

**IMPACTS OF NON-NATIVE MOUNTAIN GOATS IN INTRODUCTION
AREAS OF THE WEST:
A REVIEW OF THE LITERATURE**

Allison Jones¹, Brett Hansen¹ and Martin Moyano

May 2015

Author's Addresses:

¹Wild Utah Project, 824 S. 400 W, Salt Lake City, UT 84101 (801) 328-3550 TEL;
allison@wildutahproject.org

Introduction

This literature review summarizes the impacts that non-native Mountain Goats (*Oreamnos americanus*) are known to have, or are having, to native resource conditions (principally native plants and soil resources) on western mountain ranges where they have been introduced.

Mountain goats are bovid ungulates native to mountainous regions of northwestern North America and Canada. They historically have existed in alpine and subalpine ecosystems ranging from southeastern Alaska southwards to the Columbia River of Washington, eastwards to Idaho and western Montana and northwards into southern Yukon. Adult males tend to be larger, weighing between 209 to 342 pounds. Females, called nannies, comparatively weigh between 132 and 165 pounds. Mountain goats have multiple mates and breed in the fall months with offspring birthed in spring. The goats do not always reproduce annually, regular breeding depending on social dynamics and health. Both males and females reach sexual maturity at 18 months. Nannies usually birth a single kid, with less likely occurrences of twins and triplets. Social animals, mountain goats usually associate in herds called 'bands,' which typically consist of more than 100 goats.

Mountain goats characteristically dig away at soil and plant cover to form 'bedding sites,' also known as 'wallows,' which they use for resting. The goats are generalists with a wide-ranging diet, eating anything from tree bark to lichens and roots. Mountain goats migrate according to food availability and seasonality but tend to return to the same areas year to year, reusing wallows. Goats usually live to about twelve years of age, with sources of mortality including hunting, accidents related to steep gradients and avalanches, and predation (e.g., by bear or cougar).

Part of the impetus for this literature review was to catalogue impacts of non-native mountain goats to resources in Utah. Therefore, below we break the literature review out separately for studies done in Utah ranges where mountain goats have been introduced, versus studies and reports from other states.

Effects of mountain goats on rare plants and vegetation communities

It should come as no surprise that plants rare alpine plants, where they have evolved with little or no grazing or browsing by hooved ungulates, would suffer some sort of effect if large numbers of a grazing and browsing¹ species like mountain goats have been introduced to ranges where they were not present historically. The plant species occurring in these harsh environments above timberline have evolved to withstand severe conditions including, but not limited to, incessant winds, sub-freezing winters, minimal moisture availability, extreme solar radiation and droughts (Fowler et al. 2012). Because of the short growing season, low plant productivity, shallow soils and extreme climatic conditions, these high elevation areas are especially susceptible to modification (USDA Forest Service 1988). The addition of an additional browser/grazer, even if native bighorn sheep are present in the range, should be expected to result in impacts that can be documented in some way. The hypothesis that anywhere that was historically occupied by bighorn sheep should not suffer impacts from mountain goats needs to be further studied, but there are indications that mountain goats tend to occupy steeper slopes than bighorns (Laundre 1994), so this could result in greater erosion in places not adapted to this kind of ungulate use.

Although studies describing the species composition or vegetation communities of high-alpine flora with respect to mountain goat ecology are scarce (Wells, et al. 2012), we were able to find many examples of impacts mountain goats have had, or are having, on native plant communities in western states where mountain goats are not considered native. For example, the Colorado Native Plant Society has been monitoring the impacts of mountain goats since their introduction in the 1990's on Mt. Evans and have become alarmed by the damage done to the unique moss flora and other tundra species in the area (Weber 2010).

One area with non-native mountain goats that has been significantly studied is Olympic National Park, where several studies have documented the impact of introduced mountain goats on alpine communities and rare plants (e.g. Stevens 1979, Pfitsch 1981, Pike 1981, Pfitsch et al. 1983, Reid 1983, Carlquist 1990, Houston et al. 1994, Pfitsch and Bliss 1985, Schreiner and Woodward 1994, Schreiner et al. 1994, NPS 1995, Olympic Park Associates 1995). Houston et

¹ Mountain goats both graze herbaceous understory plants like grasses and low-growing forbs, and also browse larger forbs and shrubs (Shackleton 1999)

al. (1994) determined that total plant cover is lower in high goat density areas, and that goats caused increased disturbance in a wide variety of plant communities, irrespective of species composition. One of the chief mechanisms for the reduced total plant cover in high goat density areas is likely the difficulty for seedlings to establish when being grazed and trampled; Pfitsch et al. (1983) found that goat activities caused substantial mortality in seedlings growing in bare soil. There is general agreement that non-native mountain goats have considerably damaged and/or led to decreases in rare and native plant species by trampling, grazing and wallowing in the Park's fragile systems (e.g. Schreiner and Woodward 1994, NPS 1995). In fact the National Park Service concluded that goats have put 33 rare or endemic plant species at risk, including Olympic Mt. milkvetch - a candidate for listing under endangered species act - by trampling, grazing, wallowing in fragile areas (Houston et al. 1994, NPS 1995, Olympic Park Associates 1995). Studies for specific species have elucidated these impacts, such as a study by Pfitsch et al. (1982) on Piper's bellflower, Webster's senecio, and Olympic aster, which all suffered significantly reduced (reductions of anywhere between 20 and 60%) leaf length, flower production, and growth (cover and biomass) when grazed by goats, and that goat grazing had removed 65% of aboveground net production of Webster's senecio plants.

Researchers studying the goat impacts in Olympic Park also found that goats have been implicated in increases in undesirable plant species (Pfitsch et al. 1983, Schreiner and Woodward 1994), presumably because the goats have led to the reduction in the number of desirable plant species thus allowing yarrow, thistle, and other unpalatable plants to invade disturbed areas (Carlquist 1990). Pfitsch et al. (1983) further pointed out that most of the preferred species play a minor role in the communities in which they occur, contributing little to the total plant cover. So if the goats select for these rare plants, the impact in terms of relative abundances is even greater. Schreiner and Woodward (1994) conclude that rare plants that overlap the range of the Olympic Park goats are at risk because the mountain goat population densities likely are not controlled by plant abundance on summer ranges, and because goats are generalist herbivores with capacity to consume most plant species (Laundre 1994), including sensitive plant species if they are available. Schreiner estimated that on average it takes 10-20 years for plant communities to recover in the absence of goats.

Other researchers have studied the impacts that introduced mountain goats have also had in Yellowstone National Park. Here they found that ridgetop vegetation cover is lower and barren areas along alpine ridges are more prevalent in areas with relatively high goat use (Aho and Weaver 2003)

There have also been studies of impacts introduced mountain goats have had in Colorado. There, the Colorado Native Plant Society has been monitoring the impacts of mountain goats since their introduction in the 1990's on Mt. Evans and have become alarmed at the damage done to the unique moss flora and other tundra species in the area. (Weber 2010). Also, in Colorado, a 3-year study of the Alpine skypilot, *Polemonium viscosum*, showed that the study population suffered up to 80% loss of seed production over the course of the study, due to mountain goats (Galen, 1990). And, in Washington, A draft Conservation Agreement for *Lomatium erythrocarpum* identified impacts from introduced mountain goats and hiking trails as the two main threats to this species (USDA Forest Service 2000)

Effects of mountain goats on soil resources

The Forest Service (USDA – USFS 1988) summarized the general impacts that mountain goats can have on soil resources:

“Goats expose mineral soil by foraging, trampling bedding, pawing and wallowing. Wallows are among the most visible and significant consequences of the goats' presence in the high country. For purposes of grooming and relief from insects, goats churn up selected areas to take dust baths. With the resultant loss of plant cover, soil is lost to wind and water erosions. This condition is aggravated and often enlarged as goats return to the same wallow time after time. A small wallow originally suitable for only one animal, may eventually become large enough to accommodate a group of animals. Goat wallows from 3-300 feet in diameter and up to 3 feet deep are common. From on such large wallow, 40 tons of soils can be displaced. The average loss from other wallows is approximately 1.3 tons. Wallows are common feature in goat habitat and up to 70 can be found in a 10 acre area “ (citing personal communication, with C.H.. Driver, 1988)

Since most of the published studies of the impacts non-native mountain goats have had in areas where they have been introduced have occurred within Olympic National Park, most of the evidence of goats' impacts on soil resources has come from this national park unit. For example, in one alpine meadow where Park Service staff sampled, they found that 34% of the sampled area had been made barren by goat use, and bedding wallows covered 7% of the same area (NPS 1995). These types of goat activities remove plant cover which enhances soil erosion, causing loss of organic topsoil. The soil also provides less stability and nutrients needed for plant seedling regeneration (Pfitsch 1983). In his study in the Park, Houston (1994) found that soil displacement from just one large goat wallow was of 45 tons. Average soil loss for wallows was 1.3 tons, and in some plots 50% of plant species had been eliminated (Houston 1994). Schreiner (1994) found in the Park study area that mountain goats have reduced moss and lichen cover, which, which offer crucial stabilization to alpine soils (Robinson 1989).

Studies outside of the Olympic National Park (e.g. Yates 2005, in the Elkhorn Mountain of northeast Oregon), describe similar impacts of mountain goat trampling, dust wallows and beds that are locally severe.

Impacts of mountain goats in Utah

One thing we noted from this literature review is that there is a paucity of well designed studies to detect mountain goat impacts in places where they have been introduced in Utah. We understand that it can be very difficult to implement adequate replication and controls in areas where mountain goat herds are extremely wide ranging, where there can be confounding effects by grazing by other ungulates (elk, deer, bighorn sheep) and livestock, and where long-term effects of drought and/or climate change over time can also be difficult to control for. These issues were summed up by an undated memo in Region 4 USFS files ("Possible monitoring of potential habitat impacts of Rocky mountain goats in the Mt. Nebo and Timpanogos wilderness area") : " Following is an attempt to outline a monitoring program [for impacts from the goats]....after completing this exercise it became apparent that: A) it would be very difficult (costly and time-consuming) to perform adequate monitoring needed; B) this would be a long-term effort, spanning several decades; and C) the risk remains that the study would not be

sensitive or rigorous enough to detect changes in these resources, if indeed they are impacted by goats, before damage is significant.” It is unclear whether this memo was written before or after the introductions of goats had already occurred in Mt Nebo and Timpanogos, but the point is that the goats were obviously introduced with knowledge that the impacts they would have may never be able to be sufficiently studied or documented. It is clear that this same situation has occurred in most, if not all, of the many introductions of mountain goats in Utah. That said, the studies we were able to locate on mountain goat effects on soils and vegetation in these Utah ranges are discussed below.

Mountain goats are not native to Utah. Favored for their hunting appeal, they were introduced to Utah alpine areas in 1967. Although the Utah Department of Wildlife Resources (UDWR) expects introduced goats could be preyed upon by cougars, there has been no documented evidence of cougar predation of mountain goats in Utah. Therefore, it is up to hunters to ensure that Utah’s introduced goat populations do not exceed their ecological carrying capacity.

From early on, it appeared that this (exceeding the carrying capacity) was not difficult to do. The first introduction of mountain goats in the state occurred in 1967 in Little Cottonwood Canyon. Later that same year, Kimbal’s (1967) issued the Forest Service’s first report on the transplant and reported that insufficient harvest of mountain goat populations in winter range was leading to a decline in forage productivity, and erosion in bedding grounds.

Mountain goats were introduced onto Mount Timpanogos in Utah’s Central Wasatch Mountains 1981. Maxfeld (1999) reported that of all the rare plants in his study area on Mount Timpanogos, *Lesquerilla garretti* was most prone to impacts of mountain goats. Tuhy (1991) who also studied *Lesquerilla garretti* on Mount Timpanogos, similarly found reductions of *Lesquerilla garretti*, which Tuhy also attributed to the goats. Forest Service biologists conducting monitoring on Mount Timpanogos have also found impacts from the goats, including significant impacts on Mountain Mahogany, and detrimental effects on *Lesquerilla* populations and erosion exacerbated by goat wallowing and dusting activities (Flood 1996).

Mountain goats were introduced on southern Utah’s Tushar mountains, on the Fishlake National Forest, in 1986 and 1988. The Utah Division of Wildlife resources set up a Range Trend

monitoring site near the introduction location. The monitoring report from years 1997, 2001 and 2003 indicated that both transects at this monitoring site showed that in general perennial grass and forb cover were both reduced over this 6 year period, while mountain goat pellet readings increased significantly (at one site from 25 pellet groups to 160, and in the other site from 7 pellet groups to 82) (UDWR 2003). While 1997 indicated most plants in the transects received no or light utilization, by 2003 this had increased to light to moderate utilization (75% of plants on one transect and 22% of the plants on the other) or heavy utilization (9% of the plants on one transect and 44% on the other).

Concomitant and Cumulative Impacts of Goats

Additionally, the introduction of a new big game animal is known to increase human presence in an area through recreationists (e.g. hunters, photographers, hikers, etc.); which will increase the potential impacts to these fragile plant communities through trampling, soil disturbances and associated effects of increased human activity that may lead to significantly altered environmental conditions (Cristfield et al. 2012).

Literature Cited

- Aho, K., and T. Weaver 2003. Classification of Alpine Plant Communities of the Northern Rocky Mountain Volcanics. Report to Yellowstone National Park. YELL-NPS- 5119. 82 pgs.
- Carlquist, B. 1990. An effective management plan for the exotic mountain goats in Olympic National Park. *Natural Areas Journal* 10:12-18.
- Crisfield, V., S.E. Macdonald, A.J. Gould. 2012. Effects of recreational traffic on alpine plant communities in the northern Canadian Rockies. *Arctic, Antarctic and Alpine Research*. 44 (3): 277-287.
- Flood, P. 1996. Mountain goats on Timpanogos and Nebo – effects on soil and water. Letter to Wasatch Cache National Forest Supervisor from Paul Flood, Soil Scientist for the Wasatch Cache National Forest. USFS Region 4 files.
- Fowler, James F., Sieg, Carolyn H.; Casavant, Brian M.; Hite, Addie E. 2012. A tale of two single mountain alpine endemics: *Packera Franciscana* and *Erigeron mancus*. *Calochortiana*. 1: 110-114.
- Galen, C. 1990. Limits to the distribution of alpine tundra plants: herbivores and the alpine skipilot. *Polemonium viscosum* – *Oikos* 59: 355-358.
- Houston, D., Schreiner E., and B. Moorhead. 1994. Mountain goats in Olympic National Park: Biology and management of an introduced species. *Scientific Monographs MNP/NROLYM/NRSM-94-25*.
- Kimbal, J. 1967. Specialist's report on the Little Cottonwood Canyon mountain goat transplant. USFS Region 4 files.
- Laundré, J.W. 1990. The status, distribution, and management of mountain goats in the Greater Yellowstone Ecosystem. NPS Order #PX1200-8-0828. U.S. Department of the Interior, National Park Service. 58 pp.
- Laundré, J.W. 1994. Resource overlap between mountain goats and bighorn sheep. *Great Basin Naturalist* 54: 114-121.

Maxfeld, B.D. 1999. Population size and habitat use of Rocky Mountain goats in the central Wasatch Mountains of Utah. M.S. Thesis, Brigham Young University. Provo, UT.

National Park Service, U.S. Department of the Interior (NPS). 1995. Goats in the Olympic National Park Draft Environmental Impact Statement for Mountain Goat Management. Olympic National Park, Port Angeles WA.

Olympic Park Associates. 1995. An analysis of the Mountain goat issue in Olympic National Park. <http://www.halcyon.com/rdpayne/opa-mtngoat.html>.

Pfitch, W. A. 1981. The effects of mountain goats on the subalpine plant communities of Klahhane Ridge, Olympic National Park, Washington. M.S. Thesis, University of Washington, Seattle. 103 pp.

Pfitch, W. A. and L.C Bliss. 1985. Seasonal Forage availability and potential vegetation limitations to a mountain goat population, Olympic National Park. *American Midland Naturalist* 113: 109-121.

Pfitch, W. A., R. S. Reid, J. Harter, D. K. Pike, and L. C. Bliss. 1983. Effects of mountain goats on soils, plant communities and select species in Olympic National Park. Final report to Olympic National Park. College of Forest Resources, University of Washington, Seattle, Wash. 105 pp.

Pike, D.K. 1981. Effects of mountain goats on three plant species unique to the Olympic Mountains, Washington. M.S. Thesis, University of Washington, Seattle. 188 pp.

Reid, R.S. 1983. Patterns of juvenile mortality and life histories in response to mountain goat disturbance, Olympic National Park,. M.S. Thesis, University of Washington, Seattle.

Robinson, W.L., and E.G. Bolen. 1989. *Wildlife ecology and management*. MacMillan Publ. Co., New York.

Schreiner, E. G. 1987. Vegetation in relation to nonnative mountain goats in the Olympic Mountains, Washington: 1979-1985 progress report. National Park Service, Olympic National Park, Port Angeles, Wash, 111 pp.

Schreiner, E. G., Grasz, M.B., Kaye, T.N., Woodward, A. and N.M. Buckingham. 1994. Rare Plants. *In*: Mountain goats in Olympic National Park: biology and management of an introduced species. U.S. Dept of the Interior, NPS. Scientific Monograph NPS/NROLYM/NRSM-94/25.

Schreiner, E. G., and Woodward, A. 1994. Study documents mountain goat impacts at Olympic National Park: Park Science, v. 14, Issue 2, p. 23-25.

Shackleton, D.M. 1999. Hoofed Mammals of British Columbia. Royal British Columbia Museum, UBC Press.

Tuhy, J.S. 1991. King aster and Garreett bladderpod on the Uinta and Wasatch Cache National Forests, Utah: Final Report for challenge cost share agreements with the Uinta and Wasatch Cache national Forests. Utah Natural Heritage Program. Salt Lake City, UT.

USDA Forest Service. 1988. Environmental Assessment for the introduction of mountain goats to the Whiterocks Canyon area of the Vernal Ranger District, Ashley National Forest. Region 4 USFS files.

USDA Forest Service. 2000. Draft conservation agreement for *Lomatium erythrocarpum*, (on file report). Wallowa-Whitman National Forest

(UDWR) Utah Division of Wildlife Resources. Rocky Mountain Goat Capture and Transplant Proposal. N.p.: n.p., 1996.

Weber, Bill. 2010. "Goats on Mount Evans." Aquilegia - Newsletter of the Colorado Native Plant Society (Vol. 24 , No. 2, Summer 2010).

(UDWR) Utah Division of Wildlife Resources. 2003. Tushar Mountain Goat Trend Study no 22R 1 & 2. 2003.

Wells, Adam G., J.L. Rachlow, E. O. Garton, C. G. Rice. 2012. Mapping vegetation communities across home ranges of mountain goats in the North Cascades for conservation and management. Applied Vegetation Science. Online publication date: March 1, 2012.

Yates, G. 2005. Final report: *Lomatium erythrocarpum* survey. Prepared by Gen Yates, Forest Service Botanist, Wallowa-Whitman National Forest. Region 4 USFS Files.

