

Study Documents Mountain Goat Impacts at Olympic National Park

By E. Schreiner and A. Woodward

Approximately 12 mountain goats were deliberately introduced to the Olympic Mountains in the 1920s; the animals subsequently spread throughout the Olympic Range. Olympic National Park was created in 1938. Although mountain goats are native to the nearby Cascade Mountain Range, historical, archaeological, and anthropological evidence indicates they were absent historically from the Olympic Peninsula. The estimated Peninsula-wide mountain goat population was 550 to 800 in 1980, 1,175 plus or minus 171 (standard error) in 1983, and 389 plus or minus 106 (SE) in 1990. Several hundred animals were removed from Olympic NP between 1981 and 1989.

The mountain goat is a generalist herbivore, strongly associated with cliffs and rock outcrops (Chadwick 1983). Its food habits vary considerably among populations because of this association. Diets apparently are dictated more by whatever plant species are present than by a preference for any particular species or growth form.

Seasonal Distribution

In the Olympics, mountain goats are seasonally migratory and are distributed in "nodes" or subpopulations. Subalpine and alpine areas above 5,000 feet generally are considered to be summer range, but even on hot summer days animals sometimes are found as low as 2,000 feet. Goats generally winter on steep south and southeast facing outcrops and cliffs below 5,000 feet, and may be found down to 1,000 feet. Our studies were conducted in mountain goat summer range, which we defined as the region above 5,000 feet.

Previous studies of the interactions between mountain goats and their summer range in Olympic NP clearly demonstrated that goats changed native ecosystems. Plant community effects included reduced moss and lichen cover, increased exposure of mineral soil from wallowing and trampling, and rearrangement of plant species dominance relationships in favor of ruderal species (plants found mainly in disturbed areas, so-called disturbance-oriented species). In addition, three Olympic Peninsula and one Olympic Peninsula/Vancouver Island endemic plant taxa were consumed by goats (these are "narrow" endemics—they are found on the Olympic Peninsula or the Olympic Peninsula and Vancouver Island, but nowhere else in the world).

Even though the aforementioned studies demonstrated that goats substantially altered native plant communities, additional investi-

gations were required to extend the evaluation in space and time. Previous studies were conducted chiefly in one area of the park over a four-year period. Consequently, a series of investigations was begun in 1981 to expand our understanding of mountain goat/vegetation and soil interactions. Objectives were to describe plant communities and large herbivore sign in mountain goat summer range (5,000 ft) and to test the following two general null hypotheses:

(1) Reducing mountain goat densities will not result in changes to the relative abundance of plant species (i.e. plant community structure).

(2) Mountain goats pose no threat to the long-term persistence of rare plants.

Methodology Employed

We employed a variety of independent study methods from 1981-1992 to achieve these objectives:

(1) Extensive surveys of vegetation and herbivore use were conducted in high, medium, and low goat density areas within the 107,490 acres of land free of glacial ice above 5,000 feet;

(2) Permanent plots were established in three areas to quantify plant community responses to intentional reductions in goat density. (This is a unique aspect of our study—goat density was reduced intentionally through live capture concurrently with our permanent plot studies in areas with vastly different climates; thus we did not have to rely on exclosures as a means of evaluating the effects of herbivores);

(3) Potential effects of goats on the long-term persistence of rare plants were assessed using data on rare plant geography and abundance;

(4) The demography and autecology of a particularly rare endemic taxon (Olympic Mtn. milkvetch—we estimate the total population as about 4,500 plants) was investigated; and

(5) A series of historical photographs was used to examine qualitatively the vegetation changes over a 70-year period, specifically addressing the relationships among climate, human use, natural disturbance, and mountain goats.

In common with all other studies of ungulate grazing systems, our work demonstrated that introduced mountain goats have indirect and direct effects on the vegetation of the Olympic Mountains. We have no reason to believe that the overall biotic effects of goats on Olympics vegetation differs appreciably

from mountain goat grazing systems where the animals are native. Nonetheless, changes in the park's vegetation due to goat activity have been substantial, and the status of rare plant populations in goat habitat is of concern.

Plant Community Changes

Mountain goats modified the structure of subalpine plant communities of the Olympics. Following the reduction in goat density, ruderal species such as yarrow decreased while selected goat forage species such as Idaho fescue increased at Klahhane Ridge (estimated annual precipitation, 40-60"). Yarrow cover exceeded that of fescue when goat density was high; it was less than fescue by the end of the study.

We believe mountain goats changed the nature of the competitive relationship between these two species, particularly since a laboratory study demonstrated that Idaho fescue was the stronger competitor except when clipped (del Moral 1985). Similar changes in plant cover of these two species were observed in comparative photographs in exclosure studies (Pfitsch and Bliss 1985).

Modifications of plant communities also occurred in another area of the park. Mount Dana (estimated annual precipitation 200+ inches) plots exhibited statistically significant changes in the plant cover of selected and non-selected plant species, but no change in dominance. Percent cover of dominant, strongly competitive species such as showy sedge appeared not to respond to lower goat density. This does not necessarily mean that the sedge was unaffected by goats. This highly productive species is consumed by goats and may compensate for loss of grazed plant tissues. Graminoid species are well-known for compensatory response to grazing.

Mountain goats also influenced the Olympic ecosystems by wallowing and trampling. Wallows disturb soils and create mineral substrates for colonization by plants. Studies of Klahhane Ridge goat wallows (and bison wallows elsewhere) have shown that disturbance-oriented plant species dominate wallow edges and that this community differs from surrounding vegetation.

Presence of Wallows

We did not examine vegetation surrounding goat wallows, but did document the presence of wallows. There are fewer in areas of low goat density, but at least one wallow was found in each of the 22 areas examined across

Continued on page 24

the park. We suspect that the disturbance-like species have invaded these wallow edges as they have on Klahhane Ridge. Such a result would not be unexpected because Olympic subalpine and alpine plant communities are particularly sensitive to soil disturbance. Moreover, some scientists believe that physical disturbances associated with herbivory may be even more important than grazing as an ecosystem shaping process.

Incidentally consumed forage species may suffer intensive grazing at either high or low herbivore densities (Futayama and Wasserman 1980 and Houston 1982). These forage species may be eliminated because they exert no feedback control on herbivore population size. In a hypothetical one-herbivore/one-plant species system, the eminent biologist Graeme Caughley noted that the herbivore and plant must reach a dynamic equilibrium or the herbivore goes extinct (Caughley 1982).

Further, in a one-herbivore/two-plant system (assuming the two plant populations have different growth rates), "The extinction of one of the two plants is a direct consequence of its sharing the area with the other...It goes extinct when sharing the area because

the herbivore numbers and hence the grazing pressure is maintained at a higher level than would be possible if the slower growing plant were the only food available." (Caughley 1982:311).

Thus, rare plants may be at risk from mountain goats for at least two reasons: (1) Mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and (2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants.

Long-term Concerns

We remain concerned about the long-term persistence of rare plants in mountain goat habitat. Direct effects were observed as mortality and injuries to individuals of the endemic Olympic Mountain milkvetch. One other endemic, Olympic aster, was a plant "selected" by goats. We also found that rare plant distributions (33 taxa), including 7 of 8 endemic taxa, overlap goat summer range. We note that *the effects of goats on individual plant taxa may be severe or potentially severe, especially for taxa with very restricted distributions (i.e. those that occur in fewer*

than 5 subpopulations). Rare endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g. goats in Hawaii, Galapagos Islands).

Plant/herbivore grazing systems have been the subject of intense study by ecologists during the last two decades. Herbivores have been shown to affect numerous attributes of vegetation including plant morphology, species composition, abundance, net primary productivity, and the genetic makeup of plant populations. The scale of plant/herbivore interactions ranges from effects on individual plants to whole ecosystems. Effects of herbivores have been documented in long-established natural ecosystems such as Olympic NP (elk), Wind Caves NP (bison and prairie dogs), and the Serengeti plants of Africa (wildebeest and others). Also chronicled are the consequences of recently introduced wild ungulates (Himalayan thar in New Zealand and red deer in the Falkland Islands).

Characteristically, ungulates and vegetation are linked by strong feedback loops between the dynamics of the plants and the dynamics of the animals. Where ungulate populations are limited by available food

(PHOTO BY J. HARTER, OCTOBER 20, 1981)



resources, as their populations increase, available per capita resources (i.e. palatable plants) decrease. Natural mortality increases, and natality decreases because of insufficient food. The plants "feedback" to cause a new, lower level of the animal population. Plants and ungulate populations oscillate with decreasing amplitude over time as dynamic equilibrium is achieved. Profound vegetation changes usually occur.

We believe our studies describe only a small part of the total picture of mountain goat/vegetation relationships in Olympic NP. Recent studies demonstrate that ungulates alter nitrogen cycles and soil formation processes. Moreover, vegetative changes wrought by one herbivore may influence the feeding behavior of other herbivores (such as

the link between bison and prairie dogs). Given the relationship between site productivity and the degree of interspecific plant competition in Olympic subalpine vegetation, mountain goats are likely to have a far greater influence on individual plants, communities, and ecosystem processes than we have demonstrated here.

Status Report

Olympic staff are completing the Draft Environmental Impact Statement on mountain goat management (scheduled for release in early 1994). Once the EIS is released, a period of public comment will take place and a course of action will be selected. This may prove a significant test of NPS natural areas exotic species management policies.

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