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Mountain Goat Management in Olympic National Park: A Progress Report

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ABSTRACT: Mountain goats (*Oreamnos americanus*) were introduced into Washington's Olympic Mountains during the 1920s and have since colonized the range. Olympic National Park was established in 1938 as a natural area; goats are seen now as an unwelcome addition to the evolved biota. A total of 407 goats was removed from the park during 1981–89 under provisions of experimental (1981–87) and operational (1988–89) management programs. Several subpopulations of goats have been reduced substantially or eliminated. Prospects for additional removals are uncertain: aerial live capture was suspended in 1990 when risks to the capture team were judged to be too high. An environmental impact statement will be prepared before removals are continued.

INTRODUCTION

The spectacularly rugged Olympic Mountains dominate the landscape of Washington's Olympic Peninsula. Prolonged geographic isolation has led to appreciable levels of endemism among native plants and animals and to a fauna that is markedly less diverse than that of the nearby Cascade Mountains. Mountain goats (*Oreamnos americanus*) were introduced into the Olympic Mountains during the late 1920s and have since colonized virtually the entire range. Olympic National Park was established in 1938 as a natural area to conserve the native biota. Goats are seen now as an unwelcome addition to the fauna.

The mountain goats of Olympic National Park represent but one example of the pervasive influence of humans on the earth's biota — that of greatly accelerating the spread of plants and animals around the globe. Such introduced "exotic" or alien species often pose management problems for national parks because they disrupt ecosystems that evolved in their absence. This is the situation in Olympic National Park; goats have modified the park's vegetation — as all large herbivores do — and in that process have affected endemic plants.

We review briefly the evolution of the goat management program at Olympic park, and provide an overview of the operational management program initiated in 1988.

BACKGROUND STUDIES

Moorhead and Stevens (1982) traced the dispersal history of mountain goats in the Olympics. From an introduction of 11 or 12 individuals in the late 1920s, goats colonized most of the range by the 1970s. The

central Bailey Range of the park, characterized by deep, late-melting snow, was not colonized until the mid-1960s. Areas in the far southeast corner of the range, about 80 km from the initial release site, may still be undergoing colonization (Figure 1).

Stevens examined goat habitat use, distribution, and demography from 1977 to 1981 (Stevens 1979, 1983). She demonstrated that goats were distributed nonuniformly throughout the Olympics in "nodes" or subpopulations. Population dynamics and the condition of individuals differed markedly among subpopulations, and seemed to be related to goat densities and habitat quality.

Vegetation studies showed that grazing and wallowing by goats altered plant species composition, increased amounts of bare ground (in wallows), and reduced the standing crop of endemic plants in subalpine areas on Klahhane Ridge (Pfitsch et al. 1983, Pfitsch and Bliss 1985).

NATIONAL PARK SERVICE RESEARCH AND MANAGEMENT

U.S. National Park Service (NPS) goat management during the 1980s occurred in two phases: (1) an "experimental management program" (EMP) launched under the 1981 Environmental Assessment (U.S. National Park Service 1981), with aspects continuing through 1987; (2) an "operational management program" (OMP) initiated in 1988 under provisions of the 1987 environmental assessment (U.S. National Park Service 1987) and scheduled to run through 1992.

Carlquist (1990) traces the socio-political development of the management program,

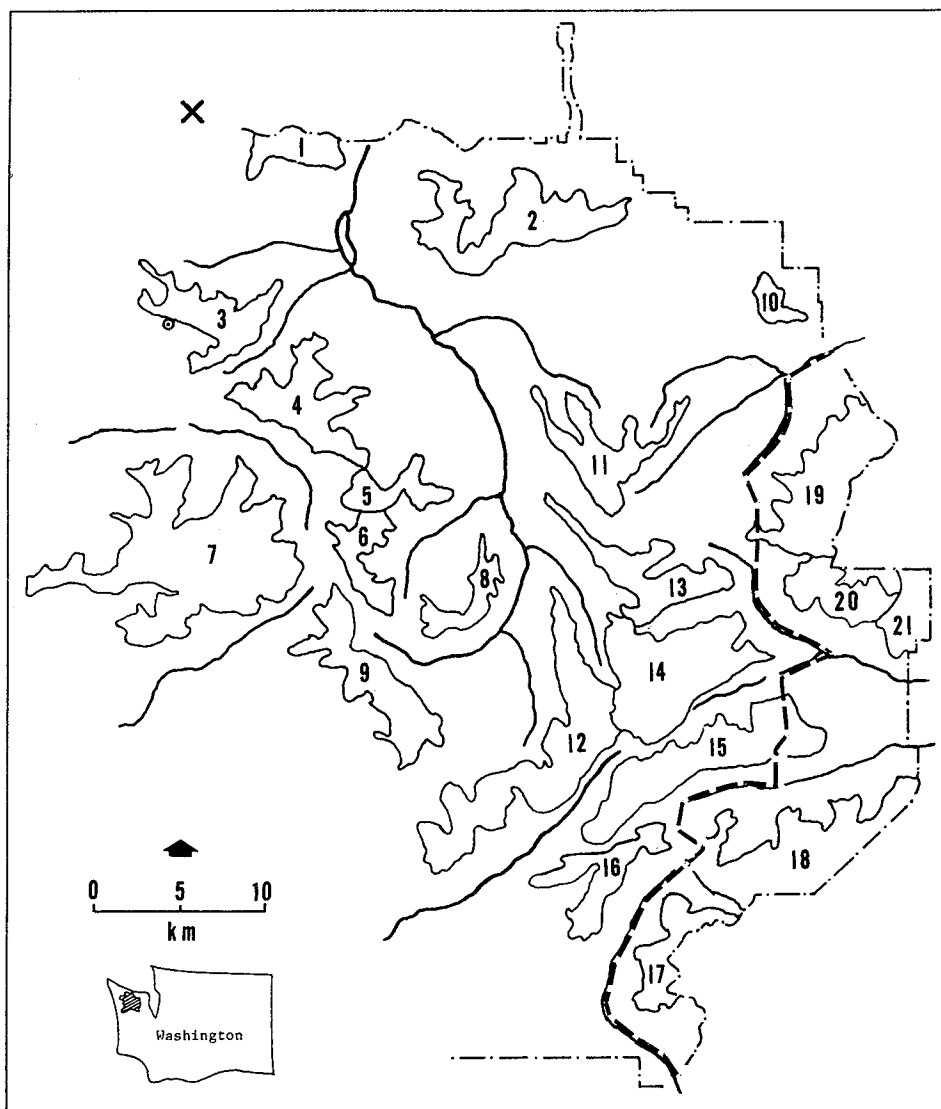


FIGURE 1. Spatial distribution of 21 subpopulations of mountain goats in Olympic National Park: (1) Hughes Creek, (2) Klahhane, (3) Appleton, (4) Carrie, (5) Ferry, (6) Barnes, (7) Olympus, (8) Dana, (9) Divide, (10) Blue Mountain, (11) McCartney, (12) Chimney, (13) Claywood, (14) Anderson, (15) LaCrosse, (16) Steel, (17) Sawtooths, (18) Stone, (19) Royal, (20) Mystery, and (21) Constance. Heavy dashed line separates the core removal area from the peripheral control area. X shows the site where goats were released during the 1920s. Modified from Hoffman 1987.

including the two environmental assessments, public meetings, levels of media coverage, etc. He also describes compromises perceived necessary by managers to reconcile conflicts between NPS management objectives and the concerns of various interest groups (particularly sport hunters, animal welfare groups, and a native plant society). Hence, we will confine this presentation to summarizing important bio-

logical and management findings.

The Experimental Management Program (EMP)

Objectives of the EMP were (1) to determine the relative feasibility and cost of various goat removal techniques, (2) to conduct studies of goat density and distribution, (3) to reduce goat densities in the

Klahhane Ridge subpopulation in order to document the species' ability to withstand exploitation, (4) to monitor the effects of these reduced densities on vegetation and soils, and (5) to evaluate sterilization as a means of population control.

Briefly, major findings of the EMP, by objective, were:

1. Each of eight goat removal techniques tested had particular strengths and weaknesses (Table 1). For example, a drop net, used effectively to capture goats on Klahhane Ridge, required animals habituated to accepting bait. Attempts to bait goats elsewhere in the park were generally unsuccessful. Aerial darting (using the immobilizing drugs M99 Etorphine and carfentanil) and aerial net-gunning were deemed the capture methods of choice for the subsequent OMP. Aerial shooting was the least expensive and safest method. Note that the costs presented in Table 1 represent start-up costs only; expense per animal captured is expected to rise steeply as goat densities are reduced and survivors become more dispersed and evasive.

2. The mountain goat population in the Olympics was estimated at 1175 ± 171 (SE) by helicopter census in July 1983 (Houston et al. 1986). The large standard error is an inherent problem with stratified random-block censuses aimed at animals exhibiting clumped distributions (Norton-Griffiths 1978), and leads to even broader confidence limits. Thus, with 95% certainty, the true population size during the 1983 census was between 840 and 1510 goats. The clumped distribution and fluctuating densities of the population do not offer much hope for greatly improving the precision of future counts.

3. The Klahhane Ridge subpopulation was reduced from about 230 to 41 goats (82%) from 1981 to 1986 (Houston and Stevens 1988). Although the subpopulation showed several classic density-dependent responses to exploitation (e.g., breeding at younger ages, producing more twins, increasing age-specific body weights), these were insufficient to compensate for annual removals that approximated the initial production of young. The finding that goat populations

Table 1. Comparison of experimental mountain goat capture and control techniques, Olympic National Park.

Technique	Precapture Requirements	Selectivity	Multiple Capture	Safety of Personnel	Safety of Goats	Relative Efficiency ^a	Cost Per Animal(\$) ^b
Foot Snare	Minimal	Good	No	Good	Good	Poor	50-100
Drop Net	Extensive	Good	Yes	Good	Good	Fair	300-500
Net Gun, Ground	Minimal	Excellent	No	Fair	Poor	Poor	300-500
Net Gun, Aerial	Minimal	Excellent	No	Fair	Poor	Good	800-1000
Ground Darting	Minimal	Excellent	No	Fair	Fair	Poor	200-400
Aerial Darting	Minimal	Excellent	No	Good	Fair	Good	600-800
Drive Net	Extensive	Poor	Yes	Fair	Poor	Poor	900-1000
Aerial Shooting ^c	Minimal	Excellent	N/A	Good	N/A	Good	30-50

^a Number of captures per unit effort.

^b Excludes transportation costs.

^c Data based on collection of biological specimens on Mt. Dana and Appleton and simulated aerial shooting on Mt. Dana.

decline dramatically when cropped at such levels may prove to be an especially useful guide for park managers.

4. Vegetation studies on Klahhane Ridge showed that a substantial reduction in goat density was required before appreciable recovery of plant communities could occur (Schreiner 1987). Preferred forage species did not increase in cover until the goats had been reduced by about 75%. Moreover, substantial grazing continued in rock outcrops preferred by goats even at the lower population levels. Thus, virtual elimination of goats will be required to appreciably reduce grazing and trampling impacts on plant species in preferred goat habitat.

5. Field sterilizations were attempted on 19 goats (13 females, 6 males) (Hoffman 1987). Males were rendered permanently sterile by chemical vasectomy. Implants of a pregnancy inhibiting drug (melengestrol acetate, MGA) rendered females sterile for 3 to 4 years, with about 90% effectiveness. The techniques currently available for sterilization however, were deemed impractic-

cal for any large-scale management application because of the need to selectively capture and treat each animal, and to repeat treatment of females. An "ideal" sterilization treatment would be permanent, usable on all sex and age classes, and deliverable by aerial darting. Such a technique does not exist, although research is underway (U.S. Seal, pers. comm. 1989, 1990).

The Operational Management Plan (OMP)

Objectives for the OMP were (1) to eliminate mountain goats from the 3250 km² "core area" of the park (Figure 1), and (2) to control (i.e., reduce) densities along the eastern boundary of the park (about 300 km²) adjacent to state managed lands where goats are hunted. Live capture was to be used exclusively for three years; shooting would then be used when capture became too expensive, inefficient, or hazardous. Goat effects on subalpine vegetation were to be monitored throughout the program. An inventory of the abundance and distribution of endemic and rare plants was also

to be conducted. An advisory committee composed of representatives from agencies and major interest groups was established to monitor the program.

Although it is too early for a detailed review of the effectiveness of the OMP, an overview of goat removals from 1981-1989 is appropriate.

Goat removals 1981-1989. The NPS removed 407 goats from the park during the period 1981 to 1989 (Table 2). This total includes 360 (88%) captured and translocated from the park, 28 (7%) capture-related mortalities, and 19 (5%) collected as scientific specimens. Two hundred sixty of these animals were removed during the period 1981 to 1987, during the EMP; 147 were removed during 1988-89, during the OMP. In addition, 3 known illegal kills have occurred within the park, and 99 goats were harvested legally by recreational hunters outside the park during the 8-year period from 1981 to 1988 (Washington Department of Wildlife 1982-1989).

Table 2. Mountain goat removals by location in Olympic National Park, 1981-1989.

Location	1981	1982	1983	1984	1985	1987	1988	1989	Subtotal
Mt. Anderson						4	2	3	9
Mt. Appleton			1	1			9		11
Mt. Barnes					2		2	2	6
Blue Mt.							1		1
Mt. Carrie						3	4	11	18
Mt. Constance							7	5	12
Chimney Peak					3			9	12
Mt. Claywood					6		3	2	11
Mt. Dana			4		25		7	7	43
Mt. Ferry					10			1	11
Hughes Creek							1		1
Klahhane	59	51	52	19	4		17	3	205
Mt. LaCrosse								1	1
McCartney Peak							1		1
Mt. Mystery								2	2
Mt. Olympus							17	10	27
Royal Basin				1			10	3	14
Sawtooth								7	7
Unknown					15				15
Subtotal	59	51	57	21	69	3	80	67	
TOTAL									407

Removals made during the OMP deserve further comment. Based on availability of personnel and funds, park managers set removal goals of 80 and 120 goats for 1988 and 1989, respectively; capture-related goat mortalities were to be held to 5%. Eighty goats were removed during 1988, with 8.7% capture mortality. Only 67 goats were removed during 1989, with a 19% mortality (Table 2, Figure 2).

Capture operations were plagued by poor flying weather both years; efforts were cancelled 19 of 30 days (67%) between May 20 and July 19, 1988, and 14 of 27 days (52%) between June 21 and July 26, 1989. (Operations usually were not scheduled during weekends and holidays to reduce conflicts with park visitors.)

The number of goats captured per day of

operation averaged 5.0 ± 2.37 (SD) during 1988 and 6.7 ± 2.06 during 1989. Goat captures per hour of flight time were 1.3 ± 0.38 and 1.3 ± 0.28 during the respective years. Even though these measures of "catch per effort" differed between years, being higher in 1989 (Mann-Whitney U Test, $\alpha = 0.05$), such statistical comparisons are misleading. Goats were, in reality, more difficult to locate during 1989, apparently because of reduced densities in areas suited for aerial capture (R. W. Olson, pers. obs.). Consequently, capture attempts were sometimes launched in more difficult terrain than during 1988, and mortalities increased. Although capture mortalities do not differ significantly between years (X^2 , $\alpha = 0.05$), the capture team views the increased mortality level in 1989 as very real. In any event, the goal of 5% capture-related goat mortality seems unreasonable

given the circumstances of capture.

Effects upon subpopulations. No recent censuses are available to document the extent of decline in goat numbers caused by the removal program; available resources have been channeled mainly to the capture operation. However, observations by the capture team, ground reconnaissance of several areas, and recorded capture sites (Table 2) all suggest that declines in the subpopulations have occurred, albeit nonuniformly, during the past 9 years. The Klahhane Ridge subpopulation, formerly the largest in the park, has been essentially eliminated, as have small subpopulations at Hughes Creek and Blue Mountain. Subpopulations at Mount Appleton, Mount Dana, Mount Claywood, Mount Constance, and Royal Basin also appear to have been reduced substantially.

The actual extent of these reductions, and the contributions by forces other than the removal program, will require detailed evaluation. In several cases the apparent declines seem out of proportion to the removals imposed. The Mount Appleton subpopulation provides an intriguing example. Stevens (1983) estimated this subpopulation at about 35–60 goats in 1980, and 46 were counted during the 1983 aerial census. Only 13–21 goats were recorded during four subsequent censuses from 1984 to 1986. Eleven goats were removed (nine in 1988), including two of seven females sterilized earlier. By 1989, no goats or their sign were observed during the removal program despite three aerial searches. There are several possible explanations for these observations. However, we suspect that substantial winter mortality may have affected this and other subpopulations. Winter snowpack returned to more "normal" levels, following unusual lows that occurred from 1976 to 1981. Such patterns would not be unusual; Smith (1984) documented strong density-independent mortality among goat populations in southeast Alaska during severe winters.

DISCUSSION

The aerial live capture program schedule for 1990 was canceled by the superintendent of Olympic National Park when two

independent assessments indicated that continued efforts posed unacceptable risks to the capture team (Peterson 1990, Machlis

et al. 1990). In addition, a full Environmental Impact Statement, rather than an Environmental Assessment, will now be neces-

sary before continuation of the removal program (M. Finnerty, pers. comm. 1990).

We believe that the information gleaned at Olympic National Park about population dynamics, herbivory, and capture of mountain goats will prove useful to managers elsewhere who are charged with maintaining populations of this fascinating Pleistocene relict.

Although we have no quarrel with the notion of re-establishing mountain goats in areas inside their historic range, we do urge caution in establishing them elsewhere. For example, goats released into the periphery of the Greater Yellowstone Ecosystem, at sites where they did not occur historically, have apparently become established in the northeast corner of Yellowstone park and are also reported periodically from nearby Grand Teton park (Laundré 1989). Such new populations may eventually pose problems to park managers that could prove embarrassingly similar to those experienced at Olympic park. Our goal is the maintenance of biological integrity of natural areas under the jurisdiction of the NPS; we fully recognize that other agencies have very different missions.

We also recognize that until quite recently, the effects upon rare or endemic plant species have not been considered very strongly when weighing the consequences of introducing non-native ungulates (and, in fairness, often with good reason at introduction sites characterized by long histories of heavy livestock grazing). This situation, however, could be changing. Recently, the NPS and the Washington Department of Wildlife signed an agreement that will permit translocation of the Olympic goats only to habitats where they occurred historically, or to zoos and approved research institutions.

ACKNOWLEDGMENTS

We thank J. Burger, P. Crawford, R. Hoffman, and V. Stevens for constructive reviews of the manuscript. Figure 1 was drawn by J. Burger.

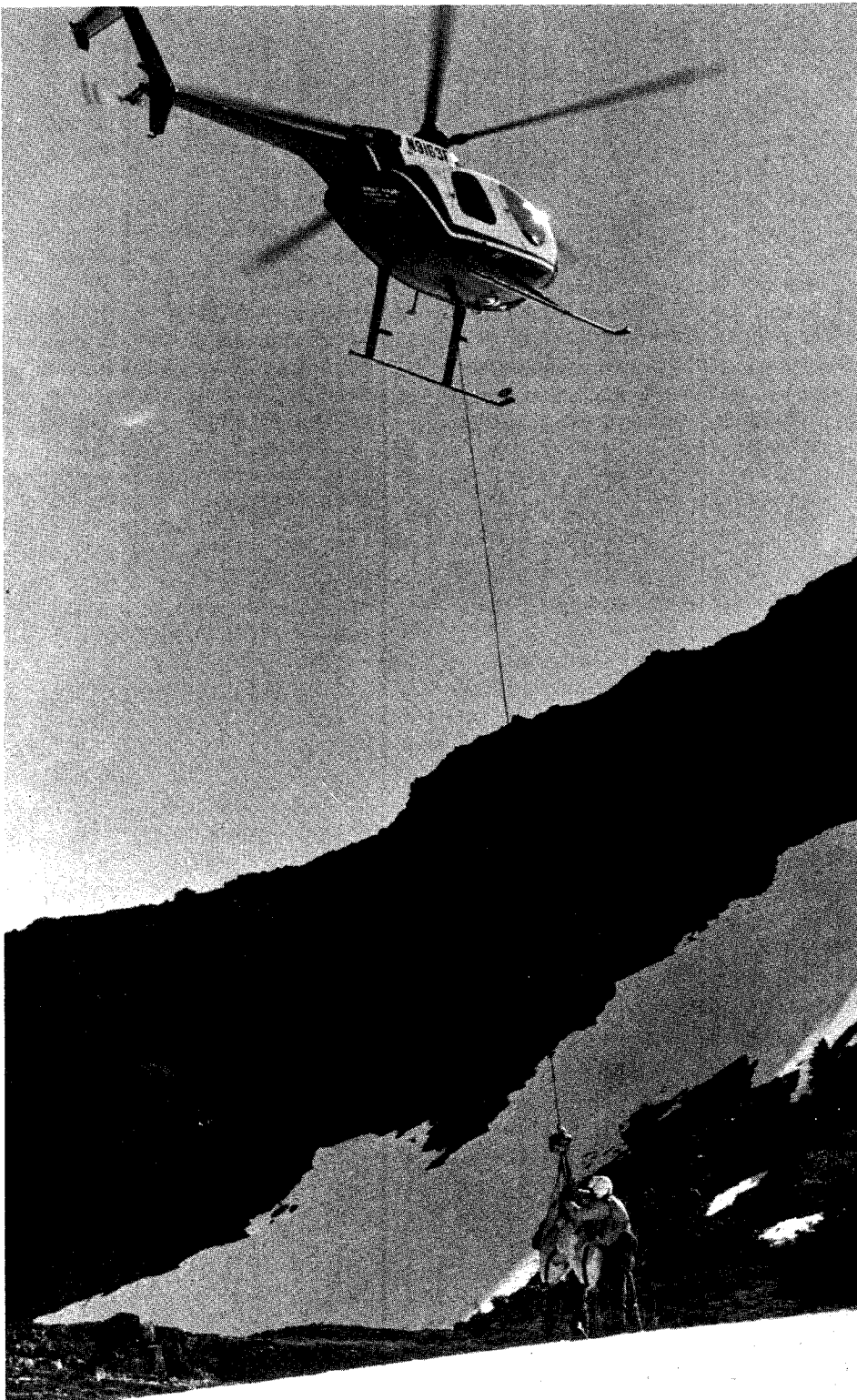


FIGURE 2. Two mountain goats, captured by aerial darting, are removed from Olympic National Park, 1988. Photo by R.W. Olson.

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