



# **Biogeography of the Mountain Goat**

*(Oreamnos americanus)*

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## 1.0 INTRODUCTION

### *The Mountain Goat:*

**Table 1:** Taxonomy of the Mountain Goat

Kingdom	Phylum	Class	Order	Family	Genus	Scientific Name
Animalia	Chordata	Mammalia	Artiodactyla	Bovidae	Oreamnos	<i>Oreamnos americanus</i>

*Oreamnos americanus*, the Latin name for the mountain goat, is an even-toed ungulate, belonging to the order Artiodactyla (Festa-Bianchet M., 2008). Despite having “goat” in its name, the mountain goat is not a true goat, but belongs to the family Bovidae which comprises of animals like gazelles, cattle, and antelopes, however, it belongs to the subfamily of Caprinae (goat-antelopes), which is comprised of 32 other species including the true goats, the chamois, muskox, and sheep (Festa-Bianchet M., 2008).



**Fig. 1: The Mountain Goat**

Mountain goats have stout bodies and a thick white fur. Their horns are black and length of approximately 250 mm long. The horns are thin and occur in both sexes (Gross, et al., 2002; “Mountain Goats”, 2007). Like some other ungulates, the mountain goats do not shed their horns, rather, they grow then

annually. Adult males which are called “billies” weigh on average 70 to 120 kg, which adult females called “nannies” weigh on the average 55 to 75 kg (Ministry of Environment, Lands and Parks, 2000). Both sexes have thin, black stiletto-like horns which grow throughout life and are never shed. The growth rings on the horns called “annuli” indicate age (Ministry of Environment,

Lands and Parks, 2000). Male and female goats look similar, but the horns are slightly different. Nannies' horns are slenderer at the base and a bit more curved toward the tip than those of billies. The Mountain Goats possess characteristically rubber-like sole comprised of even-toed oval hooves which are perfectly built and suited for climbing and balance (Gross, et al., 2002; "Mountain Goats", 2007). These feet adaptation allows the mountain goat to be able to operate in the steep terrane it dwells in. The mountain goats are considered the most sure-footed ungulates (Argali, "American Mountain Goat", 2017). In terms of habitat, the mountain goats prefer steep, rocky terranes with cliffs in alpine or sub-alpine regions. The goats stay in areas with adequate escape terrain (these must be steep rocky areas) to enable them to escape from predators. In the winter, they migrate to lowland areas, and in the summer, they migrate to high elevation ranges (Gross, et al., 2002). Throughout the year their diet varies, however, it is generally composed of grasses, mosses, woody plants, herbaceous plants and other vegetation. They get a good amount of their water from year-round snowbanks and their food (Poole and Heard, 2003). The Mountain Goat is biologically built to live in the steep and rocky terrain it occupies. Its characteristically deep chest and tremendously developed shoulder muscles give the animal great strength and support for both climbing and for pawing through snow for food (Ministry of Environment, Lands and Parks, 2000). Due to its relatively short legs which are close together, and a center of gravity that is close to the ground and well forward, the animal can travel on narrow ledges with limited footing (Ministry of Environment, Lands and Parks, 2000). Finally, as mentioned before, the Mountain Goat's cloven hooves have rough-textured traction pads that project slightly past the rim of the hooves and make them highly specialized for the rocky, slippery terrain. The toes of the Mountain Goat can spread widely apart which helps to distribute its weight over more ground, it



also closes pincer-like around rocky projections to provide for extra traction on downhill slopes (Ministry of Environment, Lands and Parks, 2000).

## 2.0 HISTORY

### 2.1 Evolution

The evolution of the Mountain Goat is little known, mostly because of the nature of the terrane it inhabits. The closest old-world relatives of the Mountain Goat are the Chamois, Goral, and Serow, however, these species are not particularly alike to the Mountain Goat, thereby will provide little clues to the origin of the mountain goat (Ministry of Environment, Lands and Parks, 2000). The most noticeable similarity between the Mountain Goat and its other relatives mentioned is relatively short, thin, sharply pointed horns (Ministry of Environment, Lands and Parks, 2000). The lineage of the Mountain Goat, for the most part, lies in obscurity, and this is mostly because of glaciation and erosion that is prominent in the steep mountains they inhabit. Because of the nature of this terrane, previously existing goat fossil has been wiped out and destroyed (Ministry of Environment, Lands and Parks, 2000).

It is believed that the ancestors of the Mountain Goat crossed the Bering land bridge between Siberia and Alaska just before the most recent Wisconsin glaciation. This idea is considered quite authentic mainly because Mountain Goat fossils dating up to 100,000 years old have been found south of the glacial limit in the United States (Ministry of Environment, Lands and Parks, 2000). However, not until about 12,000 years ago, two different species of Mountain Goat were present in the southwest United States; *Oreamnos americanus* and the smaller *Oreamnos haringtoni* (Ministry of Environment, Lands and Parks, 2000).

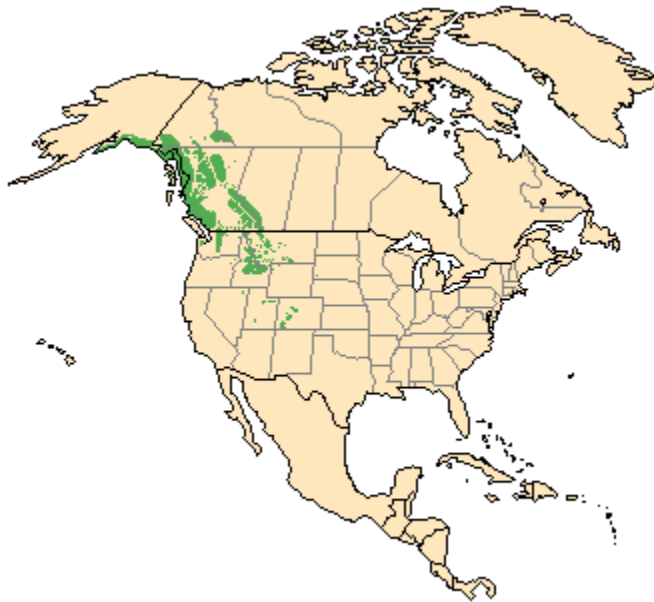
When the last Cordilleran ice sheet began to wane, Harington's goat became extinct and *Oreamnos americanus*, what we currently know as the Mountain Goat, traveled north to the snowy mountains it favours. The universally white colour of the Mountain Goats is a perfect evidence that suggests that the species evolved for thousands of years in close association with snow and ice (Ministry of Environment, Lands and Parks, 2000).

## *2.2 Historical distribution of Mountain Goat through time*

The Mountain Goat did not evolve in the North American continent, as has been previously established, they entered North America from Eurasia across the Bering land bridge during the Pleistocene glaciation prior to the last (Wisconsin) glaciation (Harington, 1971). The closest living relative to the Mountain Goat is the Chamois (*Rupicapra*). The two species now live in North America and Europe respectively, although there is no evidence that they evolved in either of the continents (Harington, 1971). Until about 12,000 years ago, only two species of Mountain Goat were present in the southwest United States, *Oreamnos americanus* and the smaller *Oreamnos haringtoni* (Ministry of Environment BC, 2003). However, when the last Cordilleran ice sheet waned, Harington's Goat became extinct and the present-day mountain goat moved north to the snowy mountains it favours. The economy of the early Neolithic was mostly based on an intensive collection of plants and hunting game (Ministry of Environment BC, 2003), however, this had little or no effect on the Mountain Goat because their habitat is not easily accessible.

Major ecological changes occurred during the last 200 years including the last episode of a drastic reduction in forest area (Ministry of Environment BC, 2003), however, this is still of no major concern to the Mountain Goat as they are above timberline most of the time and only occasionally migrate to slightly lower altitudes seasonally. The Mountain Goat is monotypic and

presently occupies "interglacial range" extending from Oregon and Idaho north to Alaska and the Yukon Territory.



**Fig. 2: Mountain goat distribution**

### **3.0 PRESENT DAY**

#### ***3.1 Current Distribution***

Today, the native range of the Mountain Goat extends from western Montana, southern Idaho, and the Columbia River in Washington north along the Rocky Mountains as far as the Chugach and Talkeetna mountains of Alaska in the United States (Chester B. et al., 1975). In Canada, they occupy British Columbia and the Yukon Territories. In British Columbia, goats are present in most mountain ranges except for those on Vancouver Island, the Queen Charlottes, and other coastal islands (Ministry of Environment, Lands and Parks, 2000).

Mountain Goats occupy alpine and subalpine areas which are characterized by steep rocky terrain, and their distribution currently includes most of the major ranges of the Coast, Cascade, and Rocky

Mountains (Chester B. et al., 1975). Mountain goats exhibit a wide tolerance for climatic conditions, and this is one of the responsible reasons for their long-term survival. They can tolerate climatic conditions ranging from tidewater along coastal inlets to the Continental Divide and from the arid Similkameen Valley in British Columbia to the Yukon border (Ministry of Environment, Lands and Parks, 2000). Though Mountain Goats are mostly confined to prominent mountain ranges, some of them occur along river canyons cut through plateaus (Ministry of Environment, Lands and Parks, 2000).

From recent estimates, it has been found that the number of Mountain Goats in North America has varied from about 75,000 to 100,000 (Ministry of Environment, Lands and Parks, 2000). This number includes;

- 14,000 to 15,000 in the western states;
- 10,000 to 25,000 in Alaska;
- about 50,000 in British Columbia;
- and small numbers in Alberta, Yukon, and Mackenzie Territory (Ministry of Environment, Lands and Parks, 2000).

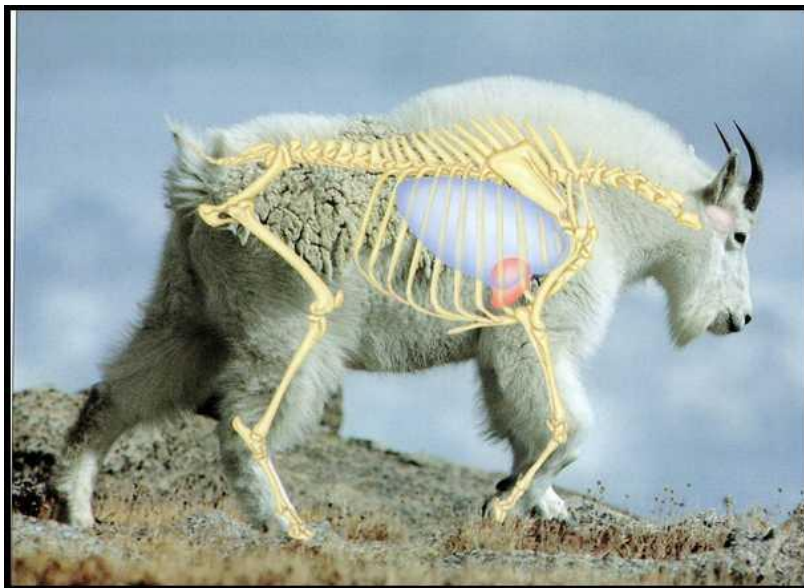
Activities of not too recent times have also helped to shape the current distribution and numbers of Mountain Goats on the continent. During the 1900s, and particularly from 1950 to 1975, Mountain Goat numbers declined in many areas, primarily because of over-hunting (Ministry of Environment, Lands and Parks, 2000). Today, recent hunting restrictions and reintroductions have largely reversed that trend. This is an example of management practices that had to be implemented to intervene before things get critical. In British Columbia for example, Mountain Goats are more numerous in the northwest part of the province, but substantial populations occur throughout the



main chain of the Rockies and in the Coast, Cariboo, Selkirk and Purcell ranges (Ministry of Environment, Lands and Parks, 2000).

### *3.2 Biological Adaptations*

Mountain Goats have over the years have adapted excellently well to the mountain environment they dwell in. They have biologically evolved over time to survive the standards of the terrane. The alpine environment is severe and harsh, few species can survive there unless specially adapted to thrive. The Mountain Goat's biological build is suited to live in steep, rocky terrain (Ministry of Environment, Lands and Parks, 2000). An adaptive feature that has helped the Mountain Goat thrive is its forequarters, which are disproportionately massive in relation to its



**Fig. 3: Forequarters section of Mountain Goat**

compact rear end (Ministry of Environment, Lands and Parks, 2000). The morphology of this section of the animal's body features a deep chest area and tremendously well-developed shoulder muscles. This gives the Mountain Goat extremely great strength for climbing steep

rocky slopes endlessly, and for pawing through thick layers of snow for food (Ministry of Environment, Lands and Parks, 2000). The anatomy of the Mountain Goat's legs is relatively short and are close together, creating a center of gravity that is close to the ground and well forward, making the animal able to travel on narrow ledges with limited footing.



**Fig. 4: Mountain Goat scaling through narrow ledge 1**



**Fig. 5: Mountain Goat scaling through narrow ledge 2**

The Mountain Goat's cloven hooves are characterized by rough-textured traction pads which project slightly past the rim of the hooves, making them highly specialized for not only rocky but slippery terrain (Sladek, M., 2017).



**Fig. 6: Cloven hooves of the Mountain Goat 1**



**Fig. 7: Cloven hooves of the Mountain Goat 2**

The toes of the Mountain Goat also can spread widely to distribute the body weight over more ground and close pincer-like around rocky projections for the purpose of providing extra traction on downhill slopes (Sladek, M., 2017). Of all North American ungulates, the Mountain Goat has the thickest and longest pelage apart from the Musk Oxen (Ministry of Environment, Lands and Parks, 2000). The goat's bearded chin and the long hair of its upper legs, which looks like pantaloons, add to the goat's distinctive

appearance (Ministry of Environment, Lands and Parks, 2000). The Mountain Goat has evolved a winter coat which consists of coarse hollow guard hairs up to 20 cm long and very fine-textured interwoven underfur that is 5 to 8 cm long. (Ministry of Environment, Lands and Parks, 2000). This adaptation enables the goats to withstand the most severe wind chill the alpine has to offer. Billies (male Mountain Goats) shed their winter coat by early July and Nannies (female Mountain Goats) somewhat later (Ministry of Environment, Lands and Parks, 2000). Their summer coat is likewise also warm, and the goats seek out cool, shady spots in hot weather. A point to note is that heat stress can be a major determinant of the Mountain Goat's distribution (Ministry of Environment, Lands and Parks, 2000).

### *3.3 Ecological Adaptations*

The Mountain Goats spend their entire lives on the mountain where they were born. Its predators include the cougar, bobcat, coyote, golden eagle, and both black and grizzly bears (Rideout & Hoffmann, 1975). Of all the predators of the Mountain Goat, the cougar is probably the most serious of these, mainly because it can traverse rugged terrain and is also large enough to attack and kill an adult Mountain Goat (Rideout & Hoffmann, 1975). Because of this dangerous



**Fig. 8: The Cougar, a major predator to Mountain Goat**

predation threat, the Mountain Goat has had to make some ecological adaptations to be able to cope.

Mountain Goats in the summer they travel back and forth to feed on grasses, flowering plants, and sedges. Because they cannot run

as fast as a cougar or coyote, they risk ambush if they feed in open alpine meadows more than 200 meters from steep cliffs where predators dare



not follow. If they spot a predator, they will climb on to steep escape terrane until the predators give up the chase and leaves, then the goats climb off the steep cliffs and resume feeding (Rideout & Hoffmann, 1975). During the winter months, the Mountain Goats spend a lot of time on steep and narrow ridges, always close to a steep escape terrane in case of a predator strike. They spend all the winter season here, from mid-October until April (Rideout & Hoffmann, 1975). The winter is vital as wind pushes the snow on the ridge unto the ground, exposing the dry grasses and lichens they feed on.



**Fig. 9: Mountain Goat winter ridge**

provides more feed for the goats under the snow the following winter season. In this way, Mountain goats create their own winter pasture, and their chosen ranges are especially fertile and suited to keep the herd well fed and healthy all winter (Rideout & Hoffmann, 1975). A predator displacement can cause them to move into

The Mountain Goats are natural farmers. They return to the same ridge every winter year after year, on this same parcel of land they urinate and defecate all in that narrow winter area, thus creating nutrients for the grasses during the next growing season, and in turn, that rich plant growth in summer



**Fig. 10: Mountain Goat winter feed area**



**Figure 11: Mountain Goat winter feed area and escape terrane**

their escape terrane for a couple of hours, but a sustained displacement of the herd, can force them to abandon their best winter habitat. If displaced, the herd can suffer exhaustion from traveling through deep snow to search for new habitat and could starve if there is not enough feed on their alternate home (Rideout & Hoffmann, 1975).

### ***3.4 Limiting Factors to Mountain Goat***

There are several factors that exist that potentially limit the Mountain Goat populations, and anyone may be the primary controlling factor at a particular time (William et al., 2003).

Some limiting factors are expatiated briefly on below;

## Parasite and Disease

When considering parasites, most of them have been considered of minor consequence for goats, except the case where the goats have already been severely stressed by other factors such as malnutrition during severe winters (Kerr and Holmes 1966, Richardson 1971, Cooley 1976). There is evidence that parasites and diseases most likely play a significant role in the regulation of some goat populations (William et al., 2003). About 30 species of helminths have been recovered from the mountain goat (William et al., 2003). Other diseases and parasites include; Lungworms, Stomach worms, *Parelaphostrongylus odocoilei* (muscle worm), the five cestodes (*Avitellina* sp., *Moniezia benedini*, *Thysanosoma actinoides*, *Taenia hydatigena*, and an unidentified Anoplocephalidae), Ticks, and other ectoparasites (William et al., 2003). Diseases, although rare, include; Pasteurellosis, Tooth abscess, Footrot from the fungal infection, Paratuberculosis caused by the bacterium *Mycobacterium paratuberculosis*, Neoplasms or tumors, Fibroma, Ecthyma and Capture myopathy observed in captured goats (William et al., 2003).

## Predators

There are many potential predators that share the Mountain Goat habitat, however, only a few of them utilize the steep cliffs to a good extent (William et al., 2003). When considering predation, the adult goats are not very vulnerable, but the kids are the ones at risk, even though they are carefully protected by their mothers (William et al., 2003). On a ridge in Alberta called Caw Ridge, a nanny was observed ramming a wolf to allow her kid to escape (Côté et al. 1997). In recent studies done by K.G. Smith et al. (1992; and, Festa-Bianchet et al. 1994) attributed most of the kid mortalities to predation - 93% (William et al., 2003). Most of the mortalities were seen to have occurred before the end of November, showing that winter conditions had nothing to do with the high kid mortality (William et al., 2003). Another data suggest that predators may be the



most important limiting factor for Mountain Goat populations in Alberta (William et al., 2003). Golden eagles and bald eagles are frequently seen harassing Mountain Goats, trying to stoop them in attempt to cause a fall (William et al., 2003).



**Fig. 12: Predator of the Mountain Goat; the Bobcat**



**Fig. 13: Predator of the Mountain Goat; the Lynx**

Cougars are the most frequent visitors on Mountain Goat ranges because of their ability to move well in the steep, rugged terrain where the goats dwell (William et al., 2003). Their stealthy ambush style of hunting, and their ability to perch with their food supply, the Cougars are considered as the predator most likely to have an impact on Mountain Goat herds (Brandborg 1955, Rideout and Hoffmann 1975, Johnson 1983). Other potential predators of Mountain Goats include lynx, bobcats and the Wolverines (William et al., 2003). Although there are no reports of goat predation by lynx or bobcats even though at least one or the other occurs on most goat range (William et al., 2003). The Coyotes are the most commonly associated predators with the Mountain Goat, several of them have been observed either chasing or harassing goats (B.L. Smith 1976, Johnson 1983), but there are no reports of coyotes actually killing them (William et al., 2003). The coyotes are considered a threat because even large herds usually retreat to secure sites when there is a presence of coyotes.

## Human Disturbance

There is limited quantitative information regarding the influence of various types of human disturbance on Mountain Goats in contrast to other species like the bighorn sheep, which are easily habituated to humans, Geist (1978) notes that Mountain Goats tend to remain far less approachable (William et al., 2003).

## Accidents

In many reports, we find mentions of goats' carcasses that are spotted at the bottom of cliffs or avalanche chutes, this perhaps is the victims of falls, snow slides or falling rock (Brandborg 1955, Holroyd 1967, B.L. Smith 1976, Wigal and Coggins 1982, Chadwick 1983, Johnson 1983). In Brandborg (1955) report, 25 carcasses were found, nearly half of them at the bases of cliffs, however, carcass location does not confirm the cause of death (William et al., 2003). Over 60% of 30 carcasses found by Chadwick (1983) were in avalanche debris, and 24 of an additional 26 carcasses reported to him were of goats likely killed by avalanches (William et al., 2003). In another report, it was observed that five goats fell to their deaths from a ledge on which they were stranded (William et al., 2003).



**Fig. 14: Goat getting tipped off a cliff**

Many a time, goats have often been seen falling as the result of aggressive or rambunctious activities that may or may not have involved the unlucky animal (B.L. Smith, 1976). Younger goats are usually more prone to such accidents, mainly because of their

rambunctious and somewhat careless behavior (Chadwick, 1983). Snow slides in late winter and early spring have caused more accidental deaths than any other natural cause (Brandborg, 1955). Most of the Mountain Goat ranges are subject to avalanches, and the goats often appear oblivious to the hazard and expose themselves to potential danger by walking out on cornices, wading through deep and unstable accumulations of snow and even feeding in avalanche chutes (William et al., 2003). Of all the common causes of natural mortality for Mountain Goats, accidents are often identified as the most common, however, such findings may overemphasize the relative significance of accidents because they are more easily detected and diagnosed than many other forms of mortality (William et al., 2003).

### Adverse Weather

Summer precipitation and temperature affect the quantity and the quality of forage availability on goat ranges (William et al., 2003). So, weather affects the nutritional condition of goats and their ability to avoid a variety of decimating factors and to survive and reproduce. When considering weather, its effects can also be more direct in approach. Most researchers have suggested that cold, wet weather, which is common in the high country around parturition, can lead to hypothermia and death of neonatal goats (Brandborg 1955, Chadwick 1983, Johnson 1983). The severity of winter can affect the goat, however, in Alberta, there is little evidence to suggest that weather severity significantly influences goat populations (K.G. Smith, 1988). Findings on Caw Ridge in Alberta suggest that most of the mortality of young goats occur before winter (Festa-Bianchet et al. 1994).

### *3.5 Mountain Goats and Diseases*

Little study or evidence has been established concerning Mountain Goat disease being significant at the population level, but individual goats contract a variety of diseases (William et

al., 2003). In Brandborg 1955 report, pasteurellosis was observed in one goat. Cowan (1951) reported two cases of tooth abscess and one of foot rot, all involving a fungal infection (*Actinomyces israeli*). Paratuberculosis, caused by the bacterium *Mycobacterium paratuberculosis*, has been confirmed in one goat in Colorado (Williams et al. 1978). Neoplasms or tumors are also occasionally seen, and one goat in Washington reportedly died of starvation because of a fibroma blocking its mouth (Johnson, 1983). In Washington, found 3 antibodies to parainfluenza were found, and bovine virus diarrhea in 17% and 43% respectively, of 35 goats examined (William et al., 2003). Although present in goats, the effects of these viruses on the population was unknown (William et al., 2003).

There has also been reporting of contagious ecthyma, a viral disease of domestic sheep and goats, this was reported to be observed in Mountain Goats from Kootenay National Park (Samuel et al., 1975). Capture myopathy is also a disease that has been observed in goats captured in Alberta and British Columbia (Hebert and Cowan 1971b, Jorgenson and Quinlan 1996). It is reported that selenium or vitamin E deficiencies may have been factors that led to this condition, which is apparently triggered by the stress of vigorous exertion (Hebert and Cowan 1971b). Because such exertion and stress could be created by predator attacks or human harassment, this condition could be a mortality factor of concern for goat populations (William et al., 2003).

### ***3.6 Relationship between Mountain Goats and Humans***

There is hardly any species on the planet that humans have not some way or the other interacted with, and the Mountain Goat is definitely not an exception. Mountain Goats have been used for game, and there are even laws in Alberta, for example, allowing resident recreational use of game to have precedence over non-resident use (William et al., 2003).

Mountain Goats also have a recreational and educational use for humans. Other recreational opportunities in addition to hunting, and educational benefit (William et al., 2003). Mountain Goats are also used for tourism and commercial use.

### Mountain Goat watching

Viewing Mountain Goats is an important part of the wilderness experience for hikers in goat country. This serves as a form of attraction where Mountain Goats are watched to help retain residents in rural communities and draws tourists from around the world with all the economic benefits that follow (Smithers BC Canada, 2017). Their white colour is easy to see against the dark colour of cliffs and open slopes in summer. Normally, Mountain Goats that are not hunted are very curious about humans and often remain in view, however, at a safe distance (Smithers BC Canada, 2017).

### Hunting

Take for example in British Columbia, the Mountain Goat hunt includes both resident and non-resident hunters (Smithers BC Canada, 2017). Hunting of Mountain Goats in this region prior to 1974 resulted in the local extinction of Mountain Goats in many areas due to excessive possession limits, easy motorized access and use of helicopters (Smithers BC Canada, 2017). Since the 1970s, Limited Entry Hunts and helicopter regulations were introduced to curb the number of goats harvested, to control access to mountains by hunters and to keep accurate records of kills (Smithers BC Canada, 2017). In British Columbia, over 28,500 Mountain Goats were harvested by hunters during the period from 1976 to 2008 for an average of 890 goats per year out of a total population in BC estimated at 40,000 to 70,000 (Smithers BC Canada, 2017).





**Fig. 15: Mountain Goat used for game**



**Fig. 16: Mountain Goat hunted for game**

The hunt of Mountain Goat is primarily a trophy hunt, and not a hunt for sustenance (Smithers BC Canada, 2017). The meat of mature Mountain Goats is considered by many to be tough and unpalatable except when ground or used in sausage (Smithers BC Canada, 2017). It is also difficult for a hunter to tell the difference

between male and female Mountain Goats, especially at shooting distances. Hunting regulations encourage hunters to shoot males only, but the reality is that up to 30% of kills are mature females (Smithers BC Canada, 2017). More regulations are coming in, a new one proposed in British Columbia in 2011 will make it illegal to shoot a Mountain Goat in a herd that includes one or more kids, this will hopefully reduce the number of harvested mature females of prime breeding age (Smithers BC Canada, 2017).



## 4.0 FUTURE

We now examine what the future holds for the Mountain Goat. A species that has been very resilient, has survived through time, through the various ages in what has been an extremely dynamic earth. From this track record, we can see that the Mountain Goat has no problem surviving through the dynamicity of the planet, but what will determine its survival for the future is the activities of humans. The future is Anthropocene themed, and the nature of man's activities will go a long way in determining the survival of this resilient and brilliant species.

### *4.1 Climate Change and Other threats to Mountain Goat*

Climate change represents a primary threat to the persistence of species as well as their biodiversity at a global scale; Urban, 2015 reports that 7.9% of species are predicted to become extinct due to climate change (White, Regolith & Levi, 2017). An understanding of how climate will have an influence on the population dynamics and viability of species is critical for forecasting, and potentially mitigating of deleterious effects of climate change (White, Gregovich & Levi, 2017). As we begin to identify the Mountain Goat and its ecosystems, which is particularly sensitive to climatic variability, along with the development of associated quantitative tools, this can help expedite our knowledge on how to stem this conservation threat (White, Gregovich & Levi, 2017). In this regard, study of cold-adapted alpine species that are especially sensitive to climate change (Dullinger et al., 2012; Gentili, Hemant, & Birks, 2015) and experiencing disproportionately rapid changes in climate (Christensen et al., 2013; Shanley et al., 2015), offer key opportunities to gain critical insights into broad scale, forthcoming effects (White, Gregovich & Levi, 2017).

Declining numbers of Mountain Goats from climate change are causing concern for the health of the species. Just like other alpine species, the Mountain Goats are quite sensitive to habitat conditions. Mountain Goats rely on high, cool, rocky terrain for their survival (Crown of the Continent, 2017). Because of Climate Change, glacier is currently experiencing warming three times the global average at higher elevations (Crown of the Continent, 2017). Increased temperatures in the high peaks where Mountain Goats live may influence their habitat and diet (Defenders of Wildlife, 2018).

Mountain Goats normally reproduce at a slow rate, a small loss can be devastating to a population. The kids and yearlings are typically the most vulnerable as many of them do not survive the winter. As stated above, another major threat to the Mountain Goat is predation. Predators like the golden eagles often prey on kids (Defenders of Wildlife, 2018). Avalanches, rockfalls, landslides, falls and malnutrition claim many goats each year (Defenders of Wildlife, 2018). Human threats as stated above may include; hunting, development and winter recreation in formerly inaccessible habitat (Defenders of Wildlife, 2018).

#### *4.2 Future Prediction for distributional changes*

Mountain Goats are so widespread and numerous, they have been stable in most areas of their habitation. Due to this, they are not considered at risk. In British Columbia for example, they have been included in the 1998 Yellow List by the BC Conservation Data Centre (Ministry of Environment BC, 2003).

The security of the Mountain Goat is partly due to their habitat. Their preference for rugged and remote habitats, typically non-ecumene places have really favoured the species. This has particularly shielded them from human developments that have harmed many other wildlife

species. Developments like; land settlement, highways, competition from livestock, logging, and other public infrastructures (Ministry of Environment, Lands and Parks, 2000). However, using British Columbia as an example again, disturbance from mining has influenced localized sites, and logging has proved a threat to coastal Mountain Goat winter ranges as well as the fringes of interior goat winter ranges and low-elevation licks (Ministry of Environment BC, 2003).

So far, the major activities that have threatened Mountain Goat distribution are generated by humans. There has been an unintended harassment of goats by helicopters in most Mountain Goat areas, and this has been a concern, particularly during the kidding season and in winter when the animals are in the poorest condition (Ministry of Environment, Lands and Parks, 2000). Snowmobiles are also a major concern in some areas (Ministry of Environment, Lands and Parks, 2000).

#### *4.3 Suggestion for Management and Conservation*

Some management goals and objective for Mountain Goats that can be and has been adopted will include;

- the maintenance of viable, productive and interconnected populations of Mountain Goats throughout their ranges (William et al., 2003).
  - an objective to this will be to monitor the distribution, size and age-sex structure of Mountain Goat populations in each management area with the use of established survey protocols and frequencies.
- the maintenance of viable, productive and interconnected habitats for Mountain Goats throughout their ranges (William et al., 2003).

- an objective to this will be to develop habitat management strategies that will be designed to protect sufficient habitat to be able to support the summer and winter goat populations for each population area (William et al., 2003). Included here, would be the development and implementation of interim habitat protection guidelines that are needed to help minimize future anthropogenic impacts, including; industry, recreation (individual and commercial), infrastructure and any other human activity (William et al., 2003).
- provision of opportunities for Mountain Goat education, the study of Mountain Goats to help increase our knowledge and enhance the conservation and management of the species (William et al., 2003).
  - an objective to this would be to partner with post-secondary institutions to foster graduate research on Mountain Goats and provide the necessary logistical and professional support needed for these research projects (William et al., 2003).

Some conservation measures can be implemented to ensure goat persistence. In some areas, goat populations depend on winter ranges where wildfires create early seral vegetation (Ministry of Environment, Lands and Parks, 2000). However, in recent years, controlling of forest fire has made many of those habitats less productive for goats. When some wildfires are allowed to run its course, goat range will be enhanced through prescribed burning and would help the recovery of goat populations (Ministry of Environment, Lands and Parks, 2000). Conservation for the future will include regular monitoring of goat numbers, careful control of hunting and poaching, and continued protection of habitat. Also controlling other human actions that help deteriorate goat's wellbeing like, controlling of helicopter flights, motor vehicle access, snowmobiles, and human

recreational activities (Ministry of Environment, Lands and Parks, 2000). These conservation measures will help ensure the future of the Mountain Goat, a unique species.

## 5.0 SUMMARY

The Mountain Goat is truly a unique species that has survived over a very long-time period in history. An even-toed ungulate, which belongs to the order Artiodactyla (Festa-Bianchet M., 2008) is not a true goat but belongs to the family Bovidae which comprises of animals like gazelles, cattle, and antelopes (Festa-Bianchet M., 2008). They have stout bodies and a thick white fur. The species is biologically built to live in the steep and rocky terrain it occupies and has perfectly evolved over time to survive in this harsh terrane. Its characteristically deep chest and tremendously developed shoulder muscles give the animal great strength and support for both climbing and for pawing through snow for food (Ministry of Environment, Lands and Parks, 2000). It is believed that the ancestors of the Mountain Goat came through the Bering land bridge between Siberia and Alaska just before the most recent Wisconsin glaciation. Mountain Goat fossils have been found which date up to 100,000 years old (Ministry of Environment, Lands and Parks, 2000). Today, the native range of the Mountain Goat extends from western Montana, southern Idaho, and the Columbia River in Washington north along the Rocky Mountains as far as the Chugach and Talkeetna mountains of Alaska in the United States (Chester B. et al., 1975). In Canada, they occupy British Columbia and the Yukon Territories. Extensive management and conservation for this species must be amply carried out to ensure its viability and survival. Over time, the Mountain Goat has survived on its own through the various time periods, but today, in the heat of the Anthropocene, the survival of this species is to a large part dependent of humans. Our activities and practices will go a long way to determine the future survival of this species.

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## FIGURES CITED

Title Page: [https://upload.wikimedia.org/wikipedia/commons/b/b5/Mountain\\_Goat\\_USFWS.jpg](https://upload.wikimedia.org/wikipedia/commons/b/b5/Mountain_Goat_USFWS.jpg)

Figure 1: <https://www.argalination.com/species/american-mountain-goat>

Figure 2: Compiled from Shackleton, 1997

Figure 3: <http://forums.bowsite.com/tf/pics/00small17697176.JPG>

Figure 4: [https://synchroniss.files.wordpress.com/2013/12/goat\\_climbing.jpg](https://synchroniss.files.wordpress.com/2013/12/goat_climbing.jpg)

Figure 5: [https://i.kinja-img.com/gawker-media/image/upload/s--P4akDnLH--/c\\_fill,fl\\_progressive,g\\_center,h\\_450,q\\_80,w\\_800/d631zbioc2mwbylnyxvq.jpg](https://i.kinja-img.com/gawker-media/image/upload/s--P4akDnLH--/c_fill,fl_progressive,g_center,h_450,q_80,w_800/d631zbioc2mwbylnyxvq.jpg)

Figure 6: [https://lh4.googleusercontent.com/-DM3LUQUzxGU/TYyxh66k-iI/AAAAAAAAAHw/ZBmWkNa13\\_E/s1600/0goathooves05.jpg](https://lh4.googleusercontent.com/-DM3LUQUzxGU/TYyxh66k-iI/AAAAAAAAAHw/ZBmWkNa13_E/s1600/0goathooves05.jpg)

Figure 7: [http://farm1.staticflickr.com/70/205930753\\_e45ec38f32\\_z.jpg?zz=1](http://farm1.staticflickr.com/70/205930753_e45ec38f32_z.jpg?zz=1)

Figure 8: <http://i.huffpost.com/gen/1164972/thumbs/o-COUGAR-facebook.jpg>

Figure 9: YouTube, 'Mountain Goat Winter Habitat'

Figure 10: YouTube, 'Mountain Goat Winter Habitat'

Figure 11: YouTube, 'Mountain Goat Winter Habitat'

Figure 12: <http://3.bp.blogspot.com/-nn7t8Kpi0j0/UAZKh4JrNI/AAAAAAAAAFIE/gNIPAOqP9IA/s1600/Bobcat.jpg>

Figure 13: [https://upload.wikimedia.org/wikipedia/commons/8/8d/Lynx\\_Canadensis.jpg](https://upload.wikimedia.org/wikipedia/commons/8/8d/Lynx_Canadensis.jpg)

Figure 14: <http://www.erdekesvilag.hu/wp-content/uploads/2013/06/214.jpg>

Figure 15: [http://www.pacificmountainguides.com/wp-content/uploads/2012/01/Mountain\\_goat\\_hunting\\_2.jpg](http://www.pacificmountainguides.com/wp-content/uploads/2012/01/Mountain_goat_hunting_2.jpg)

Figure 16: [http://thebiggamehuntingblog.com/wp-content/uploads/2014/05/089\\_89-1024x768.jpg](http://thebiggamehuntingblog.com/wp-content/uploads/2014/05/089_89-1024x768.jpg)