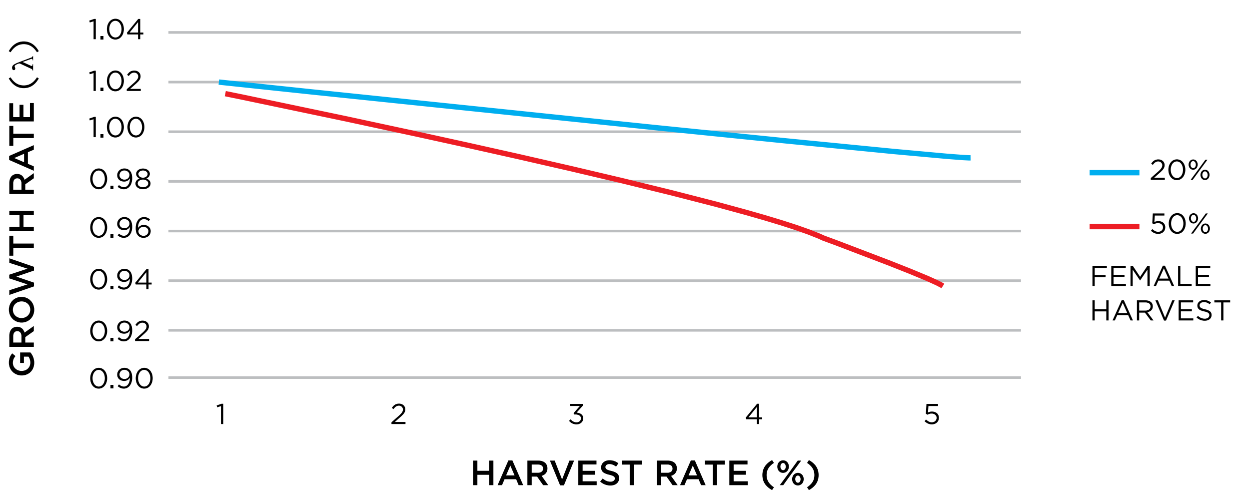

Figure 6. Population growth rates of various sized mountain goat populations with a 4% harvest rate and a range of percent females in the harvest.

Guideline 3: Allow harvest rates of ≤3% for average fecundity populations (15 kids:100 adults recruited).

Managing for a specific harvest rate should be implemented with caution. (Appendix A, Tables A-7–11). For example, regardless of population size, a 3% harvest rate with 30% females in the harvest (and recruitment rate of 15 kids:100 adults) generally maintains a stable population (bold text in Table 2). However, at a harvest rate of 3%, a population of 100 still carries a 31% probability of experiencing a 10% decline over 20 years (Table 2; Appendix A, Table A-8). If recruitment rates were high (21 kids:100 adults), with 3% harvest and 30% females in the harvest, the population would grow 4.5% annually (Appendix A, Tables A-12 and A-13). In addition, probability of 10% decline in 20 years is only 3% under this harvest scenario.

Management Direction – IDFG will provide maximum harvest opportunity possible through once-in-a-lifetime controlled hunts while working to maintain stable to increasing mountain goat populations. Harvest models were created to assist managers with development of appropriate harvest guidelines across various populations in Idaho. Managers should biennially assess mountain goat population and harvest data in relation to harvest tables. Harvest rates, population size, kid recruitment, and female survival will be used to inform harvest guidelines.

Guideline 1: Allow harvest on populations believed to maintain average recruitment rates of ≥15 kids:100 adults.

In applying this guideline, the model assumes all kids seen during a survey were recruited, which occurs approximately 1 June. A population surveyed in winter is likely to incur additional kid mortality before recruitment occurs, therefore some downward adjustment of kid:adult ratios is necessary for populations surveyed in winter.

Guideline 2: Allow harvest in populations of ≥100 mountain goats.

Modeled populations were not minimum counts, but were based on known populations. Therefore, unless a sightability model was used to determine population size, a correction factor of some kind should be applied (see discussion above). Given variability in sightability, a conservative correction to a minimum count would be 0.85, however mountain goat studies have found a range of sightability values (see Population Monitoring, page 17). Consider survey conditions, including terrain and habitat, when correcting for sightability. Total population size is at time of recruitment (~ 1 Jun).

Guideline 3: Allow harvest rates of ≤3% for average fecundity populations (15 kids:100 adults recruited).

See discussions for Guidelines 1 and 2 above. The 3% (or less) would need to be applied to a known population with a recruited kid:adult ratio of 15:100 or higher. Higher harvest rates may be appropriate for growing populations with higher than average kid:adult ratios.

Management Direction – IDFG will conduct outreach and education to mountain goat hunters to reduce harvest of females.

Strategy – Provide information to mountain goat tag holders outlining importance of reducing or eliminating nanny harvest and

Table 2. Example of harvest tables in Appendix A for a population of 100 with 3% harvest and variable percent females in the harvest (see Table A-8 for full range of variables).

Harvest Rate	Population Size, # Harvested	%Female	Probability of 10% Decline	Probability of 25% Decline	Population Growth Rate
		10	0.18	0.06	1.01
		20	0.27	0.11	1.01
3%	**100, 3**	**30**	**0.31**	**0.14**	**1.00**
		40	0.35	0.18	1.00
		50	0.43	0.24	0.99

how to identify nannies in the field, including a video with techniques for determining gender in the field prior to start of 2019 hunting seasons.

Strategy – If voluntary education does not successfully reduce statewide nanny harvest, evaluate efficacy of instituting a mandatory gender identification course for mountain goat hunters.

Management Direction – IDFG recognizes critical data needs for harvest modeling include total population estimates, adult male and female annual survival estimates, and kid recruitment rates. IDFG will identify specific data needs for populations and prioritize projects to gather that data by 2020.

Strategy – Radio-collar mountain goats to determine survival rates of adult males and females. A minimum of 30 radio-collared mountain goats (30 adult males for adult male annual survival plus 30 adult females for annual adult female survival) are needed to estimate survival.

Strategy – Identify methods to determine whether variation in observed annual kid:adult ratios is caused by differences in sightability or stochastic events.

Strategy – Use data from graduate student project to determine whether use of cameras is a valid way to estimate kid:adult ratios. Estimated project completion date is 2020.

Translocation

Goat Released CCBY IDAHO FISH AND GAME

Mountain goat translocation was a major focus of mountain goat management in Idaho beginning in 1960, with goals of augmenting small populations, reintroducing animals to historical range, or introducing mountain goats into new, unoccupied habitats. Between 1960 and 2016, approximately 270 mountain goats were translocated into or within the state (Appendix B, Table B-1). Sixty-one of those mountain goats were translocated from Washington and Utah. Eleven mountain goats were captured in Idaho and translocated out of the state. Snow Peak (GMU 9) and Black Mountain (GMU 10) were primary source populations for translocations through the mid-1990s.

Most translocations in the 1960s were into areas not previously occupied by mountain goats. Mountain goats were introduced into unoccupied ranges with appropriate habitat characteristics in Palisades (GMU 67), Seven Devils (GMU 18 and 22), and Bernard Peak (GMU 4A). Mountain goat populations introduced into unoccupied ranges of suitable habitat tend to expand rapidly. Palisades population was so productive that it became a source population for translocations from 1989 to 1997 (Appendix B, Table B-1) and provided new harvest opportunities.

Since the 1970s, translocations were primarily used to supplement declining populations and repopulate historical ranges. Success of early translocations to augment existing populations was largely unknown due to lack of radio-collaring to track survival and infrequent or inaccurate population surveys. Newly translocated populations typically experienced a period of initial expansion, followed by temporary stability. After this period of stabilization, populations tended to decline, which led to questions in the early 1990s about efficacy of translocations into declining herds, but introducing mountain goats into all suitable areas was still a priority.

For example, in Selkirk Mountains (GMU 1), 31 mountain goats were released between 1981 and 1994. A population survey conducted in 2001 showed a stable population with only 34 mountain goats observed. Idaho's most recent translocation in 2007 fared much worse. The state's largest release of 24 mountain goats occurred into unoccupied historical range in the northern Lemhi Range (GMU 29). Twenty of 23 adults were radio-collared to determine survival and recruitment. Recruitment was poor, with only 1 of 6 kids surviving a full year. Survival was very poor; 17 of 20 adults died within 3 years post-release. However, 16 mountain goats (11 ad, 5 juv) were observed in 2013, indicating at least some recruitment occurred. Mortality causes included mountain lion predation, falls, and malnutrition. An examination of mountain goat translocations into previously occupied range between 1950 and 2010 in Idaho found 1 successful, 5 failed, and 7 of unknown status (Harris and Steele 2014). Probability of a successful translocation is related to total number of mountain goats released; an average of 17 individuals were released in successful translocations compared to an average of 10 individuals in failed translocations (Harris and Steele 2014).

A species like mountain goats, found in small, remote populations with low immigration rates can have low genetic variability (Ortego et al. 2011), and low genetic diversity can lead to reduced population viability (Parks et al. 2015). A translocation of a small number of mountain goats may provide additional heterogeneity to an otherwise isolated and inbred population (see Genetic Diversity, on page 19). Fewer individuals may be needed for translocations for the purpose of increasing genetic diversity.

Other considerations should be addressed before translocating mountain goats. Appropriate and sufficient habitat, including forage species and impacts to native plant communities, should be assessed in potential translocation areas (see Habitat, on page 5). Potential disturbance related to recreational activities should also be assessed to place mountain goats in secure areas (see Recreation, on page 7). Possible disease transmission issues between mountain goats and bighorn sheep should be examined, especially in areas with species overlap (see Health and Disease, on page 14). Size and health of the donor population should be considered before moving individuals.

Management Direction – IDFG will create guidelines for mountain goat translocations in Idaho. Translocation of mountain goats may occur to augment existing populations or into unoccupied habitat when excellent mountain goat habitat is identified. The following strategies will be used to create translocation guidelines.

Strategy – Create and implement a set of protocols (checklist) to determine whether mountain goats should be released into an area.

Strategy – Develop a prioritized list of suitable locations for translocating mountain goats by 2020.

Strategy – Use most current mountain goat habitat map to verify a translocation site as high-quality habitat. Determine whether substantial changes in habitat have impacted mountain goat populations and whether current habitat conditions can support desired population levels.

Strategy – Address limiting factors (unrelated to genetic diversity) before populations are augmented in order to increase likelihood of success.

Strategy – Assess current and predicted future levels of recreational activities within the population's range and collaborate with other agencies to minimize impacts of recreational activities on newly translocated populations.

Strategy – Conduct population monitoring for all translocated mountain goats. All animals will be ear-tagged and GPS-radio collared. A population monitoring program will also be implemented to assess whether goals of translocation were achieved.

Strategy – Develop a capture and handling protocol for mountain goat translocations prior to each translocation.

Strategy – Assess risk of mountain goat translocations to health of bighorn sheep or other wildlife populations.

Strategy – Prior to any translocation, develop a protocol for health testing of source and recipient (for augmentation) populations.

Goats Released CCBY IDAHO FISH AND GAME

Mountain Goat Viewing Opportunities

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Wildlife is an important resource and is often cited as one of the reasons people choose to live here; not just for hunting, but for wildlife viewing as well. In 2011, 558,000 people participated in wildlife watching in Idaho and total related expenditures were estimated at $432,041,000 (USDI 2011).

Mountain goats offer a unique opportunity for wildlife viewing. They occupy discrete alpine habitats, have moderately high site fidelity, and exhibit distinct coloration, which makes them one of the more easily observable and identifiable species. Several populations of mountain goats across Idaho occur in close proximity to population centers and provide relatively accessible viewing opportunities. In addition, certain mountain goat populations do not seasonally migrate, offering a chance for the public to observe them year-round. Some of the best viewing locations include Farragut State Park, Scotchman Peak, Hells Canyon dam, Sawtooth Mountains, Yankee Fork, Billy's Bridge on Hwy 75, Targhee Creek, and Palisades.

Management Direction – IDFG will provide information to the public about the value of Idaho's wildlife resources, including mountain goats.

> **Strategy** – Provide educational information about mountain goats on the IDFG website, as well as via pamphlets, brochures, and signs.
>
> **Strategy** – Develop 2 interpretive viewing sites to educate the public about the value of mountain goats by 2024.

Population Management Units

Mountain goats were historically more abundant in Idaho than they are today. As across much of their range, mountain goats were overharvested in the early to mid-1900s. Some populations were used as translocation stock to supplement, re-establish, or introduce mountain goats into different areas.

Mountain goat distribution for this plan is defined as the geographic range regularly or periodically occupied by mountain goats. Not all areas within this range have sufficient suitable habitat to support persistent populations and mountain goats occasionally move outside this area. We divided mountain goat distribution into 19 PMUs based on our current knowledge of distribution and connectivity between subpopulations and populations (Figure 7). Population survey data in PMU tables may not correlate with historical reports due to PMUs occupying only parts of GMUs.

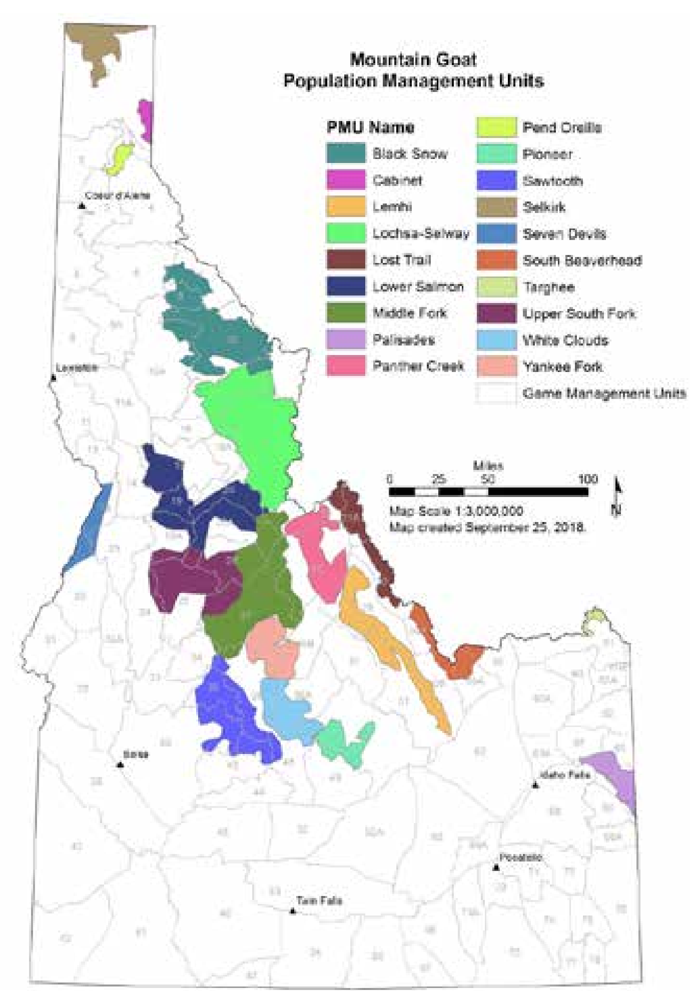


Figure 7. Population Management Units (PMUs) for mountain goats in Idaho.

Selkirk PMU

Selkirk PMU includes mountain goats in the northern Selkirk Mountains and Hall Mountain portion of GMU 1. Land ownership in the northern portion of GMU 1 is primarily Idaho Panhandle National Forest and IDL. Small amounts of BLM and private land occur within the PMU. Mountain goat habitat extends north into British Columbia. Most mountain goats in the Hall Mountain area are found in Canada. Mountain goats occupy the highest rocky peaks and some lower elevation rocky areas along Kootenai River.

Population

Mountain goats in Selkirk PMU occupy a core population area primarily along the Selkirk Crest. We know little about historical numbers of mountain goats in the Selkirks. Reports indicate as many as 195 mountain goats resided in the Selkirks in the early 1950s (Brandborg 1955). Aerial surveys in the 1970s found <15 individuals. The majority of population surveys have been aerial surveys; however 1 ground survey was attempted. There was no consistency in timing of surveys, which ranged from February to August. Mountain goats have been observed from the Canadian border to Hunt Peak. Translocations of mountain goats from Snow Peak in GMU 9 began in 1981 and continued until 1994 (Appendix B). Over 6 years, 19 mountain goats were placed in Lion, Bugle, Parker, and Ball creeks. The most recent aerial survey in 2001 found 34 mountain goats in Selkirk PMU; Hall Mountain was not surveyed. Recent observations suggest the population is stable at relatively low numbers.

Populations Surveys- Selkirk PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2001	May	26	8	34	31
All PMU	1995	Feb	30	3	33	10
All PMU	1991	Mar	13	2	15	15

***Number of kids per 100 adults.**

Harvest

Mountain goats were harvested under a general season from 1957 to 1965. Controlled hunt tags were offered until 1970, after which the season was closed. Overharvest may have led to the decline in Selkirk PMU mountain goats. In 2011, a hunt was opened with 1 tag that included both Selkirk and Cabinet PMUs. From 2011 to 2017 4 billies were harvested from Lions Creek area of Selkirk PMU.

Current Issues

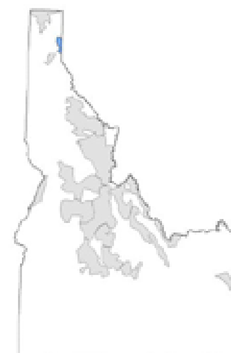
Much of Selkirk PMU within Kaniksu National Forest is managed for motorized area closures to protect grizzly bears and woodland caribou (*Rangifer tarandus caribou*), which likely benefits mountain goats. Core grizzly bear habitat covers much of Selkirk PMU and USFS prohibits motorized vehicles during spring to autumn months. The northwest and south-central portions, and Long Canyon drainage, of the PMU are currently closed to snowmobiles to protect wintering caribou. However, USFS is reevaluating the winter travel plan for Selkirk PMU. Under the 2015 Idaho Panhandle Forest Management Plan, all areas outside recommended wilderness and research natural areas could be opened to over-snow-vehicle (OSV) use. Increasing use of snow machines, paired with changes in technology and motorized restrictions, could cumulatively affect wintering mountain goats in the Selkirk Mountains. Furthermore, heli-skiing operations are seeking to expand into the highest peaks of the Selkirks, which could cause disturbance from helicopter flights and backcountry skiing. Hiking and backpacking are popular in summer months.

Management Direction – IDFG will work to maintain a stable to increasing population with secure habitat in Selkirk PMU.

Strategy – Collaborate with Idaho Panhandle National Forest and IDL to minimize potential impact of motorized and non-motorized recreation on mountain goats in the Selkirks.

Strategy – Work with Idaho Panhandle National Forest to identify ways to improve foraging habitat and population connectivity.

Cabinet PMU



Cabinet PMU includes mountain goats in the West Cabinet Mountains, specifically between Lightning Creek and the Montana border in GMU 1. The majority of this core population resides in Montana, but mountain goats are resident in Scotchman Peaks area. The majority of Cabinet PMU falls under the Idaho Roadless Rule within Idaho Panhandle National Forest. The southern part of the PMU is part of the proposed Scotchman Peaks Wilderness.

Population

All population surveys have been aerial surveys, usually by or in coordination with Montana Fish, Wildlife and Parks. There was no consistency in timing of surveys, which ranged from February to August. During aerial surveys between 1981 and 2001, between 3 and 47 mountain goats were counted on the Idaho side of the West Cabinets. Including the Montana side, total mountain goat numbers have ranged from roughly 50 to 80. A population growth-rate analysis for the Montana portion of the West Cabinets found a declining population from 2000 to 2015 with a growth rate of 0.95 (Smith and DeCesare 2017).

Harvest

Mountain goats were harvested under a general season from 1957 to 1965. Controlled hunt tags were offered until 1970, after which the season was closed due to lower population size. Idaho

Populations Surveys- Cabinet PMU						
Area	**Year**	**Month**	**Adult**	**Kid**	**Total**	**Kid:Ad***
All PMU in ID only	2001	May	15	1	**16**	7
Includes MT	2000	Aug	45	11	**56**	24
Includes MT	1998	Aug	38	10	**48**	27
Includes MT	1993	Feb	40	7	**47**	16
Includes MT	1991	Mar	19	6	**25**	32

***Number of kids per 100 adults.**

offered 1–2 any-weapon tags from 1989 to 1995. In 2011, a hunt was opened with 1 tag that included both Selkirk and Cabinet PMUs. From 2011 to 2017 1 billy was harvested out of Cabinet PMU. As of 2017 Montana Fish, Wildlife, and Parks offered 1 tag for the West Cabinet population.

Current Issues

The main issue for mountain goats in Cabinet PMU is negative interactions with hikers. Scotchman Peak is a very popular hiking trail into prime mountain goat habitat. Visitors enjoy seeing mountain goats, however intentional and unintentional feeding of mountain goats, as well as urine left by hikers, has caused mountain goats in this area to become habituated and aggressive towards people. Recent efforts by local volunteers have improved visitor education and negative interactions with mountain goats have decreased.

The roadless nature of Cabinet PMU protects mountain goats from some motorized disturbance. However, USFS is reevaluating the winter travel plan for Cabinet PMU. Under the 2015 Idaho Panhandle Forest Management Plan, all areas outside recommended wilderness and research natural areas could be opened to OSV use. Increasing interest in riding snow machines, paired with changes in technology and motorized restrictions, could cumulatively impact wintering mountain goats in the Cabinet Mountains.

Management Direction – IDFG will work to decrease negative mountain goat-human interactions while maintaining a stable population in Cabinet PMU.

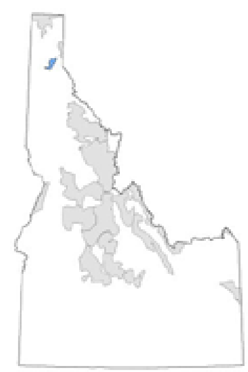
Strategy – Collaborate with Idaho Panhandle National Forest and Friends of Scotchman Peaks Wilderness to reduce potential conflicts between mountain goats and hikers using trails in Scotchman Peaks area.

Strategy – Collaborate with Idaho Panhandle National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats in the Cabinets.

Strategy – Work with Idaho Panhandle National Forest to identify ways to improve foraging habitat and population connectivity.

Strategy – Coordinate with Montana Fish, Wildlife and Parks on surveys, monitoring, and potential harvest.

Pend Oreille PMU



Pend Oreille PMU includes an introduced population of mountain goats located in GMU 4A. Currently, mountain goats are found on Bernard Peak face, but in the past they also occurred in the Green Monarchs. The USFS is the primary land manager in Pend Oreille PMU although there is some private land scattered throughout. Mountain goats inhabit a series of intermittent, precipitous cliffs that drop into Lake Pend Oreille.

Population

Historically, mountain goats were not thought to have inhabited the area south of Lake Pend Oreille. Between 1960 and 1968, approximately 20 mountain goats were translocated from Snow Peak area (Appendix B). Now Pend Oreille PMU has a core population located in Bernard Peak area with some mountain goats found to the east. The majority of population surveys have been aerial surveys; however ground and boat surveys have occurred. There was no consistency in timing of surveys, which ranged from February to October. The population increased through the 1970s and 1980s. The highest aerial survey count was 41 animals in 1984. The most recent survey in 2001 found 31 mountain goats. We believe the population is relatively stable, but not expanding from currently occupied habitat.

Harvest

The only hunting allowed in Pend Oreille PMU was an archery hunt between Lakeview and Johnson Creek with 2 controlled hunt tags, which opened in 1977. This hunt area excluded the main Bernard Peak population because of popularity with wildlife viewers. The hunt was closed in 1993 due to low numbers of mountain goats. Pend Oreille PMU has been managed for non-consumptive wildlife viewing since 1993.

Populations Surveys- Pend Oreille PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2001	May	27	4	**31**	15
All PMU	1995	Mar	13	2	**15**	15
All PMU	1992	Mar	15	6	**21**	40
All PMU	1991	Mar	11	4	**15**	36

***Number of kids per 100 adults.**

Current Issues

Pend Oreille PMU mountain goats are highly visible from a boat on Lake Pend Oreille and across the lake from Farragut State Park. They offer a unique opportunity for non-consumptive viewing by visitors and recreational boaters around Bayview.

Mountain goats in Bernard Peak area are not easily disturbed by motorized or non-motorized recreation due to lack of roads or trails. However, USFS is reevaluating the winter travel plan for Pend Oreille PMU. Under the 2015 Idaho Panhandle Forest Management Plan, all areas outside recommended wilderness and research natural areas could be opened to OSV use. Increasing interest in riding snow machines, paired with changes in technology and motorized restrictions, could cumulatively impact wintering mountain goats in Pend Oreille PMU.

Management Direction – IDFG will continue to manage Pend Oreille PMU at a stable population for non-consumptive use.

Strategy – Collaborate with Idaho Panhandle National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats in Bernard Peak area.

Strategy – Install educational signage regarding mountain goat ecology at Farragut State Park by 2022.

Black Snow PMU

Black Snow PMU includes mountain goat habitat within GMUs 7, 9, 10, 10A, and 12. The majority of the PMU is Idaho Panhandle and Nez Perce-Clearwater national forest land along with IDFG Snow Peak Wildlife Management Area in GMU 9. Idaho Department of Lands and private timber company parcels are scattered in GMUs 7 and 10A. Most currently occupied mountain goat habitat is covered under the Idaho Roadless Rule. Mountain goats between Snow Peak and Black Mountain reside in Mallard Larkins Primitive area. Much of Black Snow PMU is heavily forested and mountain goats are found on isolated rocky areas, as well as on the highest rocky peaks.

Population

Black Snow PMU likely has a metapopulation structure with 2 core areas, one in the Black Mountain-Snow Peak area and one in the eastern portion of GMUs 10 and 12, with scattered small groups spread throughout the PMU. The majority of population surveys have been aerial surveys; however 1 ground survey was attempted in GMU 7. Surveys occurred in late winter or spring. Historically, there were likely more mountain goats than seen during the first aerial survey in 1957 when the highest count of 93 occurred in

Populations Surveys- Black Snow PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad***
All PMU	2017	May	107	21	128	20
GMU 10	2010	Apr-Jun	39	8	147*	17
GMU 10**	2005	Apr-May			101	±17
GMU 10**	2002	Apr-May			98	±17
GMU 7/9	2001	May	47	13	60	28
GMU 9	1993	Feb	46	14	60	30
GMU 9	1991	Mar	34	9	43	26

***Includes 100±7 from Isabella-Collins Creek mark-resight population estimate.**
****Only includes Isabella-Collins Creek mark-resight population estimate.**
*****Number of kids per 100 adults.**

GMU 9. Snow Peak and Black Mountain areas provided primary translocation stock for the rest of Idaho. Between 1960 and 1998, approximately 140 mountain goats were translocated out of Black Snow PMU. Counts during aerial surveys in GMU 9 and 10 remained relatively stable during mountain goat trapping, indicating a stable to increasing population. The most recent survey in 2017 encountered 128 mountain goats in Black Snow PMU; however the eastern portion of the PMU showed a substantial decline from the previous survey. Mountain goats in GMU 9 historically appeared restricted to the North Fork of Clearwater River drainage, but in the 1990s observations started coming from Sisters Creek along St. Joe River in GMU 7. This area is mostly forested, with limited small rocky outcrops.

Harvest

In the mid-1950s, ≥50 mountain goats were harvested during a general-season hunt in Black Snow PMU within a 2-year period, much greater than the average of 7 mountain goats every 2 years from 2008 to 2017. Snow Peak was closed to harvest in 1958 and was managed as a statewide source of translocation stock for 40 years. A general season in the rest of Black Snow PMU ran until 1965 and controlled hunt tags have been offered since 1966. General season and liberal controlled hunts likely caused an overharvest in the Black Snow population, but the population recovered to levels that sustained regular translocation removal. Approximately 20 controlled hunt tags were offered in the late 1960s compared with 3–7 tags in 1–3 hunt areas in recent decades. Currently, 5 tags are offered across 3 hunt areas in Black Snow PMU. Female harvest has averaged 31% over the last 10 years.

Current Issues

There are concerns with increasing snowmobile and snow bike access to mountain goat habitat in both the western part of GMU 9 and eastern portion of GMU 10. High road density and timber harvest has potential to impact mountain goats in GMU 7. Since 2011 hunters with the GMU 7-9 tag have only harvested mountain goats within 1 drainage in GMU 7 due to high levels of access and visibility.

Management Direction – IDFG will work to maintain a stable to increasing mountain goat population in Black Snow PMU.

Strategy – Collaborate with Idaho Panhandle and Nez Perce-Clearwater national forests and BLM to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Work with Idaho Panhandle and Nez Perce-Clearwater national forests to identify ways to improve foraging habitat and population connectivity.

Strategy – Coordinate with Montana Fish, Wildlife and Parks on surveys, monitoring, and potential harvest.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Lochsa-Selway PMU

Mountain goats in Lochsa-Selway PMU are found primarily along the Idaho-Montana border and in rocky cliffs in the Lochsa and Selway river drainages in GMUs 12 and 17. Nearly all of these lands are managed by the USFS and much of the mountain goat habitat is located within wilderness. Areas of GMUs 16 and 16A would have been included in this PMU, but forest encroachment has eliminated much of the habitat and mountain goats have not been observed there in decades.

The 2 GMUs (12 and 17) differ in their history and accessibility. Highway 12 along the Lochsa River (Middle Fork of Clearwater River) was completed in 1962 and subsequent side roads built over time increased access to mountain goats in GMU 12. GMU 17 was designated wilderness in 1964 as part of the Selway-Bitterroot Wilderness. This wilderness designation grandfathered a limited road system though a portion of the GMU, maintaining relatively low access to mountain goat habitat.

Population

These populations were surveyed regularly until 1996 when they were dropped from the regular rotation. The Lochsa population varied from a high of 85 mountain goats in 1987 to 48 in 1996, the last year of surveys. Mountain goats are still observed through much of the area at low numbers and may still have similar population levels. The last complete survey of the Selway population occurred in 1994, when 151 mountain goats were observed. A smaller survey, targeting only prime mountain goat habitat, in the same area in 2014 revealed only 19 mountain goats. There has not been a hunt in Lochsa-Selway PMU since the 1980s and mountain goats have continued to decline in the Selway. However, Montana maintained hunts on their side long after Idaho stopped hunting this population, which may have contributed to the population decline.

These populations are not well understood, but are likely a series of loosely connected groups functioning as a meta-population. No mountain goats have been translocated into or out of this population.

Harvest

All of this PMU and surrounding area was managed under a general-season hunt until 1967, when converted to controlled hunts. Between 1967 and the mid-1970s controlled hunt tag numbers increased in the PMU while hunt area size decreased. This progression stemmed from improved understanding of mountain goat population status and distribution and efforts to offer more opportunity in a more controlled manner. Controlled hunt tag numbers peaked in the mid-1970s and declined to 17 tags in 1981. There have been no hunts in Lochsa-Selway PMU since 1982, when 1 tag was offered.

Populations Surveys- Lochsa-Selway PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
GMU 12	1996	May	43	5	**48**	12
GMU 17	1994	May	127	24	**151**	19
GMU 17	1991	May	122	44	**166**	36

***Number of kids per 100 adults.**

Current Issues

Size of the Lochsa-Selway population is unknown. We also have a lack of knowledge of how populations in Lochsa-Selway PMU may or may not interact as a meta-population. In parts of GMUs 12 and 17, timber encroachment on small islands of habitat due to fire suppression has likely impacted mountain goat distribution over the last 60 years.

Management Direction – IDFG will work to maintain a stable to increasing mountain goat population in Lochsa-Selway PMU.

Strategy – Develop better information on size and distribution of this population.

Strategy – Work with Nez Perce-Clearwater National Forest to identify ways to improve foraging habitat and population connectivity.

Strategy – Coordinate with Montana Fish, Wildlife and Parks on surveys, monitoring, and potential harvest.

Strategy – Evaluate timber encroachment and potential impacts to mountain goats.

Lower Salmon PMU

Lower Salmon PMU includes mountain goats along the South Fork Clearwater River in GMU 15 from Mill Creek to Tenmile Creek, drops south to include both sides of Salmon River from the mouth of Wind River in GMUs 19 and 19A, and east to the mouth of Disappointment Creek in GMUs 20 and 20A. The east side of South Fork Salmon River up to Elk Creek is also included. This PMU falls within parts of Nez Perce-Clearwater, Bitterroot, and Payette national forests and much of the PMU is located within Gospel-Hump and Frank Church-River of No Return (FCRONR) wilderness areas. Mountain goat habitat in Lower Salmon PMU consists largely of broken, river-canyon cliffs, but also includes several subalpine basins. Mountain goats in this PMU are very sparsely distributed in small groups and connectivity is very low.

Population

Earliest population estimates for Lower Salmon PMU come from USFS reports and an IDFG research project initiated in 1949. Brandborg (1955) estimated there were approximately 160 mountain goats in this PMU in the mid-1950s. The first IDFG aerial surveys began in 1961. Much early data was collected during partial, intermittent mountain goat surveys or incidentally during elk surveys. The first full mountain goat survey in Lower Salmon PMU was conducted in 1982. Forty-two mountain goats were observed along lower South Fork Salmon River (South Fork) and south side of Salmon River (South Main); 92 animals were counted on the north side of Salmon River (North Main) and in GMU 15. In 1990 another full mountain goat survey was conducted on the South Fork and South Main, where 36 mountain goats were observed. In 1993 a full survey of North Main yielded 49 mountain goats. No mountain goat-specific surveys have occurred along the North Main since that time. The last full survey of the South Fork and South Main occurred in 2003, when observers counted only 3 mountain goats.

Seventy mountain goats, spread over 12 events, were translocated into Lower Salmon PMU from 1966 to 2003 (Appendix B).

Harvest

Mountain goats in Lower Salmon PMU were hunted under a general-season framework during 1945–1947. In 1952 IDFG opened 2 controlled hunts, offering 5 tags. A general season was opened in 1957 that included the area north of Salmon River with the exception of upper Lochsa River and the controlled hunt area in Big Mallard Creek. IDFG reduced the general-season area to GMU 20 (still excluding Big Mallard) by 1959 and eventually closed the hunt in 1967. In 1963 2 controlled hunts were opened on the south side of Salmon River with 8 tags total. In 1972 2 additional controlled hunts were opened on the north side of Salmon River offering 4 tags. Mountain goat numbers in the PMU began to decline and IDFG reduced tag numbers and ultimately closed all hunts in this PMU by 1983. No harvest has occurred along South Fork Clearwater River.

Populations Surveys- Lower Salmon PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad**
GMU 20A*	2003	Apr	2	1	3	50
GMU 19/20	1993	Apr	43	6	49	14
GMU 19A/20A*	1990	Apr	31	5	36	14

***Only includes a portion of 20A.**
****Number of kids per 100 adults.**

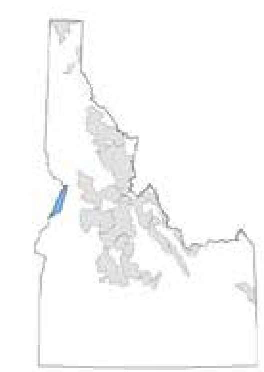
Current Issues

Population size and distribution of mountain goats in Lower Salmon PMU is poorly understood. No harvest has been allowed in the PMU since 1982, but the population still appears to be declining. Groups are widely dispersed and interaction between groups is unlikely. Therefore, population augmentation through translocations may be the most effective means of rebuilding this population. Most habitat in Lower Salmon PMU is remote and unroaded. Thus, potential impacts of motorized and non-motorized recreation are minimal.

Management Direction – IDFG will work to increase populations within Lower Salmon PMU.

> **Strategy** – Survey mountain goat population in Lower Salmon PMU by 2024.
>
> **Strategy** – Evaluate potential for successful translocations to increase population size in Lower Salmon PMU.
>
> **Strategy** – Collaborate with Nez Perce-Clearwater, Bitterroot, and Payette national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Seven Devils PMU



Seven Devils PMU (GMUs 18 and 22) is primarily managed by the USFS (Wallowa-Whitman, Nez Perce-Clearwater, and Payette national forests) and includes some BLM land. A large portion of the area used by mountain goats is contained in the Hells Canyon Wilderness. Snake River splits Hells Canyon Wilderness between Oregon and Idaho and is the deepest river gorge in North America (2,436 m [7,993 ft]).

Lower elevations are dominated by dry, barren, steep slopes and rim-rock that break over into Snake River canyon. High country is dominated by towering peaks, rock-faced slopes, and alpine lakes of Seven Devils mountain range. The area contains an extensive amount of mountain goat habitat. In addition to having a full suite of potential predators (black bear, mountain lion, and gray wolf), the PMU supports healthy populations of elk, mule deer (*O. hemionus*), and white-tailed deer (*O. virginianus*), as well as a struggling bighorn sheep population.

Population

Mountains goats in this PMU were historically counted incidentally during elk surveys. Beginning in the early 1980s, helicopters were used to conduct mountain goat surveys. In the late 1990s and into the mid-2000s, IDFG conducted research on estimating mountain goat numbers using helicopters and paintball mark-resight techniques (Pauley et al. 2006). Although early surveys did not include portions of GMU 22 containing mountain goats, paintball surveys and later helicopter surveys included GMU 22 and showed a generally growing population that peaked in 1999 at 237 (± 67) mountain goats.

Seven Devils PMU received translocations to augment the population in the 1960s. Between 1999 and 2003 this population was used as a source population for augmenting Lower Salmon PMU. Currently this population appears to be stable.

Harvest

Hunts in parts of this PMU (GMU 18 portion and a small part of GMU 23) were started in 1970 as a controlled hunt with 5 tags. This continued with minor boundary changes (including portions of GMU 22 in the late 1990s) until 2003 when the hunt areas were split into 2 hunts, GMU 18 and GMU 22 with 4 tags each. Hunter success averaged 95% over the last 10 years with females making up 24% of the harvest.

Current Issues

The majority of this PMU is within the Hells Canyon Wilderness, which precludes motorized disturbance. However, non-motorized recreation in the form of hiking and backpacking is very popular in summer months. This area is also popular with members of the pack goat community. Because mountain goats in this PMU share winter range with bighorn sheep, there is a risk of pathogen exposure and transmission among domestic livestock, mountain goats, and bighorn sheep.

Mountain goat habitat is very limited in GMU 22. Accordingly, all harvest for this portion of the PMU (4 tags) comes from a small area. In addition, female harvest is a concern and may be suppressing potential of this population.

Populations Surveys- Seven Devils PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad**
GMU 18/22	2013	Apr-May	90	26	116	29
GMU 18/22*	2007	Apr-May			194	
GMU 18/22*	2002	Apr			196	

***Mark-resight population estimate (not min. count).**
****Number of kids per 100 adults.**

Management Direction – IDFG will work to maintain a stable to increasing mountain goat population in Seven Devils PMU.

Strategy – Collaborate with Wallowa-Whitman, Nez Perce-Clearwater, and Payette national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Develop educational materials for hunters to help minimize harvest of female mountain goats.

Strategy – Survey mountain goat population in Seven Devils PMU by 2020.

Upper South Fork PMU

Upper South Fork PMU includes mountain goats in the Salmon River Mountains extending from Lick Creek range on the border of GMUs 19A, 24, and 25, along ridgelines dividing Big Creek drainage from the East Fork of South Fork Salmon River drainage (on the borders of GMUs 25, 26, and 20A) to the highest ridges on the west side of GMU 27. Mountain goats occur in small scattered groups in Lick Creek and Fitsum Creek areas on the west side of GMU 25 and southwest part of 19A, around the Pinnacles on the border of GMUs 25 and 26, along the upper ends of Big Creek, Monumental Creek, and West Fork Monumental Creek in GMU 26, and on Big Baldy Ridge, Murphy Peak, Red Peak, and Red Ridge in GMU 27. Land ownership in this PMU is almost exclusively USFS. Upper South Fork PMU includes parts of Payette, Boise, and Salmon-Challis national forests and also occurs in the FCRONR Wilderness. Mountain goat habitat in this area is extensive and consists primarily of high granite ridgelines and cirque lake basins.

Population

Population data for Upper South Fork PMU only includes mountain goat counts in the western and central portions of the PMU. Earliest population estimates were produced by the USFS Krassel Ranger District, which estimated 65–95 mountain goats in the Buckhorn Creek-Fitsum Creek-Lick Creek-Enos Lake area and 60 mountain goats in the upper Big Creek-Monumental Creek area (Brandborg 1955). IDFG flight records begin in 1959 and partial surveys continued every 1–3 years until the early 1980s. The first complete aerial survey was conducted in March 1982, which documented 41 mountain goats in Buckhorn-Fitsum-Lick-Enos area and 39 in Big Creek-Monumental area. In April 1990 another full survey counted 8 and 50 mountain goats in the same respective areas. Another partial survey occurred in April of 2003. Observers counted 6 mountain goats in Lick-Enos area (Buckhorn-Fitsum area was not surveyed) and 20 in Big Creek-Monumental Creek area. Since that time, no aerial surveys were conducted, but sporadic sightings of mountain goats from ground observations have been recorded from IDFG and USFS personnel and the public. In 2016, with help from Rocky Mountain Goat Alliance, IDFG performed a ground survey of the Pinnacles area in GMUs 25 and 26 and observed a minimum of 37 mountain goats. A survey of the central portion of this PMU in June 2018 resulted in a count of 47 individuals with a kid:adult ratio of 22:100.

Little information exists for mountain goat counts on the west side of GMU 27. The only population information to date was from a helicopter survey in February 2006 where 27 mountain goats were observed around Red Peak and Red Ridge. Ground crews observed 12 mountain goats on Red Ridge and Murphy Peak in July 2016.

No translocations have occurred into or out of Upper South Fork PMU.

Populations Surveys- Upper South Fork PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad**
GMU 25/26	2018	Jul	39	8	47	21
GMU 25/26	2003	Apr	20	6	26	30
GMU 25/26	1990	Apr	47	11	58	23

***Number of kids per 100 adults.**

Harvest

IDFG managed the portion of Upper South Fork PMU in Valley County east of South Fork Salmon River from 1943 to 1947 under a general-season framework. No harvest occurred in the PMU until 1959 when a portion of upper Big Creek, including Monumental Creek, was opened for a controlled hunt with 3 tags. By the early 1970s a total of 20 tags were allocated in Upper South Fork PMU. In 1978 IDFG closed the hunt area in the central portion of the PMU, and by 1980 and 1982, hunt areas on the west and east side, respectively, were also closed to hunting. In 2007 a hunt was opened on the east side of the PMU (including part of Middle Fork PMU in GMU 27) offering 2 tags and is currently the only mountain goat hunting opportunity offered in this PMU. Female harvest has averaged 47% in the past 10 years.

Current Issues

The majority of this PMU has been closed to hunting since 1982, but the mountain goat population appears to be declining. With 25 tags offered in a population where a maximum of approximately 100 mountain goats was ever observed, overharvest is the most likely cause for the initial decline. Information about current status of mountain goats in this PMU is lacking because a complete survey has not been conducted since 2003, however, current observations are widely dispersed across the PMU. Habitat in this PMU does not appear limiting. Due to sparse and widespread distribution, consideration of augmentation to help rebuild the population may be necessary. The amount of year-round motorized and non-motorized recreation has been increasing rapidly, especially on the west side of the PMU in Lick Creek area. As this area increases in popularity, there will continue to be additional risk of disturbance to declining mountain goat populations.

Management Direction– IDFG will work to increase the population and maintain secure habitat in Upper South Fork PMU.

Strategy – Collaborate with Payette, Boise, and Salmon-Challis national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Evaluate potential for successful translocations of mountain goats into historically occupied portions of this PMU to restore healthy populations.

Strategy – Develop educational materials for hunters to help minimize harvest of female mountain goats.

Middle Fork PMU

Middle Fork PMU is comprised of mountain goats found in Middle Fork Salmon River drainage in GMU 27, except for upper Loon Creek-Mayfield Creek area (included in Yankee Fork PMU) and portions of Marble and Pistol creeks (included in Upper South Fork PMU). The PMU also includes occupied habitat in Horse Creek drainage of GMU 21 and the farthest east portions of GMUs 20A and 26. Land ownership is primarily

Salmon-Challis, Payette, and Boise national forests. Almost the entire PMU falls within FCRONR Wilderness.

Population

Early population estimates in Middle Fork PMU suggest there were approximately 435 mountain goats inhabiting the area (Brandborg 1955). Most of this data came from USFS estimates and an IDFG research project that began in 1949. Observations were obtained during both winter and summer. A partial survey in 1963 yielded an estimate of 68 individuals and another survey in 1982 that covered a comparable area indicated 71 animals. In a 1993 spring survey, observers counted 117 mountain goats over approximately the same area as the 1963 and 1982 surveys. The first complete survey of GMU 27 documented 169 individuals during spring 1999. The same area was covered again in 2006 and ≥157 mountain goats were observed.

Two other areas within the PMU were surveyed at different times than indicated above. Occupied habitat in GMUs 20A and 26 was surveyed in 1982, 1990, 2003, and 2017 with 13, 13, 26, and 15 mountain goats observed. Horse Creek drainage in GMU 21 was surveyed in 1996, 2001, 2005, and 2010 with 18, 6, 11, and 9 mountain goats observed.

Nine mountain goats were translocated into Jack Creek in GMU 27 in 1989. Eight were translocated into Ship Island Creek in 1991. Two releases of 10 animals each occurred in western GMU 21: at Square Top Mountain in 1994 and Corn Lake in 1997.

Harvest

Mountain goats in Middle Fork PMU were harvested under a general-season framework during 1943–1945 in portions of Custer, Idaho, Lemhi, and Valley counties. With the exception of Custer County, general hunts in these areas continued until 1948, when all hunts were closed. IDFG established 5 controlled hunts in 1952, offering 19 tags in this PMU. Over the next 2 decades, new controlled hunts were added, existing hunt areas were adjusted, and tag numbers increased to a high of 59 tags across 13 different controlled hunts offered in 1974. Mountain goat populations began declining, and in 1975 IDFG reduced tag numbers and closed hunt areas. All hunts in this PMU were closed by 1984. IDFG opened a controlled hunt in 1993 with 2 tags. In 1999 another hunt was re-opened with 2 tags. Since that time, there have been 2–4 controlled hunts in the PMU with 4–6 tags. Currently, there are 2 controlled hunts offered in this PMU (1 is shared with Upper South Fork PMU) that include 4 tags. Harvest success has been 90% and female harvest rate has been approximately 32% over the last 5 years.

Populations Surveys- Middle Fork PMU

Area	Year	Month	Adult	Kid	Total	Kid:Ad*
GMU 20A/26	2017	Feb	11	4	**15**	27
GMU 21	2010	Feb	6	3	**9**	50
GMU 27	2006	Feb	132	25	**157**	19
GMU 27	1999	Apr	152	17	**169**	11
GMU 27	1993	Apr	101	16	**117**	16

***Number of kids per 100 adults.**

Current Issues

Almost all of this PMU is within designated wilderness area, so motorized recreation has little impact on mountain goats. Non-motorized recreation is very dispersed in summer and almost non-existent in winter. Female harvest is a concern and may be suppressing potential growth of this population.

Management Direction – IDFG will work to increase the population and maintain secure habitat in Middle Fork PMU.

> **Strategy** – Develop educational materials for hunters to help minimize harvest of female mountain goats.
>
> **Strategy** – Conduct a population survey of entire Middle Fork PMU by 2022.

Yankee Fork PMU

Yankee Fork PMU includes upper Loon Creek and Warms Springs Creek drainages in GMU 27, Yankee Fork drainage in GMU 36, and Squaw Creek and Thompson Creek drainages in GMU 36B. Land is managed primarily by Salmon-Challis National Forest, with private inholdings scattered throughout. Approximately one-half of the PMU lies within FCRNOR Wilderness Area. The area is characterized by high, rugged ridges and very steep drainages. Most mountain goats occupy ridge habitat of upper Loon Creek, Tango Creek, and Lightning Creek in GMUs 27 and 36; and ridges and peaks between Yankee Fork and Thompson Creek in GMU 36B.

Population

Brandborg (1955) reported an estimate of 30 mountain goats for the area between Cabin Creek Peak and Sherman Peak in 1953. More complete and targeted surveys of the entire PMU began in the early 1980s. The population appeared to be stable in the late 1980s to mid-1990s at approximately 150–200 mountain goats. The most recent survey for this PMU in 2012 yielded a minimum count of 212 individuals. Surveys have been conducted during winter and late spring and are usually done as part of an elk or deer survey. No mountain goats have been translocated into or out of this population.

Harvest

Mountain goat harvest occurred under a general-season framework for all of Lemhi and Custer Counties from 1943 to 1945. A portion of the PMU including parts of GMU 27 and 36 was opened to a controlled hunt with 5 tags in 1961 and was expanded in 1968 with the same number of tags. In addition, another hunt area was opened with 5 tags in 1968. Tag numbers were reduced to 3 and boundaries changed for both of these hunt areas in 1989. In 1997, these 2 hunt areas were combined with number of tags reduced to 2. Currently there is 1 tag available for this hunt area.

Populations Surveys- Yankee Fork PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2012	Feb	162	49	212	30
All PMU	2002	Apr	70	11	81	16
All PMU	1994	Mar	140	29	169	21

***Number of kids per 100 adults.**

A hunt area was opened in the GMU 36B portion of the PMU in 1986 with 3 tags. Tag numbers were reduced to 2 in 2009 and have remained at that level to present.

Harvest success averages approximately 88% across the PMU. Female harvest has averaged 33% over the last 4 years.

Current Issues

Two very popular and heavily travelled roads go through the middle of this PMU. Loon Creek road provides one of very few motorized access points to FCRONR Wilderness Area and receives regular use during summer and autumn. Custer Motorway is a very popular driving route that connects Sunbeam area with Challis. This road also receives regular use in summer and autumn. Loon Creek road is plowed in winter several miles up Jordan Creek to reach a large, but inactive, gold mine. This mine was decommissioned in 1997, but requires a skeleton crew to perform environmental monitoring year-round. Custer Motorway is not plowed in winter. Consequently, winter recreation use is limited, but may be increasing because of power and design improvements of snowmobiles and snow bikes.

The 2012 Halstead fire impacted a small portion of Yankee Fork PMU in upper Loon Creek. There may have been displacement of mountain goats from a small area. Effects of fire on foraging habitat are unknown.

Bonanza Peak offers a good viewing opportunity in all seasons and is visited specifically to view mountain goats.

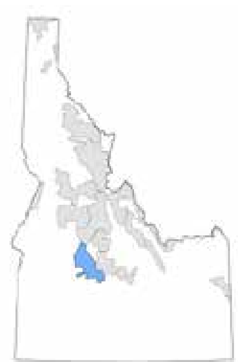
While this PMU experiences a number of potentially detrimental activities, the population appears to be stable with a relatively low female harvest rate. Nonetheless, disturbance factors should be minimized whenever possible.

Management Direction – IDFG will work to increase the population and maintain secure habitat in Yankee Fork PMU.

Strategy – Collaborate with Salmon-Challis National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Develop educational materials for hunters to help minimize harvest of female mountain goats.

Sawtooth PMU



Sawtooth PMU encompasses the rocky, jagged peaks of the Sawtooth Mountains in portions of GMUs 35, 36, and 39, as well as the Smoky Mountains in adjacent GMUs 43 and 48. Land ownership is primarily USFS (Boise National Forest in GMUs 35 and 39 and Sawtooth National Forest in GMUs 36, 43, and 48). Mountain goats occupy detached rocky cliffs along Eightmile, Tenmile, Warm Springs, and Canyon creeks in GMU 35, and Steel Mountain and North Fork Boise River in GMU 39. They are otherwise found along the main Sawtooth crest that divides GMU 36 from GMUs 35 and 39; and in the Smoky Mountains along the southern edge of GMU 36 and the northern portion of GMUs 43 and 48.

Population

Population surveys during the past 20 years have been conducted from a helicopter (Bell 47 Soloy with pilot and 2 observers) during mid-winter or late spring. All GMUs within Sawtooth PMU were flown at same time. Small, scattered groups of mountain goats (<25/group) are found along detached drainages in GMU 35. North Fork Boise River drainage in GMU 39 supports 40–60 mountain goats. The majority of the Sawtooth population occurs along headwaters of South and Middle Fork Boise rivers in GMU 39 and 43, upper South Fork Payette River in GMU 35, headwaters of Big Wood drainage in GMU 48, and along rocky cliffs and drainages on the western edge of GMU 36. Sawtooth PMU supports the largest mountain goat population in Idaho. The latest survey in winter 2019 recorded the highest number of mountain goats ever counted in Sawtooth PMU. The lower count in 2017 was due to an incomplete survey of the PMU. However, the population has been generally stable since the mid-1990s. No mountain goats have been translocated into or out of this population.

Harvest

Historically, controlled hunts for mountain goats occurred in GMUs 35 and 39 until 1981. GMU 35 had 3 hunt areas with 15 any-weapon tags and 15 archery tags. Average annual harvest for the last 5 years of the hunt (1977–1981) was 8 mountain goats. Three hunt areas with 17 any-weapon tags were offered in GMU 39. Average annual harvest for the last 5 years of the hunt was 7 mountain goats (1977–1981). Mountain goat seasons in both GMUs were discontinued between 1981 and 2004. A new hunt with 2 tags was established in 2005 for that portion of GMU 39 in Middle Fork Boise River drainage upstream from, and including, Queen's River and Yuba River drainages.

Between 2000 and 2006 2 tags were offered in Hunt Area 43. Hunt boundaries have been altered as managers learned more about mountain goat distribution and to simplify regulations. Currently

Populations Surveys- Sawtooth PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2019	Feb	427	70	524	16
All PMU**	2017	Mar	306	49	355	16
All PMU	2009	Feb	349	78	427	22
All PMU	2004	Feb	373	94	467	25
All PMU	1994	Mar	280	45	325	16

***Number of kids per 100 adults.**
****Incomplete survey.**

3 tags are available for Hunt Area 43, which incorporates portions of Units 43, 48, and 36.

Hunting in Hunt Area 36-1 was discontinued in the early 1980s in response to declining mountain goat populations, but was reinstated in 2005 with 4 tags. In 2010, that portion of GMU 35 within Sawtooth National Recreation Area was added to the hunt area.

Currently there are 9 tags in 3 hunt areas in Sawtooth PMU. There are 2 tags in GMU 39, 4 tags in GMU 35 and a portion of GMU 36, and 3 tags in GMUs 43, 48, and a portion of GMU 36. Harvest success during the past 20 years averaged 86% across the PMU. Female harvest averaged 42% during the past 10 years.

Current Issues

Human recreation in the form of heli-skiing, cross country skiing, and extreme snowmobiling are becoming more popular along the Blaine-Camas county border between GMUs 43, 48, and 36. Regulation of these activities needs to be closely monitored to assess possible impacts to wintering mountain goats. Non-motorized recreation in the form of hiking and backpacking during summer and autumn provides a valuable aesthetic role in addition to providing harvest opportunities. However, overuse of remote areas that harbor mountain goats could potentially cause individuals to alter habitat use or move out of the area.

Recently, there have been some concerns about presence of disease, such as pneumonia in native mountain goat herds. Collecting samples from harvested animals will help managers closely monitor this situation.

Four tags been offered in Hunt Area 36-1 since 2005. During that time period 43% (18/42) of animals harvested were breeding age females. During the past 5 years 11/19 (58%) of mountain goats harvested were breeding age females. Female mountain goats are susceptible to harvest and overharvest may result in rapid population declines.

Management Direction – IDFG will maintain a stable population with secure habitat within Sawtooth PMU.

Strategy – Collaborate with Boise and Sawtooth national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Work with hunters to help monitor for possible disease outbreaks by collecting samples from hunter-harvested mountain goats.

Strategy – Develop educational materials for hunters to help minimize harvest of female mountain goats.

White Clouds PMU

Within GMU 36A, White Clouds PMU includes the White Cloud Mountains, Germania Creek, upper East Fork Salmon River, West Pass Creek, Bowery Creek, and Sheep Creek. The PMU also encompasses the portion of GMU 36 from Warm Springs Creek to Galena Summit, the north end of the Boulder Mountains in GMU 48, and North Fork Big Lost River in GMU 50. Land ownership is mostly USFS, with some scattered private inholdings. High elevation, rugged terrain is almost continuous throughout the central part of the PMU. Mountain goat habitat in Sheep-Bowery creeks area and North Fork Big Lost is somewhat isolated from this central area. Portions of White Clouds, Hemingway-Boulders, and Jerry Peak wilderness areas are within the PMU.

Population

Brandborg (1955) reported an estimate of 125 mountain goats within this PMU in the early 1950s. The first complete survey of the PMU likely occurred in 1973, when 87 mountain goats were observed. A 1988 survey indicated a minimum count of 278 individuals. A survey in 2012 showed 279 mountain goats in the PMU, the highest on record. The most recent survey in winter 2018 yielded a minimum count of 220 animals. Surveys have been conducted during winter and late spring, sometimes conducted in conjunction with an elk or deer survey. No mountain goats have been translocated into or out of this population.

Harvest

Mountain goat harvest occurred under a general-season framework for all of Lemhi and Custer Counties from 1943 to 1945. There was apparently no hunting until 1960 when 9 tags were issued for 2 hunt areas. Boundaries and tag levels fluctuated somewhat until 1975 when the PMU was split into 4 hunt areas with 27 tags. Hunt-area boundaries have remained consistent to present with the exception of 36A-1, which was expanded in 2004 to include part of GMU 50, and again in 2006 to include part of GMU 48. In 1994 tag numbers for the 4 hunt areas were reduced to 17, and reduced once more in 1997 to 11 tags. Ten tags have been offered since 2009. Female harvest over the last 5 years averaged 38% across the PMU. Hunt Area 36A-3 has the most concerning female harvest rate at 50%. Harvest success across the PMU has been very high over the last 5 years, averaging 90%.

Populations Surveys- White Clouds PMU						
Area	**Year**	**Month**	**Adult**	**Kid**	**Total**	**Kid:Ad***
All PMU	2018	Feb	191	29	**220**	16
All PMU	2012	Feb	223	56	**279**	25
All PMU	2004	Jan	208	61	**269**	29
All PMU	1994	Feb	207	33	**240**	16

***Number of kids per 100 adults.**

Current Issues

The large amount of wilderness within this PMU affords an excellent opportunity for protection of this mountain goat population, particularly from motorized disturbance. However, portions of the PMU, such as Germania Creek drainage, North Fork Big Lost River, and Silver and Boulder Peaks are open to some level of motorized use during winter and summer. The western part of the PMU is a popular destination for backpacking and back-country skiing. Heinemeyer et al. (2017) documented winter recreation use and impacts to wolverines in this area which could be extrapolated to impacts on mountain goats. Further, summer hiking and backpacking use is high and increasing in popularity, which may impact critical nursery habitats. Significant levels of domestic sheep use occur in this PMU, which could result in increased disease transmission to mountain goats. Female harvest is somewhat high, ranging from 26% in Hunt Area 36A-1 to 50% in 36A-3. Although the overall population appears stable, this level of harvest, especially on female mountain goats, may be reducing productivity.

Management Direction – IDFG will work to increase the population and maintain secure habitat in White Clouds PMU.

> **Strategy** – Collaborate with Salmon-Challis and Sawtooth national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.
>
> **Strategy** – Develop educational materials for hunters to help minimize harvest of female mountain goats.

Pioneer PMU

Pioneer PMU encompasses rocky, jagged peaks of the Pioneer Mountains in portions of GMUs 49 and 50. Land ownership is primarily USFS (Sawtooth National Forest in GMU 49 and Salmon-Challis National Forest in GMU 50). Mountain goats are generally located along rocky ridges and alpine bowls along the top of the Pioneer Mountains that divides GMU 49 from GMU 50. Mountain goats are concentrated in the northern and southern portion of the Pioneer Mountains. These 2 concentrations are approximately 6 miles apart and separated by a moderately forested ridgeline with little rocky escape cover. Additionally, a smaller concentration of mountain goats is found in the White Knob Mountains in GMU

50, approximately 6 miles east of the Pioneer Mountains.

Population

Small, scattered groups of mountain goats (<25/group) are found in rocky drainages in headwaters of East Fork Big Wood River and Little Wood River in GMU 49. In GMU 50, mountain goats are located in headwaters of Wildhorse Creek and drainages in headwaters of East Fork Little Lost River. The overall population within the PMU is stable to increasing, with 150–200 mountain goats scattered across the PMU. The most recent aerial survey occurred in August 2018 and documented 172 mountain goats, including 15 mountain goats observed in the White Knob Mountains. Historically, 50–100 mountain goats were observed during aerial surveys (e.g., 75 mountain goats were observed in 2010). Pioneer PMU is a native mountain goat population without any translocations or augmentation. Mountain goats in this PMU likely interchange to an unknown degree with those in White Cloud PMU because mountain goats are separated by only 8–16 km (5–10 mi) of mountainous terrain.

Harvest

Since 1993 2 mountain goat tags have been offered in this PMU, which encompasses all of GMU 49 and that portion of GMU 50 south and east of Trail Creek and south and west of Highway 93. Prior to 2001 Pioneer PMU was divided into several different hunt areas. This mountain goat hunt was closed in 1982 because of a low kid:adult ratio, but was reopened in 1986 with 5 tags available. Tags were reduced from 5 to 2 following an aerial survey in 1992, and have remained consistent since that time. Hunter success has averaged 85% over the last 10 years, with females making up 41% of the harvest.

Current Issues

Pioneer PMU mountain goat population is stable to increasing. Ninety-seven more mountain goats were observed in 2018 compared to the 2010 survey. This increase may be a result of using 2 observers (instead of 1) and better survey conditions, rather than an exponential increase in the population. Historically, 1 observer was often used to keep weight to a minimum during this high-altitude flight which pushes safe performance limits of a helicopter. Thus, mountain goats may have been missed during previous aerial surveys.

Populations Surveys- Pioneer PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2018	Aug	140	32	172	23
All PMU	2010	Aug	59	16	75	27
All PMU	2004	Aug	62	10	72	16
All PMU	1999	Aug	40	10	50	25

***Number of kids per 100 adults.**

This mountain goat population is located near the recreational mecca of Sun Valley. The Pioneer Mountains receive year-round use from hikers, backpackers, mountain bikers, backcountry anglers, snowmobilers, snow bikers, snowshoers, back-country skiers, and heli-ski operations. Technological advancements in snowmobile and snow bike capabilities have increased interest and ability to reach some of the more remote areas occupied by mountain goats.

Management Direction – IDFG will work to maintain a stable to increasing population with secure habitat in Pioneer PMU.

> **Strategy** – Collaborate with Salmon-Challis and Sawtooth national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Panther Creek PMU

Panther Creek PMU includes mountain goats in the eastern part of GMU 21 from Colson Creek to Sage Creek and the middle and southeast portions of GMU 28. Mountain goats occur along river breaks in GMU 21 and along Panther Creek, Woodtick Creek, Moyer Creek, Iron Creek, and Williams Creek in GMU 28. Most of the PMU is under USFS ownership with a small portion under BLM ownership. Much of the area has roaded access with the exception of breaks on the north side of Salmon River.

Population

Mountain goat numbers were estimated at 25 along the Salmon River breaks in GMU 21 and 5 in lower Panther Creek in the early 1950s (Brandborg 1955). A 1967 survey in Panther Creek yielded 32 mountain goats and a more comprehensive survey in 1996 indicated 31 mountain goats in the PMU. Survey data indicates numbers remained between 25 and 50 through 2010, however, only 15 were observed during a 2016 survey. Surveys are conducted during winter as part of deer and elk abundance and composition aerial counts. Translocations of 26 mountain goats into GMU 28 occurred in 1989, 1990, 1991, and 1992 (Appendix B).

Populations Surveys- Panther Creek PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
GMU 28	2016	Jan	11	4	**15**	36
All PMU	2010	Feb	59	7	**66**	13
All PMU	2008	Jan	22	4	**26**	18
All PMU	1996	Apr	27	4	**31**	15

***Number of kids per 100 adults.**

Harvest

Mountain goat harvest occurred under a general-season framework for all of Lemhi and Custer Counties from 1943 to 1945. This was restricted to just the west side of Highway 93 in Lemhi County during 1946–1947. No mountain goat hunting was allowed until a controlled hunt was offered from 1967 to 1974 with 3 permits for the east side of lower Panther Creek. There have been no hunts in this PMU since 1974.

Current Issues

The primary issue for mountain goats in Panther Creek PMU is an apparent decline in numbers. Historical surveys indicate the population remained relatively stable until approximately 2010. Between 2010 and present, total numbers have declined by >50%. Suitable habitat is relatively patchy throughout this PMU. A variety of factors, including conifer encroachment, decline in forage base, and predation may have contributed to this decline. Another potential impact is the 2012 Mustang fire, which affected a portion of this PMU north of Salmon River that contains the highest density of historical mountain goat locations. No mountain goats were observed while surveying this area for elk in 2016. There may have been displacement of mountain goats. Effects of fire on foraging habitat are unknown.

Most of the PMU has motorized road and trail access with the exception of Salmon River breaks in GMU 21. Over-the-snow travel is unregulated except for very small areas throughout the PMU, which puts mountain goats at risk of disturbance during winter.

Management Direction – IDFG will work to increase the population and maintain secure habitat in Panther Creek PMU.

> **Strategy** – Collaborate with Salmon-Challis National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats.

> **Strategy** – Evaluate potential for successful translocations to restore healthy populations of mountain goats in Panther Creek PMU.

Lost Trail PMU

Lost Trail PMU includes mountain goats in the Beaverhead Mountains between Lost Trail Pass and Little Eightmile Creek in GMUs 21A and 30. The northern part of the PMU is primarily USFS land while

BLM ownership predominates in the southern part. The PMU is characterized by somewhat dense conifer cover in the north trending to more open habitat on the southern end. Historical and current mountain goat distribution is patchy. Occupied areas include upper North Fork-Moose Creek drainages to Lost Trail Pass, upper 4th of July Creek, Carmen-Freeman creeks to Kenney Creek, and Little Eightmile drainage.

Population

Mountain goat numbers in this PMU were estimated at approximately 20 in the Allan Mountain area and 60 from Sheep Creek to Goldstone Mountain in the early 1950s (Brandborg 1955). No known survey records exist until 1967 when 63 mountain goats were observed in GMU 21A from Lost Trail to Agency Creek. A survey in 1975 yielded a similar number. Beginning in 1981 survey boundaries were adjusted from Sheep Creek to Goat Mountain (Little Eightmile drainage), with 64 animals observed. Approximately 80 mountain goats were observed from the 1980s until the late 1990s. More recent observations ranged from 29 in 2016 to 52 in 2019. The 2019 survey counted an additional 12 individuals (10 adults, 2 kids) in an adjacent portion of Montana. A less complete record exists for the west side of North Fork Salmon River between Hughes Creek and Lost Trail Pass. A 1996 survey produced 10 animals and surveys in 2005 and 2010 indicated 4 and 15 individuals. All of these surveys have been aerial surveys conducted in winter. No mountain goats have been translocated into or out of this population.

Populations Surveys- Lost Trail PMU

Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2019	Mar	47	5	**52**	11
All PMU	2016	Jan	24	5	**29**	21
All PMU	2013	Jan	26	8	**34**	31
All PMU	2006	Jan	46	7	**53**	15
All PMU	2002	Apr	52	3	**55**	6

***Number of kids per 100 adults.**

Harvest

Mountain goat harvest occurred under a general-season framework for all of Lemhi and Custer Counties from 1943 to 1945, but was restricted to the west side of Highway 93 in Lemhi County for 1946–1947. There was no hunting in this PMU until 1961 when controlled hunts were implemented. Five permits were issued that year with the hunt boundary including North Fork Salmon River drainage, GMU 21A, and GMU 30 south to Kenney Creek. A general archery season was also part of the hunt structure. Harvest structure remained stable until 1964 when the hunt area was expanded to all of GMUs 21A and 30. Permit numbers, area descriptions, and structure of general archery season fluctuated until 1989. Permits varied between 5 and 10, the area included GMU 30A some years, and general archery season was eventually converted to a controlled hunt. Beginning in 1989, number of permits was decreased to 3, archery season was eliminated, and the hunt area was changed to a smaller area from Freeman Peak to Lemhi Pass. Number of permits was reduced to 2 for 2003–04 seasons and then eliminated completely beginning in 2007. Female harvest averaged 45% from 1995 through 2005.

Current Issues

This PMU was closed to hunting in 2007 and the population has continued to decline to present. Montana also closed their hunting season at approximately the same time. Determining causes of population decline and identifying possible solutions to re-establish a stable population is the most important priority for this PMU. There are no restrictions on motorized over-the-snow use within this PMU except in a few small areas. Historically, there have been low levels of motorized use within the PMU. However, advancements in snowmobile and snow bike capabilities have increased interest and ability to reach some of the more remote areas occupied by mountain goats. Non-motorized use in winter, although still low, has increased in recent years. The Beaverhead Endurance Run, which traverses the Continental Divide Trail along the southern part of the PMU, began in 2014 and attracts ≥200 runners during mid-July. This could be a significant source of disturbance for mountain goats living along the trail.

Management Direction – IDFG will work to increase the population and maintain secure habitat in Lost Trail PMU.

Strategy – Collaborate with Salmon-Challis National Forest and BLM Salmon Field Office to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Coordinate with Montana Fish, Wildlife and Parks on surveys, monitoring, and potential harvest. A complete survey covering Idaho and Montana is needed to provide a current population estimate.

Lemhi PMU

Lemhi PMU encompasses the Lemhi Range from just south of Salmon to the southern tip near Howe in GMUs 29, 37A, 51, and 58. Mountain goats occupy suitable habitat along the entire range. Land ownership within the PMU is primarily Salmon-Challis and Caribou-Targhee national forests, with some small BLM parcels.

Population

Estimates from the early 1950s indicated approximately 100 mountain goats occupied the PMU north of Big Creek. Historical records document winter helicopter surveys of the north end of the PMU every year from 1959 to 1976. Number of animals observed ranged from a high of 218 in 1962 to a low of 59 in 1976. Surveys were resumed in 1983 and included summer helicopter surveys of the south end of the PMU. Surveys during the 1990s and 2000s were conducted on different years and counts ranged from 61 to 157 on the south end and 16 to 47 on the north end. A helicopter survey of entire PMU in summer 2018 yielded 165 mountain goats. This population was intensely studied in the early 1970s to determine population parameters and response to hunting

Populations Surveys- Lemhi PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2018	Jul	131	34	**165**	26
GMU 51/58	2012	Jul	48	17	**65**	35
GMU 29/37A	2007	Jan	19	4	**23**	21
GMU 51/58	2005	Jul-Aug	67	14	**81**	21
GMU 29/37A	2003	Mar	51	20	**71**	39

***Number of kids per 100 adults.**

(Kuck 1978). Two translocations occurred in the PMU: 20 animals from Olympic National Park in 1982; and 24 individuals from Tushar Mountains, Utah in 2007.

Harvest

Harvest in this PMU occurred in several different hunt areas over the years, but generally was divided between GMUs 29-37A and GMUs 51-58. Mountain goat harvest occurred under a general-season framework for all of Lemhi and Custer Counties from 1943 to 1945. A controlled hunt was initiated in GMU 37A in 1960 with 20 tags. In 1966, there were 4 hunts with 35 tags. The area was divided into 7 hunt areas with 25 total tags in 1974 and then closed the following year. A hunt was opened in 2005 with 1 tag and maintained at that level to present. Success over the last 5 years has been 80% and females have made up 50% of the harvest.

A controlled hunt was initiated in GMUs 51-58 in 1967 with 8 tags. The hunt area was expanded and tags were increased to 12 in 1970. Number of tags was reduced to 3 in 1979, increased back to 6 in 2005, and again reduced to 3 for 2011–12 seasons. The hunt was closed after 2012. Harvest success was 73% in the 5 years before the season was closed. Females made up 18% of harvest during those last 5 years of hunting.

Current Issues

None of this PMU is within wilderness area, but some portions are roadless, with non-motorized restrictions on trails. However, several moderately to heavily used ATV trails traverse the mountain range in areas of mountain goat occupancy. In addition, there is some backpacking use throughout the PMU. Female harvest in the 37A hunt area is high and could negatively affect population growth.

Management Direction – IDFG will work to increase the population and maintain secure habitat in Lemhi PMU.

> **Strategy** – Collaborate with Salmon-Challis and Caribou-Targhee national forests to minimize potential impact of motorized and non-motorized recreation on mountain goats.
>
> **Strategy** – Develop educational materials for hunters to help minimize harvest of female mountain goats.

South Beaverhead PMU

South Beaverhead PMU encompasses mountain goat habitat found in the Beaverhead Mountains along the Idaho-Montana border in GMUs 30A, 58, 59, and 59A within Caribou-Targhee National Forest. Most mountain goats in the PMU are found in 4 areas of suitable habitat, the Red Conglomerates (GMU 59), Italian Peak (GMU 58 and 59A), Eighteenmile Peak (GMUs 30A and 58), and Baldy Mountain (GMU 30A).

Population

Mountain goats are native to these ranges. Reports of mountain goats date back to the early 1950s. Numbers remained low until approximately the mid-1970s. Aerial surveys in the 1980s indicated mountain goat populations in Red Conglomerates and Italian Peak areas increased enough to sustain harvest. Hunt Area 59A was established in 1983 and Hunt Area 59 was established in 1987. Hunt Area 59A was closed in 2002 and Hunt Area 59 was closed in 1994 after population declines. The latest aerial survey was conducted in 2006. Two adults and no kids

Populations Surveys- South Beaverhead PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2006	Aug	20	7	**27**	35
All PMU	2002	Aug	18	4	**22**	22
All PMU	2001	Aug	16	4	**20**	25
All PMU	1994	Aug	106	47	**153**	44

***Number of kids per 100 adults.**

were observed in Hunt Area 59 and 20 adults and 7 kids were observed in Hunt Area 59A. No mountain goats have been translocated into or out of this population.

Harvest

Harvest was initiated in Hunt Area 59 in 1987. Two tags were issued each year during the 8 years this hunt was open and 16 mountain goats were harvested (100% success). Harvest included 7 female mountain goats, which was 44% of total harvest. This represented a 6.25% harvest rate of 32 adult mountain goats observed during the 1986 aerial survey.

Harvest was initiated in Hunt Area 59A in 1983. Three tags were offered each year between 1983 and 1992, yielding a 6.5% harvest rate of 46 adult mountain goats observed during the 1982 aerial survey. Five tags were offered each year between 1995 and 2001, representing a 5.5% harvest rate of 92 adult mountain goats observed during the 1994 aerial survey. Montana Fish, Wildlife and Parks also harvested 2–6 mountain goats from this population annually from 1980 into the late 2000s. There is currently no harvest in South Beaverhead PMU.

Current Issues

Size of the South Beaverhead population is unknown. Land management allows for motorized travel over snow, however, winter distribution of these mountain goats is unknown. Motorized vehicle travel in summer is restricted on most suitable mountain goat habitat.

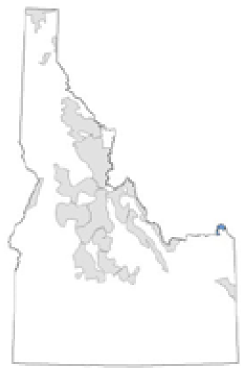
Management Direction – The Department will work to increase the population within South Beaverhead PMU.

Strategy – Survey mountain goat population in South Beaverhead PMU.

Strategy – Investigate mountain goat distribution and habitat use in South Beaverhead PMU.

Strategy – Collaborate with Caribou-Targhee National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Targhee PMU



Targhee PMU encompasses an area of suitable mountain goat range in Sawtelle Peak area and Targhee Creek drainage of GMU 61. Land management of known mountain goat range is by Caribou-Targhee National Forest.

Population

Small numbers of mountain goats have been observed in this area since 2001, most likely originating from an introduced population in the Madison Range of Montana. Three ground surveys conducted between 2001 and 2004 produced observations of 1–11 mountain goats. In 2016, a trail camera captured images of 10–15 mountain goats. In August 2018 IDFG conducted an aerial survey of Targhee PMU and adjacent mountain goat habitat in Montana where 43 adults and 14 kids were observed. No mountain goats have been translocated into or out of this population.

Harvest

There has been no harvest of mountain goats in Targhee PMU.

Current Issues

Targhee PMU has a limited amount of suitable habitat and a small population of mountain goats, which is divided between Idaho and Montana. Given the small population and limited habitat, Targhee PMU may not be able to support harvest. Current land management allows for motorized travel over snow, however, winter distribution of these mountain goats is unknown. Currently, no motorized vehicle travel is allowed in summer in the Targhee Creek portion and only 1 access road exists in the Sawtelle portion.

Management Direction – IDFG will work to increase the population within Targhee PMU.

Strategy – Investigate mountain goat distribution and habitat use in Targhee PMU.

Strategy – Collaborate with Caribou-Targhee National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Coordinate with Montana Fish, Wildlife and Parks on surveys, monitoring, and potential harvest.

Palisades PMU

Palisades PMU encompasses mountain goats found in GMU 67, primarily in the Snake River Range southeast of Highway 31. Mountain goats are occasionally observed in the Big Hole Mountains northwest of Highway 31. Land management of known mountain goat range is by Caribou-Targhee National Forest.

Population

Mountain goats were introduced into Palisades PMU between 1969 and 1971. The population increased rapidly and then quickly declined, similar to observations of other introduced populations. The population grew to a high of 281 mountain goats in 1996 and then declined to a low of 42 in 2002. More recently, the population appears to have stabilized. Over the last 5 surveys 113–156 mountain goats were observed. Observers counted 128 mountain goats during the most recent survey (2018). Most mountain goats found in Palisades PMU are distributed along high elevation ridges between Rainey Creek and the Wyoming border. They are also commonly observed in Palisades Creek and Big Elk Creek. Surveys of Palisades PMU have been conducted biannually since 1994 and are now coordinated with staff of Wyoming Game and Fish Department, who survey the eastern portion of the population in Wyoming. Surveys are conducted in August because summer range of Palisades PMU is more open than winter range. Therefore, sightability of mountain goats is higher in summer. A winter survey was conducted in 2005 and was followed up with a summer survey. As expected, number of mountain goats counted during winter was significantly less than that observed during summer (6 months later).

Populations Surveys- Palisades PMU						
Area	Year	Month	Adult	Kid	Total	Kid:Ad*
All PMU	2018	Aug	110	18	128	16
All PMU	2016	Aug	104	39	143	38
All PMU	2014	Aug	110	25	135	23
All PMU	2012	Aug	87	23	110	26
All PMU	2010	Jul	115	40	155	35
All PMU	2008	Aug	96	27	123	28
All PMU	2006	Aug	113	22	135	19

***Number of kids per 100 adults.**

Harvest

Hunts were initiated in Palisades PMU in 1983. As the population increased, tags were added. In 1990, 24 tags were offered in Palisades PMU in 5 different controlled hunt areas. Subsequent declines in population resulted in fewer tags offered and no tags were available 2003–2004. Tags were offered again in 2005 in a portion of the PMU (Mount Baird area) after a survey indicated the population was >100 animals. That portion north and west of Palisades Creek (Baldy Mountain) is still closed because of low numbers. Currently 5 tags are offered in the Mount Baird portion of the PMU. Hunter success averaged 82% over the last 10 years with females making up 17% of the harvest.

Current Issues

Much of the occupied mountain goat habitat in Palisades PMU is managed by Caribou-Targhee National Forest. Access is limited to non-motorized travel during summer months, which certainly benefits mountain goats. Snowmobile use is restricted in the Palisades Creek section of mountain goat winter habitat, but is permitted in the Big Elk Creek section. Heli-skiing operations are conducted within Palisades PMU, but are restricted in most occupied mountain goat winter range. Non-motorized recreation in the form of hiking and backpacking is popular in summer months; recently, backcountry running groups have received permits to hold races through mountain goat summer range. Effects of non-motorized recreation are unknown.

Management Direction – IDFG will maintain a stable population with secure habitat within Palisades PMU.

Strategy – Provide Caribou-Targhee National Forest information about mountain goat winter distribution and habitat use on winter range.

Strategy – Collaborate with Caribou-Targhee National Forest to minimize potential impact of motorized and non-motorized recreation on mountain goats.

Strategy – Coordinate with Wyoming Game and Fish Department on surveys, monitoring, and potential harvest.

Strategy – Develop educational materials for hunters to help minimize harvest of female mountain goats.

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Appendix A: Harvest Model and Tables

Mountain Goat Population Models

We developed a 2- and a 12-stage mountain goat population model using R 3.5.0 (R Core Team 2018). Package Rramas (Caswell 2006) was used to project population growth in both model structures although we wrote additional code to modify harvest structure outside of the package's constraints. We used vital rates published in Hamel et al. (2006, hereafter Hamel in Appendix A) as a starting point and varied survival and fecundity to approximate "well-performing," "average," and "poorly-performing" populations. Models are based on vital rates from Hamel unless otherwise noted and were considered "average." Our objective in developing these models was to extend modeling efforts begun by Hamel over a wider range of population sizes, recruitment rates, and harvest scenarios. We assumed Idaho's mountain goat populations experience similar population dynamics and have similar vitals rates compared with Alberta populations. We did not incorporate density dependence because it was not used by Hamel and does not appear to be a significant factor in mountain goat population dynamics. We also assumed kid and yearling harvest was negligible and did not incorporate such harvest into applied harvest structures. Within each modeled year, mortality occurred after reproduction.

Annual harvest was based on initial population size (e.g., an initial population of 100 was harvested as if it was 100 individuals, regardless of whether the population increased or decreased over the 20-year projection). We chose to structure harvest this way to more realistically reflect limited year-to-year knowledge of exact population size and our ability to change seasons on an annual basis in response to short-term population change. Harvest was rounded down to the nearest whole individual to prevent going over annual target harvest. We only presented annual harvest structures where harvest rate could be met on an annual basis. For example, we did not present a model of a population of 50 individuals harvested at 1% because that would equate to 0.5 individuals harvested each year.

In the 12-stage model, number of male and female individuals harvested during each time step was determined by drawing from a multinomial distribution using the target proportion of females and males in the harvest. Age classes of harvested males and females were determined separately by drawing from a multinomial distribution using the age class distribution from the previous time step.

2-Stage Population Models

The 2-stage population model included 2 age classes (juvenile and adult) and did not incorporate gender. Demographic stochasticity was incorporated using a matrix of standard deviations associated with transition probabilities. We projected population growth over 20 years with 1,000 replicates. Harvest varied across models from 1 to 12 individuals. Fecundity ranged from 0.253 to 0.535 and approximated kid:adult ratios of 10 to 21 kids per 100 adults. Hamel's fecundity value (0.395) was used as the "average" value and translated to approximately 15 kids per 100 adults. Varying fecundity values in this way, we assumed surveys were consistently conducted just before parturition, effectively measuring recruitment for the year. Using 5 initial population sizes, 1–12 individuals harvested, and 3 different fecundity values, we ran 180 model variations. Seventy-eight models are presented in our results. We excluded those models in which harvest structure was unrealistic relative IDFG's management practices (e.g., substantially 5% harvest rate or <1% harvest rate).

12-Stage Population Models

The 12-stage population model included 6 age classes (kid, yearling, 2 years, 3–4 years, 5–8 years, and 9+ years) of both male and female mountain goats. Demographic stochasticity was incorporated into the model using a matrix of standard deviations associated with transition probabilities. We projected population growth over 20 years with 1,000 replicates. Model parameters included initial population size (50, 100, 150, 200, or 250), harvest rate (1–5% per time step), and percent of females in the harvest (10–50%). Using these ranges of parameter values, we ran 125 model variations. We present 122 models in the results. We excluded models in which harvest structure was unrealistic relative to IDFG's management practices (e.g., substantially >5% harvest rate or <1% harvest rate).

Future Research Needs

In those models that included harvest, all available age classes were harvested proportional to their availability in the population. In the future, incorporation of age-class-specific vulnerability could be helpful because certain age-gender classes may be more vulnerable to harvest (e.g., mature males or dispersing juveniles). Additionally, updating transition probabilities to reflect Idaho populations could enhance applicability of models to our mountain goat populations. Development of a systematic program to investigate relationships between survey results and these modeling efforts would help us determine how closely models track observed population trends in the state.

Table A-1. 2-Stage Model with recruitment of 15 kids:100 adults and no harvest.

Initial Abundance	Probability of 10% Decline	Probability of 25% Decline	Lambda
50	0.27	0.05	1.04
100	0.08	0	1.04
150	0.02	0	1.04
200	0.01	0	1.04
250	0.01	0	1.04

2-Stage Population Model

Table A-2. Probability of decline from an initial population size of 50 and annual population growth rate (λ) for modeled mountain goat populations under different annual harvest structures over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	Kid:100 Adults	10% Decline	25% Decline	λ
2	1	10 15 21	1 0.55 0.07	0.99 0.29 0.01	0.94 1.01 1.07
4	2	10 15 21	1 0.86 0.19	1 0.71 0.08	0.85 0.98 1.05
>5	3	10 15 21	1 0.99 0.53	1 0.97 0.36	0.70 0.90 1.01

Table A-3. Probability of decline from an initial population size of 100 and annual population growth rate (λ) for modeled mountain goat populations under different annual harvest structures over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	Kid:100 Adults	10% Decline	25% Decline	λ
1	1	10 15 21	1 0.17 0	0.97 0.02 0	0.96 1.03 1.08
2	2	10 15 21	1 0.36 0.01	1 0.12 0	0.94 1.01 1.07
3	3	10 15 21	1 0.65 0.02	1 0.40 0	0.90 1.00 1.06
4	4	10 15 21	1 0.90 0.06	1 0.75 0.02	0.82 0.98 1.05
5	5	10 15 21	1 0.98 0.16	1 0.94 0.06	0.72 0.94 1.03
6	6	10 15 21	1 1 0.41	1 1 0.27	0.64 0.89 1.01

Table A-4. Probability of decline from an initial population size of 150 and annual population growth rate (λ) for modeled mountain goat populations under different annual harvest structures over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	Kid:100 Adults	10% Decline	25% Decline	λ
1	1	10 15 21	1 0.05 0	0.96 0 0	0.97 1.03 1.08
2	3	10 15 21	1 0.25 0	1 0.05 0	0.94 1.01 1.07
3	4	10 15 21	1 0.50 0	1 0.21 0	0.91 1.00 1.06
4	6	10 15 21	1 0.91 0.01	1 0.76 0	0.81 0.98 1.05
5	7	10 15 21	1 0.98 0.05	1 0.93 0.01	0.73 0.95 1.04
5.5	8	10 15 21	1 1 0.12	1 0.99 0.05	0.66 0.92 1.03

Table A-5. Probability of decline from an initial population size of 200 and annual population growth rate (λ) for modeled mountain goat populations under different annual harvest structures over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	Kid:100 Adults	10% Decline	25% Decline	λ
1	2	10 15 21	1 0.05 0	1 0 0	0.96 1.03 1.08
2	4	10 15 21	1 0.19 0	1 0.03 0	0.94 1.01 1.07
3	6	10 15 21	1 0.60 0	1 0.30 0	0.89 1.00 1.06
4	8	10 15 21	1 0.93 0	1 0.76 0	0.80 0.97 1.05
5	10	10 15 21	1 1 0.04	1 0.98 0.01	0.68 0.94 1.03
5.5	11	10 15 21	1 1 0.11	1 1 0.04	0.64 0.91 1.03

Table A-6. Probability of decline from an initial population size of 250 and annual population growth rate (λ) for modeled mountain goat populations under different annual harvest structures over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	Kid:100 Adults	10% Decline	25% Decline	λ
1	2	10 15 21	1 0.01 0	0.99 0 0	0.97 1.03 1.08
2	5	10 15 21	1 0.12 0	1 0.01 0	0.94 1.01 1.07
3	7	10 15 21	1 0.47 0	1 0.17 0	0.90 1.00 1.06
4	10	10 15 21	1 0.94 0	1 0.80 0	0.79 0.98 1.05
5	12	10 15 21	1 1 0.02	1 0.98 0	0.70 0.95 1.04

12-Stage Population Model

Table A-7. Probability of decline from an initial population size of 50 and annual population growth rate (λ) for modeled mountain goat populations with different annual harvest characteristics over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	% Female	10% Decline	25% Decline	λ
2	1	10 20 30 40 50	0.24 0.26 0.27 0.30 0.33	0.13 0.14 0.15 0.17 0.20	1.02 1.01 1.01 1.01 1.00
4	2	10 20 30 40 50	0.34 0.37 0.45 0.49 0.54	0.19 0.22 0.29 0.34 0.39	1.01 1.01 1.00 0.99 0.98

Table A-8. Probability of decline from an initial population size of 100 and annual population growth rate (λ) for modeled mountain goat populations with different annual harvest characteristics over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	% Female	10% Decline	25% Decline	λ
1	1	10 20 30 40 50	0.10 0.11 0.12 0.13 0.14	0.03 0.03 0.03 0.04 0.04	1.02 1.02 1.02 1.02 1.01
2	2	10 20 30 40 50	0.14 0.17 0.20 0.23 0.28	0.04 0.05 0.07 0.09 0.12	1.02 1.02 1.01 1.01 1.00
3	3	10 20 30 40 50	0.18 0.27 0.31 0.35 0.43	0.06 0.11 0.14 0.18 0.24	1.01 1.01 1.00 1.00 0.99
4	4	10 20 30 40 50	0.27 0.34 0.42 0.51 0.59	0.10 0.15 0.22 0.30 0.38	1.01 1.00 1.00 0.99 0.97
5	5	10 20 30 40 50	0.33 0.44 0.53 0.62 0.71	0.14 0.23 0.30 0.41 0.51	1.01 1.00 0.99 0.97 0.95

Table A-9. Probability of decline from an initial population size of 150 and annual population growth rate (λ) for modeled mountain goat populations with different annual harvest characteristics over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	% Female	10% Decline	25% Decline	λ
1	1	10	0.04	0.01	1.02
		20	0.04	0.01	1.02
		30	0.06	0.01	1.02
		40	0.05	0.01	1.02
		50	0.07	0.01	1.02
2	3	10	0.10	0.01	1.02
		20	0.13	0.04	1.01
		30	0.16	0.04	1.01
		40	0.18	0.05	1.01
		50	0.24	0.08	1.00
3	4	10	0.14	0.03	1.02
		20	0.18	0.05	1.01
		30	0.23	0.08	1.01
		40	0.28	0.12	1.00
		50	0.33	0.14	1.00
4	6	10	0.23	0.06	1.01
		20	0.32	0.12	1.00
		30	0.41	0.19	1.00
		40	0.52	0.28	0.98
		50	0.60	0.37	0.97
5	7	10	0.29	0.09	1.01
		20	0.40	0.17	1.00
		30	0.52	0.27	0.99
		40	0.63	0.39	0.97
		50	0.70	0.49	0.96

Table A-10. Probability of decline from an initial population size of 200 and annual population growth rate (λ) for modeled mountain goat populations with different annual harvest characteristics over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	% Female	10% Decline	25% Decline	λ
1	2	10	0.04	0	1.02
		20	0.05	0	1.02
		30	0.05	0.01	1.02
		40	0.05	0.01	1.02
		50	0.07	0.01	1.02
2	4	10	0.07	0.01	1.02
		20	0.10	0.01	1.01
		30	0.12	0.03	1.01
		40	0.16	0.04	1.01
		50	0.20	0.05	1.00
3	6	10	0.14	0.02	1.01
		20	0.19	0.05	1.01
		30	0.25	0.07	1.01
		40	0.34	0.13	1.00
		50	0.42	0.18	0.99
4	8	10	0.20	0.04	1.01
		20	0.29	0.09	1.00
		30	0.40	0.16	1.00
		40	0.52	0.27	0.98
		50	0.62	0.36	0.97
5	10	10	0.30	0.08	1.01
		20	0.45	0.17	1.00
		30	0.56	0.30	0.98
		40	0.68	0.43	0.97
		50	0.75	0.53	0.95

Table A-11. Probability of decline from an initial population size of 250 and annual population growth rate (λ) for modeled mountain goat populations with different annual harvest characteristics over 20 years. Red indicates a decreasing population, green indicates an increasing population.

Harvest Rate (%)	# Individuals Harvested	% Female	10% Decline	25% Decline	λ
1	2	10 20 30 40 50	0.01 0.02 0.02 0.02 0.04	0 0 0 0 0	1.02 1.02 1.02 1.02 1.02
2	5	10 20 30 40 50	0.05 0.07 0.09 0.14 0.18	0 0.01 0.01 0.03 0.04	1.02 1.01 1.01 1.01 1.00
3	7	10 20 30 40 50	0.10 0.15 0.19 0.27 0.36	0.01 0.03 0.05 0.08 0.13	1.02 1.01 1.01 1.00 0.99
4	10	10 20 30 40 50	0.18 0.27 0.40 0.53 0.62	0.03 0.07 0.15 0.24 0.37	1.01 1.00 0.99 0.99 0.97
5	12	10 20 30 40 50	0.29 0.40 0.55 0.66 0.73	0.06 0.13 0.27 0.39 0.50	1.01 1.00 0.99 0.97 0.95

Table A-12. Probability of decline from an initial population size of 100 and annual population growth rate (λ) for modeled mountain goat populations with high fecundity (~21 kids:100 adults) with different annual harvest characteristics over 20 years. Green indicates an increasing population.

Harvest Rate (%)	%Female	10% Decline	25% Decline	Lambda
1	10	0	0	1.06
1	20	0	0	1.06
1	30	0.01	0	1.06
1	40	0	0	1.05
1	50	0.01	0	1.05
2	10	0.01	0	1.06
2	20	0.01	0	1.05
2	30	0.01	0	1.05
2	40	0.01	0	1.05
2	50	0.02	0.01	1.04
3	10	0.02	0	1.05
3	20	0.02	0.01	1.05
3	30	0.03	0.01	1.05
3	40	0.04	0.01	1.04
3	50	0.05	0.02	1.04
4	10	0.02	0	1.05
4	20	0.04	0.01	1.04
4	30	0.05	0.01	1.04
4	40	0.09	0.04	1.03
4	50	0.13	0.06	1.02
5	10	0.03	0.01	1.05
5	20	0.05	0.01	1.04
5	30	0.09	0.03	1.03
5	40	0.15	0.07	1.02
5	50	0.25	0.14	1.01

Table A-13. Probability of decline from an initial population size of 200 and annual population growth rate (λ) for modeled mountain goat populations with high fecundity (~21 kids:100 adults) with different annual harvest characteristics over 20 years. Green indicates an increasing population.

Harvest Rate (%)	%Female	10% Decline	25% Decline	Lambda
1	10	0	0	1.06
1	20	0	0	1.06
1	30	0	0	1.06
1	40	0	0	1.05
1	50	0	0	1.05
2	10	0	0	1.05
2	20	0	0	1.05
2	30	0	0	1.05
2	40	0	0	1.05
2	50	0	0	1.04
3	10	0	0	1.05
3	20	0	0	1.05
3	30	0	0	1.04
3	40	0.01	0	1.04
3	50	0.01	0	1.03
4	10	0	0	1.05
4	20	0.01	0	1.05
4	30	0.01	0	1.04
4	40	0.03	0.01	1.03
4	50	0.06	0.02	1.02
5	10	0	0	1.05
5	20	0.01	0	1.04
5	30	0.04	0.01	1.03
5	40	0.09	0.03	1.02
5	50	0.18	0.08	1.01

Table A-14. Probability of decline and annual population growth rate (λ) for modeled mountain goat populations with different all-male harvest over 20 years. Green indicates an increasing population.

Initial abundance	Harvest rate (%)	10% Decline	25% Decline	Lambda
50	2	0.21	0.10	1.02
50	4	0.27	0.13	1.02
100	1	0.07	0.01	1.02
100	2	0.12	0.03	1.02
100	3	0.15	0.04	1.02
100	4	0.20	0.06	1.02
100	5	0.25	0.09	1.01
150	1	0.04	0	1.02
150	2	0.08	0.01	1.02
150	3	0.09	0.01	1.02
150	4	0.16	0.04	1.02
150	5	0.19	0.05	1.02
200	1	0.03	0	1.02
200	2	0.05	0.01	1.02
200	3	0.09	0.01	1.02
200	4	0.13	0.01	1.02
200	5	0.18	0.03	1.02
250	1	0.01	0	1.02
250	2	0.03	0	1.02
250	3	0.06	0	1.02
250	4	0.12	0.01	1.02
250	5	0.15	0.01	1.01

Appendix B: Translocation Records

Year	Month	Capture State	Capture PMU	Capture GMU	Capture location	Release State	Release PMU	Release GMU	Release Location	Adult M	Adult F	Kid M	Kid F	Total
1960	Jun	ID	Black Snow	9	Snow Peak	ID	Pend Oreille	4A	Echo Bay					**5**
1960	Jun	ID	Black Snow	10	Black Mt.	ID	Pend Oreille	4A	Echo Bay					**3**
1961	Jul	ID	Black Snow	9	Snow Peak	CO			Mount Evans	2	3			**5**
1962	Jun	ID	Black Snow	9	Snow Peak	ID	Seven Devils	18	Seven Devils	2	3	3		**8**
1962	Jul	ID	Black Snow	9	Snow Peak	ID	Pend Oreille	4A	Echo Bay					**3**
1964	Jul	ID	Black Snow	9	Snow Peak	ID	Seven Devils	18	Seven Devils					**7 or 9**
1965	Jul	ID	Black Snow	9	Snow Peak	ID	Pend Oreille	4A	Echo Bay					**4 or 7**
1966	Jun	ID	Black Snow	9	Snow Peak	ID	Lower Salmon	15	Johns Creek	4	4			**8**
1967	Jun	ID	Black Snow	9	Snow Peak	ID	Lower Salmon	15	Johns Creek	1	1-2			**2 or 3**
1968	Jul	ID	Black Snow	9	Snow Peak	ID	Pend Oreille	4A	Green Monarchs	1-2	2			**3 or 4**
1969	Jul	ID	Black Snow	9	Snow Peak	ID	Palisades	67	Palisades Creek	2	1			**3**
1969	Jul	ID	Black Snow	10	Black Mt.	ID	Palisades	67	Palisades Creek	1	1			**2**
1970	Jul	ID	Black Snow	9	Snow Peak	ID	Palisades	67	Blacks Canyon	3				**3**
1971	Jul	ID	Black Snow	9	Snow Peak	ID	Palisades	67	Palisades Creek	1	2	1		**4**
1981	Jul	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Lion Creek	1	1			**2**
1982	Jul	WA			Olympic NP	ID	Selkirk	1	Lion Creek	5	3		1	**9**
1982	Jul	WA			Olympic NP	ID	Lemhi	37A	Patterson Creek	8	12			**20**
1983	Jun-Jul	ID	Black Snow	9	Snow Peak	OR			Elkhorn Mts.	2	3		1	**6**

Table B-1. Mountain goats translocated into, out of, and within Idaho, 1960–2007.

Year	Month	Capture State	Capture PMU	Capture GMU	Capture location	Release State	Release PMU	Release GMU	Release Location	Adult M	Adult F	Kid M	Kid F	Total
1983	Jul	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Bugle Creek	2				**2**
1985	Jun	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Lion Creek	1	5			**6**
1986	Jun	ID	Black Snow	10	Black Mt.	ID	Black Snow	12	Boulder Creek					**7**
1987	Jun	ID	Black Snow	9	Snow Peak	ID	Lower Salmon	19	Oregon Butte		8			**8**
1987	Jun	ID	Black Snow	10	Black Mt.	ID	Lower Salmon	19	Oregon Butte	2	2			**4**
1989	Jun	ID	Black Snow	9	Snow Peak	ID	Middle Fork	27	Middle Fork of Salmon River		2			**2**
1989	Jun	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Parker Creek		5			**5**
1989	Jun	ID	Black Snow	10	Black Mt.	ID	Selkirk	1	Parker Creek	2	1			**3**
1989	Jul	WA			Olympic NP	ID	Seven Devils	18	Seven Devils	8				**8**
1989	Aug	ID	Black Snow	10	Black Mt.	ID	Middle Fork	27	Jack Creek	2	4			**6**
1989	Aug	ID	Palisades	67	Baldy Mt.	ID	Panther Creek	28	Williams Creek	1	1			**2**
1989	Jul	ID	Black Snow	9	Snow Peak	ID	Middle Fork	27	Jack Creek		1			**1**
1990	Jul	ID	Palisades	67	Baldy Mt.	ID	Panther Creek	28	Pine Creek	1			1	**1**
1990	Jul	ID	Palisades	67	Baldy Mt.	ID	Panther Creek	28	Panther Creek	1	4			**6**
1991	Jun	ID	Black Snow	10	Black Mt.	ID	Middle Fork	27	Ship Island Creek	4	4		1	**8**
1991	Jul	ID	Palisades	67	Baldy Mt.	ID	Panther Creek	28	Panther Creek	1	4			**6**
1992	Jun	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Parker Creek		1			**1**

Year	Month	Capture State	Capture PMU	Capture GMU	Capture location	Release State	Release PMU	Release GMU	Release Location	Adult M	Adult F	Kid M	Kid F	Total
1992	Jul	ID	Palisades	67	Baldy Mt.	ID	Panther Creek	28	Panther Creek	2	9			**11**
1994	Jun-Jul	ID	Black Snow	9	Snow Peak	ID	Selkirk	1	Ball Creek		3			**3**
1994	Jun	ID	Black Snow	10	Black Mt.	ID	Lower Salmon	20	Big Squaw Creek	4	4			**8**
1994	Aug	ID	Palisades	67	Mt. Baird	ID	Middle Fork	21	Square Top Mt.	4	6			**10**
1996	Jun	ID	Black Snow	10	Black Mt.	ID	Lower Salmon	20	Big Squaw Creek		1			**1**
1997	Aug	ID	Palisades	67	Mt. Baird	ID	Middle Fork	21	Corn Lake	4	6			**10**
1998	Jun	ID	Black Snow	10	Black Mt.	ID	Lower Salmon	15	Johns Creek	1				**1**
1998	Jun	ID	Black Snow	10	Black Mt.	ID	Lower Salmon	20	Big Squaw Creek	1	2			**3**
1999	Jun	ID	Seven Devils	18	Seven Devils	ID	Lower Salmon	20	Big Mallard Creek	4	3			**7**
2001	Mar-Apr	ID	Seven Devils	18	Bernard-Granite Creeks	ID	Lower Salmon	20	Big Mallard Creek	5	6			**11**
2003	Mar	ID	Seven Devils	18	Seven Devils	ID	Lower Salmon	20	Sheep Hill	4	6	2	4	**16**
2007	Sept	UT			Tushar Mts.	ID	Lemhi	29	Haynes Creek	5	18	1		**24**

Appendix C: Modeling Mountain Goat Distribution in Idaho

Although several species distribution models were developed for mountain goats in the Rocky Mountains (e.g., Gross et al. 2002, DeVoe et al. 2015, Lowrey et al. 2017, White and Gregovich 2017, White et al. 2018), none of these encompass all of Idaho nor do they make use of Idaho observation data. The only other statewide distribution models for mountain goat currently available are deductive habitat models developed by the Gap Analysis Project (Scott et al. 2002, USGS 2017).

To aid in development of this plan, we created a preliminary model of mountain goat distribution using maximum entropy methods (MaxEnt 3.4.1; Phillips et al. 2006, Phillips and Dudík 2008). Given a set of environmental variables and species presence locations, MaxEnt identifies correlations between each variable and presence data, compares those correlations with the range of environmental conditions available in the modeled region, and develops a continuous model of relative likelihood, or probability, of suitable habitat across the study area based on environmental similarity to known occupied sites. Our modeling process incorporated all available occurrence data and several environmental variables hypothesized to influence distributions of mountain goats in the previously mentioned modeling efforts. Conducting all spatial analyses in ArcGIS 10.5.1 (ESRI 2017), we ensured spatial data were in a common geographic coordinate system, spatial resolution (30 m x 30 m), and extent, then exported data as ASCII files for input into R and MaxEnt.

Mountain Goat Observations

All known locations of mountain goats in Idaho as of 12 October 2018 were compiled for this modeling effort. The data set included observations from numerous helicopter and fixed-wing airplane survey efforts (1960–2018), remote-camera-survey detections, GPS locations from collared animals, incidental observations recorded in the USFS Natural Resource Information System database and in IDFG regional data files, and observations previously stored in Idaho Fish and Wildlife Information System (IFWIS) Species Diversity Database (including museum specimens, older survey efforts, and incidental observations). All of these compiled data were uploaded to IFWIS Species Diversity Database for long-term data storage and accessibility.

We carefully evaluated all data for use in the distribution model to ensure observational, spatial, and temporal accuracy. Of 25,222 observations compiled, we categorized 25,005 as verified (e.g., specimen, DNA, or photograph) or trusted (e.g., documented by a biologist, researcher, or taxonomic expert) and 23,776 of these as having sufficient spatial accuracy (≤1,000 m) for our modeling purposes. Compiled observation data such as these are prone to errors of sampling bias, both geographically and environmentally, and our observations exhibited spatial clustering at fine scales in portions of the state. Species distribution models can be sensitive to such bias and spatial filtering of presence data is often suggested as a solution (Phillips et al. 2009, Veloz 2009, Kramer-Schadt et al. 2013, Radosavljevic and Anderson 2013, Boria et al. 2014). The key to spatial filtering is to randomly subsample presence data with a minimum distance separating sample points, thereby limiting spatial autocorrelation and reducing environmental bias caused by uneven sampling. That minimum distance is somewhat arbitrary, however, and depends on environmental conditions of the study area as well as resolution of data used for modeling. We reduced locally dense sampling of mountain goats by randomly subsampling with a minimum distance of 270 m. These filtering procedures (verified or trusted, ≤1,000 m accuracy, within Idaho, and >270 m separation) resulted in 4,250 observations available for use in our modeling effort.

Environmental Variables

Previous modeling efforts focused on topographic, vegetative, and heat-related suites of environmental covariates at a variety of spatial scales (Gross et al. 2002, DeVoe et al. 2015, Lowrey et al. 2017, White and Gregovich 2017, White et al. 2018). Given that topographic measures were by far the most significant variables in these efforts, and limited time constraints for our effort, we used a subset of fine-scale (30-m resolution) topographic and climatic covariates (Table C-1) that were already developed for use in other statewide modeling projects (L. K. Svancara, IDFG, unpublished data).

Topographic variables developed from National Elevation Data (30 m) (USGS 2016) included elevation, slope, aspect, compound topographic index (CTI), roughness, and vector ruggedness measure (VRM). The CTI, a steady-state wetness index, measures catenary topographic position represented by both slope and catchment size (Moore et al. 1993, Gessler et al. 1995). Although CTI aims to model soil water content, the index also characterizes landscapes such that areas with low CTI represent small catchments and steep slopes while areas with high CTI are large catchments with gentle slopes. Roughness, similar to terrain ruggedness index (Riley et al. 1999), calculates amount of elevation difference between a grid cell and its neighbors, essentially variance of elevation within the neighborhood (8x8 in this analysis). The VRM measures terrain heterogeneity within a neighborhood (9x9 in this analysis), capturing variability in both slope and aspect into a single measure. Both CTI and roughness were calculated using Evans et al. (2014) whereas VRM was calculated following Sappington et al. (2007) and Sappington (2012).

Climatic variables included a recent temperature dataset developed at finer spatial resolution (250 m) for the Northern Rockies (Holden et al. 2015) in combination with precipitation data from PRISM (800 m) (PRISM Climate Group 2012). Original PRISM precipitation data at 800-m resolution were resampled to 250 m to match temperature data. Using monthly 30-year normals (1981–2010) from both temperature and precipitation datasets, we calculated 19 bioclimatic variables patterned after Hijmans et al. (2005) which have been used extensively in wildlife habitat modeling (e.g., Elith et al. 2010, Anderson and Gonzalez 2011, Stanton et al. 2011).

Current Habitat Suitability

We supplied MaxEnt with occurrence data described above, as well as background points consisting of 10,000 randomly generated pseudo-absences across Idaho that were >270 m apart, 270 m from presence locations, and outside of waterbodies. Following recommended approaches, we then calculated species-specific model parameters with regard to collinearity, regularization multiplier, and feature types.

In an iterative approach, we optimized each model for regularization multiplier (values tested included 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 12.5, 15, 17.5, and 20) and feature types (linear, quadratic, product, threshold, hinge, and interactions) using the enmSdm package (Smith 2017) in R 3.5.0 (R Core Team 2018) and selected the best performing combination based on AICc (Warren and Seifert 2011, Wright et al. 2015). Beginning with a full model inclusive of all covariates (n = 26), we implemented a 10-fold subsample routine (withholding 30% [n = 1,275] of observations for testing) and jackknifing to measure importance of each variable to the resulting model. Variables were then ranked based on their permutation importance and removed if <2% contribution. Correlated variables (P > 0.75) were also removed, keeping the variable with the higher permutation importance. This process of model optimization, development, and variable ranking and removal was repeated until all variables had a minimum contribution of ≤2%. The final model represented the average of 10 subsample replicates using the optimized parameters and most important variables.

We imported mean model output into ArcGIS 10.5.1 (ESRI 2017) and identified areas of suitable and unsuitable habitat based on the 10-percentile training presence threshold calculated by MaxEnt (Table C-2). This threshold identifies the model value that excludes 10% of training locations having the lowest predicted value. For comparative purposes, we further binned suitable habitat using other MaxEnt calculated thresholds to identify low, medium, and high suitability. To separate low- and medium-suitability habitat we used the 'balance training omission, predicted area and threshold value' threshold, which uses weighting constants to provide a balance between over-fitting and over-estimating. To separate medium- and high-suitability habitat we used the 'equal training sensitivity and specificity' threshold, which equalizes omission and commission errors.

Results and Discussion

MaxEnt accurately predicted mountain goat distribution with area under the receiver operating characteristic curve, AUC = 0.857. The best fit model based on AICc employed linear, quadratic, product, and hinge features with a regularization multiplier of 0.5. Averaged over replicate runs, the most important variables were precipitation of driest month (bio14), roughness, VRM, temperature seasonality (bio4), and elevation (in order of permutation importance) (Table C1). Jackknife tests indicated roughness contained the most useful information by itself, as well as the most information that was not present in other variables. Predicted mountain goat suitability increased with increasing precipitation in driest month, elevation, roughness, and VRM, and with decreasing temperature seasonality.

Because selection of specific model thresholds is somewhat arbitrary and biologically meaningful thresholds can be difficult to determine, careful consideration of resulting model accuracy is necessary and reporting a range of threshold values, or none at all, is often recommended (Liu et al. 2005, Merow et al. 2013). Using selected thresholds described above, our final mountain goat model predicted 5.2 million acres of suitable habitat across the state (9.8% of Idaho), composed of 2 million acres of low suitability, 0.6 million acres of medium suitability, and 2.5 million acres of high suitability. The majority of suitable habitat is predicted to occur in Salmon region, including 40% of the area classified as high suitability.

Future Model Refinements

Given time constraints under which this model was developed, we strongly recommend additional biologic and programmatic model refinements be considered. Biologically, developing seasonal models (summer vs. winter) as well as region-specific models would address the sometimes dramatically different landscapes used by mountain goats across the state. For example, mountain goat occurrences in Upper Snake region average >2,800 m (range 2,184–3,305 m) elevation, whereas those in Panhandle and Clearwater regions average <1,500 m (range 856–2,000 m). Programmatically, further refinement of background data, as well as inclusion of different covariates, may result in better fitting models. Because MaxEnt uses background locations where presence or absence of target species is unknown or unmeasured, choice of background data influences what is modeled and perceptions about results (Elith et al. 2010, Merow et al. 2013). By default, MaxEnt assumes the species is equally likely to be anywhere in the study extent (Phillips and Dudík 2008), thus, modifying the background sample is equivalent to modifying prior expectations for species distribution (Merow et al. 2013). Assessing a range of background extents, instead of just full statewide extent of our preliminary model, may result in increased model performance (e.g., VanDerWal et al. 2009, Anderson and Raza 2010, Iturbide et al. 2015). Similarly, including additional covariates such as forest canopy cover, NDVI, heat load, snow depth, and multi-scale variations of these covariates, may improve model performance as in other efforts (e.g., DeVoe et al. 2015, Lowrey et al. 2017). Lastly, assessing potential future changes in modeled distribution of mountain goats under various climate change scenarios would be beneficial.

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Table C-1. Environmental variables used in modeling mountain goat distribution in Idaho.

Type	Variable	Code	Units	Source
Topography	Aspect	Asp	Degree	3D Elevation Program (USGS 2016), Evans et al. (2014) [CTI and Rough8], Sappington et al. (2007) [VRM]
	Slope	Slp	Degree	
	Elevation	Elev	Meters	
	Compound Topographic Index	CTI	Index	
	Roughness (8 neighbor cells)	Rough 8	Meters	
	Vector Ruggedness Measure (9 neighbor cells)	VRM	Index	
Climate	Mean annual temp	Bio1	°C	Holden et al. (2015), PRISM (2012), dismo package in R.
	Mean diurnal range	Bio2	°C	
	Isothermality (bio2 / bio7) (×100)	Bio3	Percent	
	Temp seasonality (SD × 100)	Bio4	°C	
	Max. temp of warmest month	Bio5	°C	
	Min. temp of coldest month	Bio6	°C	
	Temp annual range (bio5 – bio6)	Bio7	°C	
	Mean temp of wettest quarter[1]	Bio8	°C	
	Mean temp of driest quarter[1]	Bio9	°C	
	Mean temp of warmest quarter[1]	Bio10	°C	
	Mean temp of coldest quarter[1]	Bio11	°C	
	Total annual precipitation	Bio12	mm	
	Precipitation of wettest month	Bio13	mm	
	Precipitation of driest month	Bio14	mm	
	Precipitation seasonality (CV)	Bio15	%	
	Precipitation of wettest quarter[1]	Bio16	mm	
	Precipitation of driest quarter[1]	Bio17	mm	
	Precipitation of warmest quarter[1]	Bio18	mm	
	Precipitation of coldest quarter[1]	Bio19	mm	
	Annual mean growing degree days	gdd	No.	Holden et al. (2015)

[1]**Quarter is any 3-month time period**

Table C-2. MaxEnt modeled thresholds used in aiding interpretation of habitat suitability. Values used in displaying the final model are highlighted in bold.

Threshold	Average value
Prevalence	0.2321
Min. training presence	0.0016
10 percentile training presence	**0.3625**
Equal training sensitivity and specificity	**0.5174**
Max. training sensitivity plus specificity	0.3026
Balance training omission, predicted area and threshold value area	**0.4739**

Appendix D: Public Input Summary

During January and February 2019, the draft plan was available for comment on the IDFG website for 26 days. An e-mail encouraging hunters to comment on the plan was sent to 100,000 people. We also directly e-mailed USFS and neighboring state wildlife agencies to solicit feedback.

The draft mountain goat management plan webpage was viewed by 2,108 people and 155 of these individuals responded to the comment form. The majority of respondents were Idaho residents (92%).

Level of Support	Respondents (number)	Proportion of respondents (%)
Generally support	111	72
Support with concerns	20	13
Neutral	12	7.5
Do not support	12	7.5

Eighty people left additional comments regarding the plan. The 2 most frequently mentioned topics were general support of the draft management plan and support of reducing nanny harvest (19 comments each). Respondents' suggestions for reducing nanny harvest ranged from increasing education, to punishing hunters who harvest a nanny, to rewarding hunters who harvest a billy. Many respondents who did not support the plan provided comments unrelated to the draft plan, instead referencing recent season setting changes or non-resident tag allocation. Other comments included concerns with motorized recreation in mountain goat habitat and comments related to translocations.

Additionally, IDFG received written comments from 5 national forests in Idaho, Nez Perce Tribe, and Washington Department of Fish and Wildlife. Comments were generally supportive and provided suggestions for minor changes within PMU strategies.

After considering all public comments, the draft plan was modified and prepared for consideration by the Commission.

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