D-112A

MOUNTAIN GOAT MANAGEMENT

w/FONSI & ROD 03/88

IN

OLYMPIC NATIONAL PARK



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FINDING OF NO SIGNIFICANT IMPACT

for

MANAGEMENT OF MOUNTAIN GOATS

OLYMPIC NATIONAL PARK

PROPOSED ACTION

The National Park Service proposes to manage the introduced population of mountain goats in Olympic National Park. The plan calls for removal of all mountain goats in the interior of the park and a zone of control along the eastern periphery in which the number of goats will be reduced to the point of halting the change in plant composition.

The preferred method will be live capture using several different techniques, with all animals being relocated to native range through the Washington Department of Wildlife. After three years of live capture efforts, a shooting program may be added, with live capture remaining the preferred method. The shooting program would be administered by rangers or federal wildlife control agents. Goat carcasses will not be removed, but will be left to recycle into the ecosystem in the same way they do when goats die naturally.

SUMMARY OF IMPACTS

A major impact of this action will be to allow restoration of natural conditions for about 107,000 acres of the alpine and subalpine habitats. The control zone on the eastern periphery will have reduced impacts once the level of control is achieved. Visitor impacts will be twofold. In time there will be no goats for viewing in the interior, though there will still be goats on the periphery. The second impact on visitor experience will be the intrusion of sight and sound of helicopters during management operations over the next several years. Impacts on other agencies will be negligible from the interior clearing of goats, except for the benefit of relocated goats to areas off the peninsula. The reduction of goats in the peripheral zone may have some effect on the populations outside the park according to some of the comments heard at the public meetings. However, good goat habitat also exists outside of park boundaries on the Olympic National Forest, which will likely assure a viable population there despite the actions inside the park.

REASONS WHY THE PROPOSED ACTION WILL NOT HAVE A SIGNIFICANT EFFECT ON THE HUMAN ENVIRONMENT

The affected environment is in the alpine and subalpine zones of the park. Primary effects of the mountain goats are the result of food habits and wallowing, both of which cause changes in plant composition. Wallowing also accelerates erosion, with as much as 40 tons of soil being displaced from one wallow.

The action will stop the plant composition changes and, in time, natural processes will provide for recovery of native plant species. Some of the wallow-eroded areas may require soil conservation measures after the removal of goats. Headward erosion usually continues unless stopped by bedrock or intervention by man.

Allowing natural processes to govern plant composition without the effects of the introduced mountain goats will restore the full range of native plants, which is one of the features of this park's ecosystem.

No cultural resources would be affected by the implementation of this proposal. Critical habitat for high altitude plants will be improved. No threatened or endangered species of animal life will be affected. This action is classified as an "excepted action" from compliance with Executive Order 11988.

PUBLIC AVAILABILITY

The environmental assessment was issued November 2, 1987, and over 600 copies were distributed. Also, there were 1,100 copies of a 10-page summary given out or mailed. Sixteen meetings were conducted, reaching 657 people. Copies of the environmental assessment and the Finding of No Significant Impact are available to all interested parties. The Decision Record and the Finding of No Significant Impact will be mailed to all people who sent written responses to the park.

DETERMINATION

On the basis of the information contained in the environmental assessment as summarized above, it is my determination that the proposed project is not a major Federal action significantly affecting the quality of the human environment. Nor is the proposed action without precedent or similar to one which normally requires an environmental impact statement. Therefore, in compliance with the National Environmental Policy Act, an environmental impact statement will not be prepared.

Recommended:

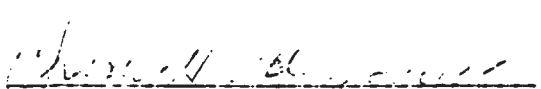


3/11/88

Robert S. Chandler
Superintendent
Olympic National Park

Date

Approved:



3/11/88

Charles H. Odegaard
Regional Director
Pacific Northwest Region

Date

DECISION RECORD

I. INTRODUCTION

Mountain goats (Oreamnos americanus) are not native to the Olympic Peninsula even though they appear to be in their natural habitat. Introduced by sportsmen during the 1920s, mountain goats now occupy most of the available habitat that is suitable to their needs: the alpine and subalpine environments of the Olympic Range. Their population on the Peninsula is estimated at 1,200, of which about 1,000 occur within Olympic National Park.

Olympic National Park was established in 1938 to preserve the integrity of all its natural features, including native plants and wildlife. The park has been nationally and internationally recognized as a Biosphere Reserve and as a World Heritage site because of this preservation of a natural and basically unmanipulated ecosystem that is still intact.

Mountain goats are causing significant changes in the sensitive high country of the park. Without an active management program, they will continue to produce long-term and significant impacts to park resources.

II. BACKGROUND OF THE PROBLEM

A. PURPOSE OF NATIONAL PARKS

A review of the purposes of national parks and the principles that guide their management provides a necessary context for discussion of mountain goats and their effects on Olympic National Park. When the National Park Service was established in 1916, part of the Congressional Act stated that the purpose of parks was to:

> "...conserve the scenery and the natural and historical objects and the wildlife therein, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

In 1963 an advisory board chaired by A. Starker Leopold issued a Report on Wildlife Management in the National Parks. This report stated that: "As a primary goal, we would recommend that the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by white man. A national park should be a vignette of primitive America" (Leopold 1963). The goal does not call for the preservation of what presently exists but calls for the restoration of what existed primevally.

The National Park Service Administrative Policies of 1970 incorporated many of the recommendations of the Leopold Report:

> "Management will minimize, give direction to, or control those changes in the native environment and scenic landscape resulting from human influences on natural processes of ecological succession. Missing native life forms may be reestablished, where practicable. Native environmental complexes will be restored, protected and maintained, where practicable, at levels determined through historical and ecological research of plant-animal relationships. Non-native species may not be introduced into natural areas. Where they have become established or threaten invasion of a natural area, an appropriate management plan should be developed to control them, where feasible."

In more recent years the park has been receiving global attention; the value of the park is recognized as transcending national boundaries. In the mid-1970s, Olympic National Park was designated by UNESCO as a Biosphere Reserve under the Man and the Biosphere Program. The principal objectives of the Biosphere Reserves are the conservation or preservation of genetic

diversity in the world's major ecosystems, providing opportunity for environmental research and education.

In 1981, this international role of Olympic was further emphasized with its designation as a World Heritage Site. This is a system which recognizes natural and cultural properties that are of "outstanding universal value to mankind." It was created by an international treaty that was developed at the World Heritage Convention in 1972. The document recommending Olympic for this designation stated, "It is apparent . . . that the Olympic National Park is the best natural area in the entire Pacific Northwest, with a spectacular coastline, scenic lakes, majestic mountains and glaciers, and magnificent temperate rainforest; these are outstanding examples of on-going evolution and superlative natural phenomena. It is unmatched in the world." But the document also expressed concern about the introduced mountain goat. "The main danger to the integrity of the site is, oddly, one of its attractions--the mountain goat. Due to the isolation of the site, mountain goats never dispersed naturally to the Olympics, so their introduction in 1925-29 may be causing significant changes in the natural ecosystem." (World Heritage Nomination, IUCN Technical Review, March 19, 1981).

B. INTRODUCTION OF GOATS TO THE OLYMPIC PENINSULA

Between 1925 and 1929, 11 or 12 mountain goats captured in Alaska and British Columbia were released near Lake Crescent. By the 1960s, subpopulations were well established in the southernmost mountain habitats of the Peninsula. The eastern margin of the Olympic Range was substantially populated by the 1970s. Mountain goats in varying densities now occupy approximately 700 square miles on the Peninsula. Migration from high density subpopulations is common; young males are normally the first

to move into new ranges and females with kids follow as higher density areas become crowded. Movements of up to 50 miles in a matter of a few weeks have been recorded. Goats periodically inhabit between 30% and 40% of the park's 922,000 total acres. This includes nearly 100% of the park's alpine zone, about 70% of the subalpine zone and a substantial portion of the montane forest zone where rocky outcrops occur.

C. GOAT BIOLOGY

Mountain goats occur natively throughout most of the mountainous Northwest, from Idaho, Montana and Washington northward through Canada into Alaska (Figure 1). In the extreme northwest corner of Washington, the Olympic Peninsula is isolated on three sides by the Pacific Ocean, the Strait of Juan de Fuca and Puget Sound, and on the fourth side the Olympic Mountains are isolated by the lowland Chehalis Valley. This topographic isolation has apparently hindered colonization by mountain goats even though they occur naturally as nearby as the Cascade Range, and can be found in Mount Rainier and North Cascades National Parks today.

Mountain goats are superbly adapted to and show a distinct preference for rocky, steep terrain. Except for the winter months, when snow forces the animals to seek shelter and forage below timberline, goats are found on rocky outcrops and open meadows in the highest elevations. They are not overtly gregarious but can occasionally be seen in small, loose herds at certain times of the year. Mountain goats are generalists in their eating habits. Although goats have preferences, they utilize nearly all species of grasses, herbs, forbs, and even coniferous tree foliage, to some degree. The goats have a salt craving which commonly peaks in early summer. This may be associated with a need to replenish sodium lost in the digestion

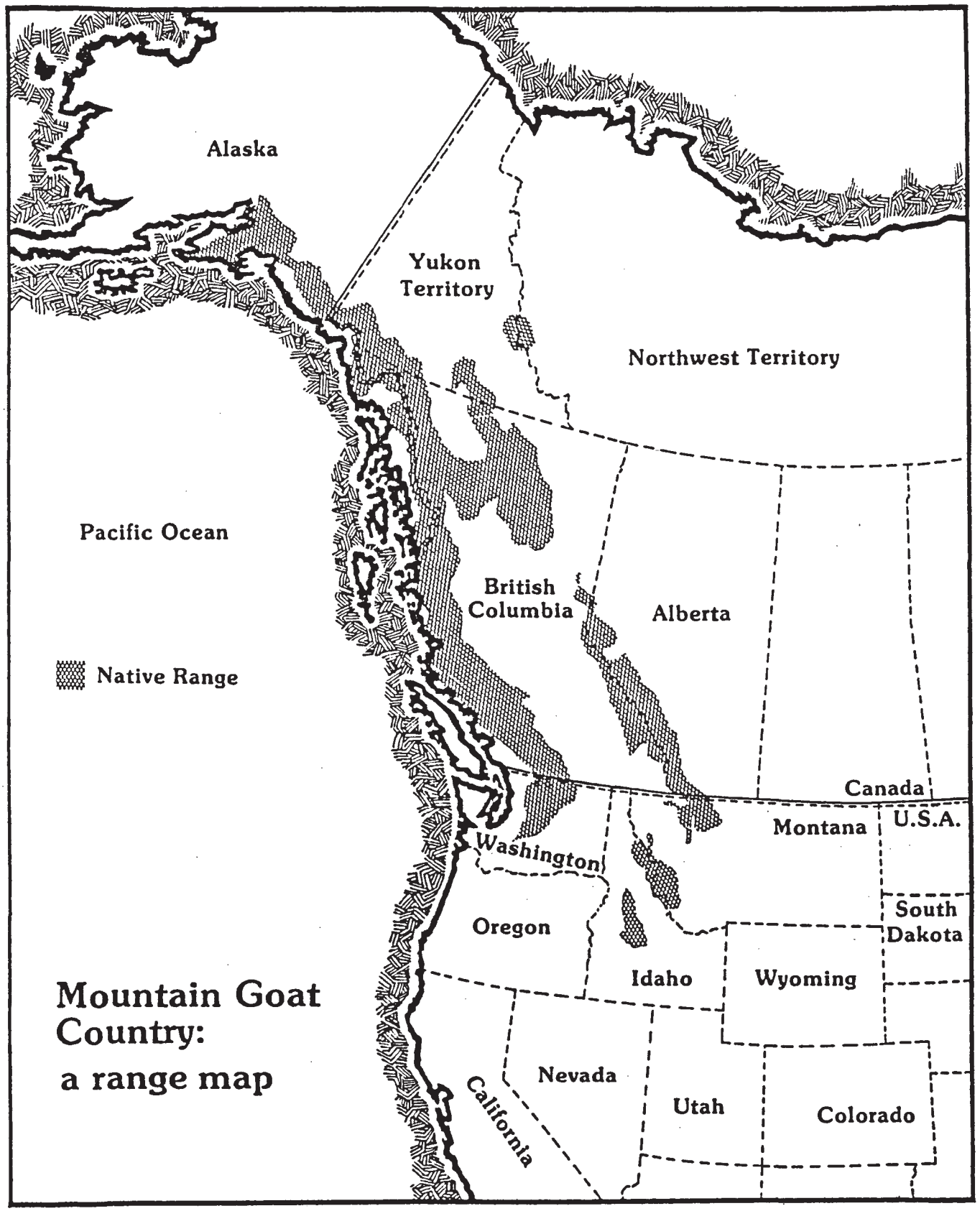

Alaska
Yukon Territory
Northwest Territory
Pacific Ocean
British Columbia
Alberta
Native Range
Canada
Montana
U.S.A.
Washington
Oregon
South Dakota
Idaho
Wyoming
Nevada
Utah
Colorado
California
Mountain Goat Country:
a range map

Figure 1

of succulent spring vegetation and/or to acquire sulfates which, after conversion to amino acids, are needed for lactation and hair growth.

Mating occurs in late November and early December. A dominant male may mate with several females and successfully prevent subdominant males from mating at all. Gestation varies from 150 to 180 days with a single offspring (sometimes two) being born in late May to early June. Kids begin a vegetative diet during their first week of life, although they depend on nursing as a mainstay for some time. Nannies maintain a close relationship with their young until just prior to the birth of a new kid. At that time the yearling is rejected by its mother. Mountain goats reach sexual maturity in one and one-half years. Some adults may live up to about 12 years.

D. REFUGIUM CONCEPT

Although mountain goats may have been present on the North American Continent for 40,000 years, there is no evidence to suggest that they ever inhabited the Olympic Peninsula. As pointed out in the wildlife section, this is due to geologic and glacial events that isolated the Olympic Mountains from other coast ranges long before the ancestral goats entered North America across the Bering land bridge. Colonization was apparently prevented by the distance between suitable habitats. Mountain goats evolved in and are thus highly dependent on an alpine environment with rocky outcrops. Puget Sound and the 75 miles of lowland forest which separated the Cascades from the Olympics were an effective barrier to migration.

Mountain goats were not unique in this respect. Several other species never made it to the Olympics, among them the bighorn sheep, grizzly bear,

Canada lynx, wolverine, red fox, pika and golden-mantled ground squirrel. Along with the mountain goat, these species occur over a vast area in the Pacific Northwest, the Olympics being a significant exception.

In all major aspects, the Olympic range is a refugium, a place where life forms and landscapes evolve with relative independence from neighboring environments. Without the influence of geographical isolation, the variety of species present in the world today would be a small fraction of what it is.

The isolation of the Olympic Peninsula has allowed some plants and animals to develop into genetically distinct forms. There are 10 plant species and varieties unique to the Olympics; among them are Piper's bellflower, Flett's violet, Olympic Mt. groundsel and Cotton's milk vetch. Moreover, the Olympics contain several plant species not usually found west of the Cascade Mountains or that normally occur in California or Southern Oregon (least bladdery milk-vetch, owl clover, Engelmann spruce, woolly sunflower, blunt sedge, Kellogia, Alice's fleabane). Endemic animals include the Olympic marmot and the Olympic snow mole. The Olympics also contain a unique butterfly (a species of fritillary) and snowshoe hares and short-tailed weasels that do not turn white in the winter. This unusual condition, the presence of unique species and the absence of expected species, is of major importance and interest to naturalists and to the scientific community. As surrounding lands on the Peninsula increasingly show the effects of development and human-caused changes, the refugium shrinks, and Olympic National Park itself becomes more of a biological island. One important value of the park is in preserving this refugium in as undisturbed a condition as possible.

III. THE ACTION PROGRAM

Mountain goats are causing significant changes in the vegetation patterns and soils throughout the alpine zones of Olympic National Park. While some areas are more heavily impacted than others, the effects of goats on many alpine and subalpine areas are noticeable even where smaller subpopulations are found. The current population within the park of about 1,000 goats is continuing to increase. If no action is taken to control or eliminate them, the changes will continue and result in permanent alteration of Olympic's alpine ecosystem. The research conducted during the past several years, however, has demonstrated that if goats are removed now, the alpine plant communities will recover.

The action being proposed is intended to slow or stop soil erosion caused by goats and to allow native plants to reestablish the patterns and composition that existed prior to the influence of mountain goats.

MAKE CORE GOAT-FREE/CONTROL NUMBERS ON PERIPHERY

The plan is to control numbers of goats in some areas and eliminate them in the majority of the park. It would achieve the result of restoring alpine vegetation types over time in those areas without goats (made goat-free) and mitigate goat effects in other areas where the numbers will be reduced and then controlled.

The difficulty is most acute along the eastern boundary of the park where mountain goats in the adjacent national forest are managed to maintain a population large enough to sustain an annual sport hunt. The mountainous terrain and widespread presence of goats along the eastern portion of the peninsula offers numerous situations where animals can freely move in and out of the park.

This action will require research and monitoring to achieve the control levels and a long-term removal program to maintain the prescribed numbers in the control zones. In the interior, study plots will be established to monitor environmental change. Approximately 800 animals from the park's core and at least 100 of some 200 occurring near the eastern park boundary will be removed. Under this alternative about 77% of the area presently occupied by goats eventually will be restored to the type of alpine vegetation patterns that existed before goats moved into the area.

The program for establishing the final level of control on mountain goat subpopulations inhabiting the eastern periphery will be developed by the park, in consultation with the Washington Department of Wildlife and Olympic National Forest. Goat populations along the eastern boundary will be managed by reducing the number of goats in peripheral subpopulations to a level that significantly reverses environmental damage now evident in these areas and inhibits reintroduction to the park interior.

A technical advisory committee will be established to monitor the overall mountain goat management program. The committee will include representatives from major interest groups and agencies involved in this issue. This includes representatives from organizations such as Olympic National Forest, Washington Department of Wildlife, Olympic Park Associates, Fund for Animals, Washington State Sportsmen's Council, Native Plant Society, and the Pacific Northwest Region of the NPS. This group will meet periodically to review the results of the program and make recommendations on possible program modifications. The committee will also serve as an important liaison with interested organizations and agencies.

No goats will be moved and released again on the Olympic Peninsula, such as live trapping in the core and moving to control areas or to areas outside the park. All live-trapped animals will be turned over to the Washington Department of Wildlife for release in native areas in Washington State or provided to other states for release in native range.

IV. METHODS TO BE USED

A. THE PROGRAM

Live capture will be used exclusively for three years. It will continue to be the preferred method until it is no longer safe or effective in terms of effort per capture. The techniques of capture can include aerial darting, aerial net guns, or ground drop nets. In each instance, the technique will depend on population characteristics, terrain and safety considerations for both personnel and goats.

After three years and when it is no longer feasible to live capture and relocate goats from a particular area, the remaining resident population will be removed by a shooting program. It is expected that at some point this will be necessary in order to eliminate the remnant population in the core areas and to ensure that new migrants do not invade areas that have been made goat free.

Mountain goats removed from the park will be transferred to the Washington Department of Wildlife for relocation to native goat ranges in Washington or other western states, and possibly Canada, as appropriate. Consideration will also be given to transferring animals to zoos or other appropriate wildlife agencies and organizations.

The park staff will stay abreast of the sterilization research that is underway in the U.S. and other countries. Any advances in sterilization which might have applicability in Olympic National Park may be used on selected subpopulations or on individual goats as the situation warrants. This recognizes the possibility that sterilization could develop into the control method of choice in future years.

B. LIVE CAPTURE

Several methods of capturing goats have been tried with varying degrees of success. Where goats are habituated to the presence of humans, as on Klahhane Ridge, a ground drop net has worked well. The same procedures on Appleton Pass met with no success. Baiting with salt can attract goats during a late spring, early summer period of 6-8 weeks, but is not particularly effective the rest of the year. Use of this large ground net has had limited success, but will continue to be used where effective.

Capturing by leg snare or a small net fired from the ground does work for an individual animal. This method can be effective for research or individual treatment such as marking or tagging and sterilization. It is not effective where a number of animals must be caught in a short time.

Aerial netting can be used where animals are not habituated to humans, and where terrain and weather allow. It has the advantage of wide area selection for efficiency in finding animals. As with any helicopter supported operation, weather is a determining factor for timing. Terrain is also a limiting factor for both safety of goats and personnel. For live capture and subsequent transportation of animals, the aerial netting method shows promise. High cost will be a factor in any helicopter supported method, especially where transportation of live animals is involved.

C. SHOOTING

Animals can be taken by shooting from the ground and/or air using rifle or shotgun. All shooting will be conducted by trained National Park Service rangers and/or federal animal control agents. Goat carcasses will not be removed, but will be left to recycle into the ecosystem in the same way they do when goats die naturally. No animals will be utilized for food or any other purpose except as authorized for research. Plans will be developed so as to minimize conflicts with backcountry visitor use.

V. ALTERNATIVES AND THE PUBLIC COMMENT

An environmental assessment was released on November 2, 1987. Alternatives on "what" to do were: no action, control numbers throughout the park, eliminate all goats from the park, and a combination of the latter two. Alternatives on "how" to go about the action were: sterilization, live capture, shooting, and a combination of live capture and shooting.

Public comments were received at each of the 16 public meetings. In addition, 89 letters were received and 205 response forms. The response forms were mailed out with copies of the environmental assessment or handed out to participants at each of the public meetings.

Several general comments can be made:

1. Most people favored action (74.7%) as opposed to no action.
2. A goat-free park, right away or eventually, was favored by 48.3% of the respondents.
3. Shooting alone or as a component in a capture/shoot program was favored by 68.3% of the respondents.

4. The letter writers preferred a goat-free park (83.8%), and a fair number spoke for eliminating goats from the entire peninsula (19 of 89).
5. Public hunting was suggested by 18 of the response form respondents, and another five letter writers suggested the same.
6. Oral comments recorded at meetings represented very close to the same breakdown as did the written responses. Some groups were more strongly oriented to public hunting, while others were "mixed" in preference for both "what" to do and "how" to go about it.
7. Most letters were written by individuals representing themselves, but several were from organizations representing larger numbers of people.

ENVIRONMENTAL ASSESSMENT

MOUNTAIN GOAT MANAGEMENT

IN

OLYMPIC NATIONAL PARK

Prepared by
Olympic National Park
600 East Park Avenue
Port Angeles, Washington 98362
September 1987

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I. INTRODUCTION

Mountain goats (Oreamnos americanus) are not native to the Olympic Peninsula even though they look and appear to be in their natural habitat. Introduced by sportsmen during the 1920s, mountain goats now occupy most of the available habitat that is suitable to their needs: the alpine and subalpine environments of the Olympic Range. Their population on the Peninsula is estimated at 1,200, of which about 1,000 occur within Olympic National Park.

Olympic National Park was established in 1938 to preserve the integrity of all its natural features, including native plants and wildlife. The park has been nationally and internationally recognized as a Biosphere Reserve and as a World Heritage site because of this preservation of a natural and basically unmanipulated ecosystem that is still intact.

Mountain goats are causing significant changes in the sensitive high country of the park. Without an active management program, they will continue to produce long-term and significant impacts to park resources.

II. BACKGROUND OF THE PROBLEM

A. PURPOSE OF NATIONAL PARKS

A review of the purposes of national parks and the principles that guide their management provides a necessary context for discussion of mountain goats and their effects on Olympic National Park. When the National Park Service was established in 1916, part of the Congressional Act stated that the purpose of parks was to:

> "...conserve the scenery and the natural and historical objects and the wildlife therein, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

In the early years of the Service, this passage was interpreted as a mandate to protect as much wildlife and habitat as possible. For a few years "good animals" (elk, deer, etc.) were protected by killing "bad animals" (predators). Little attention seems to have been paid to natural assemblages of species and ecological balance.

For the next 50 years, wildlife management in the national parks progressed into habitat manipulation to restore natural systems and even population control of excess ungulates.

In 1963, however, an advisory board chaired by A. Starker Leopold issued a Report on Wildlife Management in the National Parks. This report stated that: "As a primary goal, we would recommend that the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by white man. A national park should be a vignette of primitive America" (Leopold 1963). This simple-sounding goal has some staggering implications. The goal does not call for the preservation of what presently exists but calls for the restoration of what existed primevally. The problems of replacing extirpated species, removing exotic species and, at the same time, allowing for visitor use may preclude a total restoration of the primitive scene, but, as Leopold said ". . . if it cannot be fully achieved it can be approached."

The National Park Service Administrative Policies of 1970 incorporated many of the recommendations of the Leopold Report:

> "Management will minimize, give direction to, or control those changes in the native environment and scenic landscape resulting from human

influences on natural processes of ecological succession. Missing native life forms may be reestablished, where practicable. Native environmental complexes will be restored, protected and maintained, where practicable, at levels determined through historical and ecological research of plant-animal relationships. Non-native species may not be introduced into natural areas. Where they have become established or threaten invasion of a natural area, an appropriate management plan should be developed to control them, where feasible."

The most recent compilation of Servicewide policy, Management Policies, 1978, refines and elaborates further the earlier statements, paying particular attention to exotic species, first with clear definitions and then with details on how such species should be managed:

"Exotic species are species that occur in a given place, area or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans . . .

"The native species are species which presently occur, or once did occur prior to some human influence, in a given place, area, or region as a result of ecological processes that operate and have operated without significant direct or indirect, deliberate or accidental alterations by humans.

". . . direct or indirect, deliberate or accidental introductions by humans are ones that have permitted species to cross natural barriers to their dispersal capabilities thus giving those species opportunities to become established in areas previously inaccessible to them because of natural forces.

"Manipulation of population numbers of exotic plant and animal species, up to and including total eradication, will be undertaken whenever such species threaten protection or interpretation of resources being preserved in the park. Examples of threatening situations include: 1) being detrimental to public health, 2) disrupting the faithful presentation of the historic scene, 3) damaging historic and archeological resources, 4) threatening the perpetuation of natural features, native species (including especially those that are endangered, threatened, or otherwise unique), natural ecological communities, or natural ecological processes, and 5) significantly hampering the management of adjacent park or nonpark lands. Control programs will most likely be taken against exotic species which have a high impact on protected park resources and where the program has a reasonable chance for successful control; programs are least likely to be initiated against exotic species which have almost no impact on park resources and where there is a minimal probability for successful control."

In establishing Olympic National Park in 1938, Congress recognized the high value of this area to the nation. In a report accompanying H.R. 10024 which created the park, the purpose was stated:

". . . to preserve for the benefit, use and enjoyment of the people, the finest sample of primeval forests of Sitka Spruce, western hemlock, Douglas-fir, and western redcedar in the entire United States; to provide suitable winter range and permanent protection for the herds of native Roosevelt elk and other wildlife indigenous to the area; to conserve and render available to the people, for recreational use, this outstanding mountainous country, containing

numerous glaciers and perpetual snow fields, and a portion of the surrounding verdant forests together with a narrow strip along the beautiful Washington coast."

In more recent years the park is receiving global attention; the value of the park is recognized as transcending national boundaries. In the mid-1970s, Olympic National Park was designated by UNESCO as a Biosphere Reserve under the Man and the Biosphere Program. The principal objectives of the Biosphere Reserves are the conservation or preservation of genetic diversity in the world's major ecosystems, providing opportunity for environmental research and education.

In 1981, this international role of Olympic was further emphasized with its designation as a World Heritage site. This is a system which recognizes natural and cultural properties that are of "outstanding universal value to mankind." It was created by an international treaty that was developed at the World Heritage Convention in 1972. The document recommending Olympic for this designation stated, "It is apparent . . . that the Olympic National Park is the best natural area in the entire Pacific Northwest, with a spectacular coastline, scenic lakes, majestic mountains and glaciers, and magnificent temperate rainforest; these are outstanding examples of on-going evolution and superlative natural phenomena. It is unmatched in the world." But the document also expressed concern about the introduced mountain goat. "The main danger to the integrity of the site is, oddly, one of its attractions--the mountain goat. Due to the isolation of the site, mountain goats never dispersed naturally to the Olympics, so their introduction in 1925-29 may be causing significant changes in the natural ecosystem." (World Heritage Nomination, IUCN Technical Review, March 19, 1981).

B. AFFECTED ENVIRONMENT

1. NATURAL ENVIRONMENT

a. Climate and Geology

The Olympic Mountains form the center of the 5,000 square mile Olympic Peninsula in northwest Washington. Olympic National Park (1,400 square miles) includes the major portion of the mountains. The highest peak, Mount Olympus (7,965 feet), is 35 miles inland from the Pacific Ocean.

The climate is dominated by the maritime influence of the nearby ocean. Winters are mild and wet, summers cool and dry. The mountains form a steep barrier to moist, westerly winds off the ocean, causing a pronounced decrease in precipitation from west to east. Average annual precipitation ranges from 160 to 200 inches (13 to 17 feet) along windward slopes to only 17 inches in the leeward, northeastern parts of the Peninsula. In winter snow occurs above 4,600 feet elevation in amounts which can range from 300 to 500 inches (25 to 40 feet) annually.

The Olympic Mountains were uplifted by plate tectonic processes during the Pliocene--early Pleistocene. Oceanic sediments make up sandstones, siltstones and shales that dominate the central mountains. The peripheral Crescent Formation is a horseshoe of mountains formed when basaltic rock of the sea floor was sheared off and piled up as the oceanic plate moved under the continental plate. The steep ridges and cliffs of this formation are preferred goat habitat in many places, including Klahhane Ridge.

Glaciers and stream erosion have been important in shaping the Olympic landscape. Four major glacial periods have occurred, filling the adjacent Puget Sound with at least six different continental ice sheets. The periods of continental and alpine glaciation have been staggered so that some land has been free from ice in the higher mountains at all times. Plants unique to the Olympics occur in these undisturbed "refugia." Such areas include Klahhane Ridge, Tyler Peak, Royal Basin and Mount Constance.

b. Vegetation and Soils

Olympic National Park is noted for its massive forests, which include the largest examples of many Pacific Northwest tree species. Among these are Douglas-fir, Sitka spruce, western hemlock, Pacific silver fir and subalpine fir.

Mountain goats, however, prefer herbaceous, alpine or subalpine plant communities, which comprise about 25 percent of the park. These communities begin near the upper elevational limit of forest. Plant cover here is diverse and ranges from lush meadows on deeper soils to loose, scree slopes with little soil and very few plants. Stability of rock or soil substrates and soil moisture are primary factors shaping the distribution of these plant communities. Other influences include soil chemistry, competition with other plants, and the frequency and intensity of fire or grazing.

Large grazing animals exert two primary pressures on plants in a community: removal of plant parts through grazing, and the physical disturbance of trampling, pawing and digging. Plant species differ in their ability to withstand these disturbances. Some can tolerate

grazing or trampling that is harmful to others. Resistance is often influenced by a plant's growth form and whether its parts are low and protected or upright and exposed; other species simply are not palatable. Some species which evolved with heavy grazing may function more efficiently if they are grazed than if not. Plants not so adapted may respond to this pressure adversely.

Nine types of subalpine plant communities have been identified on Klahhane Ridge (Table 1). Goats are somewhat selective in their choice of food plants, although few species show no grazing evidence. The majority of plants on Klahhane Ridge show signs of occasional grazing. Preferred forage species which are grazed a high portion of the time and another group which is rarely taken are listed in Table 2.

Forty-two species, or varieties, of plants in the Olympic Mountains have been designated as endangered, threatened or sensitive by the Washington Natural Heritage Program (Appendix F). Ten plants are considered endemics, that is, they are found only in one place, in this case, the Olympic Mountains (Table 3). The effect of goats on two endemic species (Olympic Mt. groundsel and Piper's bellflower) and one near endemic (Olympic Mt. aster) has been studied on Klahhane Ridge (many goats) and Tyler Peak (few goats) (Pike 1981).

Soil disturbance studies indicate that trampling by goats on Klahhane Ridge has removed the lichen and moss cover that stabilizes bare soil surfaces in the absence of vascular plants. Mosses and lichens were found in only 33% of the study plots on Klahhane Ridge, in contrast to 86% of the plots on Tyler Peak.

Table 1. Subalpine plant community types on Klahhane Ridge, Olympic National Park (after Pfitsch 1981).

	Community Type	Common Name
1.	Phlox-fescue meadow	Spreading phlox Idaho fescue Threadleaf sandwort
2.	Unstable herb meadows	Woolly sunflower Western wormwood Common yarrow
3.	Scree (moving steep slopes)	Narrow-sepaled phacelia Rockslide larkspur Olympic Mt. groundsel
4.	Heather	Merten's mt. heather Red mountain-heather Partridgefoot Showy sedge
5.	Late snow dwarf sedge	Black alpine sedge Showy sedge Woolly pussytoes
6.	Lupine-sedge meadow	Broadleaf lupine Showy sedge
7.	Luetkea drainage	Partridgefoot Black alpine sedge Showy sedge
8.	Tall sedge, grass and herb meadow	Showy sedge Alaska brome Tufted hairgrass
9.	Ridge top fellfield	Common juniper Spreading phlox Field oxytropis

Table 2. Plant species which are preferred mountain goat forage on Klahhane Ridge and species which are generally avoided (Pfitsch 1981).

Common Name	Family
Idaho fescue	Graminae
Curly bluegrass	
Blue wildrye	
Alaska brome	
Showy sedge	Cyperaceae
Western wormwood	Compositae
Three-veined fleabane	
Wandering fleabane	
Woolly sunflower	
Olympic Mt. aster	
Olympic Mt. groundsel	
Parry's silene	Caryophyllaceae
Douglas' silene	
American bistort	Polygonaceae
Bluebell's of Scotland	Campanulaceae
Western hedysarum	Leguminosae
Field oxytropis	
Avoided Species	
Fendler's waterleaf	Hydrophyllaceae
Narrow-sepaled phacelia	
Indian thistle	Compositae
Broadleaf lupine	Leguminosae
Merten's mt. heather	Ericaceae
Red mountain-heather	

Table 3. Plants where goats occur that are considered unique, or endemic, to the Olympic Mountains (from Pike 1981, Schreiner et al 1986). Listed by families.

Cruciferae
Sand-dwelling wallflower
Rosaceae
Olympic Mt. rock spirea
Leguminosae
Olympic Mt. milk vetch [1], [2]
Violaceae
Flett's violet
Scrophulariaceae
Cutleaf synthryis [3]
Capanulaceae
Piper's bellflower
Compositae
Flett's fleabane
Thompson's wandering daisy [3]
Olympic Mt. groundsel
Olympic Mt. dandelion

[1] Proposed as a candidate for the federal list of threatened and endangered species (Federal Register, September 27, 1985)

[2] Listed as threatened by the Washington Natural Heritage Program, 1987

[3] Listed as sensitive by the Washington Natural Heritage Program, 1987

c. Wildlife

Protection of Roosevelt elk was an important reason for establishing the park. The large coastal form of the elk was first described in the Olympic Mountains and named after Theodore Roosevelt. These animals were threatened by overhunting around the turn of the century and required protection. A population of 4,000 to 5,000 animals now inhabits the park. Other common larger mammals include the blacktail deer, black bear and cougar. The native wolf was eliminated during the 1920s.

As with plants, the isolation of the Olympic Mountains has led to the development of distinctive animal forms (Table 4). It has also prevented a number of species in the Cascade Mountains of central Washington from colonizing the Olympics (Table 5).

2. HUMAN ENVIRONMENT

Total public visits to the park each year is now over 3 million. The backcountry receives about 100,000 use nights annually, with perhaps double that number of day hikers. Although people visit Olympic National Park from all over the world, 65% of the visitors are from the Olympic Peninsula and the nearby Puget Sound urban area, including Seattle. Nearly 200 miles of roadway in the park, including 14 spur roads, provide access to parts of a 600-mile trail system.

Mountain goats inhabit a vast portion of the park's backcountry. They are a common sight along high country trails and in one location--the Mt. Angeles/Klahhane Ridge area--goats can sometimes be seen from the Hurricane Ridge Road. In several areas of the backcountry--Royal Basin, Lake Constance, Sawtooth Ridge, Anderson Pass--goats have

Table 4. Fauna endemic or unique to the Olympic Mountains, Washington

Olympic marmot	Marmota olympus
Chipmunk	Eutamius amoenus caurinus
Snow mole	Scapanus townsendii olympicus
Pocket gopher	Thomomys mazama melanops
Butterfly	Oenis chryxus valerata
Carabid beetle	Pterostichus brunneus
Different forms of:	
Gray jay	Perisoreus canadensis
Stellar's jay	Cyanoetta stelleri

Table 5. Some mammals native to the Cascade Mountains, Washington, but absent historically from the Olympic Mountains.

Mountain goat	Oreamnos americanus
Bighorn sheep	Ovis canadensis californiana
Cascade red fox	Vulpes fulva cascadensis
Pika	Ochotona princeps
Golden-mantled ground squirrel	Spermophilus lateralis
Grizzly bear	Ursus arctos
Wolverine	Gulo luscus
Lynx	Lynx canadensis

become habituated to the presence of humans. Because they have learned to associate these campsites as a salt source from human urine deposits, they frequently approach campers quite closely, occasionally becoming a nuisance or a minor threat.

A special permit bow hunt for goats, administered by the Washington Department of Wildlife, has been in effect annually since 1967 in Olympic National Forest on lands adjoining the park. Since that time, about 8 goats per year have been taken by hunters.

No listed sites on, or eligible for, the National Register of Historic Places will be affected by any of the management alternatives being considered.

C. INTRODUCTION OF GOATS TO THE OLYMPIC PENINSULA

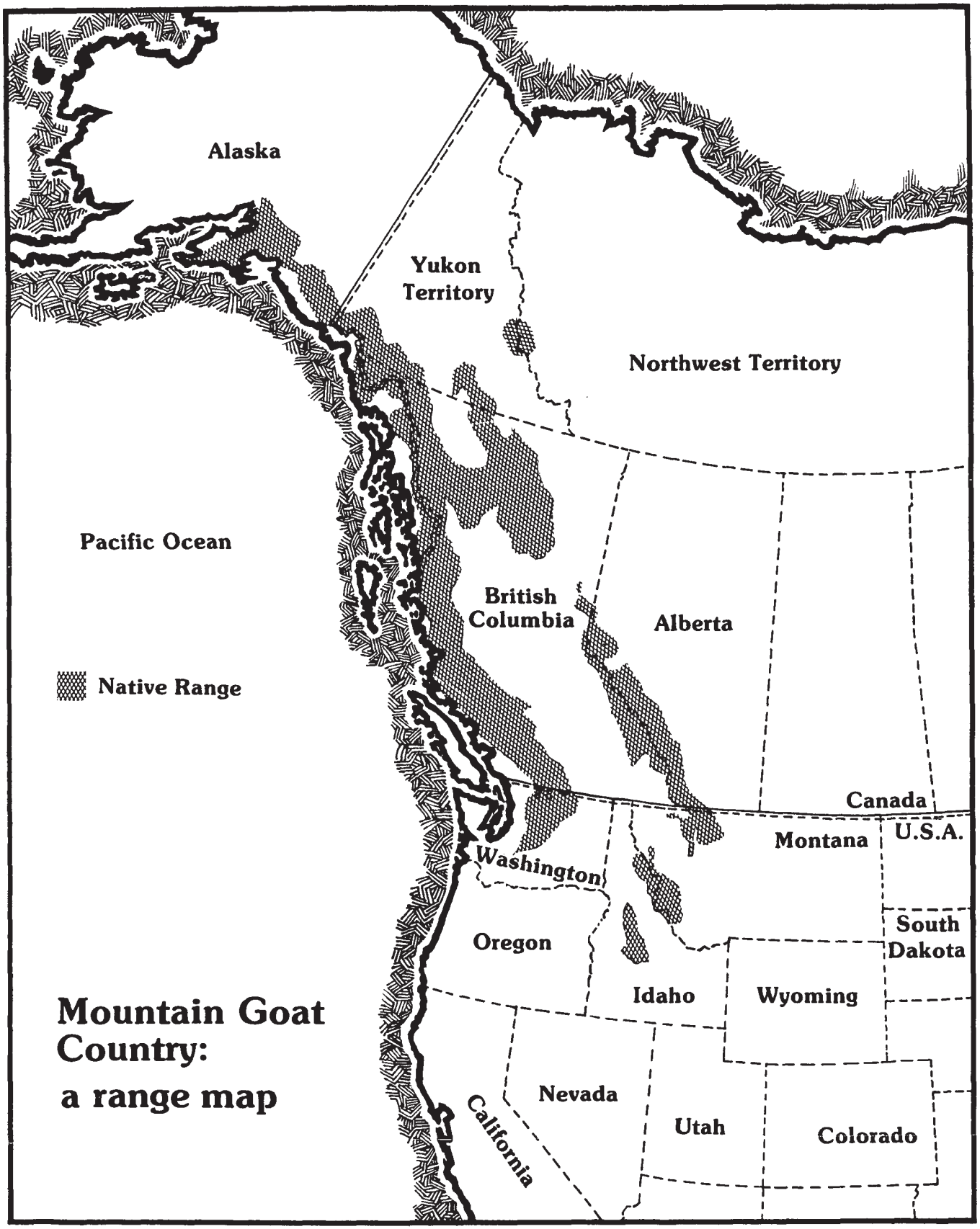
Between 1925 and 1929, 11 or 12 mountain goats captured in Alaska and British Columbia were released near Lake Crescent. By the 1960s, subpopulations were well established in the southernmost mountain habitats of the Peninsula. The eastern margin of the Olympic Range was substantially populated by the 1970s. Mountain goats in varying densities now occupy approximately 700 square miles on the Peninsula. Migration from high density subpopulations is common; young males are normally the first to move into new ranges and females with kids follow as higher density areas become crowded. Movements of up to 50 miles in a matter of a few weeks have been recorded. Goats periodically inhabit between 30% and 40% of the park's 922,000 total acres. This includes nearly 100% of the park's alpine zone, about 70% of the subalpine zone and a substantial portion of the montane forest zone where rocky outcrops occur.

D. GOAT BIOLOGY

Mountain goats occur natively throughout most of the mountainous Northwest, from Idaho, Montana and Washington northward through Canada into Alaska (Figure 1). In the extreme northwest corner of Washington, the Olympic Peninsula is isolated on three sides by the Pacific Ocean, the Strait of Juan de Fuca and Puget Sound, and on the fourth side the Olympic Mountains are isolated by the lowland Chehalis Valley. This topographic isolation has apparently hindered colonization by mountain goats even though they occur naturally as nearby as the Cascade Range, and can be found in Mount Rainier and North Cascades National Parks today.

The mountain goat is not a true goat, being more closely related to mountain dwelling antelopes of Europe and Asia. Adults weigh upwards of 100 pounds with some males weighing over 250 pounds. The goat is entirely white; its long hair grows to maximum length before the onset of winter. In late spring this coat is replaced by a shorter summer coat. Sexes are not easily distinguishable. Both sexes have true horns, black and slightly curved to the rear. Unlike antlers, these horns are not shed, though they occasionally break off in accidents.

Mountain goats are superbly adapted to and show a distinct preference for rocky, steep terrain. Except for the winter months, when snow forces the animals to seek shelter and forage below timberline, goats are found on rocky outcrops and open meadows in the highest elevations. They are not overtly gregarious but can occasionally be seen in small, loose herds at certain times of the year. Mountain goats are generalists in their eating habits. Although goats have preferences, they utilize nearly all species of grasses, herbs, forbs, and even coniferous tree foliage, to some degree. The goats have a salt craving which commonly peaks in early summer. This


Alaska
Yukon Territory
Northwest Territory
Pacific Ocean
British Columbia
Alberta
Native Range
Canada
U.S.A.
Montana
Washington
Oregon
South Dakota
Idaho
Wyoming
Nevada
Utah
Colorado
California
Mountain Goat Country:
a range map

may be associated with a need to replenish sodium lost in the digestion of succulent spring vegetation and/or to acquire sulfates which, after conversion to amino acids, are needed for lactation and hair growth.

Mating occurs in late November and early December. A dominant male may mate with several females and successfully prevent subdominant males from mating at all. Gestation varies from 150 to 180 days with a single offspring (sometimes two) being born in late May to early June. Kids begin a vegetative diet during their first week of life, although they depend on nursing as a mainstay for some time. Nannies maintain a close relationship with their young until just prior to the birth of a new kid. At that time the yearling is rejected by its mother. Mountain goats reach sexual maturity in one and one-half years. Some adults may live up to about 12 years.

E. REFUGIUM CONCEPT

Although mountain goats may have been present on the North American Continent for 40,000 years, there is no evidence to suggest that they ever inhabited the Olympic Peninsula. As pointed out in the wildlife section, this is due to geologic and glacial events that isolated the Olympic Mountains from other coast ranges long before the ancestral goats entered North America across the Bering land bridge. Colonization was apparently prevented by the distance between suitable habitats. Mountain goats evolved in and are thus highly dependent on an alpine environment with rocky outcrops. Puget Sound and the 75 miles of lowland forest which separated the Cascades from the Olympics were an effective barrier to migration.

Mountain goats were not unique in this respect. Several other species never made it to the Olympics, among them the bighorn sheep, grizzly bear,

Canada lynx, wolverine, red fox, pika and golden-mantled ground squirrel. Along with the mountain goat, these species occur over a vast area in the Pacific Northwest, the Olympics being a significant exception.

In all major aspects, the Olympic range is a refugium, a place where life forms and landscapes evolve with relative independence from neighboring environments. On a global scale, this insular effect is, to varying degrees, responsible for the great diversity of species. Extreme examples include the Galapagos and Hawaiian Islands where many species exhibit physical and behavioral characteristics profoundly different from those of their mainland cousins. Without the influence of geographical isolation, the variety of species present in the world today would be a small fraction of what it is.

The isolation of the Olympic Peninsula has allowed some plants and animals to develop into genetically distinct forms. There are 10 plant species and varieties unique to the Olympics; among them are Piper's bellflower, Flett's violet, Olympic Mt. groundsel and Cotton's milk vetch. Moreover, the Olympics contain several plant species not usually found west of the Cascade Mountains or that normally occur in California or Southern Oregon (least bladdery milk-vetch, owl clover, Engelmann spruce, woolly sunflower, blunt sedge, Kellogia, Alice's fleabane). Endemic animals include the Olympic marmot and the Olympic snow mole. The Olympics also contain a unique butterfly (a species of fritillary) and snowshoe hares and short-tailed weasels that do not turn white in the winter. This unusual condition, the presence of unique species and the absence of expected species, is of major importance and interest to naturalists and to the scientific community. As surrounding lands on the Peninsula increasingly

show the effects of development and human-caused changes, the refugium shrinks, and Olympic National Park itself becomes more of a biological island. One important value of the park is in preserving this refugium in as undisturbed a condition as possible.

The effects of introducing animals into ecosystems where they have not occurred before is well documented. The changes wrought by exotic herbivores on native plant communities and soils were recognized over 100 years ago by Charles Darwin and George Wallace (Turbott 1948). The most frequently described effect of an exotic herbivore on native vegetation is a reduction in the abundance of palatable plant species along with an increase in unpalatable species (Ellison 1960, Coblentz 1978). A general loss in plant cover also may occur. Soil erosion due to foraging and trampling may increase (Koehler 1974). Native wildlife may experience increasing competition for limited resources (Potter and Berger 1977, Wauer 1978). Eventually, a new equilibrium occurs, but in a relatively brief time such influences may profoundly change ecosystems that have developed over thousands of years.

III. SUMMARY OF MANAGEMENT ACTION TO DATE

A. EARLY SURVEYS OF THE 1960s AND 1970s

The effects of mountain goats on vegetation and the increase in numbers were recognized in the late 1960s. The large concentrations of mountain goats in the Klahhane Ridge/Mt. Angeles area were starting to create visible damage to plant communities. Estimates of total population within the park, of dispersal from the original point of release and of habitat relationships were made.

In 1973, goats were determined to have spread throughout the mountainous portions of the park and beyond the park boundaries to the east and south

(Moorhead 1973). The total park population was estimated to be 350 to 450 goats and in the Mt. Angeles/Klahhane Ridge subpopulation, the annual gain was estimated at 20%. Also in this area, trailing was beginning to appear and one wallow was measured at 30 feet in diameter by 6 to 12 inches deep. Heavy foraging on Olympic Mt. groundsel, an endemic plant to the Olympics, was noted, as was heavy trampling of two other endemics, Flett's violet and Piper's bellflower (Moorhead 1973).

The first systematic count of the same Mt. Angeles/Klahhane Ridge subpopulation was conducted in 1976, using a direct census technique. The resulting estimate of this subpopulation was in the range of 150 to 225 goats, with a median of 180 (Moorhead 1976).

B. LATE 1970s RESEARCH

An intensive five-year study of mountain goats at Olympic was begun in 1977 by Stevens. Baseline information on goat habitat, potential habitat and population in relation to habitat was collected (Stevens 1979, 1980, 1982, 1983).

It was determined that there are three essential habitat requirements:

(1) open meadows with grasses and forbs for forage,

(2) rocky outcrops with bedding and kidding areas safe from predators, and

(3) micro-climates that assist in thermoregulation.

Examples of this last requirement are late-melting snowbanks, areas of fine-textured soils for wallowing, and north facing slopes, all of which aid the goats in cooling during the summer.

A second finding of note was that the size and density of mountain goat sub-populations is more dependent on characteristics of the habitat than on distance from original release sites or length of time an area has been populated by goats.

Driver et al initiated studies in 1976 on the effects of mountain goats on soils, on plant communities and on three special plant species. These studies once again centered on Klahhane Ridge, but also included other areas of the Olympics with similar plant cover and low goat use.

The soil studies clearly showed that goats cause extensive exposure of bare mineral soil by wallowing. Further, wallows are associated with downslope movement of soil where up to 40 tons of soil have been displaced from a single wallow.

The study of plant communities showed that goat wallows are surrounded by such disturbance-oriented plants as common yarrow, sand-dwelling wallflower, narrow-sepaled phacelia and western wormwood. In the absence of wallows, these communities would be dominated by spreading phlox and Idaho fescue. Conditions of disturbance caused by the goats (exposure of bare mineral soil and wallows) prohibit the invasion of "normal" phlox-fescue community dominants (Reid, 1983). In addition, grazing by goats is associated with reduced leaf length of many plant species. Several species exhibited greater leaf length, flower height, earlier flowering and increased vigor when protected by goat exclosures (Pfitsch, 1981). The removal of plant parts, particularly leaves and seed heads, has a secondary effect on all other creatures that are dependent on that particular plant. Seed eating birds, small mammals and insects all have need for these same plants. Endemic species including Piper's bellflower and Olympic Mt. groundsel are

consumed by goats (Pike, 1981). One plant, Olympic Mt. aster, found only on Vancouver Island and in the Olympics, also is consumed. While there is no apparent danger that these species will be extirpated, their leaf length, flower production and productivity are significantly reduced by goats. In a low goat use area (Tyler Peak), plant communities containing the bell-flower and the senecio had significantly greater total cover and nonvascular plant cover (mosses and lichens) than a high goat use area (Klahhane Ridge).

C. EXPERIMENTAL MANAGEMENT

In 1981, the park embarked on a five-year experimental management program. This program, combining several research goals with the most extensive capture and removal program to date, included live capture and removal of 50 to 60 goats per year, some biological collecting (by shooting) for research purposes, experimentation with capture methods, and experimental sterilization of goats. The research portion of the experimental management program has focused on four major areas of interest:

(1) population studies, including density, numbers, trends and distribution

(2) monitoring the effects of lowered goat densities on vegetation and soils

(3) sterilization as a means of population control

(4) relative efficiency and cost of various capture and removal techniques

1. Population. Based on a 1983 census conducted by helicopter, about 1,175 mountain goats inhabit the Olympic Range (Houston, Moorhead & Olson 1986). Of these, about 1,000 (85%) occur in the park. Almost all of the park's alpine and subalpine areas are occupied by goats during

the summer (Figure 2). Goats use between 30% and 40% of the park's 922,000 acres as a year-round range.

Population trends are difficult to determine. There are few indications, however, of significant declines in unmanipulated portions of the population. Most subpopulations appear to be stable in number, except where experimental trapping has taken place. Overall, mountain goats occurring within the park are in good health. Predators do not appear to be a major cause of mortality. Most mortality is likely caused by avalanches, falls, old age, severe winters or a combination of these factors.

On Klahhane Ridge, an area chosen for its accessibility and high population density, goats were removed experimentally over a four-year period (1981-1984). The purpose of the project was to measure the population's response to reduced numbers (i.e., rebound ability). Live trapping was used to remove 183 goats from an initial population of 230. The early summer population of 1985 was about 36 goats. Preliminary analysis suggests that growth rates of yearlings, two-year olds and three-year olds increased as the overall population was reduced. The proportion of twin births increased somewhat. Overall, the population has shown very little response to reduction (i.e., birth rates have not increased dramatically).

2. Vegetation. The mountain goat is well adapted to life in the park's most fragile ecosystems, the subalpine and alpine areas. Unfortunately, these ecosystems are not as well adapted to the presence of goats. Because of the short growing season, low plant productivity, shallow soils and extreme climatic conditions, these high elevation areas of the park are especially susceptible to modification. Such factors tend to magnify changes in the landscape brought about by the goats. Since conditions

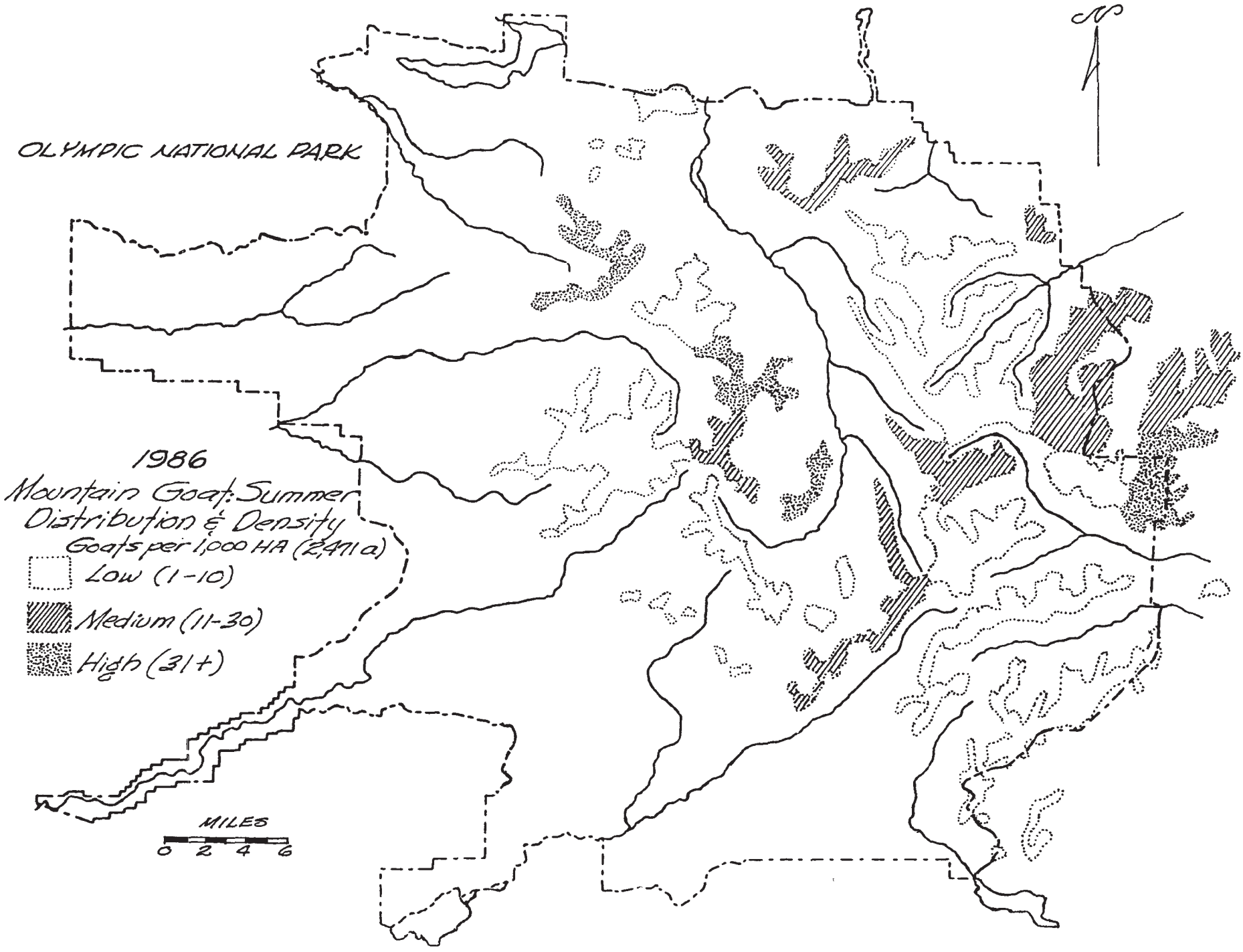

OLYMPIC NATIONAL PARK
1986
Mountain Goat: Summer
Distribution & Density
Goats per 1,000 HA (2,471 a)
Low (1-10)
Medium (11-30)
High (31+)
MILES
0 2 4 6

Figure 2

prior to the introduction of goats cannot be well documented, the effects of these animals have to be determined in a reverse fashion; e.g., by studying the response of plants and soils to the removal of 183 goats.

Studies begun in 1981 by the park staff of goat impacts on Klahhane Ridge are continuing. Such factors as plant community composition, total plant cover, status of endemics, seedling invasion, and soil erosion are being measured.

Mountain goat exclosure plots established by Pfitsch in 1980 were re-examined in 1983, 1984 and 1985 to determine if measurable changes in vegetation had occurred. Goat densities in plots outside the exclosures also changed as a result of removing 183 goats and these plots, used as controls, were also examined. In general, vegetation responded positively to exclusion of goats. Sites with initially high levels of goat use exhibited more recovery than the sites with moderate or low goat use.

Complete removal of goats (by fenced exclosures) had the most beneficial effect on vegetation. With goat use eliminated, yarrow, a disturbance-oriented plant species, lost 50% to 66% of its cover inside three exclosures, but did not change outside where goat presence was merely reduced. Data from an exclosure in "preferred" goat habitat showed that Idaho fescue, a preferred forage species, assumed community dominance over disturbance-oriented species, including Yarrow and edible thistle. Outside this exclosure, very little recovery occurred (i.e., disturbance-oriented species still dominated), indicating that only 36 goats remaining on Klahhane Ridge still had a significant influence on vegetation.

PLATE 1

LOCATION:

In the "North Cirque", headwaters of Ennis Creek along the trail to Heather Park between Klahhane Ridge and Second Divide.

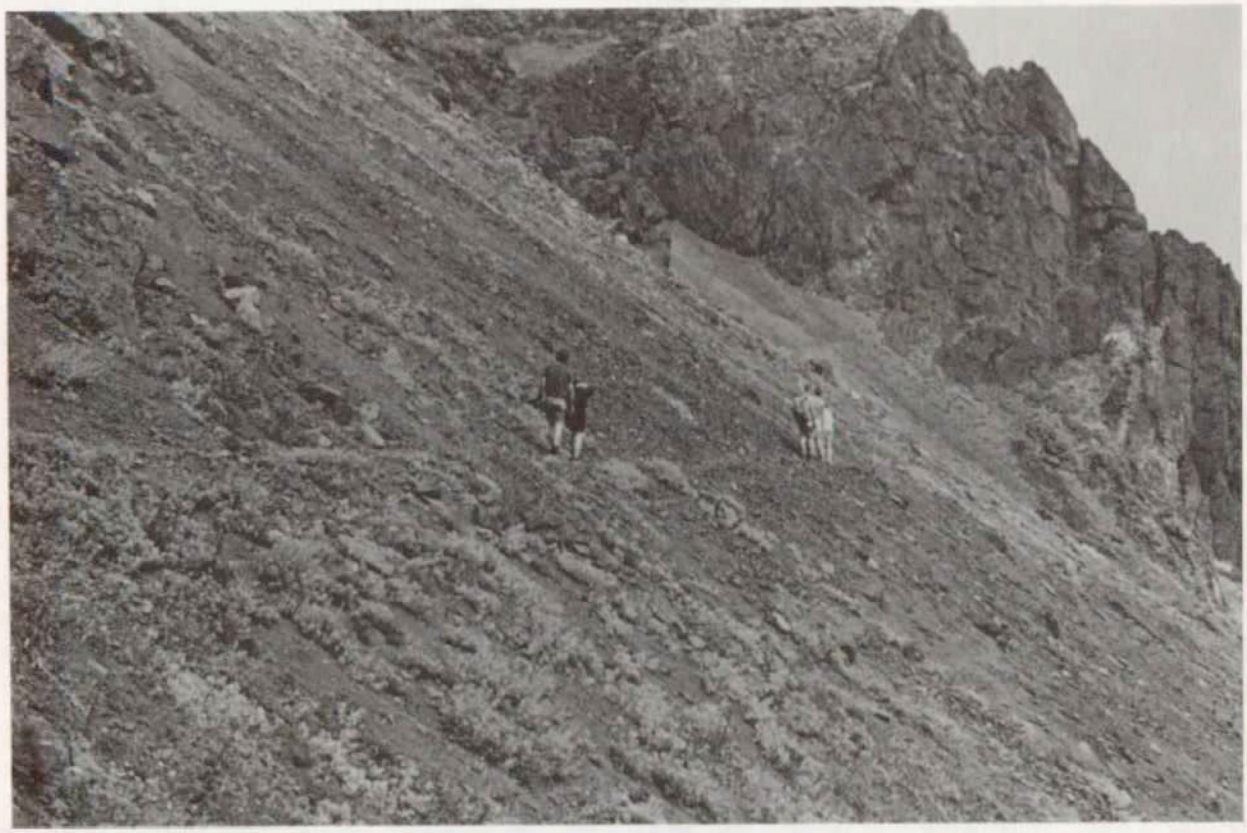
PHOTOGRAPHS:

Top, B. B. Moorhead, August 27, 1970

Bottom, E. Schreiner, D. B. Houston, August 12, 1981

VEGETATIVE CHANGES:

Foreground and left foregound show loss of most western wormwood (pale colored clumps). The site is regularly inhabited by goats. Trampling and grazing have produced this substantial reduction of plant cover. Western wormwood is a preferred goat forage species in this area.



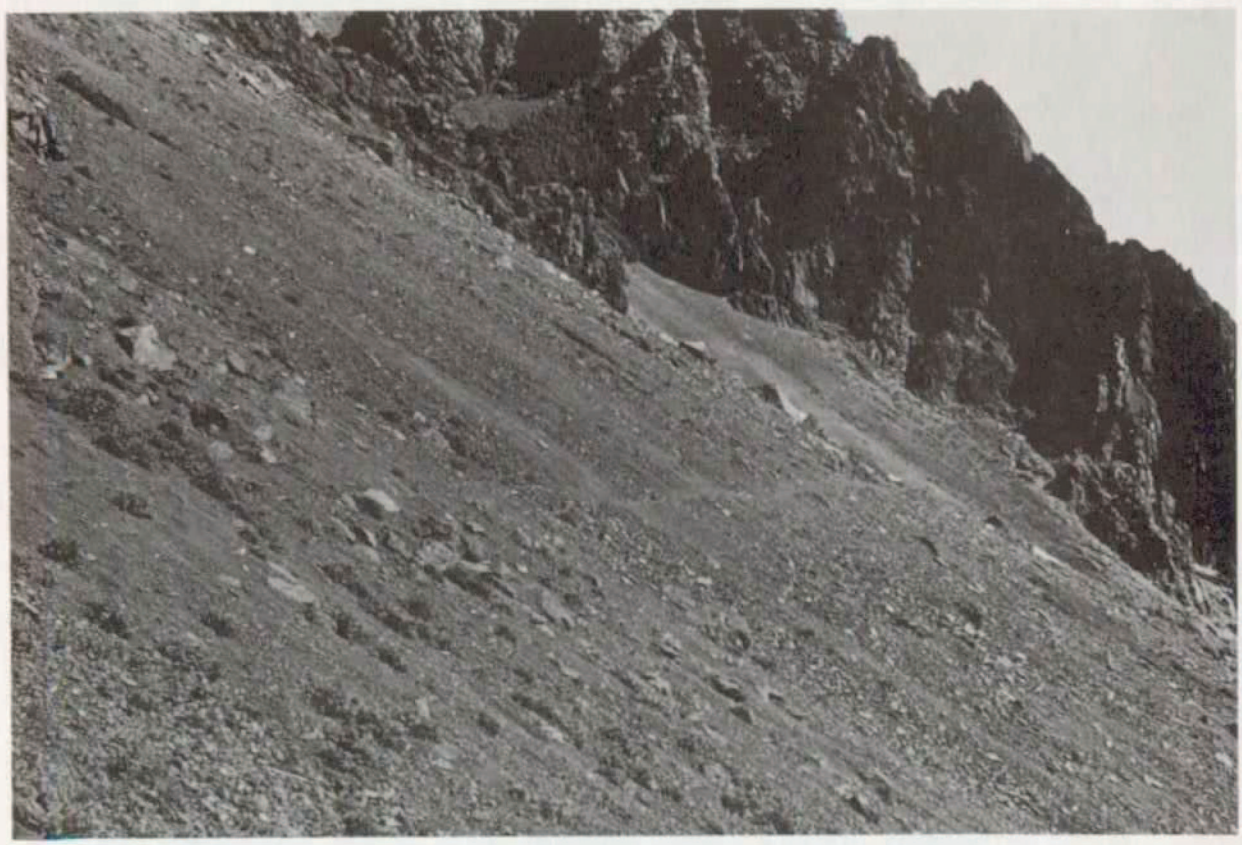


PLATE 2

LOCATION:

Lower "Big South Meadow" on Klahhane Ridge. Same as next two photographs.

PHOTOGRAPHS:

Top, J. Harter, October 20, 1981

Bottom, E. Schreiner, October 7, 1983

VEGETATIVE CHANGES:

Foreground shows the invasion of "weedy" species into the lower end of a goat wallow. The process of recovery begins slowly.

Center background shows essentially no recovery.



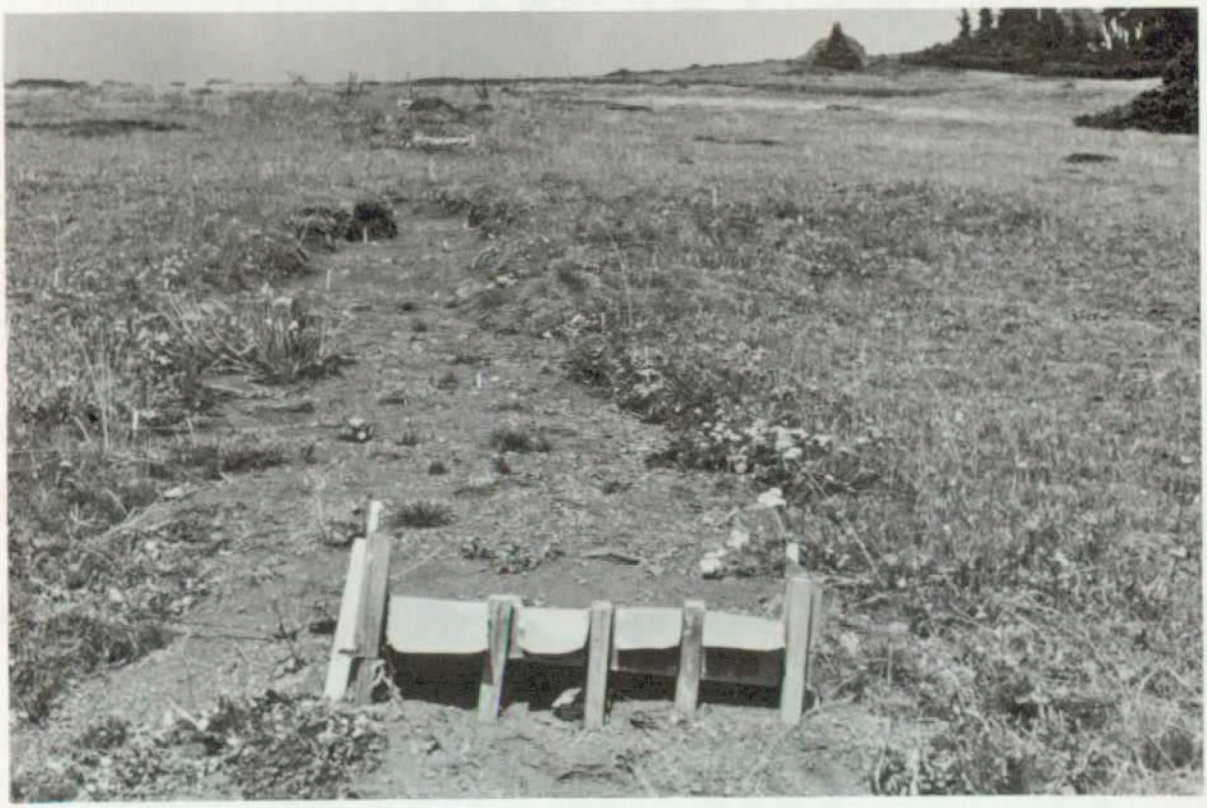


PLATE 3

LOCATION:

Lower "Big South Meadow" on Klahhane Ridge. Same as previous two photographs.

PHOTOGRAPHS:

Top, E. Schreiner, October 7, 1983

Bottom, J. E. Burger, September 24, 1985

VEGETATIVE CHANGES:

Foreground shows considerable invasion of Idaho fescue over a two-year period. This wallow is no longer used by goats.

Center background shows slower recovery of the steep edges of this wallow. The cut edges of the wallow will be visible for 25-50 years.

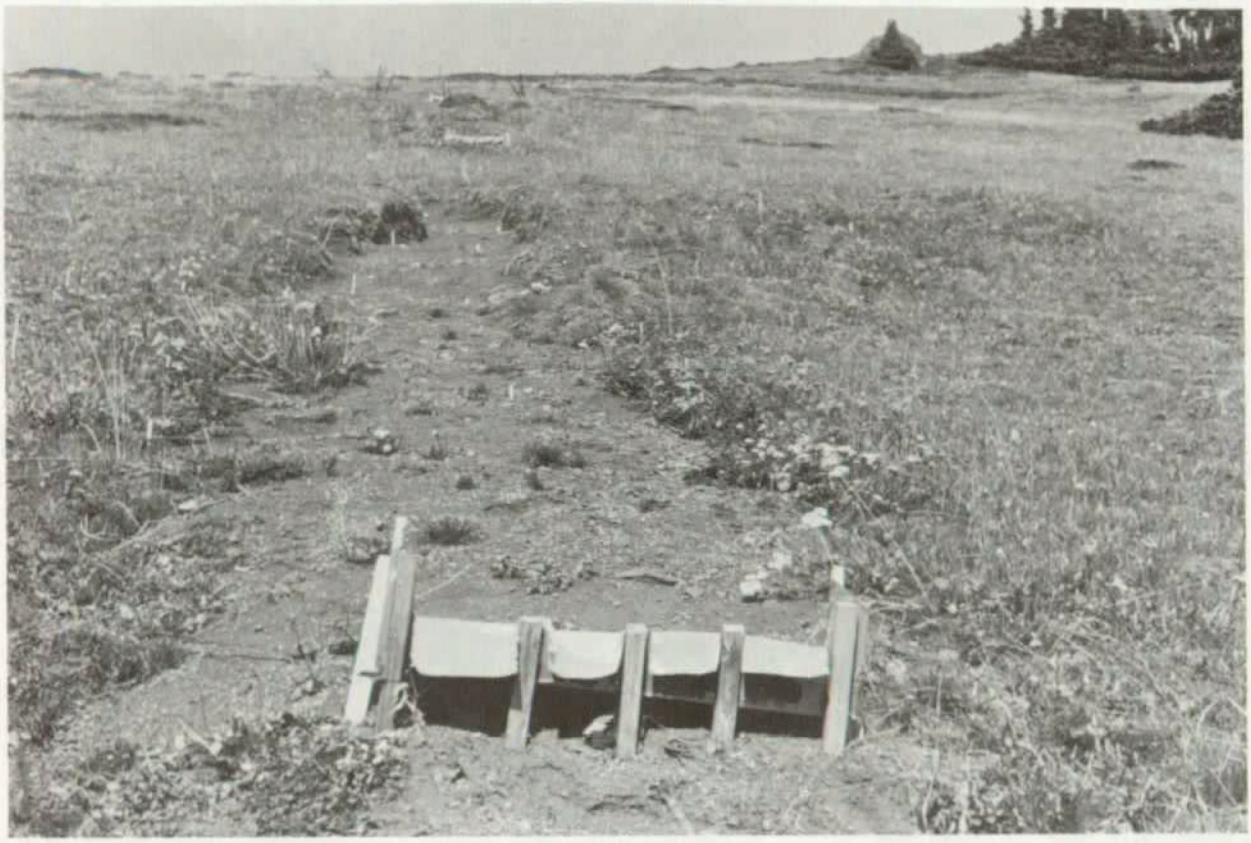




PLATE 4

LOCATION:

Klahhane Ridge, north of the Heather Park/Lake Angeles/Hurricane Ridge Trail junction.

PHOTOGRAPHS:

Top, J. W. Thompson, about 1963

Bottom, E. Schreiner, August 26, 1982

VEGETATIVE CHANGES:

Foreground shows considerable loss of plants as well as soil due to goat grazing and trampling.





PLATE 5

LOCATION:

Klahhane Ridge

PHOTOGRAPHS:

Top, L. Lack, about 1965

Bottom, D. B. Houston, August 12, 1981

VEGETATIVE CHANGES:

Foreground shows a general loss of plant cover due to mountain goat use.

Left of center shows a wallow created by goats and an increase in exposed bare mineral soil. Some soil loss may have occurred. Considerable numbers of plants have been eliminated.





PLATE 6

LOCATION:

Klahhane Ridge

PHOTOGRAPHS:

Top, B. B. Moorhead, August, 1970

Bottom, J. E. Burger, July 16, 1985

VEGETATIVE CHANGES:

Foreground shows increased cover of Merten's mountain heather (white flowers) in an area formerly used by goats.

Right background shows recovery of a talus slope. Trails and wallows visible in 1970 were no longer visible in 1985.

COMMENTS:

The 1970 photograph was taken during a time when goat densities on Klahhane Ridge were high. The 1985 picture illustrates some recovery of trails and wallows following the goat reductions from 1981-1984.

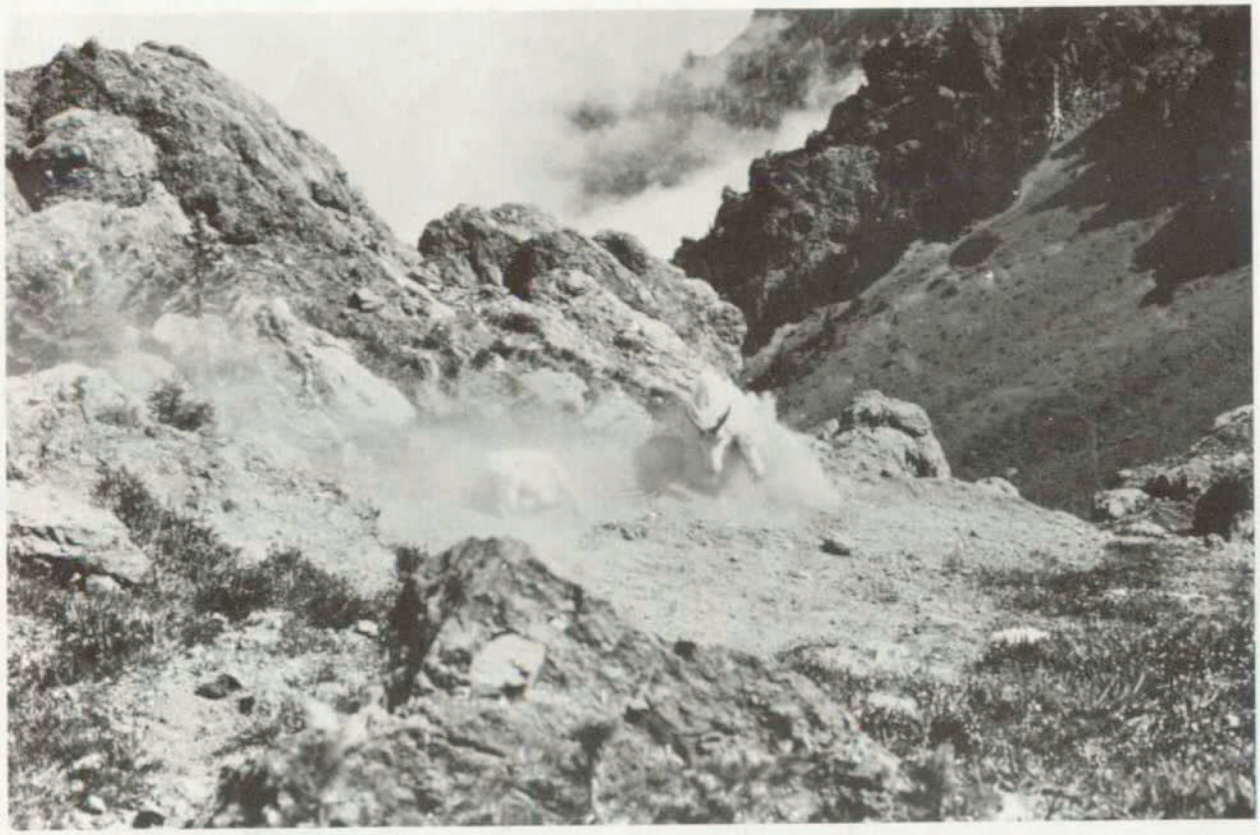




PLATE 7

LOCATION:

Klahhane Ridge, view of the Heather Park/Hurricane Ridge/Lake Angeles Trail junction from the east.

PHOTOGRAPHS:

B. B. Moorhead, July 20, 1970

D. B. Houston, August 12, 1981

VEGETATIVE CHANGES:

Foreground shows some loss of plant cover, mostly common juniper. Goats are probably responsible. The disturbance-oriented species, common yarrow, is more evident.

Left of center near the tree clump shows loss of common juniper and a more evident trail, probably due to goats.

Left background shows considerable loss of plant cover and increased exposure of bare mineral soil. This is a favorite resting place of visitors and is also frequented by goats.





PLATE 8

LOCATION:

Goat wallows at the east end of Klahhane Ridge near where the trail heads north into the Lake Angeles cirque. The site is referred to by some as "The Big Blowout". Same scene as the next two photos.

PHOTOGRAPHS:

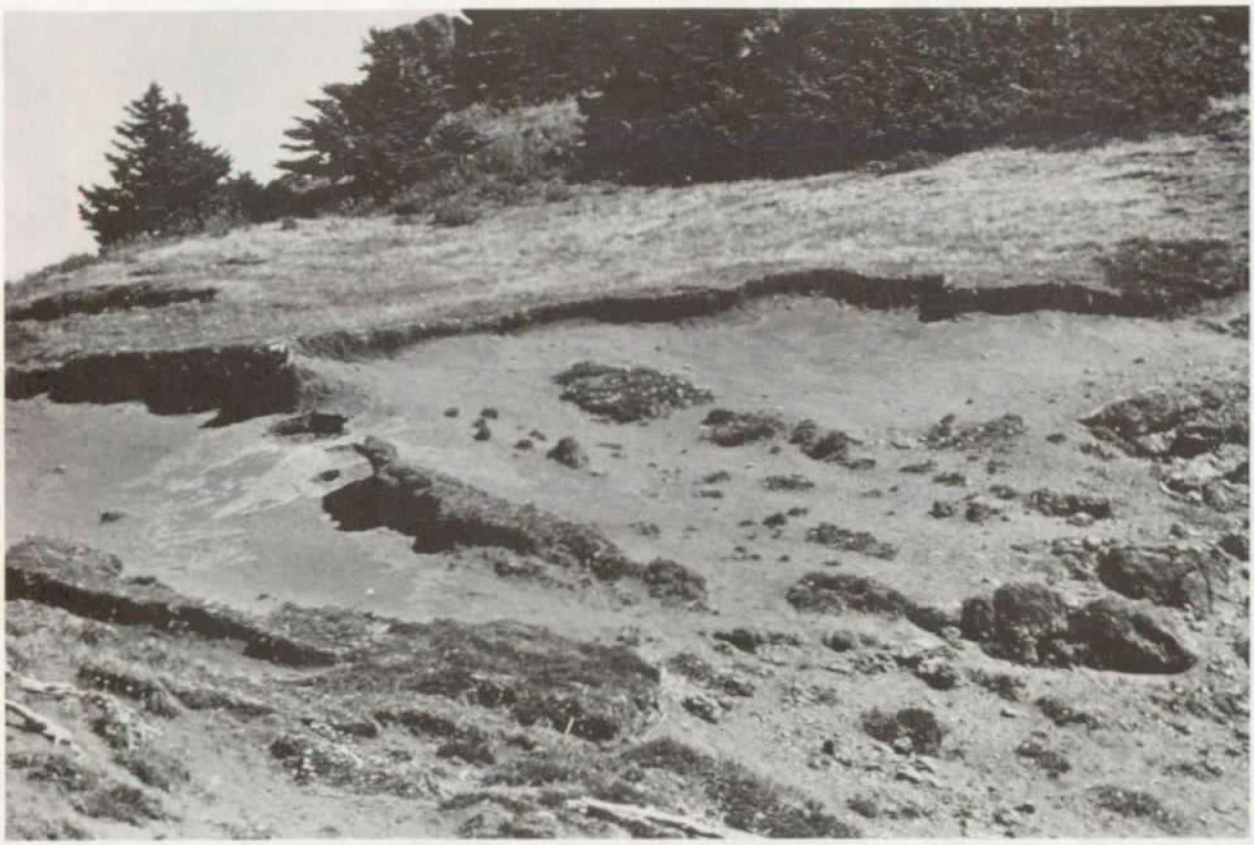
Top, L. Lack, September, 1967

Bottom, B. B. Moorhead, August, 1974

VEGETATIVE CHANGES:

Foreground shows general loss of plant clumps and expansion of a goat wallow.

Center shows loss of large areas of vegetated turf and the general receding of the wallow edge.



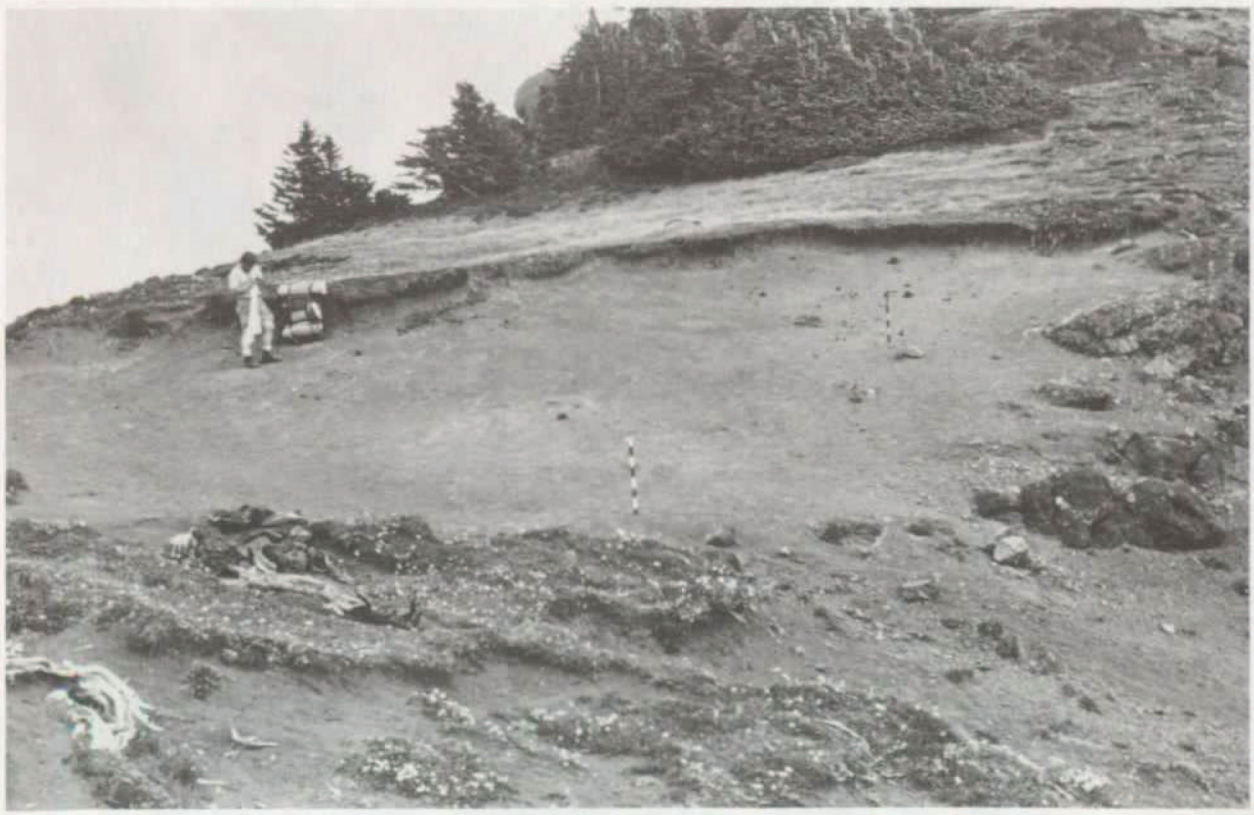


PLATE 9

LOCATION:

Goat wallow at the east end of Klahhane Ridge near where the trail heads north toward Lake Angeles. The site is referred to by some as "The Big Blowout". Same scene as the previous two photos.

PHOTOGRAPHS:

Top, B. B. Moorhead, August, 1974

Bottom, D. B. Houston, August 21, 1982

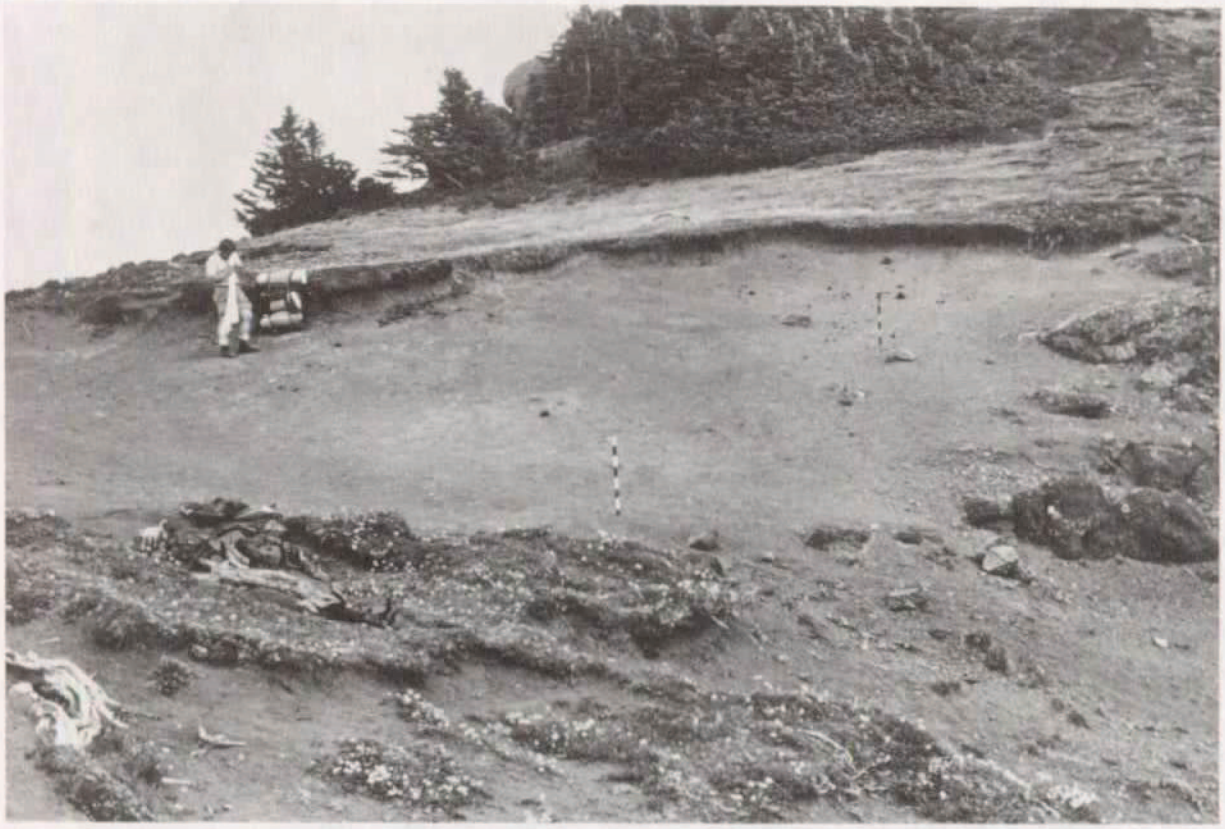
VEGETATIVE CHANGES:

Foreground shows a general loss of plant clumps and increased exposure of rocks due to soil erosion. The area is used extensively by goats for wallowing.

Right center shows increased exposure of rocks due to soil erosion.

COMMENTS:

This blowout originated as a goat wallow. The continued loss of vegetation and soil, however, is a function of wind erosion as well as wallowing by goats. Revegetation and soil stabilization would be required to stop erosion, even in the absence of goats.





Measurements on 19 plots, where goat use was lowered but not eliminated, show that the effects of lower goat density were measurable in some cases and not in others. Vegetation responded similarly to elimination of goats by exclosures, but the results were less pronounced. In low goat use sites, exclusion of goats resulted in a small measurable change, while lower goat densities did not measurably affect vegetation. In high goat use areas the lower goat density was detectable in terms of the total proportion of plant species grazed. And, significant goat use was still measurable after the population had been reduced by about 80%.

A recent survey of an Olympic endemic plant, Olympic Mt. milkvetch, listed as threatened by the State of Washington and proposed for the Federal List of Endangered Species, shows that some subpopulations of this plant may be locally extirpated by goats. Eleven subpopulations of this species have been identified, all occurring between Hurricane Hill and Deer Park. All but three subpopulations occur in areas routinely used by goats. A comparison of an area recently invaded by goats (Deer Park) with an area long used by goats (Mount Angeles) shows that Cotton's milkvetch occurs with one-third the density and percent cover in the Mount Angeles area. A careful examination of environmental data suggests that the most probable reason for the difference is the history of goat use. This argument is strengthened by the fact that Idaho fescue, a plant preferred by goats, is virtually absent from Mount Angeles plots while it is an important component of Blue Mountain plots. Permanent plots show loss of some plants occurred between 1985 and 1986.

There is some evidence that mountain goats compete with other animal species in the Olympics. Wood (1973), for example, notes that the Olympic Marmot prefers to eat Idaho fescue, American bistort, harebell, lupine, sandroot,

catchfly, showy sedge, tiger lily, arnica, avalanche lily and magenta painted cup. Mountain goats in the same general area also prefer Idaho fescue, American bistort, harebell, catchfly and showy sedge. Observations in the Klahhane Ridge area also suggest some diet overlaps between deer and goats.

Numerous small mammal, bird and invertebrate species depend on particular vegetation structures for food and cover. Since goats alter both vegetation structure and composition, it is suspected that other animal populations dependent on "pre-goat" vegetation have also had their numbers altered by goats. However, no specific studies were conducted to identify or measure specific changes.

3. Soils. 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 park's 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 erosion. 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 to 30 feet in diameter and up to 3 feet deep are common on Klahhane Ridge. From one such large wallow, 40 tons of soil have been displaced. The average loss from seven other wallows was 1.3 tons. More than 70 wallows were found in one 10-acre area on Klahhane Ridge. Wallows are common features in goat habitat elsewhere throughout the park.

Lower goat density on Klahhane Ridge has been associated with some recovery of wallows (see Plates 2 and 3). Wallow measurements, however, show that some wallows are still used by goats. In these cases, erosion continues and invasion by plants is essentially nil. It has been observed that use of a wallow by only one goat effectively prevents plant recovery.

4. Sterilization. Sterilization techniques have been field tested on mountain goats since 1982. A research program to monitor treated animals and analyze the effectiveness of various management options was completed in 1987 (Hoffman & Wright, 1987). Nineteen mountain goats, 13 female and 6 male, have been treated. Procedures tested range from permanent to temporary in their effect. Permanent methods tested include tubal ligation of females (2 animals) and vasectomy of males (6 animals). Techniques which require intensive surgery, such as tubal ligation, have been found to be impractical for general field use.

Temporary sterilization of female goats, by skin implants of the pregnancy inhibiting drug MGA, has been the principal procedure tested. Eleven animals have been treated and monitored for three to five years. Results in 1985 indicated a 50% decline in the reproductive rate of a test sub-population, where 60% to 70% of the adult females had been treated. Length of the drug effect is apparently three to four years with 90% effectiveness. Difficulties in selective capture of enough females in remote locations, and with a likely need to repeat the treatment periodically, suggest that this technique will have only limited practical application.

Each of the sterilization procedures tested so far requires a reliable and efficient method of capture to apply the treatment. Capture of free-ranging mountain goats has been found to be difficult, costly and

unpredictable. A sterilization technique that requires nonselective capture and treatment of animals, i.e., young and old of either sex, would have the best likelihood of being applied under these circumstances. An ideal treatment would be deliverable rapidly (as by remote injection from a helicopter), would be effective with either sex, would be permanent or of at least five years' duration and would elicit few side effects or apparent behavioral changes. Thus far, no such treatment is available.

The effectiveness of sterilization was also tested by computer simulations. Information on age classes, longevity, sex ratios, reproduction rates, population densities, etc. were modelled in combination with different sterilization rates. With random sterilization, significant population reduction could occur if more than 50 goats were removed from the breeding population each year for 30 consecutive years. If 75-100 animals (male and female) could be systematically sterilized, unit by unit, throughout the park each year, it is estimated that 15 years would be required to essentially eliminate the goat population. Anything less than 20 animals per year would not produce a declining population. In all simulations, total elimination was projected as virtually impossible. A residual population would probably continue to evade capture/sterilization.

5. Capture. Large amounts of time, effort and funds have been used over the past five years in determining the feasibility of six capture techniques. While all live removal methods worked to some degree, none singly or in combination demonstrated the potential to substantially effect the entire park's goat problem. With each technique, success depended on a very narrow range of conditions. All were severely restricted by terrain, weather, safety and goat behavior.

Shooting was tested on a very limited scale since its effectiveness is well documented by a variety of wildlife control programs worldwide. Thirteen animals have been taken in the last five years for biological examination, and a simulated shooting experiment was conducted in 1983.

Computer simulations were also generated for a range of removal rates. If it were possible to remove 60 animals each year, the population could be virtually eliminated in 25 years. Removing 25 goats each year results in operations continuing for 60 to 125 years.

Capture techniques evaluated include:

a. Foot snare at baited site: Goats are attracted to a salt bait, step into a hand-operated rope snare and are caught by one leg. One person maintains rope tension while a second person subdues the animal. Analysis: While usable in any weather and with only slight hazard to goats and personnel, it is limited to subpopulations that are already highly habituated to humans. Attempts to bait animals at other locations have been generally unsuccessful.

b. Drop net on baited site: A large (40' x 40') net is suspended in circus tent fashion over the bait. While animals are beneath it, the net is dropped. Analysis: Has been used with excellent success on Klahhane Ridge. Widespread application requires large, habituated groups of goats plus a large capture crew. The technique is further limited by extensive preparation and logistical requirements. Few suitable capture sites occur in the park. Mountain goats are attracted to salt as a bait for only a 6-8 week period, creating a narrow window of opportunity each year.

c. Drive net: Linear nets 8 feet high, 80 feet long and supported by 9-foot poles are erected across escape routes. Goats are herded by helicopter into the net where they become entangled. Analysis: Good in theory, but not successful in practice due to "uncooperative" goat behavior; requirement for extensive knowledge of goat travel routes. Rugged terrain and safety of personnel are major factors.

d. Net gun: Deployed from either the ground or from helicopters, a 150 square foot net, either three or four sided, is shot from a three- or four-barreled gun. After deployment on a single goat, the animal is restrained. Analysis: Effectiveness is restricted by terrain, safety considerations for the animals and safety for the shooting team. Aerial deployment tested in 1985 by an experienced contractor showed the technique to be useful in good weather, on moderate terrain.

e. Chemical immobilization: Either from the ground or from a helicopter, a dart containing Etorphine (M99) is shot from a darting rifle. After an induction time of 5 to 12 minutes, the animal is caught and restrained. A reversal drug (M50-50) can be administered at any time, rapidly countering the effect of the M99. Analysis: An excellent capture technique for selected individuals in accessible terrain. M99 is extremely hazardous to humans; extensive and tedious safety precautions are mandatory.

f. Shooting: Goats are shot with rifles either from helicopters or from the ground. Analysis: The effectiveness of shooting cannot be approached by any other technique. It is adaptable to all habitats and terrain, logistical problems are minimal, hazards to personnel are low, and it is very cost effective.

IV. NEED FOR THE PROPOSAL

Mountain goats are causing significant changes in the vegetation patterns and soils throughout the alpine zones of Olympic National Park. While some areas are more heavily impacted than others, the effects of goats on many alpine and subalpine areas are noticeable even where smaller subpopulations are found. The current population within the park of about 1,000 goats is continuing to increase. If no action is taken to control or eliminate them, the changes will continue and result in permanent alteration of Olympic's alpine ecosystem. The research conducted during the past several years, however, has demonstrated that if goats are removed now, the alpine plant communities will recover.

The actions being proposed (except for the no-action alternative) are intended to slow or stop soil erosion caused by goats and to allow native plants to reestablish the patterns and composition that existed prior to the influence of mountain goats.

V. MANAGEMENT ALTERNATIVES

The management of mountain goats in Olympic National Park requires discussion of both "what" to do and "how" to go about it. This section will deal with the alternatives of "what" to do about the goat issue. Methods will be discussed in Section VII.

Alternatives range from allowing present conditions to continue (no action), through control, elimination/control mix and total elimination possibilities. All of these alternatives confine management actions exclusively to Olympic National Park.

A. NO ACTION--ACCEPT GOAT POPULATIONS

The present courses of action, trends and conditions would be continued.

Under this alternative, mountain goats would be considered as new and permanent constituents of park ecosystems, the so-called "naturalized" concept. Goats would be allowed to establish a geographic distribution, population densities, population numbers and all other ecological relationships without human interference or manipulation in the park. Park management would not attempt to mitigate any goat-induced changes in the ecosystem.

Park supported research and monitoring of goat ecology would continue. Live capture of a few animals and some biological collection would be accomplished to meet research requirements. Continued research and monitoring is desirable because (1) the goats at Olympic present an excellent opportunity to study the effects of an introduced herbivore on an otherwise pristine environment, and (2) the continued gathering of pertinent data would be necessary in order to make informed management decisions in the future.

B. CONTROL

The objective of this alternative would be to achieve some recovery of vegetation by reducing each subpopulation by 70-80%, parkwide. By reducing but not eliminating each subpopulation, there would be required "maintenance" on a a cyclic basis into the foreseeable future.

This alternative accepts the fact of goat impact and continual change in plant composition. The monitoring program would be continued, with removals on at least a biennial basis. Any goat-free areas would be maintained in that condition.

This control process would start in the core of the park and progress toward the periphery. The program would become an integral part of park operations and would continue indefinitely.

C. PREFERRED MANAGEMENT ALTERNATIVE:

MAKE CORE GOAT-FREE/CONTROL NUMBERS ON PERIPHERY

The objective of this alternative would be to control numbers of goats in some areas and eliminate them in the majority of the park. It would achieve the result of restoring alpine vegetation types over time in those areas without goats (made goat free) and mitigate goat effects in other areas where the number was reduced.

While it is technically feasible to remove goats, the population distribution inside, and more important outside the park, limits the ability to make the park goat free. The difficulty is most acute along the eastern boundary of the park where mountain goats in the adjacent national forest are managed to maintain a population large enough to sustain an annual sport hunt. The mountainous terrain and widespread presence of goats along the eastern portion of the peninsula offers numerous situations where animals can freely move in and out of the park.

The preferred alternative is to remove all mountain goats from the interior core of the park and to establish a control program in those subpopulations along the eastern boundary and inside the park, parallelling the U.S. Forest Service wilderness areas. The removal of goats from the park's core would be a primary focus during the first phase of the program.

This alternative would require research and monitoring to achieve the control levels and a long-term removal program to maintain the prescribed numbers in

the control zones. In the core area, study plots would be established to monitor environmental change. Approximately 800 animals from the park's core and 100 of some 200 occurring near the eastern park boundary would be removed. Under this alternative about 77% of the area presently occupied by goats eventually would be restored to the type of alpine vegetation patterns that existed before goats moved into the area.

The program for establishing the level of control on mountain goat subpopulations inhabiting the eastern periphery would be developed by the park, along with the Washington Department of Wildlife and Olympic National Forest. Goat populations along the eastern boundary would be managed to maintain a huntable population of goats outside the park while reducing the number of goats in peripheral subpopulations to a level that significantly reverses environmental damage now evident in these areas and inhibits reintroduction to the park core.

A technical advisory committee would be established to monitor the mountain goat management program. The committee would include representatives from major interest groups and agencies involved in this issue. This includes representatives from organizations such as Olympic National Forest, Washington Department of Wildlife, Olympic Park Associates, Fund for Animals, Washington State Sportsmen's Council, Native Plant Society, and the Pacific Northwest Region of the NPS. This group would meet periodically to review the results of the program and make recommendations on possible program modifications. The committee would also serve as an important liaison with interested organizations and agencies.

It is estimated that the control areas could be brought to a maintenance level within 10 years by a variety of methods. Removal of any excess animals from control areas could then be accomplished on an alternate year

basis. Depending on methods used, elimination of goats from the core areas to be made completely goat-free would take from five to thirty years. No goats would be moved and released again on the Olympic Peninsula, such as live trapping in the core and moving to control areas or to areas outside the park. All live-trapped animals would be turned over to the Washington Department of Wildlife for release in native habitat areas in Washington State or provided to other states for release in native range.

D. ELIMINATION--TOTAL REMOVAL OF GOATS FROM PARK

Goats would be totally eliminated from Olympic National Park under this alternative. By systematically removing animals from the park's central areas and working toward the boundary, habitats would become goat-free. Animals missed during initial operations would be removed as they are found and/or when it is logistically practical. Two or three sites would be established as study areas for the purpose of measuring vegetation recovery and other effects as goats are removed. Aside from a monitoring program keyed to these sites, no formal research projects are anticipated.

Depending on the methods used in removing the animals, the elimination of goats from Olympic National Park could be accomplished in five to thirty years.

E. OTHER ALTERNATIVES

Among the removal options not discussed because of violation of existing federal laws, being counter to National Park Service policy, questionable effectiveness, or simply too costly were: opening the park to public hunting, the use of biocides, introduction of predators, and fencing key boundary areas.

VI. ENVIRONMENTAL CONSEQUENCES OF MANAGEMENT ALTERNATIVES

A. NO ACTION

1. Impacts on the ecosystem: Alteration of vegetation by wallowing would continue as goat populations increase. As distribution and densities of subpopulations reach equilibrium, vegetation impacts would tend to stabilize at different levels from those that existed in the past. No immediate threat of parkwide extinction of endemic plant species would be likely, but primary productivity and flower production would continue to be reduced by grazing and some localized subpopulations of plants could be eliminated. Plant species preferred by goats would continue to decrease in overall cover, and invasion by disturbance-oriented species which are generally uncharacteristic of the natural community would increase until a new and different equilibrium occurred. The variation of colors in flowering plants would be reduced toward a more homogenous color, tending toward white.

The rate of soil erosion would continue to mount, as would the overall amount of bare mineral soil. The size of wallows would increase and new wallows would appear as goats become established in new areas.

2. Impacts on human use and enjoyment: Opportunities would continue for visitors to view and photograph mountain goats easily in an outdoor setting. Such opportunities would increase in both frontcountry and backcountry locations.

Particularly in backcountry settings, some visitors would be disturbed or frightened by the nuisance of close, threatening and unwelcome encounters with goats. Goats which have become habituated to the presence of humans often display aggression while seeking salt (which

they associate with human foods, sweat and urine). This aggression can be intimidating if not dangerous and can adversely affect the quality of a park experience.

Some visitors would continue to be disturbed by the altered, nonpristine ecosystem. This would be especially true of biological scientists who view national parks as exceptional and ideal places in which to do research in undisturbed, naturally-functioning ecosystems.

3. Impacts on other agencies: Goat hunting managed by the Washington State Department of Wildlife outside the park would be enhanced. As the park population of 1,000 continued to grow, the huntable subpopulations outside the boundaries would be augmented. It is also possible that with a continuous resupply of goats coming from the park, the state could begin its own capture and transplant program using goats from Olympic National Forest to stock other areas of the state. Removal methods would necessarily have to be in concert with laws and policies governing Wilderness Areas on National Forests.

Legislation enacted in 1984 designated much of the Olympic National Forest land adjacent to the east park boundary as wilderness. Most of the higher elevation portions of this new wilderness are now goat habitat. U.S. Forest Service policy does not require the removal of exotic species from designated wilderness areas, but it prohibits the introduction of new species and discourages any activities that would tend to enhance populations of already established exotics. A recent Wildlife Department program of attracting goats out of the park with salt baiting has been stopped, and Forest Service policy discourages any methods used to encourage the migration of goats into Forest Service Wilderness Areas.

4. Costs: Of any of the alternatives, this would be, by far, the least expensive. There would be no long-term commitment to a costly management program. The costs of a nominal research and monitoring program would be modest.

B. CONTROL

1. Impacts on the ecosystem: Ecosystem alterations would be reduced and/or arrested at a certain level, but, with minor exception, never eliminated entirely. It is assumed that there would be a substantial reduction in the rates of wallow enlargement and development, destruction of vegetation and soil erosion. Eventually, these changes would stabilize within each management unit. Some units would exhibit more impacts than others because control would be based on a broad reduction of 70-80% of current populations and not specific environmental criteria. Impacts found in the "peripheral zone" would generally be more severe than those exhibited in core areas until the entire park had been stabilized at reduced levels.

In spite of their reduced presence, mountain goats would remain as an introduced species, thus creating a permanently altered environment. Aesthetic and scientific values, although relieved of some pressure by the diminished presence of goats, would continue to be significantly compromised.

Helicopters would be used extensively regardless of the method selected. Impacts are more specifically addressed under removal alternatives.

2. Impacts on human use and enjoyment: Opportunities for viewing would be significantly reduced and require more effort on the part of

the visitor. Adverse goat/human interactions would continue at a somewhat reduced frequency with more potential for such in the park's peripheral areas.

3. Impacts on other agencies: Reducing peripheral subpopulations by as much as 50% may cause a decrease in mountain goat numbers outside the park. It is possible that a reduction in goat numbers along the boundary may produce a less than viable population from a hunting perspective. Harvest from the three units along the park's eastern margins averages about 8 animals per year. This yield is from a total population of about 200 goats. There is no evidence to suggest that habitat outside the park is of less quality than that available inside the park.

If nonpark mountain goats are attracted into the park by vacated habitat, the effect would benefit the Olympic National Forest in its wilderness management goals of discouraging the spread of exotic species. There would also be less goat induced stress to the habitat, including pressure on endemic plant species.

The removal of goats from the park's interior areas would probably have little, if any, effect on neighboring subpopulations.

4. Costs: The costs of a control program are directly related to the removal technique(s) that would be selected. Table 6 provides a simplified comparison of unit costs. Contrasted with other management strategies, a control program would require a long-term funding commitment. The maintenance of subpopulation levels would make annual funding essential.

C. MAKE CORE GOAT-FREE/CONTROL NUMBERS ON PERIPHERY

1. Impacts on the ecosystem: Under this alternative, natural conditions would be restored in about 107,000 acres of alpine and subalpine habitats. Peripheral areas would generally exhibit reduced impacts. Depending on the removal method(s) selected and the time frame for implementation, operations within the park's core could take from five to twenty-five years. Impacts would be more pronounced in the control areas and extend over an indefinite number of years. Impacts in the interior would be as described in alternative "D"--a gradual slowing, stabilization and eventual return to pre-goat status.

2. Impacts on human use and enjoyment: The opportunity to view goats would be restricted to the park's eastern and southeastern boundary areas. A major portion of the park's central area would eventually be restored to natural conditions thus, enhancing the aesthetic and scientific values of the landscape. Due to their migratory nature, goats located along the park boundary may sooner or later be harvested by hunters outside the park. The maintenance of a huntable population would be of direct benefit to the hunting public.

Helicopters would be used extensively in nearly all phases of the removal operations and could impact the wilderness character for at least three weeks each year.

3. Impacts on other agencies: Creating a central goat-free area within the park probably would have no measurable effect on the state's goat management program on the Peninsula.

The major issue would probably center around the determination of boundary subpopulation levels that would satisfy both NPS and Washington Department of Wildlife requirements. Setting levels that would simultaneously reduce environmental impacts in the park and maintain a huntable population outside the park will require a cooperative research effort.

4. Costs: As with previously discussed alternatives, costs are linked to removal techniques. The program would first deal with eliminating animals from the park's core. Once accomplished, some expense would be involved in maintaining the area goat-free. Peripheral areas would require a more complex and costly strategy over an indefinite period of time. The control program would become part of the park's annual operations, requiring an ongoing removal project and a variety of research and monitoring operations.

D. ELIMINATION--TOTAL REMOVAL OF GOATS FROM PARK

1. Impacts on the ecosystem: As goats are removed, the rate of disturbance to soils and plant communities would slow, stabilize and eventually reverse itself. Flower production in endemic species would slowly be restored to pre-goat levels. Removal of goats would allow plant invasion of bare areas. No new wallows would develop and the rate of soil erosion would diminish. Without remedial action, it is likely that the size of some existing wallows would continue to increase; once the erosive processes of wind and water begin to act in wallows, they tend to continue until an equilibrium is reached.

Depending on the removal technique(s) selected, elimination may require a time frame about equal to the control alternatives. Once goats are

completely removed, there would still be a need for an annual or bi-annual maintenance program to deal with goats migrating across the boundary.

2. Impacts on human use and enjoyment: As the removal of goats progresses, goats would be fewer in number and more wary of humans, thus decreasing opportunities for mountain goat observation and photography in the park. Eventually, no goats would be seen.

Helicopters would be used extensively in nearly all phases of the removal operations and could impact the wilderness character for at least three weeks each year.

3. Impacts on other agencies: The subpopulations of goats managed by the Washington Department of Wildlife could decline as goats inside the park are removed. As goats are removed from the park habitat, some of the "nonpark" goats might tend to drift into the park. A consequent loss of viewing and hunting opportunities outside the park may result, although Olympic Peninsula goat hunting represented about six percent of Washington goat harvest in 1986. To the extent that the live-capture technique is utilized, then goats transplanted from the park to other areas of the state could enhance populations in their native range and improve hunting opportunities.

Wildlife agencies from other states could benefit from the increased number of mountain goats available to help build up depleted stocks, and some goats might also become available to zoos.

4. Costs: Costs are directly related to the method(s) selected to remove the animals. Shooting is, in all instances, the least expensive means; live capture is invariably the most costly, due to equipment, personnel and relocation requirements. A long-term commitment would be required to maintain a goat-free area because of migration back into the park from outside areas.

VII. METHODS (THE "HOW TO")

All of the management alternatives, except for the no action, require some goat removal. Thus, this section addresses the various alternatives for how to remove goats. If "no action" is selected, then none of this methodology will apply.

As described earlier in this assessment, goats can be removed from the park in several ways. Each method has advantages and disadvantages regardless of the management alternative being considereed. See Table 6 for a comparison of the various methods in terms of safety, efficiency and other factors. This section on the "how to" of removing goats will discuss sterilization, capturing and shooting; the environmental consequences of each; and will be followed by a preferred alternative on methodology.

A. STERILIZATION

Both male and female goats can be made sterile in field procedures. Of the several methods tried, all require the animal to be captured and immobilized, at least for a short time.

Given the uncertain duration of effect, the widespread use of the temporary estrus inhibitor, MGA, is impractical. Unless a kid is closely associated

Table 6. Comparison of various experimental capture and population control techniques

Technique	Precapture Requirements	Selectivity	Multiple Capture	Safety Personnel	Safety Goats	Relative Efficiency[4]	Cost Per Animal
Foot Snare	Minimal	Good	No	Good	Good	Poor	$ 50-100[1]
Drop Net	Extensive	Good	Yes	Good	Good	Fair	300-500
Net Gun[2], 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	900-1100
Aerial Shooting[3]	Minimal	Excellent	N/A	Good	N/A	Good	30-50

Notes: [1]--Excludes transportation costs. Technique used only for marking and sterilization.
[2]--Data based on capture of a single animal on Mt. Dana with net gun by ground team.
[3]--Data based on collection of biological specimens on Mt. Dana and Appleton and simulated aerial shooting on Mt. Dana.
[4]--Number of captures per unit effort.

with a nanny, field identification of male/female is very difficult from any distance, further complicating a program of treating females.

Field treatment of male goats is complicated if surgical vasectomy is used, and simple if castration is chosen. However, both again require the animal to be captured and immobilized, and the field recognition of sexes is still a factor.

An ideal solution for sterilization that is permanent, applicable to either sex and deliverable without capture and immobilization has not been invented. Some research toward such a method is being done (largely outside the National Park Service) and progress will be monitored by the park staff. Nothing is available in the near term.

B. LIVE CAPTURE

Several methods of capturing goats have been tried with varying degrees of success. Where goats are habituated to the presence of humans, as on Klahhane Ridge, a ground drop net has worked well. The same procedures on Appleton Pass met with no success. Baiting with salt can attract goats during a late spring, early summer period of 6-8 weeks, but is not particularly effective the rest of the year. Use of this large ground net has had limited success.

Capturing by leg snare or a small net fired from the ground does work for an individual animal. This method can be effective for research or individual treatment such as marking or tagging and sterilization. It is not effective where a number of animals must be caught in a short time.

Aerial netting can be used where animals are not habituated to humans, and where terrain and weather allow. This process requires a staging

area to hold and prepare animals if the capture site is a long distance from the nearest road. It has the advantage of wide area selection for efficiency in finding animals. As with any helicopter supported operation, weather is a determining factor for timing. Terrain is also a limiting factor for both safety of goats and personnel. For live capture and subsequent transportation of animals, the aerial netting method shows promise. High cost will be a factor in any helicopter supported method, especially where transportation of live animals is involved.

C. SHOOTING

Animals can be taken by shooting from the ground and/or air using rifle or shotgun. All shooting would be conducted by trained National Park Service rangers and/or federal animal control agents. Carcasses would be left to recycle into the ecosystem; some may be relocated within the general area if human contact with the remains is likely. No animals would be utilized for food or any other purpose except as authorized for research directly applicable to the program. Use as food would require transportation of the carcass out of the backcountry, proper handling to keep the meat from spoiling, and some method of determining that the animal was disease-free. Plans would be developed so as to eliminate conflicts with backcountry visitor use.

D. THE PREFERRED ALTERNATIVE METHOD

Live capture would be used until all reasonable attempts have been exhausted. It would continue to be the method used until it was no longer safe or effective in terms of effort per capture. The method of capture can include aerial darting, aerial net guns, or ground drop nets. In each instance,

the method will depend on population characteristics, terrain and safety considerations for both personnel and goats.

When it was no longer feasible to capture and relocate goats from a particular area, the remaining resident population would be removed by a shooting program. It is expected that at some point this will be necessary in order to eliminate the remnant population in the core areas and to ensure that new migrants do not invade areas that have been made goat free.

In all cases, however, live capture would be the removal method of choice and would be used exclusively during the first three years of the program. Mountain goats removed from the park would be transferred to the Washington Department of Wildlife for relocation to native goat ranges in Washington or other western states, and possibly Canada, as appropriate. Consideration would also be given to transferring animals to zoos or other appropriate wildlife agencies and organizations.

As mentioned in the preferred management alternative, the task group set up to monitor the effectiveness of the program will also assess the methods employed and their relative success each year. The first phase five-year program of elimination in the core and control on the eastern periphery will thus require both live capture and eventually some shooting. Program redirection at the five-year review may indicate a change in balance of efforts of live capture and shooting.

While the goat removal program is underway, the park staff will stay abreast of the sterilization research and application that is underway in the U.S. and other countries. Any advances in sterilization which might have applicability

in Olympic National Park may be used on selected subpopulations. This recognizes the possibility that sterilization may develop into the control method of choice in future years.

VIII. ENVIRONMENTAL IMPACTS OF ALTERNATIVE METHODS

A. STERILIZATION

The impacts of sterilization, which is not a present option, are here included in the light of what such a method could be expected to accomplish if it were to become a viable option.

1. Impacts on the ecosystem: The sole "advantage" of a sterilization program, if and when it becomes feasible, lies in the fact that the goat would not have to be killed or live-captured. Having lost its reproductive capability, the population slowly diminishes. On the other side of the issue, a sterilized population would continue to impact the environment as long as goats remained.

If a long-term or permanent sterilant could be developed for administering by a darting rifle, it may be possible to treat most, if not all, of the park's goats within ten years. In this scenario, the park would likely be free of goats within an additional ten years.

2. Impacts on human use and enjoyment: Visitors would continue to interact with goats over an extended period of years. The opportunity to view and photograph the animals would slowly diminish. Soils and vegetation would exhibit a gradual recovery. The more heavily impacted areas would be rehabilitated once a subpopulation is substantially reduced.

3. Impacts on other agencies: The effects of the sterilization alternative on the management programs of other agencies would likely be

similar to those of other options. Eliminating the reproductive ability of goats inhabiting areas along the park boundary would affect sub-population densities outside the park. The level of this effect would, of course, depend on how many park animals are sterilized.

This technique would have the least affect upon the animals themselves as they would not be subjected to anything more than the temporary stress of inoculation.

4. Costs: Should sterilization ever become a practical means of controlling or eliminating the goat population, it is likely that animals could be treated for less than $100 each. This assumes that the sterilant could be delivered by darting rifle fired from a helicopter. Any other method of sterilization would be considerably more costly and less effective.

In any event and whatever the decision, an ongoing budget commitment must be made to insure that funds and effort expended in the early years are not later negated by lack of follow-through.

B. LIVE CAPTURE

1. Impacts on the ecosystem: The effects of live capture are varied depending on the method(s) selected. Aerial netting or darting would require extensive helicopter use over several years, possibly as many as 20 or 30. Several staging areas would be required in the more remote areas of park wilderness. All would be temporary, probably not operated for more than three or four weeks during any given year. Final preparations for shipping the animals to new areas would take place in frontcountry locations such as Sweet's Field in the Elwha Valley. Revegetation and

other site restoration of the staging areas would occur immediately upon abandoning any work site.

Drop netting may be feasible with high density subpopulations such as are found in Royal Basin. If used, the process would involve one or more base camps for a period of several years.

Live capture in any form is extremely stressful to mountain goats. Post-capture myopathy, the animal's physiological response to sudden trauma and confinement may, whether treated or not, cause death. Although a medical protocol has been developed to reduce these effects, all captured and confined goats experience some trauma.

2. Impacts on human use and enjoyment: The single, most significant impact of live capture would be the sight and sound of a helicopter in the park's backcountry for at least three weeks each year for a 20- to 30-year period. The visitor's perception of wilderness would be disrupted by the presence of a helicopter and the capture activities. Scheduling could only partly mitigate this impact because the success of the program would dictate an intensive search and capture operation. Transplants are best accomplished in the spring and summer when the newly relocated animal can become adjusted to the habitat before the onset of the critical survival season--winter.

On the other hand, relocated goats benefit hunters, photographers, naturalists and others who value the presence of the animal. The additional animals would be valuable in reestablishing viable populations in habitats and locations where native populations have been extirpated or reduced in number.

3. Impacts on other agencies: The Washington Department of Wildlife has supported the park's experimental live capture program. From this standpoint, methodology is not a critical issue. The Department would benefit directly in having a substantial number of goats available for transplant or for exchange with other state game agencies. Such a program would also result in direct costs to the Department for the expense of relocation once the animals are turned over to them.

Olympic National Forest would experience few direct effects with live capture techniques. The noise of helicopter operations would have a temporary impact on wilderness values.

4. Costs: The logistics required for any live capture technique result in costs from $500 to $1,000 per animal. This does not include costs incurred by the state in transporting the animal to the release site. Almost all of the expense is involved with processing the animal to insure its survival, not only for the duration of its confinement but also after it is released in new habitat. Assistance would be required from benefitting agencies, principally the Washington Department of Wildlife.

C. SHOOTING

1. Impacts on the ecosystem: The impacts associated with shooting are the least of any removal technique. Shooting offers the advantage of a rapid, safe, inexpensive and effective means of eliminating or reducing goat-caused impacts. Any management strategy that involves shooting could be essentially completed/stabilized in five to seven years. The shooting operation itself would have a brief, transitory effect on the backcountry. A helicopter would be used in locating the animals and, depending on

terrain, weather and safety factors, either used for transporting ground crews or for a shooting platform. No attempt would be made to remove the carcasses; they would be permitted to recycle within the ecosystem. All shooting would be conducted by trained park rangers or federal animal control agents.

2. Impacts on human use and enjoyment: In general and over the long term, removing goats by shooting would have the least effect on park visitor use. Shooting can be accomplished within a relatively short period of time and with the least disruption in terms of the logistics required to carry it out. The method is highly selective in that it can be applied in ways that least affect visitors' enjoyment of the park. For example, shooting can be scheduled at times when few or no visitors are in the immediate vicinity. However, helicopters and shooting will produce disturbing noises to those wilderness users who hear them. Also, shooting does not require backcountry staging areas, involved facilities or support personnel.

3. Impacts on other agencies: Shooting within interior subpopulations would have little, if any, effect on neighboring jurisdictions. In respect to shooting within peripheral subpopulations, some effects would be produced outside the park since goats are known to migrate freely back and forth across the boundary. It is assumed that exterior groups would be reduced to some degree as park goats are removed, regardless of the method.

Most of the goat habitat outside the park is administered by the U.S. Forest Service as legislated wilderness. Shooting would not directly

affect agency policies or operations. Exotic species are not prohibited in wilderness areas managed by the Forest Service.

Shooting obviously precludes relocating animals to depleted native habitats and to zoos. The value of a goat for these purposes is thus lost.

4. Costs: In almost all instances, shooting can be accomplished for about $50 per animal. Aside from the cost of helicopter operations in support of aerial or ground shooting teams, there would be almost no expenses associated with logistics. Costs for the major portion of the program could amount to approximately $50,000 if essentially all the goats are shot over a five-year period. About $5,000 per year would be needed for another three or four years to eliminate residual animals.

D. THE PREFERRED ALTERNATIVE METHOD

The preferred alternative method for removal is a combination of Alternatives B and C. The impacts of this alternative are the same as discussed in B and C above and are commensurate with the amount that each technique is actively utilized. In all cases, however, live capture would be the removal method of choice and would be used exclusively during the first three years of the program. Refer to page 65, section D, for the description of this preferred alternative.

APPENDIX A

PERSONS AND AGENCIES CONSULTED

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APPENDIX B
Matrix

MANAGEMENT ALTERNATIVES	Ecosystem Impacts	Visitor Impacts	WDW Impacts	NPS Impacts	Cost
A. No Action--Accept goat populations.	Continuation of present trends; impacts probably increasing until equilibrium reached.	Viewing opportunities increased, nuisance increased; altered ecosystem of less value for research, aesthetics.	Huntable goats likely to increase.	Policy conflicts continue. Major compromise of NPS principles.	Least.
B. Control	Substantial impact reduction with eventual stabilization at specified levels.	Viewing diminished. Nuisance reduced. Permanent changes to ecosystem but to a lesser degree.	Possible reduction of huntable population.	Policy conflicts recognized but not dealt with fully.	Required research into acceptable impact levels raises costs; long-term funding.
C. Make Core Goat Free/Control Numbers on Periphery	Restoration of intact interior ecosystem is possible. Impacts on periphery similar to B.	Goat viewing limited to SE and E areas of park. Pristine ecosystem for research, visitors in core.	Similar to B.	Policy conflicts remain.	Long-term funding required.
D. Elimination--Total removal of goats from park.	Lessening rates of impact followed by stabilization and then recovery of ecosystem.	Viewing opportunity eliminated. Pristine ecosystem for research and visitor enjoyment restored.	Possible loss of all goat hunting on the peninsula.	Complies with NPS principles and policies.	Moderate to very high depending on methodology.

APPENDIX C
Matrix

SOME ALTERNATIVE METHODS	Ecosystem Impacts	Visitor Impacts	WDW Impacts	NPS Impacts	Cost
A. Live Capture	Some impact caused by capture team camps. High stress for goats.	Major noise impact of helicopters for many years.	Goats would be available for restocking of goat range elsewhere in state.	Complies with NPS policy except for noise impact and time required.	Very high for both NPS and WDG; $500-$1,000+ per animal.
B. Shooting	Least long-term impact from shooting itself. Transitory noise impact from helicopters and firearms.	Noise impact in wilderness setting could be only partially mitigated by proper scheduling. Emotional impact significant.	None.	Shooting not in conflict with NPS policy. Noise impact in wilderness is in conflict.	$30-$50 per animal.
C. Live Capture/ Shooting	Much the same as with live capture with some additional noise impact from firearms.	Same as for live capture.	Same as for live capture.	Combines the advantages of the two methods. Prolonged impacts from goats and operations.	Less than for live capture alone.

APPENDIX D

GLOSSARY

List of Common and Scientific Names Used in the Text

Common Name	Scientific Name
Alaska brome	Bromus sitchensis var. sitchensis
Alice's fleabane	Erigeron aliceae
American bistort	Polygonum bistortoides
Avalanche lily	Erythronium montanum
Black alpine sedge	Carex nigricans
Blue wildrye	Elymus glaucus var. glaucus
Bluebell's of Scotland	Campanula rotundifolia
Blunt sedge	Carex obtusata
Broad-leaf arnica	Arnica latifolia var. latifolia
Broad-leaf lupine	Lupinus latifolius
Columbia lily	Lilium columbianum
Common juniper	Juniperus communis
Common yarrow	Achillea millefolium var. millefolium
Curly bluegrass	Poa incurva
Cutleaf syntheris	Synthyris pinnatifida var. lanuginosa
Douglas' silene	Silene douglasii var. douglasii
Douglas-fir	Pseudotsuga menziesii var. menziesii
Englemann spruce	Picea engelmannii
Fendler's waterleaf	Hydrophyllum fendleri var. albifrons
Field oxytropis	Oxytropis campestris var. gracilis
Idaho fescue	Festuca idahoensis
Indian thistle	Cirsium edule
Kelloggia	Kelloggia galioides
Least bladdery milkvetch	Astragalus microcystis
Merten's mt. heather	Cassiope mertensiana var. mertensiana
Mountain owl-clover	Orthocarpus imbricatus
Narrow-sepaled phacelia	Phacelia leptosepala
Olympic Mt. aster	Aster paucicapitatus
Olympic Mt. dandelion	Taraxacum olympicum
Olympic Mt. groundsel[1]	Senecio neowebsteri
Olympic Mt. milkvetch[2]	Astragalus australis var. olympicus
Olympic rockmat	Petrophytum hendersonii
Pacific silver fir	Abies amabilis
Parry's silene	Silene parryi
Partridgefoot	Luetkea pectinata
Piper's bellflower	Campanula piperi
Red mountain-heather	Phyllodoce empetriformis
Rockslide larkspur	Delphinium glareosum
Sand-dwelling wallflower	Erysimum arenicola var. arenicola
Showy sedge	Carex spectabilis
Sitka spruce	Picea sitchensis
Spreading phlox	Phlox diffusa
Sticky oxytropis	Oxytropis viscida var. viscida
Subalpine fir	Abies lasiocarpa var. lasiocarpa

Common Name	Scientific Name
Threadleaf sandwort	Arenaria capillaris
Three-veined fleabane	Erigeron subtrinervis var. conspicuus
Tufted hairgrass	Deschampsia cespitosa va. cespitosa
Wandering fleabane	Erigeron peregrinus var. callianthemu
Wandering fleabane	Erigeron peregrinus var. thompsonii
Western hedysarum	Hedysasrum occidentale var. occidentale
Western hemlock	Tsuga heterophylla
Western wormwood	Artemisia ludoviciana
Woolly sunflower	Eriophyllum lanatum var. lanatum
Woolly pussytoes	Antennaria lanata

[1]Also known as Webster's senecio

[2]Also known as Cotton's milkvetch. Former name: Astragalus cottonii

APPENDIX E

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APPENDIX F

PLANTS OF THE OLYMPIC PENINSULA LISTED AS ENDANGERED, THREATENED OR SENSITIVE BY THE WASHINGTON NATURAL HERITAGE PROGRAM

1 = Endangered; 2 = Threatened; 3 = Sensitive

WNHP Status	Scientific Name	Common Name
3	Agoseris elata	Tall agoseris
3	*Aster sibiricus var. meritus	Siberian aster
2	*Astragalus australis var. olympicus	Olympic Mt. milkvetch
3	*Astragalus microcystis	Least bladdery milkvetch
3	*Botrychium lanceolatum var. lanceolatum	Lance-leaved grape-fern
2	Calamagrostis crassiglumis	Thickglume reedgrass
3	*Carex circinata	Coiled sedge
3	Carex interrupta	Green-fruited sedge
3	*Carex obtusata	Blunt sedge
3	Carex pauciflora	Few-flowered sedge
3	*Carex pluriflora	Several-flowered sedge
3	Carex saxatilis var. major	Russet sedge
3	*Carex stylosa	Long-styled sedge
3	Cimicifuga elata	Tall bugbane
3	Coptis asplenifolia	Spleenwort goldthread
3	Epipactis gigantea	Giant helleborine
3	*Erigeron aliceae	Alice's fleabane
3	Erigeron peregrinus peregrinus var. thompsonii	Wandering fleabane
3	*Erythronium revolutum	Coast fawnlily
3	Galium kamtschaticum	Kamchatka bedstraw
3	Gentiana douglasiana	Swamp gentian
3	Lobelia dortmanna	Water lobelia
3	Lycopodium inundatum	Bog clubmoss
3	Microseris borealis	Boreal microseris
3	*Montia diffusa	Branching montia
2	Ophioglossum vulgatum	Adder's-tongue
3	Orobanche pinorum	Pine broomrape
3	Oxalis suksdorfii	Western yellow oxalis
3	*Oxytropis viscida	Sticky oxytropis
2	Pleuricospora fimbriolata	Sierra pinesap
3	Plantago macrocarpa	Alaska plantain
3	Polemonium carneum	Great polemonium
3	*Poa laxiflora	Loose-flowered bluegrass
3	Puccinellia nutkaensis	Nootka alkaligrass
3	*Ranunculus cooleyae	Cooley's buttercup

WNHP Status	Scientific Name	Common Name
3	Sanicula arctopoides	Footsteps of spring
3	*Saxifraga debilis	Pygmy saxifrage
3	Sanguisorba menziesii	Menzies' burnet
3	*Spiraea densiflora densiflora	Subalpine spirea
3	*Synthyris pinnatifida var. lanuginosa	Cutleaf syntheris
3	Utricularia intermedia	Flat-leaved bladderwort
3	Woodwardia fimbriata	Great chain-fern

*Known subalpine or alpine species