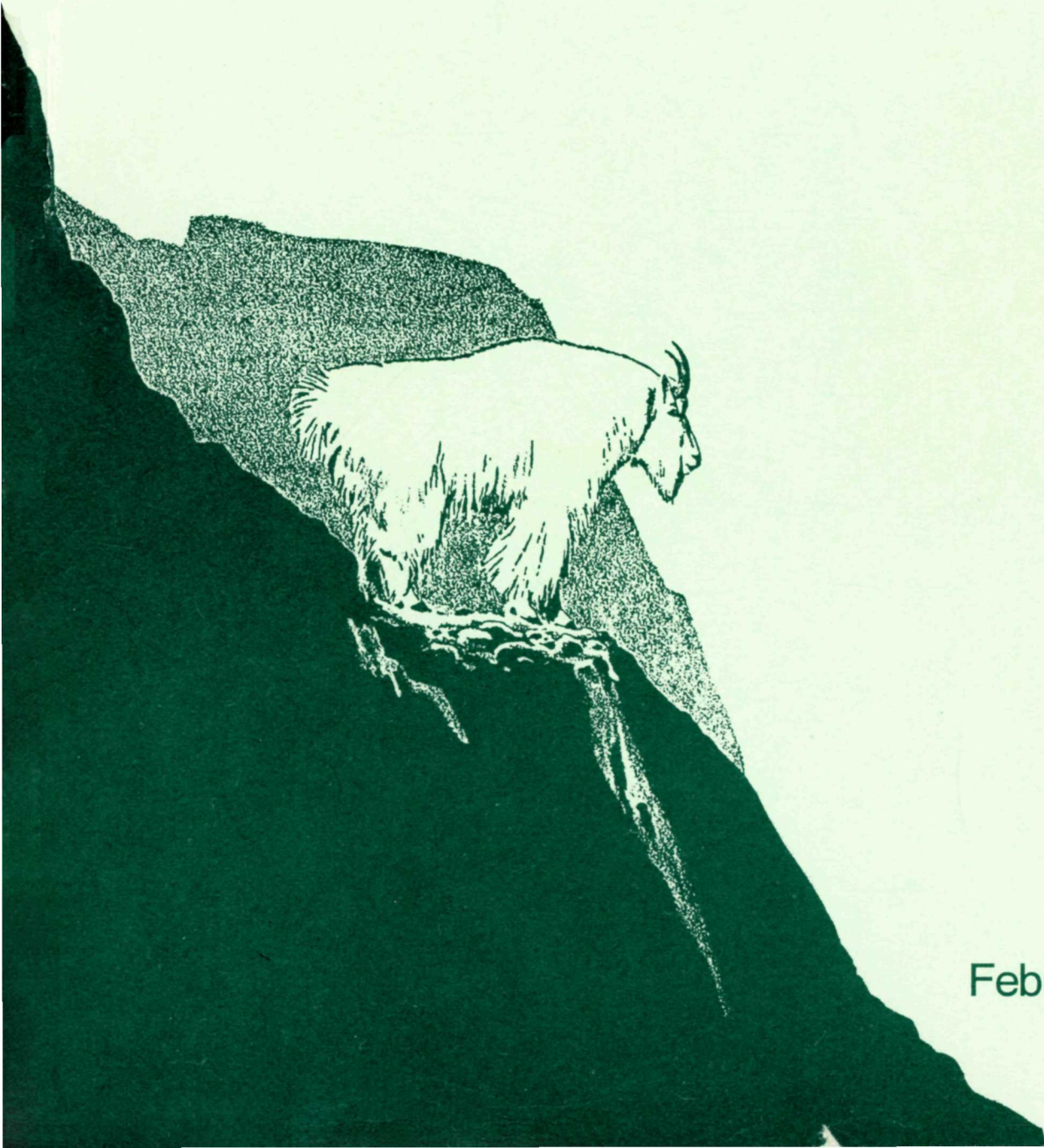


Goats in Olympic National Park:

Draft Environmental Impact Statement for Mountain Goat Management



February 1995



IN REPLY REFER TO:

United States Department of the Interior

NATIONAL PARK SERVICE

Olympic National Park
600 East Park Avenue
Port Angeles, Washington 98362-6798



March 21, 1995

Dear Interested Party:

Enclosed is a copy of the Draft Environmental Impact Statement (DEIS) for mountain goat management within Olympic National Park. Public involvement and comment are important in the federal decision-making process. Public comments will be accepted until May 31, 1995. Public meetings will be held in both Port Angeles and Seattle to receive comments on this document. The schedule for these meetings is:

Seattle: Wednesday, May 3 in the Jackson Federal Building, North Auditorium, use 1st Avenue entrance between Madison Street and Marion Street, 7:00-10:00 pm

Port Angeles: Thursday, May 4 in the Vern Burton Community Center, 308 E. 4th Street, 7:00-10:00 pm

Announcements will be placed in local newspapers giving further details.

Please send written comments to:

Superintendent, Olympic National Park, 600 E. Park Ave.,
Port Angeles, WA 98362, (360) 452-4501 no later than
May 31, 1995.

An NPS scientific monograph on mountain goats at Olympic National Park has also been published recently. The title is *Mountain Goats in Olympic National Park: Biology and Management of an Introduced Species*. The monograph is available for review at the same locations as this DEIS (see page 143 for a list), as well as at many local libraries throughout western Washington. Copies may also be obtained from Olympic National Park. Any comments concerning the information contained in the monograph would also be welcomed at this time.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

for

MOUNTAIN GOAT MANAGEMENT WITHIN OLYMPIC NATIONAL PARK, WASHINGTON Clallam, Grays Harbor, Jefferson, and Mason Counties, WA

Lead Agency: U.S. Department of the Interior, National Park Service

Cooperating Agencies: U.S. Department of Agriculture, Forest Service
State of Washington, Department of Fish and Wildlife

Three alternatives for future management of mountain goats within Olympic National Park are analyzed in this document. **Alternative 1, the proposed action**, is the National Park Service's preferred alternative. This alternative proposes elimination of mountain goats from the park by shooting from helicopters. Ecosystem impacts from goats would cease in approximately three years. **Alternative 2, the no-action alternative**, identifies no active management concerning the park goat population, other than monitoring. The goat population would likely increase to approximately 1,400 animals. Impacts to native ecosystems would increase dramatically. **Alternative 3** is similar to alternative 1 except that it allows for a short-term live-capture program before elimination by shooting. Ecosystem impacts from goats would cease in approximately four years.

For further information contact:

Superintendent, Olympic National Park
600 East Park Avenue
Port Angeles, Washington 98362
Telephone: (360) 452-4501

The National Park Service will accept written comments on this draft EIS for a period of 60 calendar days, starting from the notice of availability of this document.

SUMMARY

Introduction

The Olympic Peninsula is a large peninsula in northwest Washington State. The Olympic Mountains form the core of the peninsula and are extremely rugged and steep. Eleven major river drainages radiate from the mountainous interior.

Mountain goats (*Oreamnos americanus*) are not native to the Olympic Peninsula. Goats are native to the mountainous areas of Alaska, British Columbia, Alberta, Idaho, Montana, and Washington's Cascade Range. It is estimated that 7,000 goats live within native range of the Cascades (WDW 1992).

Approximately 11 goats from Alaska and Canada were introduced to the peninsula during the 1920s, before Olympic National Park (ONP) was established. The initial purpose of these introductions was apparently to develop a population which could be hunted. In 1938, the park was established and hunting was prohibited on park lands shortly thereafter.

The introduced goat population grew in size and goats dispersed throughout suitable areas of the peninsula. By 1983, the goat population on the peninsula was estimated to be approximately $1,175 \pm 171$ (SE) animals.¹ During the 1980s, Olympic National Park conducted experimental and operational management programs using translocation and reproductive control methods to reduce the goat population. The live-capture program was halted in 1989 for several reasons: employee safety, animal safety, and changing Department of the Interior rules concerning several helicopter landing techniques which were used. A census conducted in 1990 documented a population of 389 ± 106 (SE) animals.¹ Results from an additional census in 1994 showed no statistical difference from the 1990 results.¹

Goats occupy the higher elevation alpine or subalpine vegetation communities occurring at or above treeline. Goat summer range within the park consists of approximately 107,600 acres (43,546 ha) which are free of glacial ice above 5,000 ft (1,520 m) elevation, although goats also sometimes use areas below this elevation during the summer (Houston et al. 1991a). Vegetation communities within goat summer range include subalpine meadows, as well as scree and rock areas with little or no vegetation. Approximately 90% of goat summer range on the peninsula is within the park. The remainder is primarily within Olympic National Forest.

The high elevation areas of Olympic are essentially alpine and subalpine "islands" because the peninsula is surrounded by large bodies of salt water on three sides and by lowland forests on the south. This geographic isolation produced an assemblage of plants and animals that differs from other areas in Washington. In addition, the peninsula's history of glaciation allowed unique plants to develop on the peninsula. Some Olympic Peninsula plants, which developed in the absence of mountain goats, have not been found anywhere else in the world.

¹ Using the standard errors (SE) of these estimates (the '171' and '106' figures) multiplied by a statistical factor means that with 95% certainty the true population size in 1983 was between 840-1,510 goats, and in 1990, between 181-597. In 1994, the estimate was 288 ± 32 (SE), with 95% certainty the true population was between 225-351 goats. Unusually hot weather during the 1994 census may have resulted in a low estimate.

Goat Impacts

The non-native goats are causing significant impacts to native ecosystem processes and components within Olympic National Park. Research concerning the goat population and these impacts began in the 1970s. The following information on goat impacts was drawn primarily from: Houston et al. 1994b and Pfitsch et al. 1983.

Documented goat impacts on vegetation include changes in dominance and competitive relationships between plant species which alter the relative abundance of species in native communities. Goats directly and indirectly alter plant communities through changes in plant structure, reproductive patterns, growth rates, and seedling establishment. Local plant impacts in wallow areas include decreased plant material and decreased cover.



Mountainous interior of Olympic National Park. (ONP photo: Janis Burger).

Threats to 33 known rare and/or endemic plant taxa (see glossary, p. 147) from goat trampling, wallowing, and grazing include risks to individual plants, subpopulations, and populations. Habitat for these rare taxa substantially overlaps with habitat considered ideal summer range for goats (Houston et al. 1994b). Goats consume four endemic taxa and have injured or killed individuals of the rarest endemic species (Houston et al. 1994b; Pike 1981).

The Olympic Mt. milkvetch (*Astragalus australis* var. *olympicus*) is a Federal category 1 candidate species under the Endangered Species Act and is listed as threatened by the Washington Natural Heritage Program. A Category 1 candidate is a species under review for listing as threatened or endangered and for which the U.S. Fish and Wildlife Service has sufficient information to support the

proposal to list. Habitat for this endemic plant substantially overlaps with habitat considered ideal for goats to reach high densities (Houston et al. 1994b). Schreiner (Houston et al. 1994b) documented goat-caused mortality of *Astragalus* plants even at medium goat densities. Grazing and trampling impacts by goats are "sometimes intense." Grazing (much of it severe) was evident on as many as 72% of the milkvetch plants in three plots in a given year. Schreiner documented mortality of *Astragalus* plants due to goat wallowing. Extensive injury (grazing and trampling) to plants in one subpopulation was "entirely attributable to mountain goats." The entire known population of this species in the world contains 3,800-4,000 plants, all within goat habitat of the Olympic mountains. The smallest of these subpopulations contains only 37 plants in an area approximately 65 ft. by 80 ft. (20m x 25m) (ONP files).

Park managers are concerned about the fate of these rare and/or endemic taxa because introduced herbivores have driven rare plants to extinction elsewhere (Houston et al. 1994b).

Soil impacts from goats include wallows and trailing. In the early 1980s, wallow complexes up to 2,475 ft² (230 m²) in size were measured (Pfitsch et al. 1983). With reductions in goat numbers, some recovery of soil impacts occur. However, wallows which are continually used will not fully recover.

Some goat use was detected even at low goat density (Houston et al. 1994b). At low numbers, goat reproduction rates may be higher and goats continue to use preferred habitats (Houston et al. 1994b). Thus, even at a low average parkwide density, goats would still occur at higher actual densities in their preferred areas than in other areas and cause a higher level of impacts in those preferred areas. It is reasonable to expect that impacts to vegetation and soils do occur even at low goat densities, although such impacts have not been quantified.

Issues

The scoping process for this draft environmental impact statement (DEIS) included public meetings, written comment from the public, and consultation with pertinent federal and state agencies. The following issues were identified: 1) damage to Olympic Peninsula alpine and subalpine native ecosystems by goats; 2) effect of goat management on recreational experiences and commercial interests; 3) effect of management alternatives on human safety; 4) exotic status of goats on the peninsula; 5) effect of agency mandates and legislative constraints on goat management; 6) financial cost of management alternatives; 7) ethical concerns of a goat management program; 8) effectiveness of alternatives in achieving program objectives; 9) adequacy of current biological data; 10) impacts of goat management on other resources, such as wetlands, floodplains, air quality, historic resources, and water quality.

There are two issues on which biologists disagree concerning goat management at Olympic:

- 1) Wildlife biologists disagree concerning what effect elimination of goats within the park might have on goat subpopulations outside the park. If goats were eliminated from ONP, the population remaining on the peninsula outside the park may or may not remain viable in the long-term. It is possible that the population might remain viable long-term and reach an equilibrium level estimated at approximately 250 goats outside the park. However, in 50 to 100 years, goats could disappear from the entire peninsula as a result of elimination within the park. This issue is unresolved and there is no way to accurately predict the outcome.
- 2) Wildlife experts generally agree that contraceptives would not provide a practical and effective means of control for goats within the park. One problem is achieving a sufficient

level of control to protect native ecosystems. However, some wildlife scientists feel that contraceptives would have some applicability, perhaps in combination with lethal methods, for the Olympic goat population. Further discussion of this issue is included in appendix B, beginning on page 181.

NPS Authority and Mandate

Olympic National Park must act within limitations of all applicable legislation, regulations, and National Park Service policy.

Congress established the National Park Service in 1916 by passing the Organic Act (39 Stat. 535, 16 USC 1), which asserts that the fundamental purpose of the National Park System is "to conserve the scenery and the natural and historic objects and the wild life 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." The 1978 Amendments to the Organic Act (PL 95-250, 92 Stat 163, 16 USC §1a-1) state "the protection, management and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established...."

The National Park Service 1988 Management Policies address protection of native ecosystems and management of exotic species. "The National Park Service will manage the natural resources of the national park system to maintain, rehabilitate, and perpetuate their inherent integrity" (Chapter 4:1). NPS policy more specifically addresses:

Native Plants: NPS "will seek to perpetuate native plant life as part of natural ecosystems" (4:8).

Exotic Plants and Animals: "Management of populations of exotic plant and animal species, up to and including eradication, will be undertaken whenever such species threaten park resources or public health and when control is prudent and feasible. Examples of threatening situations include... interfering with natural processes and the perpetuation of natural features or native species (especially those that are endangered, threatened, or otherwise unique) ..." (4:12).

Other applicable legislation, regulations, and National Park Service policy are described beginning on page 18.

Purpose and Need for Action

The purpose of this proposed action is: to the maximum extent possible using safe, reliable, effective and economical techniques, protect the natural vegetation, soils, and ecological processes in the alpine and subalpine areas within Olympic National Park from threats caused by mountain goats.

Mountain goats cause significant impacts to native ecosystems of Olympic National Park. These goats are an exotic (non-native) species within the park. NPS management policy is to take action on exotic species whenever such species threaten park resources and when control (up to and including eradication) is prudent and feasible (NPS 1988). The National Park Service need is native ecosystems free from any grazing, wallowing, trampling, and other threats by non-native mountain goats.

The Alternatives and Their Consequences

Alternative 1: Eliminate Goats by Shooting (proposed action and preferred alternative)

This alternative provides for elimination of exotic mountain goats from Olympic National Park. Upon completion of the initial elimination program, a maintenance program would be necessary to remove goats that cross into the park from adjacent lands. Shooting from helicopters would be the primary method used for both the elimination and the maintenance programs. All goats within the park would be killed. If goats were eliminated through this preferred alternative, goat impacts and threats to native ecosystems would be largely eliminated in approximately three years. Risks to rare and/or endemic plants from goats would be essentially removed. Wilderness, biosphere reserve and world heritage values would be preserved. Wilderness users would be impacted during the management program, however the long-term effect would be an improved wilderness experience because impacts from exotic goats would no longer be present. All visitors would experience resources unimpaired by exotic goats, however they would no longer have an opportunity to observe goats within the park. Ecosystem recovery would occur. Shooting from helicopters is safer than helicopter live-capture operations because there is no need to land or release passengers in the formidably steep terrain inhabited by mountain goats.

Alternative 2: No Action

Under this alternative, no active goat management would be conducted. Monitoring of goat populations and associated impacts could occur. Mountain goats would likely increase to an equilibrium level of about 1,400 animals (Hoffman and Wright 1987). Ecosystem impacts, including risks to rare and/or endemic plants, would also increase. Wilderness, biosphere reserve and world heritage values would be compromised. Opportunities for park visitors to observe goats would increase.

Alternative 3: Eliminate Goats by A Combination of Live-capture and Shooting

Under this alternative, a live-capture operation could be conducted for one season before initiation of an NPS-conducted shooting program. Live-capture operations would be subject to commitment by non-NPS agencies or organizations, within four months after issuance of the record of decision, to participate in such a program. Following the live-capture program, any remaining goats would be eliminated from the park by shooting. If no group commits to participate within the specified period, the National Park Service would implement a shooting program during the first field season after the record of decision.

Goat impacts and threats to native ecosystems would be essentially eliminated in approximately four years. Risks to rare and/or endemic plants from goats would be removed. Wilderness, biosphere reserve and world heritage values would be preserved. Wilderness users would be impacted during the management program, however the long-term effect would be an improved wilderness experience because impacts from exotic goats would no longer be present. All visitors would experience resources unimpaired by exotic goats, however they would no longer have an opportunity to observe goats within the park. Ecosystem recovery would occur. Although live-capture procedures previously used would be modified for safer operations, participants involved in the live-capture program would still be exposed to a high level of risk. Employees would not need to rapidly exit the helicopter under

hazardous field conditions during the shooting program, therefore risks to employees during the elimination and maintenance programs would be lower.

Thirteen other alternatives were considered, but rejected. These alternatives were not fully developed in the document. A list of these alternatives, with reasons for rejection, is included in the "Alternatives" section beginning on page 37.

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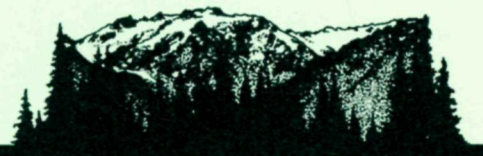
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Purpose and Need for Action



PURPOSE

The purpose of this proposed action is: to the maximum extent possible using safe, reliable, effective and economical techniques, protect the natural vegetation, soils, and ecological processes in the alpine and subalpine areas within Olympic National Park from threats caused by mountain goats.

NEED FOR ACTION

Mountain goats cause significant impacts to native ecosystems of Olympic National Park. These goats are an exotic (non-native) species within the park. NPS management policy is to take action on exotic species whenever such species threaten park resources and when control (up to and including eradication) is prudent and feasible (NPS 1988). The National Park Service need is native ecosystems free from any grazing, wallowing, trampling, and other threats by non-native mountain goats.

Goat summer range within the park consists of approximately 107,600 acres (43,546 ha) free of glacial ice above 5,000 ft (1,520 m) elevation, although goats sometimes use areas below this elevation during the summer (Houston et al. 1991a). If the National Park Service takes no action, the mountain goat population size will increase. At every location where one or more goats occur, goat impacts also occur. Impacts will increase as the goat population increases.

Impacts from goats to native ecosystem components -- especially vegetation, soils, and ecological processes of alpine and subalpine areas -- include direct and indirect alteration of plant communities through soil loss, and changes in plant cover, structure, reproductive patterns, seedling establishment, and growth rates. Collectively, these changes alter plant community composition, including relative abundance and dominance relationships. Such plant community changes result in effects on other ecosystem components (insects, other herbivores, etc.) which are difficult to assess or predict.

Soils of alpine and subalpine areas are thin and fragile and are easily eroded if disturbed by mountain goats (Pfitsch et al. 1983). Schreiner (Houston et al. 1994b) documented over 700 wallows 11-215 ft² (1-20 m²) in size within 22 study areas throughout goat summer range in the park. As the goat population increases, soil erosion will continue or increase from goat wallows, trails, and areas of extensive grazing.

Inherent risks to native ecosystem components accompany changes in the goat population. As the goat population increases, risks to rare and/or endemic plants (populations, subpopulations, and individual plants) will increase. Individual rare and endemic plants will likely be destroyed. If goats remain, the risk of local extinction of rare plant subpopulations and populations will be higher than if goats are removed.

If goats remain in Olympic National Park, wilderness, biosphere reserve and world heritage values and the scientific value of a relatively pristine ecosystem will continue to be compromised by goat impacts. The visitor experience of natural resources unimpaired by exotic goats will continue to be diminished. Derogation of park values and the integrity of native resources within the park will also continue.

In short, the National Park Service need is to be free from native plant community composition changes, soil loss, and increased risks to rare and/or endemic plants resulting from mountain goats.

The National Park Service also needs scientific, wilderness, biosphere reserve and world heritage values free from further derogation caused by the presence of non-native mountain goats.

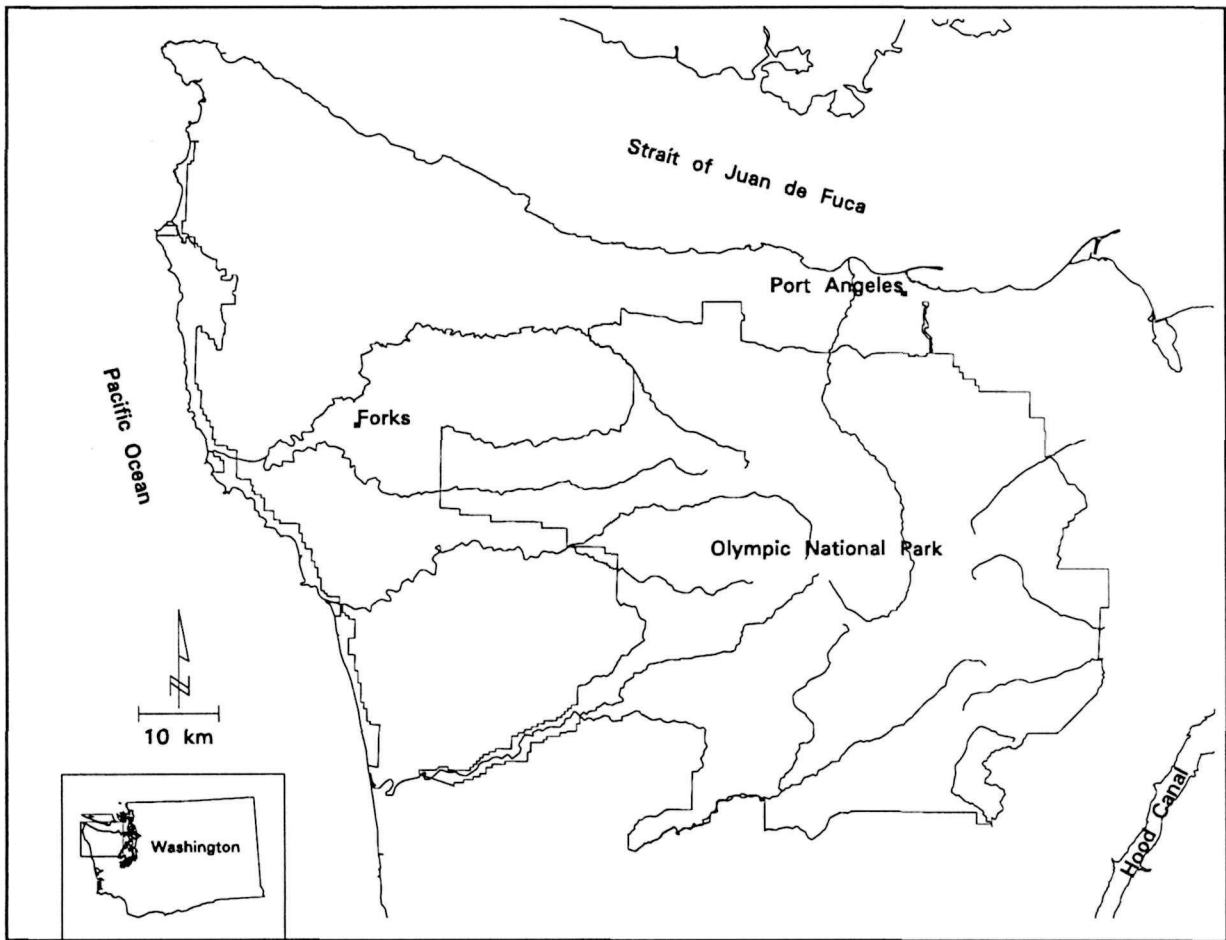


Fig. 1 - Vicinity map.

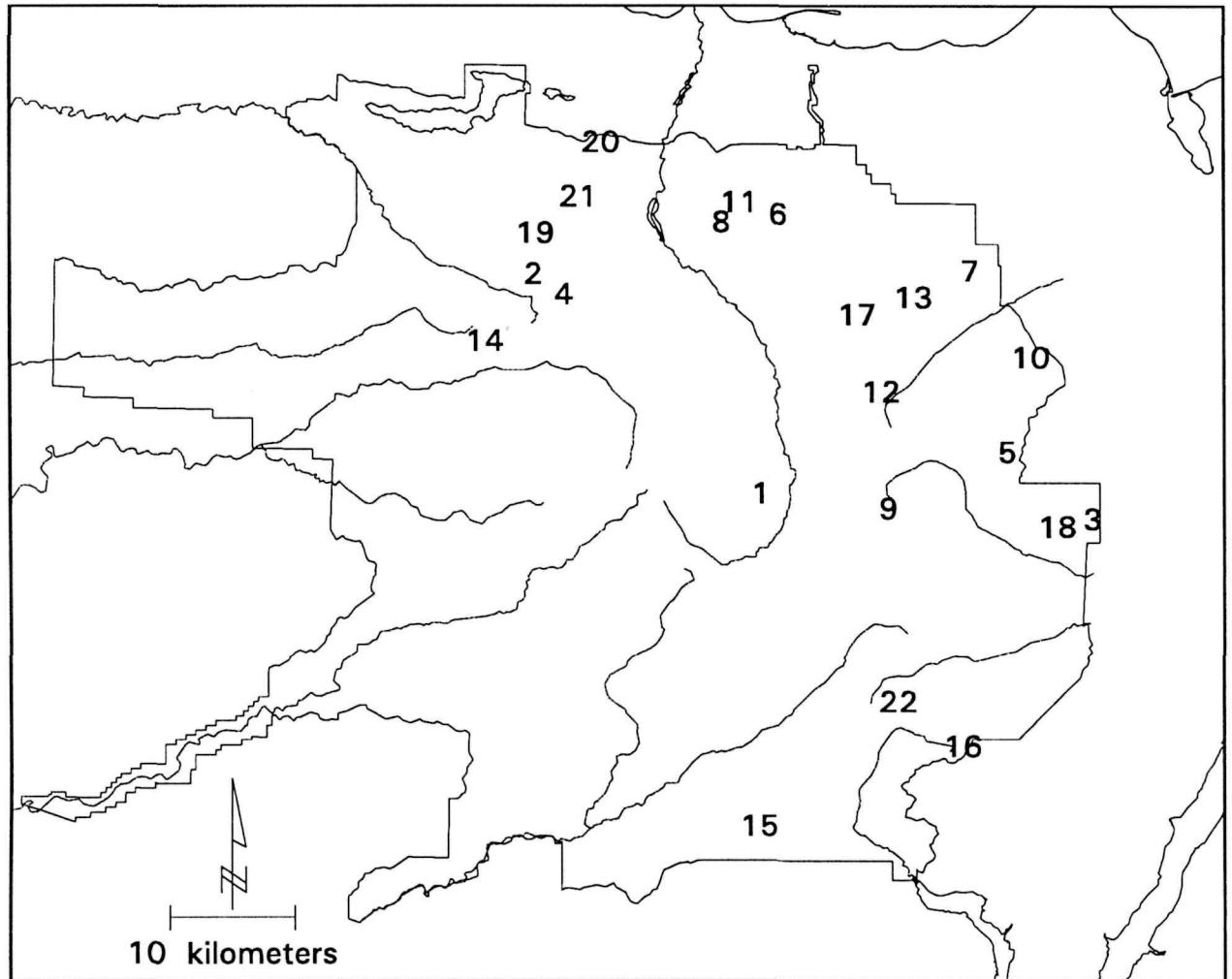


Fig. 2 - Key to locations within Olympic National Park (modified from Houston et al. 1994).

<u>Code</u>	<u>Area Name</u>	<u>Code</u>	<u>Area Name</u>
1	Mount Dana	12	Grand Lake
2	Mount Appleton	13	Maiden Peak
3	Mount Constance	14	Hoh Lake
4	Schoeffel Creek	15	Six Ridge
5	Royal Basin	16	Mount Stone
6	Mount Angeles	17	Obstruction Peak
7	Deer Park	18	Constance Pass
8	Hurricane Hill	19	Crystal Ridge
9	Sentinal Peak	20	Baldy Ridge
10	Greywolf Ridge	21	Happy Lake Ridge
11	Griff/Unicorn	22	Mount Steel

PRINCIPAL ISSUES AND CONCERNS

An Interagency Goat Management Team (IGMT), composed of members from Olympic National Park, Olympic National Forest and the Washington Department of Fish and Wildlife (WDFW, formerly the Washington Department of Wildlife), was established by a Memorandum of Understanding in 1991. The National Park Service manages both habitat and wildlife within the park. The Forest Service manages wildlife habitat within the national forest, while Washington Department of Fish and Wildlife manages wildlife on national forest lands.

The IGMT worked together during 1991 and 1992 (a total of 22 team meetings) with a goal to develop an EIS addressing mountain goat management by all three agencies on all Olympic Peninsula goat habitat. Early in 1993, the agencies made a decision to narrow the EIS focus to Olympic National Park only. This decision was made for several reasons. Research on goat populations and impacts has largely been focused within the park. Differences in agency mandates and policies were also reevaluated. Olympic National Forest and Washington Department of Fish and Wildlife continued to work with the park in development of this document, however the other agencies participated as cooperating agencies with special expertise relative to the mountain goat issue on the peninsula. The National Park Service is the lead agency on the EIS. The formal Memorandum of Understanding expired in October 1993 and was not renewed.

The National Environmental Policy Act of 1969 (PL 91-90), requires that "there shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). This process is called "scoping."

The scoping process for this document was initiated on October 24, 1991, with the *Federal Register* publication of a Notice of Intent to prepare an EIS. In January 1992, the first IGMT newsletter was distributed, including a public comment form. Four public scoping meetings were held in January of that year. Specifically, the public was asked in both the newsletter and the meetings to provide input on "1) what should be done to manage mountain goats on the peninsula, and 2) what methods should be used to achieve those management goals" (IGMT 1992). Over 220 people attended the public meetings and over 600 written comments were received during the scoping period.

At the conclusion of the scoping process, agency concerns and significant issues identified by the public were consolidated into the following major issues. Some of these issues have been developed into resource elements which are used to compare the alternatives. Others are being considered in the DEIS process, but not included as comparison elements. Each issue is briefly discussed here with references to other sections of the DEIS for more in-depth information.

Issues for Analysis in the EIS:

The following major issues were raised in the scoping process and are addressed at length in the "Environmental Consequences" section.

1. Damage to Olympic Peninsula alpine and subalpine native ecosystems by goats

Goat-caused damage to native ecosystems is an important issue that was raised by both the agencies and the public. The public asked for identification and description of damage to plant communities, rare plants, soils, and ecosystem processes.

Goats are causing significant impacts to native ecosystem processes and components within Olympic National Park. Extensive research concerning goat impacts has been conducted since the 1970s.

Goats directly and indirectly alter plant communities through changes in plant cover, plant physical structure, reproductive patterns, growth rates, and seedling establishment. The combination of these changes results in modifications to plant communities and relationships within those communities. Community modifications include changes in the relative abundance of various types of plants. Local plant impacts in wallow areas include decreased plant biomass, standing crop, numbers, and cover.

Threats to 33 known rare/endemic plant taxa from goat trailing, wallowing, and grazing include risks to individual plants, subpopulations, and populations. At least four of these taxa are known to be eaten by goats; one (*Aster paucicapitatus*) was found to be a preferred forage species for goats (Pfitsch and Bliss 1985). Olympic Mt. milkvetch (*Astragalus australis* var. *olympicus*) is a category 1 candidate for the federal endangered species list (see appendix A, page 147, for further discussion of category 1 status) and is listed as threatened by the Washington Natural Heritage Program (WNHP). Schreiner (Houston et al. 1994b) documented death of *Astragalus* plants from goat wallowing.

Soil impacts from goats include wallows and trailing. In the early 1980s, wallow complexes up to 2,475 feet² (230 m²) were measured (Pfitsch et al. 1983). Schreiner (Houston et al. 1994) documented over 700 wallows 10-215 ft² (1-20 m²) in size within 22 study areas throughout goat summer range in the park. Displacement of 45 tons (41 megagrams) of soil was documented from one large wallow, while the average soil loss from seven other wallows was 1.3 tons (1.2 megagrams) (Olympic National Park 1985).

Goats impact over 107,600 acres (43,546 ha) of native ecosystems within their summer range in Olympic National Park. Houston et al. (1994b) did not find anyplace within suitable habitat in the park that had not been used by goats.

Ecosystem impacts are discussed at length in appendix B, beginning on page 153, which summarizes all previous research related to the goat management issue at Olympic. An abbreviated summary is found later in this "Purpose and Need" section beginning on page 23.

2. Effect of goat management on recreational experiences and commercial interests on the Olympic Peninsula

The public identified a wide range of recreational and commercial pursuits on the peninsula that could be affected by goat management actions. The National Park Service has a mandate to provide for public enjoyment of parks, as well as preserving these areas.

Recreational experiences that could be affected include enjoying wilderness values, backpacking, and viewing or photographing goats, plants and native communities. Although this document specifically addresses management alternatives for Olympic National Park, management action within the park could have implications for recreational hunting of goats on other peninsula lands.

Commercial interests that could be impacted include tours to view or photograph wildlife and native ecosystems.

3. Effect of various management alternatives on human safety

This is primarily a management concern for the safety of employees working on goat management. Goat management techniques vary from those with low employee risk to those with very high employee risk.

The operational management program was discontinued after the 1989 season partly because of the unacceptably high level of risk to employees conducting a live-capture operation at low goat densities. See pages 38, 40, 41 and appendixes B (page 153), C (page 205), D (page 209) for more information on risks associated with the live-capture program.

4. Effect of various management alternatives on archeological resources

Archeological resources in the alpine and subalpine areas are fragile and susceptible to disturbance. Archeological sites can be damaged whenever soils or vegetation are disturbed, such as by wallowing goats or by live-capture operations.

More information on archeological resources is on pages 79, 94, 110, 127.

5. Financial costs of goat management alternatives

Prudent use of taxpayers' funds is an important concern identified by the public and agency personnel. Federal budget constraints are a reality that must be considered.

Costs for each alternative have been estimated. Assumptions used in estimating these costs are included in appendix E, beginning on page 217.

Issues Considered, But Not Analyzed

The following nine issues identified during scoping have been considered during preparation of this DEIS, and may be discussed elsewhere in the document, but they were not analyzed in the "Environmental Consequences" section.

1. Exotic Status of Mountain Goats on the Olympic Peninsula

By policy, parks are managed to preserve native ecosystems. The presence of an exotic species is, by policy, undesirable within a national park. The Park Service is particularly concerned with the presence of an exotic species that threatens park resources, causing impacts to native ecosystem processes and rare plants.

Some members of the public question whether mountain goats are an exotic (nonnative) species on the Olympic Peninsula. There is general acceptance of the fact that individual exotic goats were released on the peninsula during the 1920s. However, questions were raised during the scoping process about the presence of mountain goats historically and prehistorically. Prehistoric times are those for which no written records occur, while historic times refer to those for which written records are known to exist.

As part of the DEIS process, the National Park Service thoroughly re-examined all the evidence relative to the presence of goats on the peninsula prior to the 1920s. Three reports were produced. Dr. Susan Schultz addressed historical evidence (Schultz 1993); Dr. Randall Schalk investigated ethnographic and archeological evidence (Schalk 1993); Dr. Douglas Houston and Dr. Edward Schreiner addressed biogeographical considerations (Houston and Schreiner 1993). These three reports all concluded that goats were not historically present on the peninsula prior to the 1920s. Dr. Schalk could not make conclusive statements as to presence of goats during prehistoric times (the Late Pleistocene or Holocene prior to the 19th century). If a hypothetical population of goats was indeed present on the peninsula during the Late Pleistocene or Holocene, it must have become extinct before historic times. NPS policies for natural resource management are "aimed at providing the American people with the opportunity to enjoy and benefit from natural environments evolving through natural processes minimally influenced by human actions" (NPS 1988). The aim is not to recreate late Pleistocene or early Holocene biotas. A species that naturally went extinct would no longer be considered a native species under NPS policy. The current goat population is an exotic species, regardless of whether a prehistoric form of goat was present or not.

Concern over the status of goats is, in part, due to an article written by Dr. R. Lee Lyman, an anthropologist with the University of Missouri at Columbia, which asserts that a hypothetical prehistoric mountain goat population may have existed on the Olympic Peninsula (Lyman 1988). Dr. Lyman later stated "That I can build such a model or scenario, of course, does not mean that goats were present in the Olympics prior to 1925" (Lyman 1993).

Two historic accounts by 19th century explorers are often cited relative to the presence of goats on the peninsula before 1925: an 1896 *National Geographic* magazine article by Samuel Gilman (Gilman 1896) and an 1890 *Seattle Press* article by C. A. Barnes (Barnes 1890). Schultz notes that these references "are unsupported by any observational detail. Neither account provides any information on the circumstances, location, or date of a specific goat sighting, nor a description of the animal. When weighed against the numerous, detailed observations provided by skilled wildlife observers who did not find any evidence of goats during this same period, such reports are clearly of questionable validity" (Houston et al. 1994b).

Several ethnographic and archeologic sources are also often cited to indicate that goats may have been present on the peninsula prior to the 1920s (for example, Dunn 1845 and Reagan 1917). Schalk (1993) concludes "Although the ethnographic sources indicate the lack of mountain goat populations in this region, they document the existence of a trade network that brought mountain goat wool and horns to native populations of the Olympic Peninsula....The keeping of wool dogs by the native people of the Olympic Peninsula conforms to a broader pattern in which these dogs were kept by groups lacking direct access to mountain goat populations....Horn spoons were extensively traded on the Northwest Coast and, therefore, might be encountered in archaeological deposits in areas far removed from the regions where the mountain goats themselves lived."

The three NPS reports, and Dr. Lyman's article, were individually reviewed by nine independent reviewers selected by professional societies (The American Society of Mammalogists, the Forest History Society, The History of Science Society) and the Department of Interior Consulting Archeologist. Each reviewer concluded that the evidence indicates goats were not historically present on the peninsula before their introduction in the 1920s, i.e., mountain goats are an exotic species on the peninsula.

Excerpts from the three NPS reports, Dr. Lyman's article, the nine independent reviews, and Dr. Lyman's comments on two of the NPS reports are included in appendix F, beginning on page 225. The full text of the 13 documents is available from Olympic National Park.

The exotic/native issue was not analyzed in the "Environmental Consequences" section because the status of goats would not change regardless of which alternative is selected.

2. Agency mandates (including policies) and legislative constraints affecting management of goats

During the scoping process some members of the public suggested changes to Forest Service, WDFW, and NPS mandates and policies. Changes of this nature are not within the scope of this document.

Olympic National Park must act within limitations of legislation, regulations, and National Park Service policy. The public asked for a clear presentation of applicable legal and policy constraints. NPS authority and mandates are explained on page 18 of this document. Forest Service and WDFW mandates are included in appendix G, beginning on page 241.

Agency mandates and legislative constraints were not analyzed in the "Environmental Consequences" section because mandates and legislation would not change regardless of which alternative is selected.

3. Ethical concerns of a goat management program

A wide range of ethical concerns was identified by the public during the scoping period and throughout the EIS process. Topics included issues relating to environmental ethics, animal welfare, and animal rights. Ethics is not an environmental issue and is outside the realm of NEPA. Although this issue is not appropriate for specific inclusion in an EIS, the public's concerns have been considered in developing the document and a discussion of the public concerns is included in appendix H, beginning on page 247.

Ethical concerns are not included as a resource element used to compare alternatives in the "Environmental Consequences" section, however impacts on goats are included under the Impacts on Wildlife Resources element in the "Environmental Consequences" section.

4. Effectiveness of management alternatives in achieving program objectives

Prudent use of public resources requires that any alternative selected should be effective and be reasonably expected to meet objectives as identified in the purpose and need statements found on page 3.

Effectiveness is not an environmental issue and is not within the realm of NEPA. Although not specifically included as a resource element used to compare alternatives in the "Environmental Consequences" section, consequences described under the other resource elements in that section address effectiveness.

5. Adequacy of current biological data to make a management decision

During the scoping process the public identified many areas of concern relative to this question. These included goat population information, data concerning goat impacts on native ecosystems, status of rare plants on the peninsula, level of goat impacts on rare plants, role of predators on goat populations, role of salt blocks in goat behavior, and status of goat contraceptive and sterilization technology.

Extensive research has been conducted in Olympic National Park relative to mountain goats and their impacts. Anecdotal investigations started in the 1960s, with formal research beginning in the 1970s and continuing to the present. Topics included: history of goat introductions, dispersal, population dynamics, goat behavior, vegetation impacts, goat management techniques (monitoring, capture/translocation, reproductive control), soil impacts, impacts on small mammals, habitat utilization, computer population modelling, and risk assessment of goat management programs. During the past thirty years, approximately 40 goat-related research projects at Olympic have resulted in approximately 80 reports. There are sufficient biological data to make a sound management decision.

The public asked for a complete and understandable presentation of all available research data. A short summary of research relative to mountain goat biology and management is included later in the "Purpose and Need" section of this DEIS. A more detailed summary of all research is included in appendix B, beginning on page 153. All research reports are also cited in the list of references. For any unpublished research summarized, copies of the complete reports are available from Olympic National Park.

Adequacy of data is not analyzed in the "Environmental Consequences" section because data would not change regardless of which alternative is selected.

6. Impacts of goat management on wetlands and floodplains

The National Wetlands Inventory has been completed for Olympic National Park and Olympic National Forest. Wetlands identified in goat habitat areas were associated with streams, alpine lakes, and snow melt ponds. This issue is not addressed because wetlands and floodplains would not be affected by any goat management activities.

7. Impacts of goat management on air and water quality

These issues were not addressed because goat management activities (under any of the alternatives considered) would not be expected to have significant impacts on air or water quality.

8. Impacts of goat management on other park operations

Goat management operations could affect other park operations directly, for example by altering staff schedules, or indirectly through diversion of limited funding into goat management programs. Although these types of impacts will be factors in management decisions, they are not considered as comparison elements in this DEIS because they are outside the realm of NEPA.

9. Impacts of goat management on historic and ethnographic resources

Goat management activities (under any of the alternatives considered) would not be expected to impact sites listed on the National Register of Historic Places or other significant historic resources. No impacts would be expected on ethnographic resources from goat management activities proposed under any of the alternatives.

Historic and ethnographic resources are not addressed in the "Environmental Consequences" section because no impacts would be expected regardless of the alternative selected.



Fig. 3 - Mountain Goat Native Range

PREHISTORY AND HISTORY OF MOUNTAIN GOATS ON THE OLYMPIC PENINSULA

Generally, prehistoric times are those for which written records are not known. Conversely, historic times refer to those for which written records are known to exist. The transition from prehistoric to historic is often a transitional period rather than a specific point in time.

No archeologic evidence has been found to prove that mountain goats did or did not exist on the Olympic Peninsula during prehistoric times. If such a prehistoric population did exist during the Holocene or late Pleistocene, it must have become extinct before historic times.

Mountain goats are native to the Cascade mountains in central Washington, as well as other areas of western Canada and the United States (Fig. 3, page 14). Due to the isolation of the Olympic Peninsula, goats did not occur historically in this area. The peninsula is surrounded on three sides by large bodies of saltwater and on the fourth side by extensive lowland areas, thus no alpine or subalpine habitat corridors for natural dispersal connect the Olympics with native goat habitat in the Cascade mountains.

Goats were introduced to the Olympics during the 1920s, before the establishment of Olympic National Park. Initially, four goats from British Columbia were released near Lake Crescent on January 1, 1925. At least seven additional goats

were obtained from Alaska and released in 1927 or 1929. Two of these later goats were released in the Elwha River drainage, while the rest were apparently released near Lake Crescent.

The purpose of these goat introductions was apparently to establish a population which could be hunted. At the time of the releases, the U.S. Forest Service administered much of the peninsula. In 1938, Olympic National Park was established and hunting was prohibited on park lands shortly thereafter.



Goat captured in Alaska for introduction to Olympic National Park, 1927. (ONP photo).

During the 1930s, groups of mountain goats were sighted on Mount Storm King near the initial release site. From 1929 to 1935, goats were seen on Mount Appleton, Mount Angeles, Mount Constance, and in the upper drainages of the Dungeness River (Moorhead and Stevens 1979). Goats were well established throughout the northern and eastern portions of Olympic National Park during the 1940s and were observed annually on Mount Anderson (Moorhead and Stevens 1979).

In 1947, park staff estimated a park-wide population of approximately 100 goats, 35 of which were in the Mount Constance/Dosewallips area (Macy 1947). By 1967 goats were established in sufficient numbers outside the park to begin a special permit bow hunt, administered by the Washington Department of Fish and Wildlife, within Olympic National Forest. Approximately eight goats have been legally taken by hunters annually (Table 4, page 78).

By the late 1970s, goats were thought to occupy about 444,600 acres (1,800 km²) in Olympic National Park and Olympic National Forest, with about 90% of this habitat in the park (Moorhead and Stevens 1982).

Goat summer range within the park consists of approximately 107,600 acres (43,546 ha) free of glacial ice above 5,000 ft (1,520 m) elevation, although goats sometimes use areas below this elevation during the summer (Houston et al. 1991a). They also winter in portions of the lower elevation montane forest where suitable rocky cliffs are found.

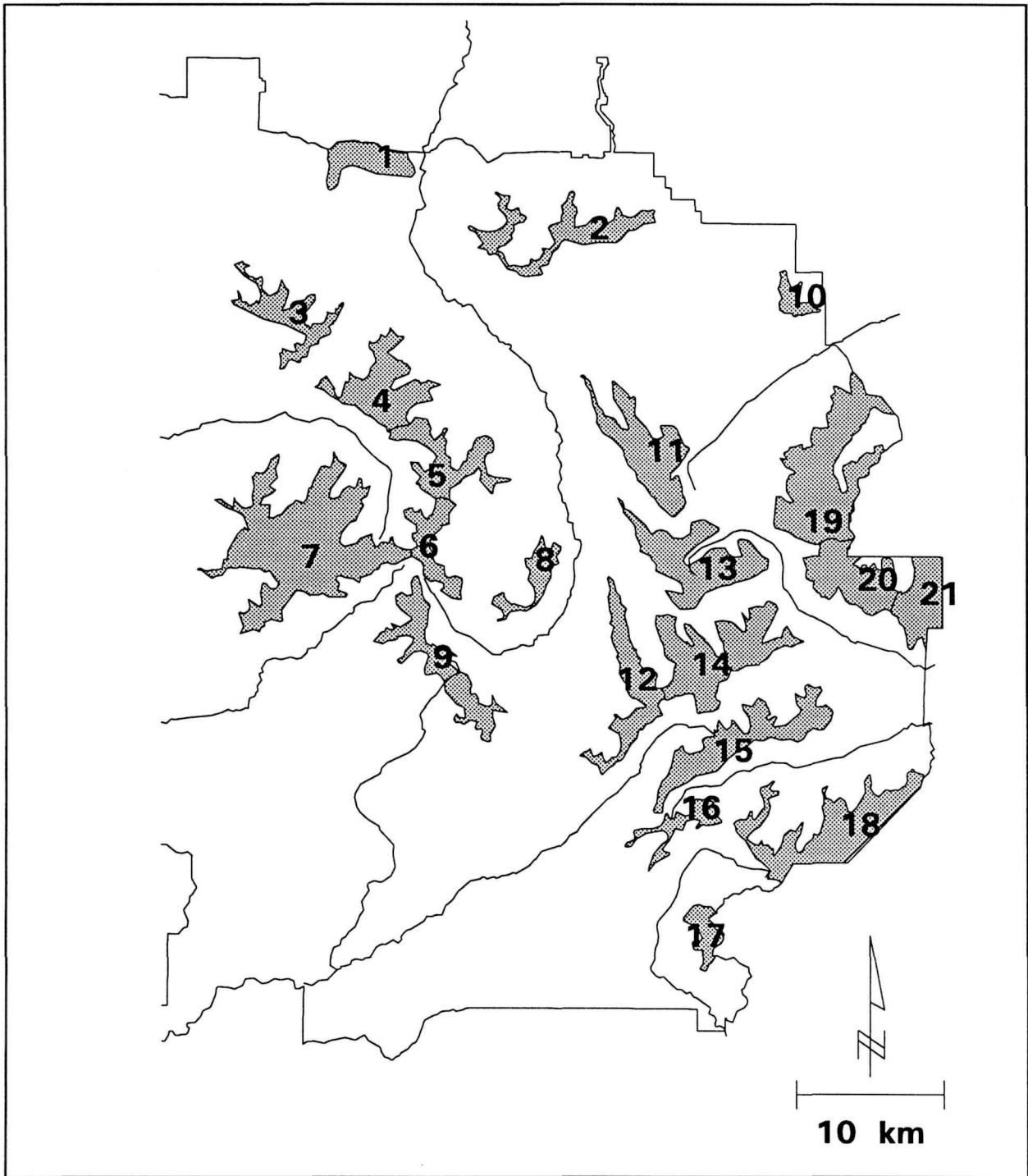


Fig. 4 - Spatial distribution of 21 subpopulations of mountain goats in Olympic National Park: (1) Hughes Creek, (2) Klahhane, (3) Appleton, (4) Carrie, (5) Ferry, (6) Barnes, (7) Olympus, (8) Dana, (9) Divide, (10) Blue Mountain, (11) McCartney, (12) Chimney, (13) Claywood, (14) Anderson, (15) LaCrosse, (16) Steel, (17) Sawtooths, (18) Stone, (19) Royal Basin, (20) Mystery, and (21) Constance (modified from Hoffman 1987).

NATIONAL PARK SERVICE AUTHORITY AND MANDATES

The Organic Act of 1916 (39 Stat. 535, 16 USC 1) asserts that the fundamental purpose of the National Park System is "to conserve the scenery and the natural and historic objects and the wild life 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." The 1978 Amendments to the Organic Act (PL 95-250, 92 Stat 163, 16 USC §1a-1) state "the protection, management and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established...."

16 USC § 3 states, "The Secretary of the Interior ... may ... provide in his discretion for the destruction of such animals and of such plant life as may be detrimental to the use of any of said parks, monuments, or reservations."

Under the Wilderness Act of 1964 (PL 88-577, 78 Stat 890, 16 USC 1131 *et seq.*), designated wilderness areas "shall be administered ... in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character...." The 1988 Washington Park Wilderness Act (PL 100-668) designated 876,669 acres (3,550 km²) of Olympic National Park as wilderness under the authority of the Wilderness Act.

The Endangered Species Act of 1973 (PL 93-205, 87 Stat 884, 16 USC § 1531 *et seq.*, as amended) defines the purposes of that act as "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species...." The NPS Natural Resource Management Guideline requires that management of federally listed candidate species and state endangered and threatened species "should, to the greatest extent possible, parallel the management of federally listed species" (NPS 1991, 2.275).

The National Park Service 1988 Management Policies address protection of native ecosystems and management of exotic species. "The National Park Service will manage the natural resources of the national park system to maintain, rehabilitate, and perpetuate their inherent integrity. The natural resource policies of the National Park Service are aimed at providing the American people with the opportunity to enjoy and benefit from natural environments evolving through natural processes minimally influenced by human actions... natural resources will be managed with a concern for fundamental ecological processes as well as for individual species and features. Managers and resource specialists will not attempt solely to preserve individual species (except threatened and endangered species) or individual natural processes; rather, they will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and ecological integrity of the plants and animals"(Chapter 4:1). "Ecological processes

altered in the past by human activities may need to be abetted to maintain the closest approximation of the natural ecosystem..."(4:2). NPS policy more specifically addresses:

Plants: NPS "will seek to perpetuate native plant life as part of natural ecosystems"(4:8).

Genetic Resources: NPS "will strive to protect the full range of genetic types (genotypes) native to plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity"(4:10).

Exotic Plants and Animals: "Management of populations of exotic plant and animal species, up to and including eradication, will be undertaken whenever such species threaten park resources or public health and when control is prudent and feasible. Examples of threatening situations include... interfering with natural processes and the perpetuation of natural features or native species (especially those that are endangered, threatened, or otherwise unique) ..."(4:12).

The National Park Service 1991 Natural Resources Management Guideline (NPS 1991) section on exotic species management states, "Control or eradication will be undertaken, where feasible, if exotic species threaten to alter natural ecosystems, seriously restrict, prey on, or compete with native populations..." (2.289). This section recommends, "An ecosystem level approach to exotic species control is probably the best long-term and cost effective management strategy, particularly with widespread exotics. For example,... removal of exotic ungulates may restore native vegetation"(2.290). The guidelines also emphasize that "protection and preservation of native ecosystems represents one of the primary legal mandates of the National Park System"(2.294).

Olympic National Park was created by Congress in 1938. A report which accompanied H.R. 10024, defined the purpose of the park as "... 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..."

The Olympic National Park Master Plan and accompanying Final Environmental Statement, prepared in the mid-1970s, identify goat management and preservation of rare, endangered and endemic vegetation as concerns. Objectives for park resource management identified in the Master Plan include "Maintain or restore, where possible, the primary natural resources of the park, and those ecological conditions that would prevail were it not for the advent of modern civilization."

The 1989 Olympic National Park Statement for Management identifies non-native mountain goats as a major issue. The management objective for natural resources is stated, "To conserve, maintain and restore, where possible, the primary natural resources of the park and those ecological relationships and processes that would prevail were it not for the advent of modern civilization."

The 1991 Resources Management Plan lists the primary objective for resource management within Olympic National Park as "Protect the park's natural resources and values, unimpaired. Where warranted, restore natural conditions on lands altered by human activity. Maintain all components and processes of naturally evolving park ecosystems, including natural abundance, diversity, and

ecological integrity of native plants and animals...." The plan states that "Disturbance (caused by non-native mountain goats) of alpine/subalpine vegetation and soils is of great concern... introduced mountain goats are found in alpine and subalpine habitats over about 35% of the park. Removal of this species remains the highest field priority in the park."

The 1980 Backcountry Management Plan and 1992 Addendum state, "Natural wildlife behavior and life processes must prevail." Mountain goats are discussed as "a nuisance to campers." Goats can be a nuisance for hikers and campers because they seek salt from humans: 1) goats chew on sweaty items, such as shirts or socks; and 2) goats consume human urine from the ground; sometimes the animals follow people, waiting for them to urinate. Goat damage to soils and endemic plants is also discussed.

Olympic National Park is valuable not only to the citizens of the United States, but also to the people of the world. Olympic has been designated as both a biosphere reserve and a world heritage site.

The park was designated by the United Nations Education, Scientific and Cultural Organization (UNESCO) as a biosphere reserve under the Man and the Biosphere Program in 1978. The purpose of biosphere reserves is to conserve genetic resources in the world's major ecosystems and to provide opportunity for long-term research on the function and management of those ecosystems.

Olympic National Park was designated as a world heritage site in 1981. The World Heritage Program was created by international treaty at the World Heritage Convention in 1972 to recognize natural and cultural properties which are of "outstanding universal value to mankind." The nomination technical review completed by the International Union for Conservation of Nature and Natural Resources (IUCN) stated, " ... 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" (IUCN 1981). The technical review also stated, "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." By treaty, law, regulation, and NPS guidelines, world heritage sites are to be managed for the protection, conservation, and rehabilitation of this heritage and to avoid any negative impact on the site's integrity (UNESCO World Heritage Convention Treaty 1972; Public law 96-515; 36 CFR 73; National Park Service 1991, 4.21). In a 1987 letter to the park superintendent, the executive officer of the IUCN stated, "In our role as technical advisor to the World Heritage Committee we have been following the goat management issue in Olympic National Park with interest...we would encourage your Service to act to eliminate mountain goats from the World Heritage Site" (Thorsell 1987).

Definitions

The National Park Service Natural Resource Management Guideline (NPS-77, 2.284) contains the following definitions:

"Exotic Species: A species occurring in a given place as a result of direct or indirect, deliberate, or accidental actions by humans."

"Native Species: A species that occurs and evolves naturally without human intervention or manipulation."

"Exotic, non-native, introduced, and alien are synonymous terms."

The 1988 NPS Management Policies (4:11) contain definitions similar to those in the Guideline, however the policy definition of exotic species continues "The exotic species introduced because of such human action would not have evolved with the species native to the place in question and, therefore, would not be a natural component of the ecological system characteristic of that place." Under NPS definitions, mountain goats are an exotic species within Olympic National Park.

RELATIONSHIP TO PREVIOUS NPS MANAGEMENT ACTIONS

NPS management action concerning mountain goats at Olympic began as early as the 1960s and intensified in the 1980s. A short summary of past management is included here because any future management action will build on past experiences. An understanding of preceding programs provides an important basis for understanding the current situation.

A more detailed description of previous management action can be found in appendix C, beginning on page 205.

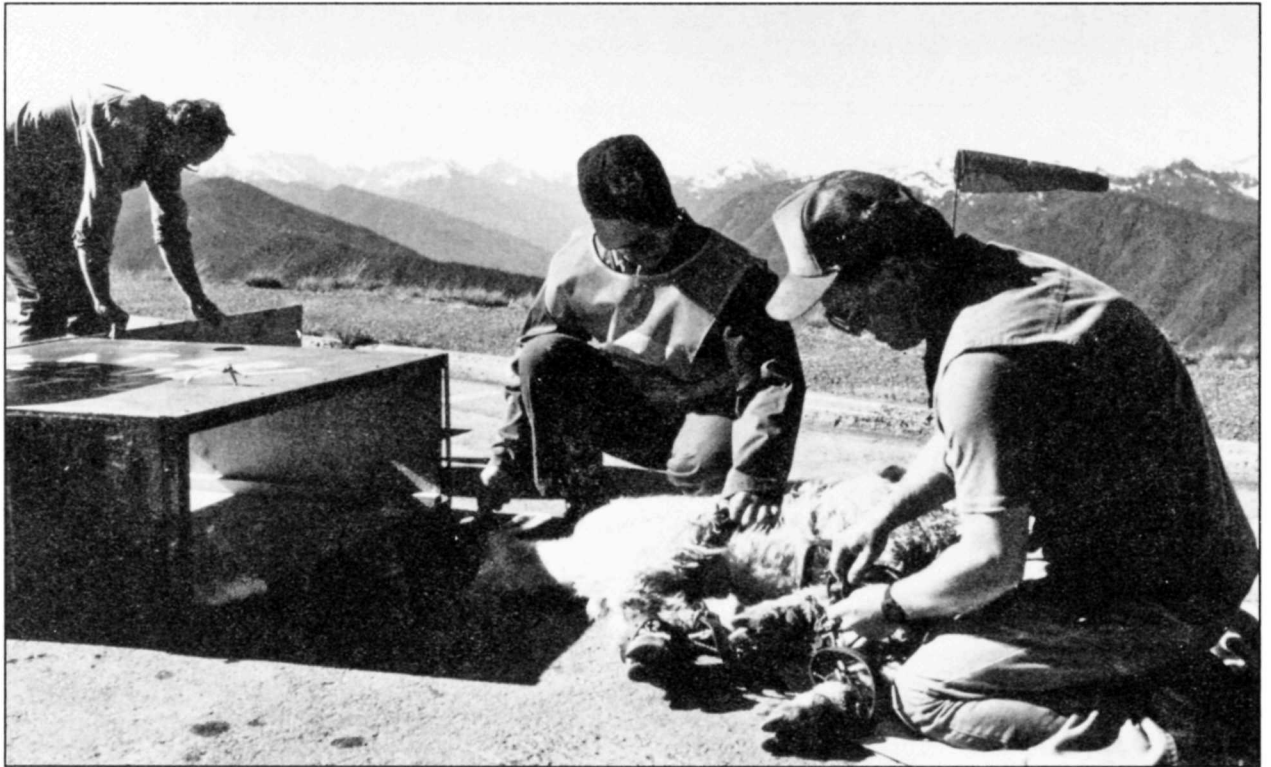
Experimental Management Program

Based on a 1981 environmental assessment (ONP 1981), the experimental management program was conducted in the early 1980s. The purpose was to evaluate live capture and sterilization techniques, to document soil and vegetation impacts, and to track population trends. The results from various projects of this program are presented in the research summary (appendix B, page 153).

Operational Management Program

A second environmental assessment written in 1987 (ONP 1987) identified a program that would establish a goat-free park core with goat numbers controlled on the park periphery. Live capture techniques were to be used for the first three years, with shooting a possibility in following years. Research on goat impacts was to continue.

After two years of live capture (1988-89) the program was evaluated and the following factors considered: 1) the Department of the Interior's aircraft use rules were changed to prohibit (unless waived) several helicopter landing techniques which were commonly used during the goat program; 2) a Clark University/University of Idaho risk analysis of goat live capture seriously questioned the overall safety of the program; 3) capture-related mortality exceeded the stated goal of less than 5% (8.75% in 1988 and 19% in 1989); 4) results of research showed that rare plants were concentrated on the park periphery and that goat impacts on native plant communities were parkwide. The result of this evaluation was to discontinue live capture due to high risk to personnel, high mortality rate of goats and ineffectiveness of the program in affording needed resource protection.



Goat live-capture on Hurricane Ridge, 1988. (ONP photo: Janis Burger).

Artificial Salt Bait Sites

At various times salt bait sites have been utilized in the park. At Klahhane Ridge, the park set out salt in the 1960s to observe salt preferences (plain, iodized or mineralized) in goats. It is also possible that the public placed salt there to enhance photography or viewing opportunities.

In the 1970s the park established a salt bait site on Klahhane Ridge during drop net and foot snare capture operations. Use of salt at this site was discontinued in 1984. Salt bait was also used briefly at Royal Basin during live-capture operations.

Part of the experimental management program included testing salt baits for one or two summer seasons to enhance live-capture at eight sites throughout the park (see appendix C, page 205). None of these sites were successful and in 1984 all use of salt was discontinued.

The salt site at Klahhane Ridge clearly increased goat impacts within about 165 feet (50 m) of the site, but studies of 130 tagged goats at Klahhane showed that goats using the salt were resident goats and salt did not attract goats from long distances. Goat densities were not affected nor did the salt site affect the vegetation studies, the closest sample site being .5 mile (.75 km) distant (Houston and Schreiner personal communication). Minimal impacts to resources were observed at other salt sites.

SUMMARY OF MOUNTAIN GOAT RESEARCH

Extensive research has been conducted on mountain goats and their impacts in Olympic National Park. Formal research began in the 1970s and continues to present. Topics include: goat introductions, dispersal, habitat utilization, population dynamics, population modelling, and behavior; impacts to vegetation, soil and small mammals; goat management techniques (monitoring, capture, reproductive control); and risk assessment of management programs.

During the past 30 years, approximately 40 goat research projects have resulted in about 80 reports. This includes university masters and PhD projects, as well as those conducted by NPS and their contractors. Many of these reports have been published in scientific journals. A brief summary of research findings is included here, while a longer summary is included in appendix B, beginning on page 153.

General information on goat biology is summarized beginning on page 70.

Population and Habitat Research

Stevens (1979, 1983) showed that goats in the Olympics are distributed nonuniformly in subpopulations. Subpopulation dynamics and the condition of individual animals differed greatly and seemed related to goat density and habitat quality.

Houston and Stevens (1988) documented density dependent responses in survival of kids, minimum breeding age, and litter size. This suggested subpopulations are limited by quantity and quality of winter food.

Habitat quality is the most important factor determining subpopulation density (Stevens 1979). Open meadows, slide rock and open scree are the most important for feeding. Rocky bluffs are important for escape. Snow, bare ground, and coniferous forest are used primarily for thermoregulation, although ground cover under conifers is an important food source in the heat of summer.

Dispersals occur at all densities, but increase when competition for nutrients becomes more intense at higher densities (Stevens 1983).

The 1983 census estimated that 1175 ± 171 (SE) goats occurred on the peninsula. The 1990 census estimate was 389 ± 106 (SE) (Houston et al. 1983). A 1994 census estimated the goat population at 288 ± 32 (SE) (Houston et al. 1994a). The 1994 census estimate was not significantly different from the 1990 estimate, statistically.

Predators are not a major cause of goat mortality in the Olympics (ONP 1985; Houston et al. 1994b).

Hoffman and Wright's modelling of goat populations (1987) showed that if the population contained approximately 600 female goats initially and 100 were treated with contraceptives every year, it would take approximately 30 years to eliminate the population (assuming 100% effectiveness for one year). Starting with 1000 goats, removal of any less than 50/year for 20 years would have no significant

long-term effect on the population. Hoffman and Wright estimated the maximum sustainable population for goat habitat in the park at approximately 1,400 animals.

Goat Impacts

Rare, threatened and endangered plants

Habitat for the Olympic Mt. milkvetch (Federal category 1 candidate species; listed as threatened by WNHP) substantially overlaps with habitat considered ideal for goats to reach high densities (Houston et al. 1994b). Schreiner (Houston et al. 1994b) showed goat-caused mortality of *Astragalus* plants even at medium goat densities. Grazing and trampling impacts by goats are "sometimes intense." Grazing (much of it severe) was evident on as many as 72% of the milkvetch plants in three plots in a given year. Schreiner documented mortality of *Astragalus* plants due to goat wallowing. Extensive injury (grazing and trampling) to plants in one subpopulation was "entirely attributable to mountain goats." The entire known population of this species in the world contains only 3,800-4,000 plants, all within goat habitat of the Olympic mountains. The smallest of these populations contains only 37 plants in an area approximately 65 ft. by 80 ft. (20m x 25m) (ONP files).

Threats to 33 known rare/endemic plant taxa (including *Astragalus*) from goat trailing, wallowing, and grazing include risks to individual plants, subpopulations, and populations. Schreiner (Houston et al 1994) noted that rare plant distribution, including seven of eight endemic taxa, overlaps goat summer range. At least four of these taxa are known to be eaten by goats. The endemic *Aster paucicapitatus* was frequently and heavily grazed by goats. This is a "most preferred species" of forage for goats (Pfitsch and Bliss 1985).

"Rare plants may be at risk due to mountain goats for at least two reasons: (1) mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and (2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants" (Houston et al. 1994b).

"Pike (1981) found that three endemics exhibited increased standing crop when they were protected from ungulates in goat summer range...direct observations and permanent plots indicated that goats consumed and sometimes wallowed on the endemic *Astragalus australis* var. *olympicus*" (Houston et al. 1994b).

Native Plant Communities

Houston et al. (1994b) found that goats directly and indirectly alter plant communities through changes in plant morphology, reproductive patterns, and growth rates. Additionally, soil disturbance from trampling and wallowing affects seedling establishment (Reid 1983). The combination of these changes leads to altered plant community composition so that disturbance oriented and unselected species increase in abundance as selected species decrease. Community dominance shifts toward disturbance oriented species (Houston et al. 1994b).

Plant biomass, standing crop, numbers and cover decrease locally around wallows. Comparative photos have shown an inverse correlation between plant cover and mountain goat density (Houston et al. 1994b).

Goat use caused "a significant decrease" of moss and lichen cover on rock outcrops (Pike 1981; Pfitsch et al. 1983).

Goat use (tracks, droppings, wallows) was detected even at low goat density (Houston et al. 1994b). It is reasonable to expect that impacts to vegetation do occur even at low goat densities, although such impacts have not been quantified.

Schreiner (Houston et al. 1994b) found that vegetation in mountain goat summer range responded to reductions in goat density, i.e., some plant recovery is evident when goats are reduced to low densities.

Soils

Goats cause erosion associated with wallows or trails, and generalized erosion due to locally decreased vegetative cover and goat-caused soil changes.

Wallowing. In the early 1980s, Pfitsch et al. (1983) measured wallow complexes up to 2,475 ft² (230 m²) in size. Wallowing removed soil surface layers. Wallows had finer-textured soil near the surface, low organic matter, and larger particles that moved downslope. In areas with shallow soils, wallowing displaced the fine materials, leaving scree and gravel. These impacts also reduced water-holding capacity, reduced nutrients available for vegetation, increased soil aeration and increased surface temperature. The soil resulting from goat impacts provided less stability for plant regeneration (Pfitsch et al. 1983). Soil changes and disturbance caused major shifts in plant community composition around wallow edges (Pfitsch 1981, Reid 1983).

Trampling. Trampling and trailing cause increased sheetwash erosion and displacement of large soil particles (Pfitsch et al. 1983).

Capture Methods

Virtually all feasible methods of non-lethal mountain goat control have been attempted and/or evaluated. Approximately 693 mountain goats were live-captured between 1977 and 1989 (Houston et al. 1994b). Capture methods included: rope snare, padded leg-hold traps, wire snare, drop net, ground and aerial net guns, ground and aerial chemical immobilization, drive net, manual capture, ground and aerial shooting. These capture methods are described and evaluated in appendix D, beginning on page 209.

Several methods of reproductive control have been tried at Olympic, including: surgical and chemical vasectomy, surgical steroid implants, tubal ligation (by surgery and by laparoscopy). Other methods of reproductive control were evaluated for use, but not actually attempted: oral administration of chemical sterilants, non-surgical cervical closure, intrauterine devices, Caslick's operation, ovariectomy (or "spaying"). None proved suitable for large-scale application on goats at Olympic (appendix B, page 153).

Alternatives



INTRODUCTION TO ALTERNATIVES

Three alternatives were developed based on public and agency issues and concerns identified during the scoping process. The alternatives are:

- 1) Eliminate goats by shooting
- 2) No action
- 3) Eliminate goats by a combination of live-capture and shooting

Under all alternatives it is assumed that:

- 1) No change would be made to the existing law prohibiting recreational hunting within Olympic National Park.
- 2) Public information activities concerning goat management would continue.
- 3) Current goat management practices would continue on adjacent lands.
- 4) All helicopter use would be carried out in consultation with the U.S. Fish and Wildlife Service to lessen any potential impacts to marbled murrelets and other threatened or endangered species. Flight paths would be planned to avoid areas within 0.25 mi (400 m) of nesting northern spotted owls or marbled murrelets.

ALTERNATIVE 1. ELIMINATE GOATS BY SHOOTING (Preferred Alternative)

Under this alternative, goats would be eliminated from the park using helicopter-assisted shooting by authorized representatives.

The aerial portion of the shooting program would typically be conducted with one contracted helicopter (and pilot) and three NPS employees: one observer and two marksmen. This operation would be conducted during mid-May to mid-July, with the possibility of a September/October operational period for a total of approximately 30 operational days per year. Approximately 5.5 hours of flight time would be anticipated per day. Three days per week has been found to be the optimum schedule for this type of operation due to goat behavior. The helicopter would take off and land at previously established helispots, such as Sweets Field or Hurricane Ridge, which are outside wilderness/backcountry areas.

Ground-based shooting would be conducted by backcountry rangers in very limited circumstances as opportunities arise during the normal course of their duties.

Elimination of goats would be accomplished as rapidly as possible, requiring an initial intensive three-year program. It is possible that a less-intensive program could be required for another two years. Time required for elimination would depend on many factors, including logistics, availability of funding, goat behavior/response to reduced population levels, safety and weather variables. For analysis, it is assumed that the goat population at the beginning of the elimination program could contain up to 500 animals.

Upon completion of the initial elimination program, a continuing maintenance program would likely be required to shoot goats that migrate into the park from adjacent lands. The maintenance program would be conducted approximately every five years (or more frequently as necessary) and would probably include a helicopter survey to eliminate goats observed in the park. This survey would be conducted during the time period from mid-May to mid-July.

Both the elimination and maintenance programs would comply with NPS Special Directive 94-5 entitled Aerial Capture, Eradication, and Tagging of Animals (ACETA). This directive specifies mandatory training and certification for aerial wildlife eradication programs.

In most cases, all goat carcasses (from the elimination and maintenance programs) would be left in place to recycle into the ecosystem. If a carcass were on a trail or in a heavily used visitor area, it would be moved to eliminate potential problems, such as odor or conflict between scavengers and visitors.

A monitoring program would be established to evaluate ecosystem response. Previously established permanent milkvetch plots would be monitored every year. Additionally, new permanent milkvetch plots would be established in the Mt. Angeles area and monitored yearly. Community-level permanent vegetation plots would be monitored every year at Lake Constance, Klahhane Ridge and Mt. Dana initially, and at 2-5 year intervals later. Timing of the monitoring cycle during later years depends on the amount of baseline data that have been collected in each area. In areas for which a large amount of baseline data have been collected over many years, the interval between sampling would be longer.

Small, temporary campsites would be needed for monitoring crews of 2-6 people; some of these campsites may involve temporary construction of wood tent platforms to protect vegetation. The sites would be used for a few weeks in any one location and would be removed at the end of that time. Established campsites would be used where available. However, in most cases, previously existing campsites could not be used because the monitoring sites would be located in steep, remote, alpine areas in which no campsites exist. Monitoring would require helicopter support to move equipment and supplies. No more than 10 short flights would be expected each summer season and would be conducted on weekdays. No helispots would be constructed.

No formal goat censusing would be conducted under this alternative.

ALTERNATIVE 2. NO ACTION

This alternative would continue current mountain goat management within Olympic National Park. No goat population management or control action would be taken. Mountain goats would likely increase to some equilibrium level.

Monitoring of goat impacts would continue. Research concerning ecosystem impacts and differentiation of goat impacts from non-goat impacts would also continue. Monitoring would be extensive because of increased risks to vegetation communities and rare plants caused by increasing goat numbers.

This monitoring program would potentially include monitoring of:

- *Previously established permanent community-level vegetation plots on Klahhane Ridge, Mt. Dana, and Mt. Constance.
- *New permanent community-level plots that would be established in other areas, such as Appleton Pass and Royal Basin.
- *Existing permanent milkvetch plots.
- *New permanent milkvetch plots that would be established in the Mt. Angeles area.
- *Permanent plots that would be established in populations of those rare species that are known from 5 or fewer locations in ONP.

Small, temporary campsites would be needed for monitoring crews of 2-6 people. Some of these campsites may involve temporary construction of wood tent platforms to protect vegetation. The sites would be used for a few weeks in any one location and would be removed at the end of that time. Previously established campsites would be used where possible, however in most cases established sites could not be used because the monitoring plots are in very steep and remote areas. Monitoring would require helicopter support to move equipment and supplies. No more than 10 short flights would be expected each summer season and would be conducted on weekdays. No helispots would be constructed.

Monitoring of goat population numbers and dynamics would continue. A population census would be conducted every five years, using the 1990 helicopter census design (Houston et al. 1991a). This census requires approximately 4.5 hours of helicopter counting time each day for seven days during July. The helicopter would take off and land at previously established helispots outside wilderness and backcountry areas.

Evaluation of the applicability of any newly developed management methods could continue. Appropriate environmental documents would be prepared to evaluate potential impacts of any such use.

ALTERNATIVE 3. ELIMINATE GOATS BY A COMBINATION OF LIVE-CAPTURE AND SHOOTING

Under this alternative, a live-capture operation could be conducted for one field season before initiation of an NPS-conducted shooting program. Live-capture operations would be subject to a timely (within four months after issuance of the record of decision) commitment by non-NPS agencies or organizations to participate in such a program. The NPS reserves the right to decide what its level of participation in further live-capture programs would be. However, regardless of the level of NPS participation, any live-capture program would be conducted under the direction of the National Park Service and in accordance with NPS-defined criteria. Following the live-capture program, any remaining goats would be eliminated from the park by shooting. If no group commits to participate in a live-capture program within the specified period, the National Park Service would implement a shooting program during the first field season after the record of decision.

The National Park Service has used goat live-capture programs at Olympic for many years in both experimental and operational management situations. NPS has determined that live-capture is not the most safe, reliable, effective or economical method for elimination of goats. However, the National Park Service also recognizes that there may be other organizations who feel commitment of their funding to a short-term live-capture program would be worthwhile.

Live-capture Program

Qualified agencies (non-NPS) or organizations interested in conducting a short-term live-capture program in the park could work in a partnership arrangement with the National Park Service and WDFW. An NPS live-capture operation would likely be conducted within the following parameters. If another agency or organization were to conduct the program, operations might differ slightly from this, but would conform with NPS-defined criteria.

- The live-capture program would be conducted for one field season. Helicopter operations would be allowed only on weekdays. It is likely that one helicopter would conduct live-capture operations for this program at any given time within the park. This is based on safety, noise, coordination, size of landing zones, and capture-effectiveness considerations. It is expected that the helicopter would operate for 8 hours each day for three days each week. It is anticipated that operations would occur only during the spring/early summer (mid-May through mid-July) and, possibly, fall (September/October). Live-capture would not be conducted during mid-summer for several reasons: 1) during the heat of summer, goat behavior is such that capture would be more difficult; 2) heat adds an additional stress on captured animals leading to more problems with capture myopathy; 3) heat affects aircraft performance, hence safety; and 4) mid-summer is when most visitors use backcountry areas of the park and would be disturbed by extensive helicopter operations. A fall capture period has not been attempted during previous live-capture operations at Olympic because the weather can be very unpredictable (e.g. a "window of opportunity" is only available in some years, depending on the onset of high country snows) and all aircraft are often committed to firefighting operations in the western U.S. at this time of year. Inclusion of a fall capture period in this alternative would depend on these types of factors.

- WDFW would be responsible for distribution of captured animals. Goats would be transferred to state wildlife agencies for release at sites where the introduction has been

approved by appropriate state and federal authorities. Environmental impact statements would likely be required for introductions in non-native ranges. A live-capture program would not be initiated unless availability of agencies to receive translocated goats is assured.

-A medical protocol for handling goats in a humane manner would be required and must be approved by wildlife veterinarians.

-Approved methods for this live-capture operation would likely be aerial chemical immobilization (i.e., darting) and/or use of a net gun from a helicopter.

-Helicopter operations associated with the live-capture program would be conducted using helispots at Hurricane Ridge, Sweets Field (in the Elwha drainage) or locations outside the park as a base of air operations.

-If an agency or organization other than NPS conducts a live-capture program, park officials could operate a helicopter on occasion, accompanying the live-capture helicopter, to evaluate and oversee the program.

-The live-capture operation could be conducted in any portion of summer goat range within the park. However, provisions would be made to ensure protection of those rare plant taxa which are known from 5 or fewer locations in ONP (appendix I, page 249). It is likely that live-capture operations would not be permitted in the immediate vicinity of these subpopulations.

-An NPS-approved operations plan would be required for each day of the live-capture operation. The plan would include specific areas of operation on each day, so that the park visitors could be informed of noise impacts, etc.

-NPS live-capture operations were discontinued in 1989 partly due to unacceptable levels of risk associated with this type of operation. If NPS conducted the live-capture program, previously used methods would be modified for employee safety. This would mean that only goats in areas which allow use of safe techniques would be captured.

Participating agencies or organizations would be responsible for the safety of non-NPS individuals involved in live-capture operations.

-The live-capture program would be required to comply with NPS Special Directive 94-5, Aerial Capture, Eradication, and Tagging of Animals (ACETA). This directive specifies training and certification required for anyone (federal or non-federal) conducting live-capture operations within a national park area.

Shooting Program

Upon completion of a one season live-capture program, remaining goats would be eliminated from the park using helicopter-assisted shooting by authorized representatives. This portion of the program would be similar to the proposal.

The aerial portion of the shooting program would typically be conducted with one contracted helicopter (and pilot) and three NPS employees: one observer and two marksmen. This operation would be conducted during mid-May to mid-July, with the possibility of a September/October

operational period for a total of approximately 30 operational days per year. Approximately 5.5 hours of flight time would be anticipated per day. Three days per week has been found to be the optimum schedule for this type of operation due to goat behavior. The helicopter would take off and land at previously established helispots, such as Sweets Field or Hurricane Ridge, which are outside wilderness/backcountry areas.

Ground-based shooting would be conducted by backcountry rangers in very limited circumstances as opportunities arise during the normal course of their duties.

Elimination of goats would be accomplished as rapidly as possible, requiring an initial intensive three-year program. It is possible that a less-intensive program could be required for an additional year or two before elimination is achieved. Time required for elimination would depend on many factors, including number of goats live-captured, logistics, availability of funding, goat behavior/response to reduced population levels, safety and weather variables.

For purposes of analysis, it is assumed that the goat population at the beginning of the live-capture program could contain up to 500 animals and at the start of the shooting program approximately 400 animals would remain.

Upon completion of the initial elimination program, a continuing maintenance program would likely be required to shoot goats that migrate into the park from adjacent lands. The maintenance program would be conducted approximately every five years (or more frequently, if necessary) and would probably include a helicopter survey to eliminate goats observed in the park. The maintenance program would be conducted during the time period from mid-May to mid-July.

Both the elimination and maintenance programs would comply with NPS Special Directive 94-5, Aerial Capture, Eradication, and Tagging of Animals (ACETA).

In most cases, all goat carcasses (from the elimination and maintenance programs) would be left in place to recycle back into the ecosystem. If a carcass were near a trail or in a heavily used visitor area, it would be moved to eliminate potential problems such as odor or conflict between scavengers and visitors.

Monitoring

A monitoring program would be established to evaluate ecosystem response. Previously established permanent milkvetch plots would be monitored every year. New permanent milkvetch plots would be established in the Mt. Angeles area and monitored yearly. Community-level permanent vegetation plots would be monitored every year at Lake Constance, Klahhane Ridge and Mt. Dana initially and at 2-5 year intervals later. Timing of the monitoring cycle depends on the amount of baseline data that has been collected in each area. In areas for which a large amount of baseline data has been collected over many years, the interval between sampling would be longer.

Rare plant populations would be monitored during the live-capture operation to assure that the operation does not damage those plants.

Small, temporary campsites would be needed for monitoring crews of 2-6 people. Some of these campsites may involve temporary construction of wood tent platforms to protect vegetation. The sites would be used for a few weeks in any one location and would be removed at the end of that time. Established campsites would be used where possible, however most monitoring plots are located in

very steep and remote areas where no established sites exist. Monitoring would require helicopter support to move equipment and supplies. No more than 10 short flights would be expected each summer season and would be conducted on weekdays. No helispots would be constructed.

ALTERNATIVES CONSIDERED, BUT REJECTED

During the scoping and development process of the document, the following 13 alternatives were suggested for inclusion in the DEIS. The National Park Service considered these additional alternatives, but did not fully develop them for the reasons stated.

R-1. Reduce and Limit Goat Population to a Predetermined Level Using Both Shooting and Non-lethal Methods (i.e., live-capture and/or reproductive control)

Under Alternative R-1, mountain goat management units would be identified within Olympic National Park. Goat density would be reduced to, and limited at, prescribed levels within each zone. Prescribed levels would be based on goat population and impacts research. In most or all management zones, plant impacts would necessitate limiting goat populations to low or very low densities evenly distributed (Houston et al. 1994b). Goats could be eliminated within some units. The limitation program would continue indefinitely.

Under this alternative a combination of methods, including shooting, live-capture, contraception (ZP vaccine, norgestomet biobullets, orally administered contraceptives, etc.), or sterilization, could be used for reduction and limitation.

Reasons for Rejection

Rejection of this alternative was not based on any one factor. Rather, the combination of many factors led to the unsuitability of the alternative.

Agency Mandates and Objectives. This alternative would not meet NPS mandates and management objectives relative to exotic species management, ecosystem protection and restoration, wilderness, biosphere reserve and world heritage site values, and rare plant protection.

Goat Biology. Several factors of goat biology would affect implementation of this alternative.

Research has shown that lower density goat subpopulations are healthier and exhibit higher rates of reproduction than higher density subpopulations. At low numbers, goat reproduction rates may be higher and goats continue to use preferred habitats (Houston et al. 1994b). Thus, even at a low average parkwide density, goats would still occur at higher actual densities in their preferred areas than in other areas and cause a higher level of impacts in those preferred areas. Rock outcrops and adjacent scree/talus slopes throughout goat range are considered preferred habitat areas. Such areas also provide the primary habitat for some plants, including several endemic species.

Maintaining a goat population at the low density required to limit plant impacts may not be possible because the population may not remain viable below a certain density level, in spite of the healthy condition and higher reproduction rates of the remaining individuals. Small populations of species may show high extinction rates.

Capture and handling of any wild animal causes some unavoidable deaths. Capture related mortality of 8-19% (or more) could be expected during live-capture operations.

During past live-capture operations at the park, most or all of the captured goats were transplanted to areas where hunting occurs. Therefore, in some cases, great effort and expense was incurred to translocate an animal which was then legally killed by hunters.

Goat Impacts (Ecosystems). This alternative would not meet the need for assured protection of native ecosystems. Ecosystem impacts caused by exotic goats would continue. Schreiner detected goat use (tracks, wallows, droppings) in areas with goat densities of less than 2.59 animals/mi² (1 animal/km²) (Houston et al. 1994b). "Even where all goat use was eliminated by exclosures, six years were required before significant community realignment occurred" (Schreiner 1987).

Specific goat impacts to native communities and soils are detailed in the analysis of the no-action alternative beginning on page 101 of this document.

Goat Impacts (Candidate, Threatened & Endangered Species). This alternative would not meet the need for assured protection of the Olympic Mtn. milkvetch. Under this alternative goats could be eliminated in areas where the milkvetch occurs, however the distance goats would need to travel to reinvade these areas would be much less than with the elimination alternative. In the past goats have reached very high densities in the areas where the milkvetch occur, thus these sites would likely be preferred areas for goat reinvasion. Risks to category 1 plant species would continue. Schreiner documented goat-caused mortality of *Astragalus* plants even at medium goat densities (Houston et al. 1994b). *Astragalus* was grazed in more than half of the subpopulations that were sampled by Schreiner (Houston et al. 1994b). Grazing and trampling impacts by goats are "sporadic, but sometimes intense." He also found that "extensive grazing and trampling of plants at Unicorn Peak in 1987 were entirely attributable to mountain goats" (Houston et al. 1994b). Grazing was evident on up to 72% of the milkvetch plants in some plots in a given year; much of that impact could be classified as severely grazed. Schreiner also documented mortality of *Astragalus* plants due to goat wallowing. "Two (milkvetch) plants were killed by a wallowing goat at Blue Mountain, where goats numbered fewer than 10 animals." (Houston et al. 1994b)

Specific goat impacts to *Astragalus* are detailed in the analysis of the no-action alternative beginning on page 101 of this document.

Goat Impacts (Rare/Endemic Plants). This alternative would not provide needed protection of rare and endemic plants. Impacts to rare/endemic plants would continue. Threats to 33 known rare/endemic plant taxa from goat trailing, wallowing and grazing include risks to individual plants, subpopulations and populations.

Although goats might not directly kill the last individuals in a population of rare plants, they "may increase the risk of extinction by fragmenting populations or habitats. Risk of extinction increases as populations are fragmented or reduced in number (Pimm 1991). Extinction often involves a combination of forces acting on small, fragmented populations (Houston et al. 1994b). Introduced herbivores have driven rare, endemic plants to extinction or near extinction elsewhere (Houston et al. 1994b). Park managers are concerned that introduced goats could drive some rare, endemic plants to extinction at Olympic.

Specific goat impacts to rare and endemic plants are detailed in the analysis of the no-action alternative beginning on page 101 of this document.

Safety. Shooting from helicopters, while hazardous, would be the safest method of control. All other methods would require employees to quickly exit from helicopters that are hovering or only partially touching the ground, which is extremely hazardous. Safe, effective techniques for live capture of wild

mountain goats in the steep terrain and weather conditions found in the Olympics currently do not exist. Previous live capture operations were discontinued, in part, because the degree of risk to employees for serious injury or fatality was found to be unacceptably high. Toe-in, one-skid, and step-out helicopter landings have since been prohibited by the Department of Interior Office of Aircraft Services.

There are critical helicopter performance limitations during capture operations. Certain conditions of altitude and speed must be maintained in order to land safely in the event of engine failure, even if suitable landing areas are available. The emergency landing technique for helicopters with engine failure is called "autorotation". "Simply put, if you are flying slow you must have altitude; if you're flying low, you must be moving fast" (Olson 1994). If you are flying a helicopter low and slow, the pilot cannot execute an autorotation, even if the helicopter happened to be flying over a perfect landing spot when the engine failed. Most wildlife live-capture operations require flying low and slow for extended periods of time. Therefore, the helicopter is flying at (or beyond) the limits of safety most of the time, especially in the extreme terrain of the Olympics (where there are few suitable landing sites).

The more a person is exposed to even a minor risk, the greater the chance for injury or fatality. Employees would be repeatedly exposed to these risks every year for many years, thus impacts would be significant (in duration).

Feasibility. This alternative is not feasible because it does not meet the need for assured protection of the native ecosystem, including rare/endemic plants.

Houston (Houston et al. 1994b) states, "...low precision in determining goat numbers (i.e., wide confidence intervals surrounding estimates -- to be expected based on all earlier counts)...means that tracking actual subpopulation numbers closely enough to maintain... narrowly defined limits of acceptable densities in the park would be nearly impossible." Monitoring ecosystem impacts with the level of accuracy needed for a sustained limitation program would also be very difficult (or impossible). Thus, it is not feasible to try to maintain some specified goat population or impact level.

It is not possible to reduce goats to a uniform low density over the entire park because goats are gregarious, habitat quality varies across the landscape, and some habitat is only seasonally available.

Cost. This alternative, if it could be implemented, would be extremely expensive and continue in perpetuity. It is unlikely that continued long-term funding at a level necessary for this program would be available.

Scientific Review. Nine wildlife experts were individually asked to evaluate the applicability of contraceptives for use on goat populations in Olympic National Park. Seven of these scientists cited significant obstacles to effective application of non-lethal methods at the park, while several scientists suggested that a combination of shooting and non-lethal methods might provide *some* level of control. None advocated the use of non-lethal methods for elimination of goats, nor the use of non-lethal methods alone for control. Excerpts from these reviews begin on page 181. A chart summarizing all the reviews is also included beginning on page 187. The scientists identified several main factors that would limit success of a contraception program:

- 1) Currently available contraceptive agents are effective for approximately one year, so each animal would need to be re-treated annually (Fayrer-Hosken 1994; Garrott 1994; Gill and Baker 1994; Kirkpatrick 1994; McCullough 1994; Plotka 1994; and Warren 1994).

- 2) Effective remote delivery of contraceptive agents with current technology is problematic, particularly under the extreme field conditions found at Olympic (Garrott 1994; Kirkpatrick 1994; McCullough 1994; and Warren 1994).
- 3) Treatment of a high enough proportion of the population is extremely difficult, if not impossible, especially in the rigorous field conditions at Olympic (Fayrer-Hosken 1994; Garrott 1994; McCullough 1994).
- 4) The level of control possible using contraceptive technology is not sufficient to ensure ecosystem protection (McCullough 1994 and Warren 1994).
- 5) Although several contraceptive agents have been effective in tests with captive animals, none have been proven effective in large wild populations, especially in field conditions similar to Olympic. (McCullough 1994; Plotka 1994; and Warren 1994).
- 6) The humaneness of remotely delivered contraceptives has been questioned. McCullough states "... the projectile does inflict pain and suffering. Humane considerations do require that these effects be taken into account, especially if repeated (e.g., annual) treatments are required. Such procedures, if performed on laboratory animals, would surely call for anesthetization" (McCullough 1994). Jessup cites "...the only problem with [the biobullet] appears to be associated with acute pain and localized trauma at the implant site" (Jessup 1994). One of the captive animals treated by Jessup "carried the hind limb" for 21 days.
- 7) Safety concerns (i.e., the risk of helicopter crashes) are greatest with sustained use of non-lethal approaches (McCullough 1994 and Warren 1994).
- 8) Cost-effective methods of wildlife contraception are currently not available (Fayrer-Hosken 1994; Gill and Baker 1994; McCullough 1994; and Warren 1994).

***R-2. Reduce and Limit the Goat Population
to a Predetermined Level
Using Only Capture/ Translocation and/or Reproductive Control***

Under Alternative R-2, mountain goat management units would be identified within Olympic National Park. Goat density would be reduced to, and limited at, prescribed levels within each zone. Prescribed population levels would be based on goat population and impacts research. In most or all management zones, plant impacts would necessitate limiting goat populations to low or very low densities evenly distributed (Houston et al. 1994b). Goats could be eliminated within some units. The limitation program would continue indefinitely.

Capture/ translocation and/or reproductive control would be the only methods used.

Reasons for Rejection

Rejection of this alternative was not based on any one factor. Rather, the combination of many factors led to the unsuitability of the alternative.

All of the reasons for rejection of Alternative R-1 above are also reasons for rejection of this alternative. Please refer to the above discussion of those reasons common to both alternatives. Additional reasons for rejection specific to use of only capture/translocation and/or reproductive control are discussed here.

Goat Biology. It is not possible to capture enough goats using live-capture methods. Previous experience during the ONP experimental and operational management program has shown that the

maximum number of goats that can be live captured in the first year of a program is approximately 15% of the population, with a smaller proportion of the remaining population captured in each subsequent year. Even if a capture/translocation rate of 15% could be maintained every year, the earliest the population would reach low density parkwide would be 18 years from the start of the program (Hoffman and Wright 1987). In some portions of goat habitat, the terrain is so rugged that live-capture is impossible.

It is not possible to treat enough goats using reproductive control techniques. Although Hoffman and Wright (1987) did not consider reduction to low density in their population models, they did evaluate the use of contraceptives for elimination of goat populations: they modelled a population initially containing approximately 600 females. If 100 of those females were treated with contraceptives every year, it would take approximately 30 years to eliminate the population (assuming 100% of the treated females remained infertile for a one year time period). Reduction of the population to low density using only reproductive control, if it were possible, would likely take almost as long. A longer infertility period could be achieved using chemical vasectomy or female hormone implants, however both of these methods would require capture and field treatment of the animal which is not technically feasible.

Capture and handling of any wild animal causes some unavoidable deaths. Capture related mortality of 8-19% (or more) could be expected during live-capture operations.

During past live-capture operations at the park, most or all of the captured goats were transplanted to areas where hunting occurs. Therefore, in some cases, great effort was made to translocate an animal which was then legally killed by hunters.

Safety. Safe, effective techniques for live capture of wild mountain goats in the terrain and weather conditions found in the Olympics currently do not exist. Any work in and around helicopters is inherently dangerous, however live-capture operations are especially so since (once an animal is darted or netted) employees must quickly exit onto very steep terrain from helicopters that are hovering or only partially touching the ground. Previous live-capture operations at Olympic were discontinued because the level of risk to employees for serious injury or fatality was found to be unacceptably high. Since that time, new Department of Interior Office of Aircraft Services regulations have prohibited the use of toe-in, single-skid or step-out helicopter landings. This alternative could not be implemented without the use of such procedures.

The risk of employee fatalities while implementing this alternative would be significantly higher than the risk associated with the no action or either of the elimination alternatives.

Feasibility. This alternative is not feasible because it does not meet the need for assured protection of the native ecosystem, including rare/endemic plants. It is not possible to reduce goat densities to a low enough level to ensure ecosystem protection over the entire park using only capture/translocation and/or reproductive control.

In 1994, nine scientists individually reviewed the applicability of contraceptives for use on goat populations in Olympic National Park. Each of the reviewers concluded that contraception alone would not control the goat population at Olympic. McCullough (1994) stated, "...by itself contraception will not achieve the desired control unless some breakthrough in delivery in the field allows easy treatment of a large proportion of the population." Fayrer-Hosken (1994) concluded that "...the goat population could not be significantly reduced by current immunocontraceptive technology." Gill and Baker (1994) stated, "...the current state of contraceptive technology favors lethal methods over non-lethal methods to control numbers of mountain goats...." Warren (1994) explained "...the

level of control attainable with contraceptives may not be sufficient for you to achieve your objectives of preservation of unique floral communities in ONP." More-complete excerpts from these reviews begin on page 181.

Cost. This alternative, if it could be implemented, would be extremely expensive and continue in perpetuity. It is unlikely that continued long-term funding at a level necessary for this program would be available. However, because the number of goats that could be translocated or treated for reproductive control is limited by physical factors, biological factors and operational constraints, even unlimited funding would not increase the feasibility of this alternative.

R-3. Eliminate Goats in Selected Park Areas by Shooting; Take No Action in Other Areas

Goats in approximately one-half of summer range within the park would be eliminated by shooting. After elimination, a maintenance program would be needed indefinitely to remove goats dispersing into the areas. No management action would be taken on the other one-half of goat summer range.

Reasons for Rejection

Rejection of this alternative was not based on any one factor. Rather, the combination of many factors led to the unsuitability of the alternative.

Agency Mandates and Objectives. This alternative would not meet NPS mandates and management objectives relative to exotic species management, ecosystem protection and restoration, wilderness and other special designations, and rare plant protection.

Goat Biology. Elimination of goats in half the park would not necessarily mean half of the goat population would be shot. More or less than one-half the population could be shot, depending on which management units were identified for elimination. It is assumed that up to approximately 250 goats would be shot during the initial program.

Goats in the other one-half of the park would increase to the maximum sustainable population level. For analysis, it is assumed that the total goat population in the park would increase to one-half the estimated park-wide maximum population, or approximately 700 goats. This would represent an increase of 200-300 goats over the present population.

Dispersals occur at all subpopulation densities, but increase when competition for nutrients becomes more intense at higher densities (Stevens 1983). Dispersals from subpopulations in the no-action one-half would increase, requiring a long-term maintenance program to shoot animals dispersing into the elimination areas. Using Houston's worst case estimate of 10% immigration (Houston et al. 1994b), up to 70-80 dispersing goats could be shot each year.

Goat Impacts (Ecosystems). The no-action subpopulations would increase to maximum goat density. As a result, impacts to soils and native communities would increase in one-half of goat summer range within the park. In these areas, impacts of this alternative would be similar to impacts of the no action alternative.

Impacts would be reduced in the subpopulation areas identified for elimination. Impacts would not, however, cease because goats from the no-action subpopulations would disperse back into the elimination areas.

The goat population within the park would increase by 200-300 animals if this alternative were implemented. Goats in one-half of their range would reach maximum densities. Many individuals would migrate from those areas into the elimination areas.

Goat Impacts (Threatened & Endangered Species). Habitat for Olympic Mt. milkvetch substantially overlaps with habitat considered ideal for goats to reach high densities (Houston et al. 1994b). Under this alternative goats could be eliminated in all areas where the milkvetch occurs within the park, however the distance goats would need to travel to reinvade these areas would be much less than with the total elimination alternatives. In the past goats have reached very high densities in the areas where the milkvetch occur, thus these sites would likely be preferred areas for goat reinvasion. It would not be possible to maintain these areas goat-free at all times.

Reinvading goats from the no-action areas would continue to eat, wallow on and trample milkvetch plants, causing continued impacts and threats to individual plants, subpopulations, and the entire population. It is certain that risks would be greater than with the elimination alternatives.

Goat Impacts (Rare/Endemic Plants). Thirty-three taxa of rare/endemic plants are known to grow in goat summer range in the Olympic Mountains (Houston et al. 1994b). Generally, rare plant habitat and goat habitat coincide. Rare/endemic plant populations occur in every goat subpopulation area within the park (Houston et al. 1994b). Therefore, it would not be possible to eliminate goats from all areas in which rare plants occur.

Goat numbers would increase to maximum density in the no-action areas; impacts to rare/endemic species from grazing, wallowing and trailing would also increase in those areas. Threats to these plants include risks to individual plants, populations, and subpopulations. It is certain that risks would be greater with this alternative than with the elimination alternatives.

Although goats might not directly kill the last individuals in a population of rare plants, they "may increase the risk of extinction by fragmenting populations or habitats. Risk of extinction increases as populations are fragmented or reduced in number (Pimm 1991). Extinction often involves a combination of forces acting on small, fragmented populations" (Houston et al. 1994b). "Rare, endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g., goats in Hawaii and the Galapagos Islands; Loope et al. 1988)" (Houston et al. 1994b). It is possible that goats could cause some taxa of rare/endemic plants to become extinct at Olympic if this alternative were selected.

Safety. The elimination and maintenance programs would involve shooting goats from a helicopter, but the animals would not need to be recovered as they would during a live-capture program. Therefore, employees would not need to exit the helicopter under hazardous field conditions, such as hovering or toe-in and one-skid landings in steep terrain.

Any work involving helicopters is inherently dangerous, including the possibility of fatalities. The more a person is exposed to even a minor risk, the greater the chance for injury or fatality. Employees would be exposed to these risks every year for decades, thus impacts would be significant (in duration).

Feasibility. This alternative is not feasible because it does not meet the need for assured protection of the native ecosystem, including rare/endemic plants.

Many goats would be shot every year, yet there would be an increased number of goats in the park.

It is not possible to maintain one-half the park in a goat-free condition, while allowing goats in the other half to reach maximum densities. Dispersals from the high density areas would mean that the "goat-free" areas would not actually be free of goats.

Under this alternative, a costly, never-ending helicopter operation would be required to maintain a goat population, with associated impacts, of several hundred animals more than the current population.

Cost. This alternative, if it could be implemented, would be expensive and continue in perpetuity. It is unlikely that continued long-term funding at a level necessary for this program would be available.

R-4. Manage plants only, do not actively manage goats

This alternative includes management of rare, threatened, or endangered plants by maintaining populations in a greenhouse or within permanent fences to exclude goats.

Reasons for Rejection

The alternative does not meet NPS/Wilderness Act/Endangered Species Act mandates/policies. This alternative does not address the problem of exotic species within the park.

Plant populations that occur only in a greenhouse and are no longer found in their native habitat cannot be considered viable wild populations. It is also uncertain if the plants could be propagated in a greenhouse. The number of rare species is too great to feasibly use greenhouse propagation. Greenhouse propagation of rare plants ignores their role as an integral part of a functioning ecosystem.

While temporary fencing as part of local site restoration programs may be used in conjunction with other alternatives, it is not feasible to construct/maintain fencing around plants of concern because of size of areas, steepness, rocky substrate, and snowpack. Fences would interfere with natural ecosystem processes, such as snow accumulation and melting, and could harm the plants they were intended to protect.

R-5. Introduce predators, or augment predator populations, to control/eliminate goats

Reasons for Rejection

Native predators. Reintroduction or augmentation of native predator populations could be included as part of other alternatives, however it cannot stand alone as an alternative.

"Healthy" populations of native predators, such as cougars, already exist on the peninsula. Predation is not as significant as habitat factors in limiting goat populations, in the Olympics or elsewhere. Predation alone would not meet goals of reducing or eliminating goats.

Wolves are native to the Olympic Peninsula, but were extirpated by the early twentieth century. Reintroduction of wolves could be considered, but not as a means to achieve goat reduction or elimination.

Exotic predators. It is not logical to introduce a new exotic to solve a current exotic problem. Introduced predators would likely cause future impacts to the native ecosystem. This alternative doesn't meet NPS/Wilderness mandates/policy concerning exotic species and maintenance of native ecosystems.

R-6. Control impacts of recreation use only

This alternative suggests that human-caused impacts from recreational use of the park should be controlled, while no action should be taken on goat-caused impacts.

Reasons for Rejection

This would not address the documented problem of goat impacts or the issue of exotic species within a park. This is outside the scope of this DEIS.

ONP is currently managing recreational uses to address the problem of impacts.

ONP has a legal mandate to allow for and manage recreational uses.

R-7. Delay all action for a specified time period, then implement management based on increased research

Reasons for Rejection

Essentially, this alternative is addressed in the no action alternative. At any future time, management actions can be reassessed under the no action alternative and, with appropriate NEPA compliance, a new management program could be implemented.

The current research database is sufficient to make a management decision.

R-8. Goats are native and should be managed as a native species

Reasons for Rejection

As part of the DEIS process, the National Park Service thoroughly re-examined all known evidence relative to the presence of goats on the peninsula prior to the 1920s. Dr. Susan Schultz addressed historical evidence (Schultz 1993; Houston et al. 1994b); Dr. Randall Schalk investigated ethnographic and archeological evidence (Schalk 1993); Dr. Douglas Houston and Dr. Edward Schreiner addressed

biogeographical considerations (Houston and Schreiner 1993; Houston et al. 1994b). These three reports each concluded that goats were not historically present on the peninsula prior to the 1920s.

Dr. Schalk could not make conclusive statements as to presence of goats during prehistoric times (the Late Pleistocene or Holocene prior to the 19th century). If a hypothetical population of goats was indeed present on the peninsula during the Late Pleistocene or Holocene, it must have become extinct before historic times. NPS policies for natural resource management are "aimed at providing the American people with the opportunity to enjoy and benefit from natural environments evolving through natural processes minimally influenced by human actions" (NPS 1988). The aim is not to recreate late Pleistocene or early Holocene biotas. A species that naturally went extinct would no longer be considered a native species under NPS policy if subsequently reintroduced by humans. The current goat population is an exotic species, regardless of whether a prehistoric form of goats was present or not.

Some members of the public have suggested that an article written by Dr. R. Lee Lyman, an anthropologist with the University of Missouri at Columbia, proves goats are native. Dr. Lyman's article conjectures that a hypothetical prehistoric mountain goat population could have existed on the Olympic Peninsula, although no proof of such a population exists at this time, and that if archeological proof were found we would know if his theory is correct (Lyman 1988). Dr. Lyman later stated "That I can build such a model or scenario, of course, does not mean that goats were present in the Olympics prior to 1925" (Lyman 1993).

Two historic accounts by 19th century explorers are often cited relative to the presence of goats on the peninsula before 1925: an 1896 *National Geographic* magazine article by Samuel Gilman (Gilman 1896) and an 1890 *Seattle Press* article by C. A. Barnes (Barnes 1890). Schultz notes that these references "are unsupported by any observational detail. Neither account provides any information on the circumstances, location, or date of a specific goat sighting, nor a description of the animal. When weighed against the numerous, detailed observations provided by skilled wildlife observers who did not find any evidence of goats during this same period, such reports are clearly of questionable validity" (Houston et al. 1994b).

Several ethnographic and archeologic sources are also often cited to indicate that goats may have been present on the peninsula prior to the 1920s (for example, Dunn 1845 and Reagan 1917). Schalk (1993) concludes "Although the ethnographic sources indicate the lack of mountain goat populations in this region, they document the existence of a trade network that brought mountain goat wool and horns to native populations of the Olympic Peninsula....The keeping of wool dogs by the native people of the Olympic Peninsula conforms to a broader pattern in which these dogs were kept by groups lacking direct access to mountain goat populations....Horn spoons were extensively traded on the Northwest Coast and, therefore, might be encountered in archaeological deposits in areas far removed from the regions where the mountain goats themselves lived."

The three NPS reports, and Dr. Lyman's article, were individually reviewed by nine independent reviewers selected by professional societies (The American Society of Mammalogists, the Forest History Society, The History of Science Society) and the Department of Interior Consulting Archeologist. Each reviewer concluded that the evidence indicates goats were not historically present on the peninsula before their introduction in the 1920s, i.e., mountain goats are an exotic species on the peninsula.

Based on the entire historic, ethnographic and archeologic record currently available, NPS has concluded that mountain goats are an exotic species on the Olympic Peninsula. Therefore, this alternative was eliminated from detailed study.

Excerpts from the three NPS reports, Dr. Lyman's article, the nine independent reviews, and Dr. Lyman's comments on two of the NPS reports are included in appendix F, beginning on page 225. The full text of the 13 documents is available from Olympic National Park.

R-9. Change agency mandates

This alternative includes several issues: 1) Changing NPS mandates/policy to accept exotic goats within a park; 2) Putting all goats under the management of WDFW; 3) Changing NPS mandates/policy to allow for recreational hunting within Olympic National Park.

Reasons for Rejection

These types of changes would require action by the United States Congress. Such action is beyond the scope of this DEIS.

Federal mandates and NPS policies are established for ecosystem-based resource management. For example, the 1988 NPS Management Policies states, "The natural resource policies of the NPS are aimed at providing the American people with the opportunity to enjoy and benefit from natural environments evolving through natural processes...Natural resources will be managed with a concern for fundamental ecological processes." Mandates and policies are national in scope. There is no sound rationale for changing mandates/policies on the basis of individual situations.

Recreational hunting is prohibited by statute (16 USC 256 b) and is incompatible with NPS policies on natural resource protection and recreational uses in Olympic National Park.

R-10. Move goats to areas where rare plants do not occur

Reasons for Rejection

Relocation to areas off the peninsula could be used in combination with other methods to reduce goat populations and associated impacts. However, it is of limited effectiveness as a stand-alone alternative.

Relocating goats from within the park to goat habitat adjacent to the park would not be an effective means of population/impact reduction. Goat dispersal distances of 10 to 34 mi (16 to 54 km) have been documented on the Olympic Peninsula. It is likely that goat populations would recolonize habitat from which they had been removed.

Generally, rare plant habitat and goat habitat coincide. There may be no area of goat habitat on the Olympic Peninsula where rare plants do not occur.

This alternative doesn't address problems of impacts to soils and more common native vegetation. It also does not address the problem of an exotic species' presence within park ecosystems.

All of the problems inherent in the live capture/ relocation of goats would remain.

R-11. Manipulate goat behavior only

This alternative includes management actions to manipulate goat behavior, thus providing protection for rare plants. Actions include baiting goats into areas with no rare plants, applying repellents on plants, and providing substitute sources of feed for goats.

Reasons for rejection

Use of bait to keep goats in particular areas. Research has shown that baiting goats is not effective in "wild" (non-habituated) populations. Habituated subpopulations can only be baited at certain times during the year. Baiting could create severe goat impacts in bait areas. This alternative does not address issue of impacts to soils and more common native vegetation. It is not feasible due to logistics and effort required in the terrain/climate found on the Olympic Peninsula.

Plant repellents. This is not feasible because it would require extensive treatments repeated frequently in difficult terrain and weather conditions. Repellents would interfere with native animal species feeding on vegetation. This solution does not address the significant impacts caused by physical disturbance to plants and soils from trampling and wallowing. If only rare or endemic plants were treated, impacts to more common vegetation might increase. It would not be possible to treat all vegetation and, even if it were possible, such treatment would eliminate the food source for all herbivores.

Provide substitute food sources for goats. This is not feasible because food would need to be provided frequently for a large number of goats over a very large area in difficult terrain/weather conditions indefinitely into the future. It doesn't address other significant impacts of goats, such as trampling and wallowing. This alternative would not meet NPS and Wilderness Act mandates of ecosystem management.

None of these alternatives addresses the problem of the presence of an exotic species within the park.

R-12. Conduct no management reductions or removals, cease hunting in Olympic National Forest, and allow goat population to reach ecological equilibrium with the environment

Reasons for Rejection

For management action within Olympic National Park, this is essentially identical to the no action alternative (alternative 2.); while for lands within Olympic National Forest, this is outside the scope of this EIS.

This alternative would not meet management objectives.

This option does not address problem of goat impacts on vegetative communities, soils, ecosystem processes, and rare, threatened and endangered plant species. Damage would continue to increase.

The issue of an exotic species within the park would not be addressed by this alternative.

***R-13. Eliminate recreational hunting of goats
in Olympic National Forest***

Reasons for Rejection

The alternative is not relevant to this DEIS. Alternatives considered for the purposes of the document focus on management of goats within Olympic National Park only.

The elimination of goat hunting would require action by the Washington Wildlife Commission which is also beyond the scope of this document.

Table 1 summarizes information found in the "environmental consequences" section beginning on page 81.

Table 1. Impacts Summary Chart			
Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Wildlife Resources	Up to 500 goats would be shot within the park during the initial elimination program. An unknown number of additional goats, possibly as many as 20 animals/year, would be shot during the maintenance program. The goat population outside the park may or may not remain viable long-term under this alternative. Although impacts of goats on other wildlife have not been proven, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Removal of goats, and subsequent ecosystem restoration, could benefit several native wildlife species.	The goat population within the park would likely increase to approximately 1,400 animals. Outside the park, the goat population would probably be maintained at current levels by hunting. Although impacts of goats on other wildlife have not been proven, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Any such impacts on other wildlife would increase under this alternative.	An estimated 100 goats would be captured during the live-capture program. 10-20% of these animals could die as a result of capture. Approximately 400 goats would be shot within the park during the initial shooting program. An unknown number of additional goats, possibly as many as 20 animals/year, would be shot during the maintenance program. The goat population outside the park may or may not remain viable long-term under this alternative. Although impacts of goats on other wildlife have not been proven, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Removal of goats, and subsequent ecosystem restoration, could benefit several native wildlife species.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Vegetation Resources	Elimination of goats would essentially eliminate threats to native vegetation, including rare/endemic plants, from goats. Vegetative recovery would be expected. This alternative provides the most protection for vegetation and offers a high level of assurance that resources would be effectively protected. The primary differences between alternative 1 and alternative 3 is that this alternative provides for elimination one year earlier than alternative 3 and that no damage to vegetation would be anticipated as a direct result of goat management actions under this alternative. Alternative 1 would meet NPS mandate, policy and management objectives for protection and restoration of T&E, rare, and endemic taxa and native vegetation to the maximum extent possible.	This alternative would result in more than a three-fold increase in goat numbers, which would lead to increased impacts on category 1, rare, and endemic vegetation. Individual rare/endemic plants would certainly be lost. Some populations could be lost and extinction of some rare/endemic taxa could occur. More goats would also cause increased impacts to native vegetative communities. This alternative would not meet NPS mandates, policy and management objectives relative to protection and restoration of T&E, rare, endemic, and native vegetation.	Elimination of goats would essentially eliminate goat-caused threats to native vegetation, including rare/endemic plants. Vegetative recovery would be expected. This alternative provides protection for vegetation and offers a high level of assurance that resources would eventually be effectively protected. The two elimination alternatives provide the most protection for vegetation resources. There are two primary differences in vegetation impacts between alternative 1 and alternative 3: impacts would be minimized one year sooner in alternative 1 than in this alternative and the live-capture portion of this alternative could cause direct impacts to vegetative communities and rare plants. Alternative 3 would meet NPS mandate, policy and management objectives for protection and restoration of T&E, rare, and endemic taxa and native vegetation, however not as quickly as possible.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Soils	Soil impacts would be reduced to the maximum extent possible. Impacts would not be totally eliminated because of goats dispersing into the park.	This alternative would result in increased numbers of goats on the peninsula, leading to increased soil impacts.	This alternative would result in virtual elimination of goats in the park. Soil impacts would be reduced, although not as quickly as possible. Impacts would not be totally eliminated because of goats dispersing from outside the park. The two elimination alternatives provide more restoration and protection for soils than the no action alternative. There are two primary differences in soil impacts between alternative 1 and alternative 3: impacts would be minimized one year sooner in alternative 1 than in this alternative and the live-capture portion of this alternative could cause direct soil impacts.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Visual Resources	Elimination of goats would virtually eliminate the possibility of viewing goats within the park and would increase the possibility of seeing undisturbed native ecosystems. Effects of this alternative on visual resources would be negative for those visitors that value seeing goats more than seeing native ecosystems, while the effect would be positive for those visitors who value the visual integrity of native ecosystems more than goat sightings. Goats could still be viewed outside the park: on the peninsula, elsewhere within Washington; and throughout western North America.	Effects of this alternative on visual resources would be positive for those visitors that value seeing goats more than seeing native ecosystems, while the effect would be negative for those visitors who value the visual integrity of native ecosystems more than goat sightings.	Elimination of goats would virtually eliminate the possibility of viewing goats within the park and would increase the possibility of seeing undisturbed native ecosystems. Effects of this alternative on visual resources would be negative for those visitors that value seeing goats more than seeing native ecosystems, while the effect would be positive for those visitors who value the visual integrity of native ecosystems more than goat sightings. Goats could still be viewed outside the park: on the peninsula, elsewhere within Washington; and throughout western North America.
Impacts on Wilderness Values	Goats impact wilderness values. Elimination of goats would have a positive long-term effect on wilderness values. Elimination of goats requires use of firearms and helicopters within the wilderness areas. Therefore, the alternative would have a negative short-term impact on wilderness values and experiences during the actual management programs.	More goats would cause more impacts on wilderness resources. This alternative would have short-term and long-term negative impacts on wilderness values because goats and the impacts caused by goats are human-caused influences within the wilderness area.	Goats impact wilderness values. Elimination of goats would have a positive long-term effect on wilderness values. This alternative requires use of live-capture equipment, firearms and helicopters within the wilderness area. Therefore, the alternative would have a negative short-term impact on wilderness values and experiences during the actual live-capture, shooting, and maintenance programs.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Human Safety	Although working in and around helicopters is inherently risky, employees would not need to rapidly exit the helicopter under hazardous field conditions. Therefore, risks to employees during a shooting program would be low relative to any other method of control or elimination.	Risks to human safety would be minimal with this alternative.	Participants in the live-capture phase of the program would be exposed to a higher level of risk than with either other alternative. Methods would be modified from those used in the 1988/1989 live-capture program to increase safety. Although working in and around helicopters is inherently risky, employees would not need to rapidly exit the helicopter under hazardous field conditions during the shooting phases of the program. Therefore, risks to employees during the elimination and maintenance program would be low relative to any other method of control or elimination.

Table 1. Impacts Summary Chart (Continued)			
Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Values Related to Special Designations	Elimination of goats would minimize ecosystem impacts, which would have a positive effect on the values associated with world heritage site and biosphere reserve designations.	Increased numbers of goats cause increased ecosystem impacts. This alternative would have a negative effect on values associated with the biosphere reserve and world heritage site designations.	Elimination of goats would minimize ecosystem impacts, which would have a positive effect on the values associated with world heritage site and biosphere reserve designations. Both elimination alternatives would have less impacts on these values than the no action alternative would. The primary difference between alternative 1 and alternative 3 is that impacts would continue for one additional year under this alternative to provide for a live-capture operation.
Cost	Alternative 1 would be the most cost effective alternative to achieve goals for ecosystem protection and restoration. The relative cost per animal would be very low for a shooting program. Total cost of this alternative over the first ten year period would be approximately \$364,000 for operations; and approximately \$455,000 for vegetation monitoring. Future costs (beyond the initial ten year period) would be minimal: approximately \$27,000 every five years for the maintenance program.	Estimated total cost of this alternative over the first 10 year period would be approximately \$585,000-\$1,028,000, including vegetation and goat monitoring. These costs would continue indefinitely.	Alternative 3 would be the most expensive of the three alternatives. The relative cost per animal is very low for the shooting program, but high for the live-capture program. Cost of this alternative over the first ten year period would be approximately \$579,000 for operations; and approximately \$455,000 for vegetation monitoring. The substantial cost of a live-capture program could be borne by an agency or organization other than NPS. Future costs (beyond the initial ten year period) would be minimal: approximately \$27,000 every five years for the maintenance program.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Archeologic Resources	Implementation of this alternative does not require ground operations outside of developed areas. Therefore, no impacts to archeological resources would be expected during implementation of alternative 1. Goats could impact archeological resources by disturbing soils and vegetation. Risk of goat-caused damage to cultural resources would be minimized if goats were eliminated within the park.	Risk to undiscovered archeological sites would increase as goat numbers increase.	Soil and vegetation impacts caused by ground operations during the live-capture phase could damage archeological resources. Implementation of the shooting phases does not require ground operations outside of developed areas. Therefore, no impacts to archeological resources would be expected during these operations. Goats could impact archeological resources by disturbing soils and vegetation. Risk of goat-caused damage to cultural resources would be minimized if goats were eliminated within the park. Minimizing this risk would take one year longer than under alternative 1.
Impacts on Local and Regional Economy	Olympic National Park and Olympic National Forest employment and visitation would not be affected by this alternative. Goat hunting could possibly be affected by this alternative, which would have a minor effect on the peninsula economy. Thus, the local and regional economy would not be significantly affected by this alternative.	Olympic National Park employment and visitation would not be affected by this alternative. Goat hunting would also not be affected. Thus, the local and regional economy would not be affected by this alternative.	Olympic National Park and Olympic National Forest employment and visitation would not be affected by this alternative. Overall, the local and regional economy would not be significantly affected by this alternative.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Tourism	In the past, park visitation has increased regardless of goat population numbers. Other species of large mammals would continue to be available for viewing or photographing. It is unlikely that elimination of goats would impact tourism significantly.	Total park visitation would be unaffected by this alternative. Visitors wishing to view or photograph wildlife would continue to see goats, and would likely have opportunity to see more goats. Minimal impacts on tourism would be expected from this alternative.	In the past, park visitation has increased regardless of goat population numbers or goat management operations. Other species of large mammals would continue to be available for viewing or photographing. It is unlikely that this alternative would impact tourism significantly.
Impacts on Hunting Outside the Park	Impacts on hunting are uncertain. If the goat population outside the park remains viable long-term (50-100 years), this alternative would not likely have any effect on hunting. If the goat population outside the park declines or disappears, goat hunting could be reduced or eventually cease within the next 50 to 100 years. Opportunities for goat hunting would continue in areas of Washington other than the Olympic Peninsula. It is estimated that approximately 7,000 goats occur elsewhere in the state.	Opportunities for goat hunting outside the park would continue or increase with this alternative.	Impacts on hunting are uncertain. If the goat population outside the park remained viable long-term (50-100 years), this alternative would not likely have any effect on hunting. If the goat population outside the park declined or disappeared, goat hunting could be reduced or eventually cease within the next 50 to 100 years. Opportunities for goat hunting would continue in areas of Washington other than the Olympic Peninsula.

Table 1. Impacts Summary Chart (Continued)

Resource Element	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Impacts on Park Visitor Use and Experience	This alternative would not be likely to change levels of visitor use. Visitor experiences would be impacted by noise, closures, etc. on a short-term basis during the implementation of the program. Upon completion of the elimination program, opportunities for viewing goats within the park would be essentially eliminated, while opportunities to experience unimpaired ecosystems would increase. Impacts to visitor safety would be minimal or non-existent.	It is unlikely that this alternative would affect the level of visitor use. Effects of this alternative on visitor experience could be positive or negative: positive for those visitors who value goats more than native ecosystems and negative for those who value native ecosystems more than goats.	This alternative would not be likely to change levels of visitor use at all. Visitor experiences would be impacted by noise, closures, etc. on a short-term basis during the implementation of the program. Upon completion of the elimination program, opportunities for viewing goats within the park would be essentially eliminated, while opportunities to experience unimpaired ecosystems would increase. Impacts to visitor safety would be minimal or non-existent.

Affected Environment



INTRODUCTION

The following description of the affected environment contains information on environmental factors that relate to the goat management issue on the Olympic Peninsula or that are helpful in a general understanding of the issue. It is not a comprehensive description of all environmental factors on the peninsula because factors unrelated to goat management are not included.

TOPOGRAPHY

The Olympic Peninsula is a 5,300 square mile (13,800 km²) peninsula in northwest Washington. It is surrounded on three sides by saltwater: the Pacific Ocean on the west, the Strait of Juan de Fuca to the north, and Hood Canal/Puget Sound on the east. On the south, the peninsula is bounded by lowlands in the Chehalis River valley.

The Olympic Mountains form the core of the peninsula. These mountains are extremely rugged and steep. Eleven major river drainages radiate out from the mountainous interior.

Elevations on the peninsula range from sea level at the Pacific Ocean to 7,973 feet (2,430 m) on Mount Olympus, 35 miles (56 km) inland.

Topography is pertinent to goat management for several reasons: topography is important to explain why mountain goats did not naturally occur on the peninsula; topography influences climate and vegetation; and the rugged topography of the peninsula is a significant limiting factor in certain goat management activities, such as helicopter use and live capture techniques.

GEOLOGY AND GLACIAL HISTORY

The Olympic mountains are one of the youngest mountain systems in the world. They began uplift by plate tectonic processes during the Miocene epoch. The central core area of the mountains is composed of marine sedimentary sandstones, siltstones, and shales. The peripheral Crescent Formation and Blue Mountain Unit were created by submarine volcanic activity. This peripheral crescent was then sheared off of the ocean bottom by movement of the oceanic plate under the continental plate along a subduction zone. Continued shearing, folding and uplifting thrust the crescent above the sedimentary core. The Olympic Peninsula is still geologically active, with continued uplift and erosion.

Glacial activity, both alpine and continental, is a significant factor in the formation of the Olympic Peninsula. Several major periods of glaciation have occurred. Continental and alpine glaciation has been staggered spatially and temporally, leaving some ice-free areas within portions of the Olympics at all times. Alpine glaciers remain in the high portions of the mountains today.



The mountainous interior of Olympic National Park. (ONP Photo: L. Kirk).

BIOGEOGRAPHY

Biogeography is the study of the geographic distribution of plants and animals. This topic is particularly important in understanding the goat management issue because: 1) the geographic isolation of the Olympic Peninsula produced an assemblage of plants and animals that differs from other areas in Washington; and 2) glacial "refugia" allowed unique plants to develop on the peninsula.

The high elevation areas of Olympic are essentially alpine and subalpine "islands" because the peninsula is surrounded by large bodies of salt water on three sides and by lowland forests on the south. The nearest native goat range is in the Cascade Mountains east of Puget Sound. Twelve species of mammals which occur in the Cascades are absent from the Olympics, although other species of mammals are found in both areas.

During the last glaciation, ice-free areas within portions of the Olympics occurred at all times. The peninsula's geographic isolation, which limited interaction with plants and animals occurring outside the peninsula, and these "refugia" from the ice allowed unique species of plants and animals to develop. The Washington Natural Heritage Program lists 106 species, or varieties, of plants occurring

on the peninsula as rare. Fourteen vascular plant taxa are endemic. Thirty-three rare and/or endemic plant taxa are found within goat summer range. Five mammal species or subspecies are endemic to the peninsula.

"The terrestrial mammal fauna (48 species, excluding bats and marine mammals) of the Olympic Peninsula is impoverished compared to the nearby Cascade Range in Washington" (Houston et al. 1994b). Species diversity of plants is also discussed: "...the Olympic flora is notable for the absence of species common in the Cascades, as well as the presence of species not found in the Cascades.... Subalpine and alpine vascular floras of the Olympics and the North Cascades differ, but neither is necessarily more diverse (Pike 1981). Twenty-four percent of 1,054 native Olympic species were not found in the North Cascades; conversely, 36% of 1,248 North Cascade species were not found in the Olympics" (Houston et al. 1994b). Five coniferous tree species found in the Cascade Range do not occur on the Olympic Peninsula.

A list of endemic species is found in Table 2, page 66; a list of mammal and bird species absent from the Olympics, but found in the Cascades is in Table 3, page 68.

CLIMATE

The maritime climate is moderate. Winters are mild and wet, while summers are cool and relatively dry.

The steep mountains form a barrier to moist winds off the ocean, producing a significant rain shadow effect. Average annual precipitation ranges from 160 to 200 inches (400-500 cm) on the west slope to 17 inches (43 cm) on the leeward, northeastern portion of the peninsula. Deep winter snows occur above 4,600 feet (1,394 m) elevation. Snowfall amounts range from 300 to 500 inches (750-1,250 cm) annually. Most (80%) annual precipitation occurs from October through March.

Temperatures throughout the year are moderated by the marine influence. Average monthly summer temperatures range from 49° F to 64° F (9-18° C) in the lower elevations. During winter, average monthly temperatures in the lowlands are 36° F to 52° F (2-11° C). Cooler temperatures are found at higher elevations.

Climate is important in goat management because weather influences vegetation and can be a limiting factor for management activities, such as helicopter use.

SOILS

A wide variety of soils are found on the Olympic Peninsula. These soils have been formed from many different geologic substrates, including volcanic and sedimentary rocks and glacial drift.

The Olympic National Forest Land and Resource Management Plan Final Environmental Impact Statement (1990) states, "In general, soils developed from marine basalt predominate in the south and west portions of the forest, while sedimentary derived soils dominate to the north and east. Metamorphosed sediments and volcanics are generally found at higher elevations toward the interior of the forest. Soils derived from continental glacial drift are located at lower elevations along the

northern and eastern flanks. The Olympic source glacial drift soils are found throughout, but the major soil areas are on the west side at lower elevations."

Although no detailed, park-wide soil surveys have been conducted within Olympic National Park, areas utilized by goats have been studied. High elevation soils in the Olympics are young and poorly developed. Soils in the Klahhane Ridge area developed from Crescent Formation sandstones and volcanic basalt and breccia. Harter (Pfitsch et al. 1983) found that "soils of the Phlox-fescue meadow (on Klahhane Ridge) most closely resemble Haploborolls while soils of a more mesic phase of this community type were classified by Kurmoto and Bliss (1970) as Orthic Hapludolls." Harter also stated, "Soils of the unstable herb meadows show even less development than the soils of the Phlox-fescue meadow...(they) have developed on volcanic substrates and most closely fit the description of Typic or Lithic Ustorthents..."

Alpine and subalpine soils on the peninsula are generally acidic with pH values ranging from approximately 4.5 to 5.7 for most soils. Values for soils on calcium bearing substrate range from about 6.0 to 7.0 (Schreiner, personal communication).

VEGETATION

Vegetation of the Olympic Peninsula is extremely diverse due to elevational and climatic variety. Mixed conifer forests from sea level to timberline are dominated by species such as western hemlock, Douglas-fir, Sitka spruce, Pacific silver fir, mountain hemlock, subalpine fir and lodgepole pine. Many species, including Douglas-fir, Sitka spruce, western hemlock, and Pacific silver fir, reach world record size on the peninsula. Treeline, the upper elevational limit of forests, is approximately 5,300 feet (1606 m) on the wet west side and approximately 6,200 feet (1879 m) on the drier east and north sides of the peninsula.

Goats occupy the higher elevation alpine or subalpine vegetation communities occurring at or above treeline. Mountain goat summer range is generally identified as areas above 5,000 feet (1,520 m) which are free of glacial ice, although goats do sometimes use lower elevation areas during the summer. These communities range from subalpine meadows and herbaceous communities to scree and rock areas with little vegetation of any kind. Substrate stability and soil moisture are the primary factors determining community distribution. Alpine and subalpine communities are found in approximately 25% of Olympic National Park.

Goats often winter on steep forested cliffs or rock outcrops at lower elevations (some as low as 600 feet [183 m]).

Nine subalpine plant communities on Klahhane Ridge have been identified by Pfitsch (1981). All of these vegetation types showed varying amounts of grazing use by goats. In Schreiner's work throughout goat summer range, sixteen plant communities were sampled. "...mountain goat sign was found in all but one community type. Mountain goat sign was encountered twice as often as that of any other herbivore in 12 of the 16 community types" (Houston et al. 1994b).

The Olympic National Park Resource Management Plan (1992) states, "Subalpine and alpine meadows are far more complex than forested lower elevation zones. Community structure and composition depend on snow retention, temperature, moisture, and disturbance. Major communities range from those dominated by cushion plants on wind-swept ridges to areas dominated by black sedge or pussytoes where snow melts considerably later. Other communities are dominated by pink mountain

heather, showy sedge, or a combination of large forbs and grasses such as saussurea, sage, rye grass, and Sitka brome. Communities such as the Phlox-Fescue type occur primarily from Tyler Peak to Hurricane Ridge. Talus and scree slopes may be dominated by fireweed, the endemic Olympic Mountain milkvetch or cut-leaved synthyris, alumroot, delphinium, or sage depending on rates of substrate movement, depth to mineral soil and the moisture regime. Rocky outcrop vegetation includes a suite of other species including at least three endemics. In short, the number of subalpine and alpine communities is probably greater than the number of forested communities in all other biotic zones combined."

The Washington Natural Heritage Program lists 106 species, or varieties, of plants occurring on the Olympic Peninsula as rare. Of these, 33 taxa (species, subspecies and/or variety) are known to grow in areas comprising mountain goat summer range (elevations above 5,000 feet [1,520 m]).

Four category 2 candidate species of plants occur in the park, although none grow within goat habitat. A category 2 species is one for which proposing to list under the Endangered Species Act is possibly appropriate, but insufficient information is available to support the proposal.

The Olympic Mt. milkvetch (*Astragalus australis* var. *olympicus*) is a Category 1 candidate for the federal endangered species list and is listed as threatened by the WNHPP. The milkvetch is found in only 12 known subpopulations in the world, all within goat habitat of the Olympic Mountains. Eleven of these subpopulations are within the northeastern portion of the park, while one is within Olympic National Forest. The smallest of these subpopulations contains only 37 plants in an area approximately 65 ft. by 80 ft. (20m x 25m) (ONP files).

An endemic species is one that is naturally confined to a particular region and has a restricted geographic distribution. Fourteen vascular plant taxa in the Olympics are endemic. Six are found only on the Olympic Peninsula and nearby Vancouver Island, while eight are found only on the peninsula. Seven of the eight narrow endemics found only on the peninsula occur at an average elevation of 4,950-6,170 feet (1,500-1,870 m), which corresponds to goat summer range. Five of the six taxa found on the peninsula and Vancouver Island occur at an average elevation above 5,000 feet (1,520 m) (Houston et al. 1994b). The number of alpine endemics on the peninsula is high due to long-term isolation from other alpine and subalpine areas.

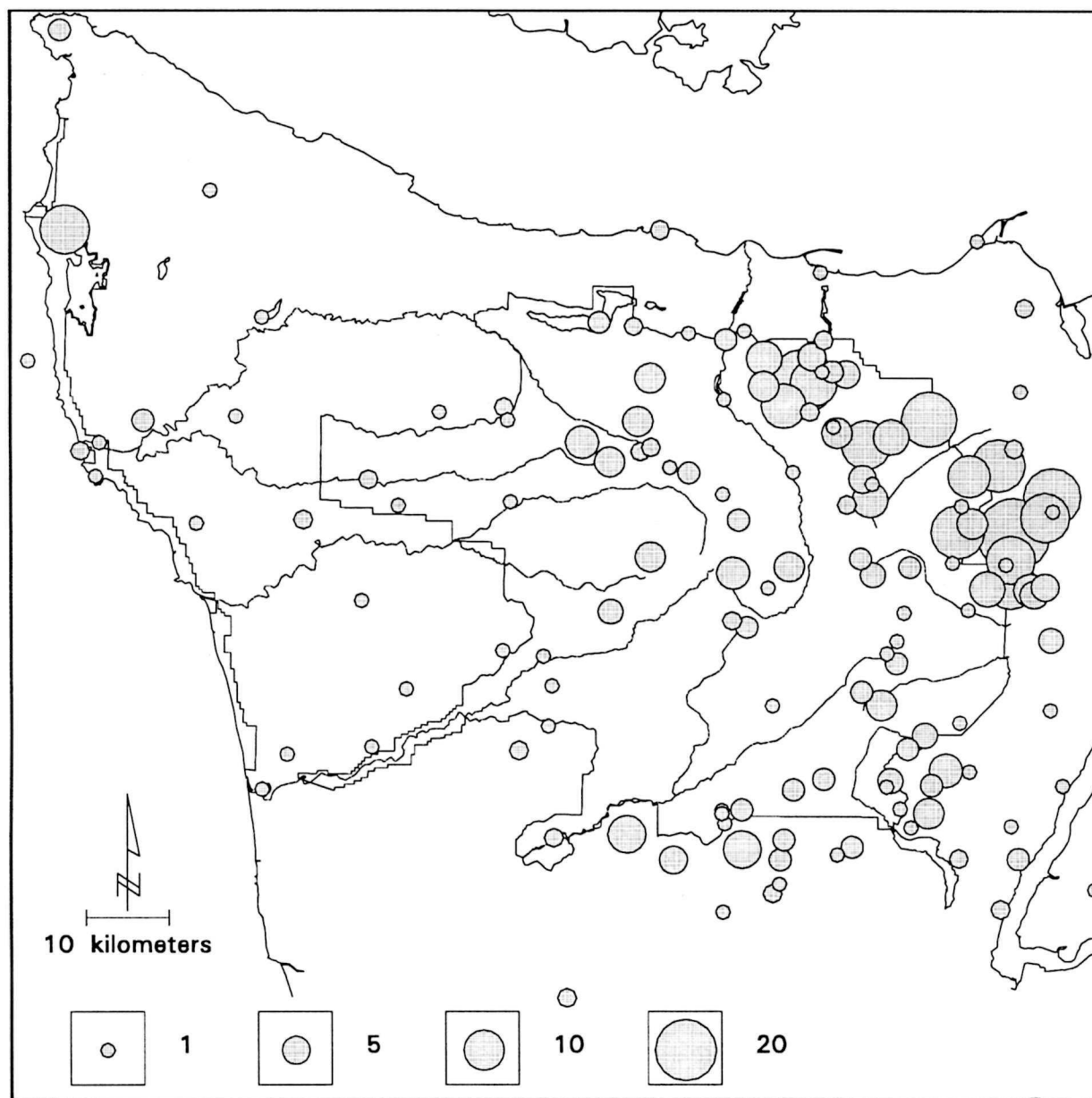


Fig. 5 - Number of WNHP-listed vascular taxa found at collection areas on the Olympic Peninsula. Circle size is proportional to the number of plant taxa found at each site (modified from Houston et al. 1994).

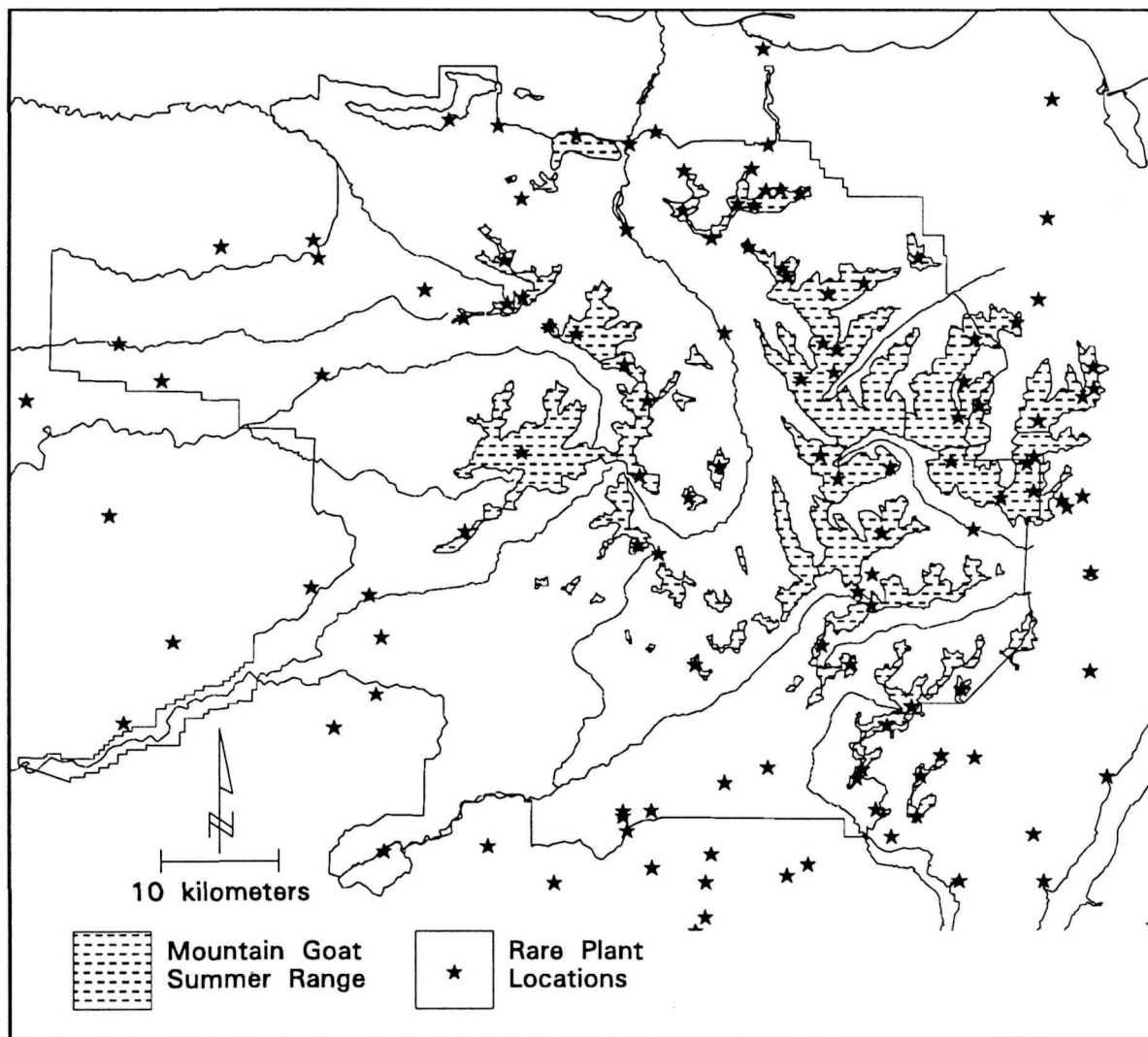


Fig. 6 - Known collection locations for WNHP-listed taxa in relation to mountain goat summer range on the Olympic Peninsula (modified from Houston et al. 1994).

Table 2. Endemic Fauna and Flora of the Olympic Peninsula
(Modified from Houston et al. 1994b)

VERTEBRATES

MAMMALS

Olympic marmot	<i>Marmota olympus</i>
Olympic yellow-pine chipmunk	<i>Tamias amoenus caurinus</i> ¹
Olympic snow mole	<i>Scapanus townsendii olympicus</i>
Olympic Mazama pocket gopher	<i>Thomomys mazama melanops</i>
Olympic ermine	<i>Mustela erminea olympica</i>

AMPHIBIANS

Olympic torrent salamander	<i>Rhyacotriton olympicus</i>
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FISH

Olympic mud minnow ²	<i>Novumbra hubbsi</i>
"Beardslee" rainbow trout ³	<i>Oncorhynchus mykiss irideus</i> (lacustrine form)
"Crescenti" cutthroat trout ³	<i>Oncorhynchus clarki clarki</i> (lacustrine form)

INVERTEBRATES

INSECTS

(Lepidoptera - butterflies and moths)

Olympic arctic ⁴	<i>Oeneis chryxus valerata</i>
Hulbirt's skipper	<i>Hesperia comma hulbirti</i>

(Orthoptera - grasshoppers)

Olympic grasshopper	<i>Nisquallia olympica</i>
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(Coleoptera - beetles)

Mann's gazelle beetle	<i>Nebria danmanni</i>
Quileute gazelle beetle	<i>Nebria acuta quileute</i>
Sylvan gazelle beetle ⁴	<i>Nebria meanyi sylvatica</i>
Johnson's snail eater ⁴	<i>Scaphinotus johnsoni</i>
Tiger beetle	<i>Cicindela bellissima frechini</i>

MILLIPEDES

Millipede ⁴	<i>Tubaphe levii</i>
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MOLLUSCS

Arionid slug	<i>Hemphillia dromedarius</i>
Arionid jumping slug	<i>Hemphillia burringtoni</i>

Table 2. Endemic Flora and Fauna of the Olympic Peninsula (continued)

VASCULAR PLANTS

Pink sandverberna ⁴	<i>Abronia umbellata acutulata</i>
Olympic Mt. milkvetch	<i>Astragalus australis</i> var. <i>olympicus</i>
Piper's bellflower	<i>Campanula piperi</i>
Flett's fleabane	<i>Erigeron flettii</i>
Thompson's wandering fleabane ⁵	<i>Erigeron peregrinus peregrinus</i> var. <i>thompsonii</i>
Henderson's rock spirea	<i>Petrophytum hendersonii</i>
Webster's senecio	<i>Senecio neowebsteri</i>
Olympic Mt. synthyris	<i>Synthyris pinnatifida</i> var. <i>lanuginosa</i>
Flett's violet	<i>Viola flettii</i>
Olympic aster ⁴	<i>Aster paucicapitatus</i>
Magenta paintbrush ⁴	<i>Castilleja parviflora</i> var. <i>olympica</i>
Lance-leaf springbeauty ⁴	<i>Claytonia lanceolata</i> var. <i>pacifica</i>
Blood-red pedicularis ⁴	<i>Pedicularis bracteosa</i> var. <i>atrosanguinea</i>
Tisch's saxifrage ⁴	<i>Saxifraga tischii</i>

CRYPTOGAMS

Liverwort ⁴	<i>Porella roellii</i> forma <i>crispata</i>
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¹ Trinomials indicate "subspecies".² Occurs south to Chehalis River.³ Formerly considered a distinct species; currently considered a lake-adapted form of the subspecies.⁴ Also occurs on Vancouver Island.⁵ Not found in Olympic National Park.

Table 3. Mammal and bird species absent historically from the Olympic biota, but that occurred in the Cascade Mountains¹ (Modified from Houston et al. 1994b).

MAMMALS

Grizzly bear	<i>Ursus arctos</i>
Wolverine	<i>Gulo gulo</i>
Red fox ²	<i>Vulpes vulpes</i>
Coyote ³	<i>Canis latrans</i>
Lynx	<i>Lynx canadensis</i>
Water vole	<i>Microtus richardsonii</i>
Golden-mantled ground squirrel	<i>Spermophilus lateralis</i>
Northern bog lemming	<i>Synaptomys borealis</i>
Porcupine ⁴	<i>Erethizon dorsatum</i>
Pika ⁵	<i>Ochotona princeps</i>
Mountain sheep	<i>Ovis canadensis</i>
Mountain goat	<i>Oreamnos americanus</i>

BIRDS

White-tailed ptarmigan	<i>Lagopus leucurus</i>
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¹Scientific names from Honacki et al. (1982).

²Subsequently introduced (Aubry 1984).

³Colonized the Peninsula during the early 20th century (Dalquest 1948).

⁴Occasional dispersing individuals, apparently no established population (Scheffer 1949, Johnson and Johnson 1952, NPS unpubl. records).

⁵Merriam found no pikas, but was uncertain that they were entirely absent.

WILDLIFE RESOURCES

The geographic isolation of the Olympic Peninsula affected wildlife populations, as well as vegetation. Forty-eight species of terrestrial mammals (excluding bats and marine mammals) occur on the Olympic Peninsula. Mammalian species diversity is low relative to the nearby Cascade range (Houston et al. 1994b). Some mammalian species are common to both areas. Five mammal species or subspecies are endemic to the peninsula: Olympic marmot, Olympic yellow-pine chipmunk, Olympic snow mole, Olympic ermine, and Olympic Mazama pocket gopher. Several mammals which are native to the Cascade range are not native to the Olympics. These include mountain sheep, pika, red fox, wolverine, lynx, and mountain goats.

Olympic National Park was originally established, in part, to protect the peninsula's population of Roosevelt elk. This subspecies was first described in the Olympic mountains. It is estimated that 4,000 to 5,000 elk now inhabit the park.

Blacktail deer are also common on the peninsula.

Predators present in the area include black bear, cougar, bobcat, bald and golden eagles, and coyote. Wolves were native to the Olympics, but were eliminated in the 1920s.

THREATENED AND ENDANGERED SPECIES

The U.S. Fish and Wildlife Service identified four species of endangered wildlife and seven species of threatened wildlife in or near Olympic National Park. Of the endangered species, only peregrine falcons (*Falco peregrinus*) occur in goat habitat. The gray wolf (*Canis lupus*) may have occurred in goat habitat, however wolves were essentially extirpated from the peninsula before the goat introductions. Of the threatened species, bald eagles (*Haliaeetus leucocephalus*) are found in goat habitat, primarily during fall, winter or spring. Northern spotted owls (*Strix occidentalis caurina*) may overlap with goats locally and temporarily in winter at lower elevations, but generally they do not overlap.

Ten additional animal species were identified as candidates for listing under the Endangered Species Act. Of these, northern goshawks (*Accipiter gentilis*) may overlap in goat winter habitat, but probably do not nest in goat summer habitat. Pacific fishers (*Martes pennanti pacifica*) are likely to occur in goat habitat, at least seasonally. No wolverines have ever been documented in the park.

The U.S. Fish and Wildlife Service identified four plant taxa in or near the park as candidates for listing under the Endangered Species Act. Of these, only the Olympic Mt. milkvetch (*Astragalus australis* var. *olympicus*) is found in goat habitat. The milkvetch is a Category 1 candidate for the federal endangered species list and is listed as threatened by the WNHP.

GOAT BIOLOGY

Physical Description

Taxonomically, mountain goats (*Oreamnos americanus*) are not true goats. They are more closely related to antelopes of the mountainous regions of Europe and Asia.

The average size of adult goats is about 3 feet (1 m) tall and 3-5 feet (1-1.5 m) in length (Stevens 1983). Adult males typically weigh 150-225 pounds (68-102 kg), while adult females are 120-160 pounds (54-73 kg) (Stevens 1983; Wigal and Coggins 1982). The sexes are not easily distinguishable to an untrained observer. Both sexes have short, unbranched horns. These are true horns which are not shed each year. The long, dense white fur is well adapted to cold conditions. The hair grows to its greatest length in the fall and is shed in late spring. During the annual molt, goats may shed in a patchy manner and appear somewhat ragged until mid-summer. Goats are predominantly white except for the horns, eyes, nose, and hooves, which are black.

Female goats are called nannies, while males are billies. A goat during its first year of life is a kid. During its second year a goat may be called a yearling.

The hooves of mountain goats are especially adapted to the steep rocky terrain preferred by the animal. Unlike most other ungulates, goats have a pliable pad which protrudes over the hard nail. This provides excellent traction on rock or ice.

Distribution/Habitat

It is thought that ancestral mountain goats crossed the Bering land bridge from Asia into North America during the mid-Pleistocene, about 2.5 million years ago. The goats then moved south through the continuous alpine areas of the high mountain ranges in western Canada and the northwest United States. Their current native range includes mountainous areas of southern Alaska, British Columbia, Alberta, Idaho, Montana, and Washington's Cascade Range.

The recent range of goats has been extensively expanded in this century by human actions. Transplanted populations have been established in Oregon, Nevada, Utah, Colorado, Wyoming, and South Dakota. Goats have also been introduced on the Olympic Peninsula in Washington, and in areas of Idaho and Montana outside of their native range.

Johnson (1977) estimated that 100,000 goats live in the western United States and western Canada. WDW estimated that the goat population in Washington's Cascade Range totalled approximately 7,000 goats in 1992 (WDW 1992).

Alpine and subalpine areas are preferred goat habitat. On the Olympic Peninsula, Stevens (1979) revealed that good summer goat habitat includes three components: feeding areas, escape cover, and behavioral temperature control options. She found meadows are important feeding areas, while other grass and forb areas are also utilized. Escape cover for goats consists of steep, rocky areas. Stevens reported that temperature control options include permanent snow, northern exposures, good soil

development for wallowing, and late summer water supplies. Areas of Olympic National Park above 5,000 ft (1,520 m) can be considered as ideal goat summer habitat (Houston et al. 1994b).

Diet

Mountain goats are ruminants or "cud-chewing" mammals. Their stomachs are four chambered and support microorganisms that facilitate digestion.

Goats are generalists in their diet. They consume a wide range of vegetation including grasses, forbs, ferns, shrubs, mosses, lichens, and coniferous tree foliage.

Pfitch and Bliss (1985) studied goat foraging at Olympic National Park: "The areas used by the mountain goats during the snow-free season are constrained by time of snowmelt and their thermoregulatory needs. Snow-free time can be divided into three seasons with respect to the areas used by goats for foraging. During the spring (May to June) goats forage mainly on S slopes; deep snow discourages access to areas on the N side. By summer (July to mid-August) the entire ridge is accessible, but the goats spend most of their time on the N side of the ridge...With the onset of lower autumn temperatures, generally accompanied by increased precipitation (mid-August to November), the goats forage over the entire ridge." Pfitch and Bliss sampled 51 plant species and found goats selectively grazed 13 and "avoided" 18 species. It should be noted, however, that most species (even those "avoided") showed evidence of grazing by goats. "Avoided" species were consumed less than would be expected based on their occurrence within the plant community. They found that grazing frequency and intensity were very high for Idaho fescue (*Festuca idahoensis*) and showy sedge (*Carex spectabilis*), indicating that goats prefer these species.

During winter months, forage availability is restricted by snow and goats consume whatever is available. Their diet is composed of shrubs and coniferous trees which protrude from the snow. Goats paw under the snow to find sedges, forbs, and tubers. They also seek out vegetation growing on ridges and ledges which are kept snow-free by wind (Chadwick 1983).

Goats in some populations are attracted to salt licks during the early summer, however other populations thrive in areas with no natural mineral licks. Salt may be needed to replenish sodium lost in digesting succulent spring forage or to obtain sulfates needed for lactation and hair growth (Pfitch and Bliss 1985). "Sodium may be deficient in soils and vegetation of alpine areas that receive heavy precipitation, and salt craving displayed by goats in the Olympic Mountains in spring and early summer may reflect reduced availability of this element (Robbins 1983)" (Houston et al. 1994b).

Reproduction

The goat breeding season is November to early December. Goats are polygamous. Stevens and Taber (1980) found that on the colonizing edge of dispersing populations in the Olympics, nannies may produce their first kid at age two (i.e., females breed as yearlings). In most areas, it is more likely that a nanny will begin reproducing at three or four years of age. Billies reach reproductive age at two years old, however dominance by older males generally prevents young males from breeding.

The gestation period is approximately 186 days. Kids are typically born in late May. In the Olympics, Stevens and Taber (1980) documented kidding as early as May 11 and ending as late as June 30. Generally, each nanny will have a single kid. Twins are not uncommon and a significant number of nannies have no kid in a given year. Reproductive rates in Olympic National Park range from 27 to almost 100 kids per 100 nannies (Stevens and Taber 1981). Nannies leave other goats to give birth on ledges in high cliff areas. Kids are able to climb steep areas within hours of their birth. The nanny and kid remain separated from other goats for three to eighteen days before joining a "nursery" group. Nannies begin to discourage nursing after the kid is about a week old. Nursing does continue to some degree until August or September, however the kid is also foraging within several days after birth. Young goats remain with their mothers until the nanny gives birth to another kid the next year. If the nanny has no offspring the following year, the yearling may remain with her for an additional year.

Stevens and Taber (1980) observed considerable variation in goat sex ratios at birth, but found no statistically significant difference from 50/50. Sex ratios for adult goats in Olympic National Park were found to be 0.5 billies to each nanny. In Olympic National Forest, Johnson (1983) documented ratios of 0.2 billies per adult nanny.

Behavior

Stevens and Taber (1980) studied summer goat behavior in the Olympic Mountains and found that feeding and bedding are the major activities in a goat's daily routine. Feeding peaked in the early morning and late afternoon, while bedding was most prevalent in mid-day heat and at night. Other behavior included wallowing, licking minerals, travelling, and eating snow. These other actions generally followed the same daily variation as feeding, with a higher level of activity in morning and evening.

Goats wallow to aid in heat dissipation, to lessen effects of insects, and for body grooming. Wallows are created by goats pawing and throwing soil on themselves. Wallows can be quite deep and extensive. A particular site may be used by a single goat or by several animals simultaneously.

During summer months, goats are found in the higher elevations of the peninsula. Stevens and Taber (1980) observed that goats most often utilized areas between 5,500 and 6,500 feet (1,667-1,970 m) elevation.

Goats move to lower elevations during the winter. Although they may be within forested areas, goats remain close to rocky ridges and bluffs. Houston and Stevens (1988) found goat winter ranges as low as 1,485 feet (450 m) elevation. In the Elwha drainage, goats have been observed at elevations of 600-1,000 feet (200-300 m) (Houston personal communication).

During most of the year goats are separated into two types of groups. Nursery groups contain females of all ages, kids, and young males. Adult males remain solitary or form small bachelor groups of two to eight individuals. During the fall mating season, these groups temporarily disband. In the spring, nannies isolate themselves to give birth.

Older goats are usually dominant over younger ones. Stevens (1983) noted that this is true except in the case of kids in the company of their nanny. These kids benefit from the nanny's social standing.

Dominance between males and females is less clear than age related dominance. Stevens (1983) stated that in the Olympics, males dominate females, probably due to the males' much larger body size. Other researchers have documented apparent female dominance over males in some goat populations (Chadwick 1983).

Dominant individuals usually displace less dominant goats at a coveted resource, such as a mineral lick or bedding site. In males, this behavior is very important because only the dominant males are generally able to mate successfully.

Mortality Factors

Most goats in the wild may live to approximately 7 to 10 years old once they survive their first years. Chadwick (1983) reported that the oldest goat he'd observed in the wild was 13 years old. Stevens and Taber (1980) reported that in the Olympics, the oldest known goat was 12. In captivity, goats have been reported to live to 20 years of age.

Survival of young goats during their first winter was found to vary from 40% to 100% in the Olympics (Stevens 1983). Stevens states the variability seems to relate to the condition of the nanny and the severity of the winter.

It is difficult to directly document causes of goat mortality due to the rough terrain and severe winter conditions within their range.

Dangers inherent in life on steep mountain slopes, such as avalanches and falling, appear to be significant causes of goat mortality (Stevens and Taber 1980; Chadwick 1983; Wigal and Coggins 1982). Weather can also be an important factor in mortality, particularly cold rains during the kidding period and above normal winter snowpack (Johnson 1983). Houston and Stevens (1988) state that population parameters "suggest that strong density-independent forces affect demography--i.e., large-scale winter mortality from deep snow, avalanches, etc. may be commonplace--thus masking density-dependent relationships."

Wolves, cougars, grizzly and black bears, bobcats, bald and golden eagles, and coyotes have all been shown to prey or scavenge on mountain goats. Golden eagles often prey on goat kids in Idaho and Montana (Chadwick 1983; Wigal and Coggins 1982). Stevens (1979) states that although "The peninsula does support populations of cougar, bobcat, coyote, black bear, and golden eagles, all of which are capable of taking at least small goats...In the Olympics predation is not thought to be an important factor in mortality." "Predation on goats is considered a comparatively minor source of goat deaths in the park. We have more records of deaths by falls than by predators" (Houston et al. 1994b).

Hunting of goats may be a significant mortality factor on populations throughout their range. An archery hunt was initiated in Olympic National Forest in 1967. An average of eight goats are taken by hunters per year on the peninsula. Hunting is not permitted within the park.

Many parasites and diseases have been documented in goat populations, including ticks, lice, parasitic worms, bacteria, and viruses. Stevens (1983) compared occurrence of eight parasites in several goat subpopulations at Olympic National Park. She found two parasite species present in over 80% of the animals in all subpopulations. She also noted that the Klahhane Ridge subpopulation showed a

higher prevalence of seven of these parasites than any other subpopulations. Stevens hypothesized that poor nutrition and lower demographic vigor occurred in the Klahhane subpopulation due to the high density of goats. At the time of her study, Klahhane Ridge had higher goat densities than any other area known in North America. Johnson (1983) presents data on eight parasites from goats in the Olympics. One parasite (*Eimeria* sp.) was present in 98% of the fecal samples, however *Capillaria* was present in only .5% of samples.

Although numerous diseases and parasites are known to affect mountain goats, Chadwick (1983) states that "the overall role of parasite and disease organisms in regulating, or limiting, those populations is minimal." Johnson (1983) noted, "In Washington, goats in some populations are heavily parasitized. Parasites can contribute to mortality directly, or indirectly when animals are stressed by nutrition, other diseases, adverse weather, and other factors present in populations."

WETLANDS AND FLOODPLAINS

The National Wetlands Inventory has been completed for Olympic National Park and Olympic National Forest. Wetlands identified in goat habitat areas were associated with streams, alpine lakes, and snow melt ponds. No wetlands or floodplains would be affected by goat management activities.

SOCIOECONOMIC SITUATION

Land Ownership/Jurisdiction

Olympic National Park contains approximately 922,000 acres (3,733 km²) on the peninsula. Within the park, the National Park Service has exclusive federal jurisdiction. Approximately 60% of the park boundary (excluding the coastal strip) is shared with Olympic National Forest. About 96% of the park is designated wilderness.

Olympic National Forest occupies 632,324 acres (2,560 km²) (Olympic National Forest 1990). Six wilderness areas within the forest contain about 88,265 acres (358 km²). Wildlife populations on national forest lands are administered by the Washington Department of Fish and Wildlife.

The Washington State Department of Natural Resources manages over 364,700 acres (1,477 km²) on the Olympic Peninsula, primarily for timber production (Olympic National Forest 1990).

Several Indian reservations on the peninsula occupy over 235,000 acres (951 km²) (Olympic National Forest 1990). The largest reservations are the Quinault, Makah, and Skokomish.

Several forest industry corporations manage approximately 915,000 acres (3,704 km²) on the peninsula (Olympic National Forest 1990).

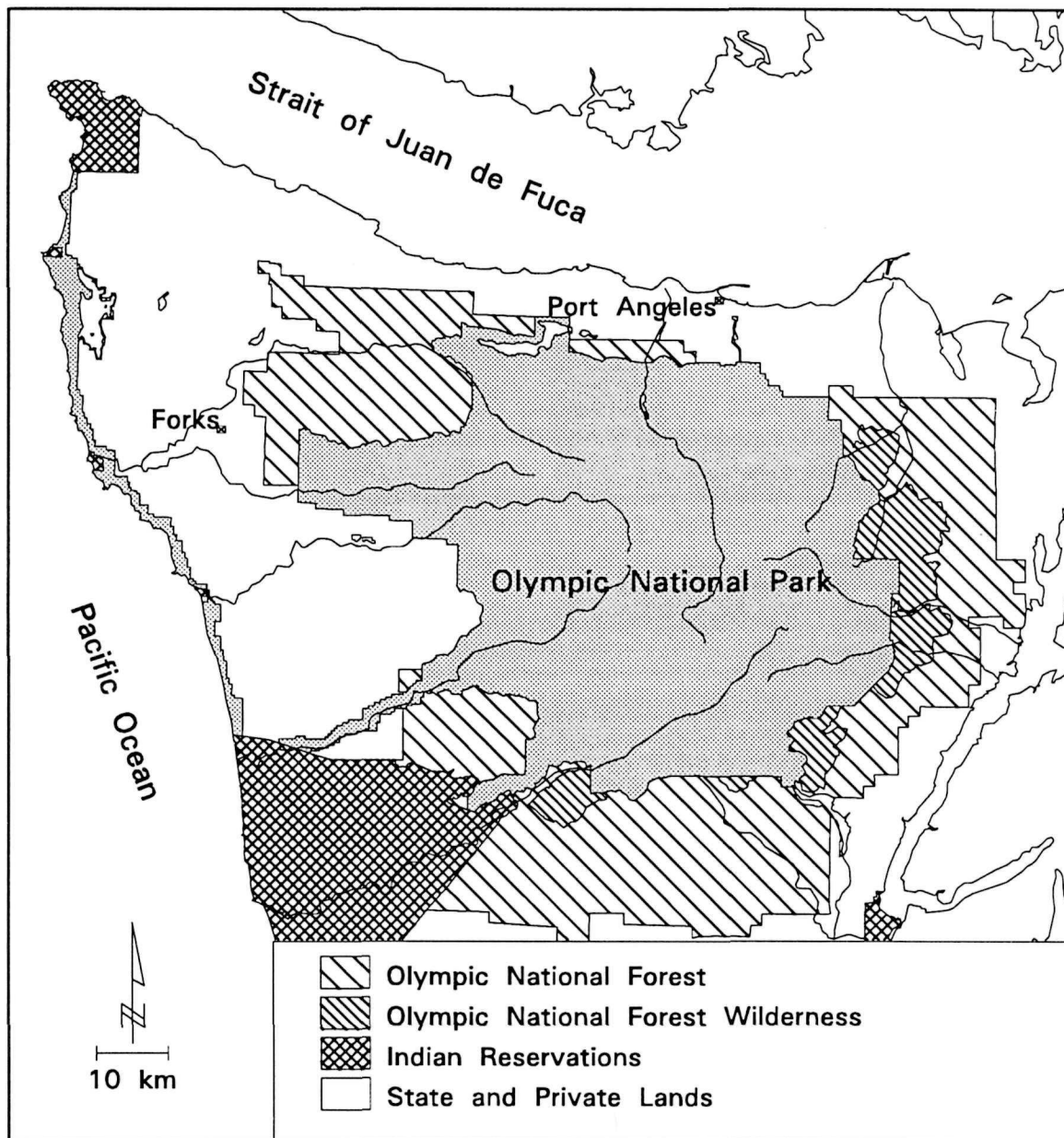


Fig. 7 - Land ownership.

General Community Information

Clallam, Jefferson, Mason and Grays Harbor Counties encompass ONP and ONF. The peninsula is primarily rural. Most communities are located along Highway 101 on the periphery of the peninsula. Population centers include Port Angeles (population 17,710), Sequim (3,616), and Forks (2,862) in Clallam County; Aberdeen-Hoquiam (25,485) in Grays Harbor County; Shelton (7,241) in Mason County; and Port Townsend (7,001) in Jefferson County (Clallam County Economic Development Council 1991; U.S. census 1990).

Total combined population for the four counties is approximately 179,000. Between 1980 and 1989, the combined population of Clallam, Jefferson, and Mason Counties increased by approximately 13%. During the same time period, the population of Grays Harbor County declined by about 4% (Olympic National Forest 1990).

General Economic Information

The economy of the peninsula is based primarily on timber related industries, tourism, fishing, and retirement. Employment in the area is almost equally composed of government, wholesale and retail trade, services, and wood/paper products manufacture (Olympic National Forest 1990; Clallam County Economic Development Council 1991).

In 1989 per capita income on the peninsula was as follows: \$12,798 in Clallam County, \$11,787 in Grays Harbor County, \$13,551 in Jefferson County, and \$12,050 in Mason County. Income on the peninsula was slightly below the State of Washington figure of \$14,923 per capita (U.S. Census 1990).

Role of ONP in The Local Economy

Olympic National Park employs approximately 250 people on the peninsula. The park's annual operating budget is approximately \$6.5 million.

Annual visitation to the park was 4,261,561 in 1994. It is estimated that approximately 78% of park recreation visitation is nonresident.

A 1993 economic report on Olympic National Park (Taylor and Phillips 1993) showed that the park generated a total of \$21.4 million directly into the 1989 peninsula economy. NPS actually spent \$5.9 million of that amount, while nonresident park visitors spent \$15.5 million. The report estimated that those expenditures generated \$39.3 million in economic activity in the four county area. Park-related economic activity provided, directly or indirectly, for the equivalent of 866 full time jobs in the region. Park-related expenditures resulted in \$15.8 million of wage and salary payments to residents.

ONP Visitor Attitudes

A visitor survey at Mount Rainier National Park (Johnson et al. 1992) documented that almost 88% of park visitors feel that the balance of the natural ecosystem is very important or extremely important. In the same survey, visitors indicated that the three most important management priorities should be balance of the natural ecosystem (30%); forests and plants (23%); and beautiful scenery (20%). Wildlife was selected as the most important management priority by 11% of visitors.

Although visitors to Olympic were not included in the Mount Rainier survey, many visitors go to both parks and it can be assumed that Olympic visitors' attitudes are similar.

Role of Wildlife in the Local Economy

In 1992, a report on economic impacts of hunting and non-consumptive recreation was published by WDFW (Southwick Associates 1992). In 1991, hunters in all categories (big game, small game, migratory birds, etc.) spent \$33.5 million on the Olympic Peninsula. This figure includes 50,000 hunters hunting on 600,300 days for all game species combined. During the same year, state-wide data showed expenditures of \$106.5 million on big game hunting.

An annual average of \$450 was spent per individual hunting big game species during 1991 in the entire state of Washington. (Southwick Associates 1992) In 1991, 21 people with goat permits for the Olympic Peninsula reported actually hunting (out of 38 total goat permits issued). Using the \$450 figure, the total annual expenditure of goat hunters on the peninsula would be estimated at \$9,450.

From 1967 through 1993, an average of eight goats were harvested annually by hunters on the peninsula (Table 4, page 78). This represented just under 4% of the total (archery-only units, muzzleloader units, and any-legal-weapon units) goat harvest statewide and approximately 47% of the statewide archery-only goat harvest.

Table 4. Washington Department of Fish and Wildlife Goat Hunting Statistics, 1967 - 1993

(NOTE: statistics for 1994 were not available when this DEIS went to print, but will be included in the FEIS.)

Year	Olympic Peninsula			Washington State	
	Permits Authorized	Actual Hunters	Goats Killed	Goats Killed: All Weapons	Goats Killed: Archery Only
1967	20	17	7	309	7
1968	20	17	3	339	3
1969	20	12	3	326	3
1970	20	12	4	340	4
1971	20	15	3	316	3
1972	20	17	6	257	10
1973	20	17	5	266	7
1974	20	15	7	272	15
1975	20	18	4	238	9
1976	20	17	8	287	14
1977	20	11	6	276	18
1978	30	21	8	282	26
1979	30	20	6	222	17
1980	45	33	18	269	35
1981	45	30	16	274	35
1982	45	37	15	196	31
1983	40	32	17	197	31
1984	45	32	10	159	21
1985	45	34	9	113	20
1986	40	32	8	125	18
1987	40	31	13	140	24
1988	40	34	11	123	25
1989	40	29	12	99	19
1990	40	35	9	93	13
1991	38	21	2	66	10
1992	38	32	10	92	17
1993	35	28	7	76	14
Average	32	24	8	213	17

A 1985 national survey conducted by the U.S. Fish and Wildlife Service reported that 69% of Washington residents participate in nonconsumptive wildlife associated recreation. The study conducted for the Washington Department of Fish and Wildlife (Southwick Associates 1992) documented that 748,700 people were involved in primary nonconsumptive use of wildlife statewide during 1991 including 143,600 nonresidents. A total of \$354.4 million was spent by people involved in primary nonconsumptive use of wildlife in Washington. Such users are defined in the study as those who "undertake an activity for the main purpose of enjoying wildlife." No specific figures were developed for nonconsumptive use on the Olympic Peninsula.

CULTURAL RESOURCES

Human occupation of the Olympic Peninsula dates as early as 12,000 years ago (Gleeson personal communication). This date comes from the Manis Mastodon Site, an archeological site in the Sequim valley. Most of the peninsula's extensive archeological sites are former villages found along the coast that date from 3,000 to 1,000 years ago.

Prehistorically and historically, the subalpine and alpine areas of the Olympic mountains were utilized by Native Americans. Limited archeological surveys of these areas in recent years have tripled the number of documented archeological sites in the park. Extensive survey of the upland areas will undoubtedly reveal additional sites.

The documented high country sites contained early to middle Holocene materials. Stone tools from subalpine and alpine meadows are comparable to Olcott materials found in the Puget lowlands and the Cascades which date from 9,000 to 5,000 years ago. The sites are low density lithic scatters and are in soil approximately four inches (10.2 cm) deep. The scatters are usually comprised of flakes, chipped stone, and tools. These sites are not deeply stratified, but are thin. Archeological sites, like the alpine vegetation, are fragile and susceptible to disturbance.

Sites from the later period have not been found at Olympic. This may be in part because of a changing emphasis by Native Americans to a greater dependence on major sedentary villages. Another factor may be the perishable nature of the artifacts. At late period archeological sites along the coast, most of the artifacts are made of wood, bone, and shell. These artifacts would have a short life on the exposed acidic alpine soils. Also, only a limited area has been surveyed to date. Later period sites may be found, but they will likely be similar to the early sites, with a low density of tools in a thin soil. These later sites may be hard to see because they possibly lack the obvious chipped stone tools of the earlier sites.

Ethnographic accounts document use of the Olympic high country as a travel route between village groups. Seasonal high mountain camps were the staging areas for hunting and gathering expeditions. Native Americans from around the peninsula utilized the mountain resources to supplement their diets, and to seek spiritual well-being, however, utilization of the mountains by peninsula tribes was probably short and limited to the snow-free months. As a result, deposits are shallow and scattered. High country archeological sites are particularly valuable because they have not been affected by sea level changes or flood plain activity and impacts from recent geologic activity are unlikely.

Environmental Consequences



INTRODUCTION

Resource elements used to compare the environmental consequences of the alternatives were selected to address the issues identified during scoping (see page 7).

For all alternatives, cumulative impacts have been analyzed only for topics for which these impacts are anticipated.

In order to estimate costs of each alternative some assumptions were necessary. These assumptions are described, along with more detailed cost information, in appendix E, beginning on page ?.

A matrix, beginning on page 50, summarizes the information contained in this section.

ALTERNATIVE 1. ELIMINATE GOATS (THE PREFERRED ALTERNATIVE)

Impacts on Wildlife Resources

Analysis

Goats. All goats within the park would be eliminated to the maximum extent possible. The population would decrease rapidly; elimination would likely be achieved in approximately three years. Some subpopulations might exhibit density-dependent reproductive increases during this period, but such responses would not be expected to compensate for animals removed.

Goat dispersal across park boundaries from Olympic National Forest would likely occur. Permanent dispersals of 25-36 mi (40-58 km) have been documented in the Olympics. Houston estimates that up to 20 goats could disperse into the park each year (Houston et al. 1994b). Thus, it is likely that goats from ONF would recolonize the eastern portion of the park, necessitating a long-term maintenance program to keep the park free of goats.

Up to 500 goats would be shot during the initial elimination program. More goats, possibly as many as 20 animals/year, would be shot during the maintenance program. The American Veterinary Medical Association Panel on Euthanasia (1986) states, "...competently performed gunshot is an acceptable method of euthanasia." The report goes on to say that advantages of gunshot are "(1) Euthanasia is instantaneous; and (2) under field conditions, gunshot may be the only effective method available."

Alternative 1 meets NPS mandates, policy, and management objectives for exotic species to the maximum extent possible.

Other wildlife. The northern spotted owl and marbled murrelet are listed as threatened under the Endangered Species Act. Both birds are associated with old growth forests. Since the elimination program would be conducted in goat summer range, the only impact of the program would be helicopter activity enroute to alpine and subalpine areas. Helicopter activities would on occasion occur within 0.25 mi (400 m) of nesting spotted owls and marbled murrelets. Local helicopter noise and rotor-wash disturbance would be very brief (<1 minute), infrequent, and located primarily in open, rocky subalpine habitat at higher elevations. Such activities would be planned in consultation with USFWS to avoid owl and murrelet habitat as much as possible and would not be likely to have an adverse impact on either species.

The Olympic marmot is an endemic ground-dwelling rodent that is common in goat habitat. Goats and marmots potentially compete with each other. Removal of the goat population could benefit marmots by reducing soil disturbance and increasing plant foods locally.

Black-tailed deer, Roosevelt elk, and smaller herbivorous mammals and birds occur widely in goat habitat. Where their activities overlap with goats and similar plant foods are used, it is reasonable to assume that such species could benefit from the removal of a possible competitor such as goats.

Impacts on native carnivore populations due to removal of goats would be minimal because alternative native prey species would be available. Scavengers would have a temporary abundance of food locally during the elimination program because of the presence of goat carcasses.

Indirect Effects

It is impossible to predict indirect effects of elimination within the park on future goat population levels outside the park. Two scenarios are possible:

- 1) With the resultant lower overall goat density on the peninsula, it is possible that the population outside the park might not remain viable long-term (more than 50-100 years). In that case, goats might eventually disappear from the peninsula.
- 2) It is also possible that the population outside the park might remain viable indefinitely. The maximum sustainable population for habitat outside the park has been estimated at approximately 200-250 goats (Houston et al. 1994b), although hunting could maintain the population at a lower level.

Other impacts discussed for this alternative assume that a viable population would remain long-term outside the park. If not, the maintenance program would no longer be needed to remove immigrants into the park.

Bald eagles (threatened) and peregrine falcon (endangered) are potential seasonal predators of small mammals and ground-nesting birds in goat habitat. Both are unlikely to be adversely affected by this alternative. Removal of the goat population would likely result in restoration of native vegetation, which could lead to more small mammals and birds locally, providing a somewhat larger prey base for raptorial birds like eagles and falcons.

It seems likely that restoration of soils and native vegetative communities would also improve habitat for invertebrates.

Conclusion

Up to 500 goats would be shot within the park during the initial elimination program. An unknown number of additional goats, possibly as many as 20 animals per year (i.e., up to 100 goats during each of the five-year maintenance cycles), would be shot during the maintenance program.

The goat population outside the park may or may not remain viable long-term under this alternative.

Although impacts of goats on other wildlife have not been studied enough to prove they occur, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Removal of goats, and subsequent ecosystem restoration, could benefit several native wildlife species.

Cumulative Impacts

Goats were not historically present on the peninsula. Approximately 11 individuals were introduced in the 1920s and expanded to a maximum population of approximately 1,175 goats in 1983. In 1990, the population was estimated at approximately 389 goats. The 1994 census resulted in an estimate of

approximately 288 goats, which was statistically no different than the 1990 estimate. During the three-year elimination program proposed in this alternative, the population would be essentially reduced to zero within the park.

Regionally and nationally, the effect on the total population of mountain goats would be insignificant. Native populations of goats would remain in the nearby Cascade Mountains (WDFW estimated approximately 7,000 animals in 1992), and elsewhere in the United States and Canada (total number estimated at approximately 100,000 animals [Johnson 1977]).

Impacts on Vegetation Resources

Analysis

Threatened and endangered species. Olympic Mt. milkvetch is a Federal category 1 candidate species and is listed as threatened by WNHP. Goat habitat overlaps with Olympic Mt. milkvetch habitat (Houston et al. 1994b).

Goats damage and kill milkvetch plants by eating them, trampling them, and wallowing on them (Houston et al. 1994b). If goats were eliminated from the park, grazing, trampling and wallowing would be minimized to the maximum extent possible. Therefore, threats to the milkvetch from goat grazing, trailing, and wallowing would be minimized in about three years (at the conclusion of the initial elimination program). Maximum milkvetch population recovery from the presently impacted condition would likely require 25 to 100 years depending on the site (Schreiner personal communication).

Goat subpopulations would remain on the peninsula outside the park for the near future and possibly indefinitely. Some goats would likely move back into the park from those remaining subpopulations. As a result, elimination of goats in the park would not completely eliminate the threat of goat impacts to milkvetch plants, subpopulations, and populations.

The milkvetch occurs in only 12 known subpopulations in the world. Eleven of the subpopulations are within the northeastern portion of the park. This area is most likely to be affected by dispersing goats moving into the park from outside the boundary. The twelfth subpopulation is within goat habitat in Olympic National Forest.

This alternative would meet NPS mandates, policy and management objectives for protection of T&E species to the maximum extent possible.

Rare and/or endemic species. Thirty-three taxa of rare and/or endemic plants are known to grow in goat summer range in the Olympic Mountains (Houston et al. 1994b).

At least four endemic species are grazed by goats (Houston et al. 1994b; Pfitsch and Bliss 1985; Pike 1981). It is reasonable to expect that goats also eat other rare/endemic plants because goats are generalist herbivores with the capacity to eat most plant species (Houston et al. 1994b). Goats have killed rare plants by wallowing and trampling on them (Houston et al. 1994b).

If goats were eliminated from the park, grazing, trampling and wallowing would be minimized to the extent possible. Therefore, threats to rare/endemic taxa from goats would be minimized in approximately three years (at the conclusion of the initial elimination program). Threats to these plants include risks to

individual plants, populations, and subpopulations. Threats also include the possibility of local extinction of species. It is certain that threats would be less with elimination than with any other alternative.

Impacts would not be totally eliminated in the park because of dispersal of goats from outside the park. This would be especially true along the park-forest boundary, where concentrations of rare and endemic plants are highest. However, impacts would be minimized to the maximum extent possible for management action within the park (i.e., with no management action to reduce goat numbers outside the park).

This alternative would meet NPS mandates, policy and management objectives for protection of rare and endemic species to the maximum extent possible.

Native Communities. All large grazing mammals modify ecosystems (Crawley 1983). Goats are known to affect native communities by eating plants, trampling plants, and wallowing on plants. These activities alter plant reproductive patterns, growth rates, seedling establishment, and structure (Houston et al. 1994b). These effects change the relative abundance of plants; disturbance-oriented and relatively unpalatable species increase as palatable species decrease. Community dominance shifts toward disturbance-oriented species.

Comparative photos have shown that when mountain goat density decreases, plant cover increases (Houston et al. 1994b).

Local impacts in goat wallows include decreased plant numbers, cover, and live plant material (Houston et al. 1994b). Soil disturbance caused by dispersing goats may still provide sites for exotic species to invade native vegetation.



Webster's senecio (*Senecio newwebsteri*), an endemic plant of the Olympic Peninsula. (ONP photo: Janis Burger).

Elimination of goats within the park would minimize goat-caused impacts to native communities to the maximum extent possible within about three years (at the completion of the initial elimination program). Impacts would not be completely eliminated in the park because of dispersal of goats from outside the boundary.

Native communities would be restored significantly, but complete restoration would not occur in areas used by dispersing goats. Some heavily impacted areas could be actively rehabilitated to facilitate recovery. Community recovery could take decades in some areas.

Small areas of vegetation would be temporarily impacted in campsites used by vegetation monitoring crews. Impacts would be minimized by use of tent platforms and impacts would be of short duration (one to three weeks in any one site). Full vegetation recovery would be expected in a very short time. These short-term impacts would be less than with any other alternative because vegetation monitoring would be less intensive and last for fewer years.

This alternative would meet NPS mandates, policy and management objectives for protection and restoration of native ecosystems to the maximum extent possible.

Ecosystem impacts outside the park would differ significantly under two possible goat population trend scenarios:

- 1) If goat populations decrease, associated ecosystem impacts would also decrease. If the goat population disappears from areas outside the park, goat impacts would cease and community restoration would eventually occur.
- 2) If goats outside the park increase to the maximum possible population, ecosystem impacts would also increase.

Indirect Effects: None identified.

Conclusion

Elimination of goats would essentially eliminate threats to native vegetation, including rare/endemic plants, from goats. Vegetative recovery would be expected. This alternative provides the most protection for vegetation and offers a high level of assurance that resources would be effectively protected.

The primary differences between alternative 1 and alternative 3 are that this alternative provides for elimination one year earlier than alternative 3 and that no damage to vegetation would be anticipated as a direct result of goat management actions under this alternative.

Cumulative Impacts

Locally and regionally, native vegetation has been lost or impacted outside the park due to many factors, such as timber harvest and increasing development. As native vegetation becomes more rare, national parks are becoming the last remnants of unimpacted vegetation. Native vegetative communities would receive the greatest level of protection and restoration under this alternative. In turn, native wildlife which depends on vegetation would also be favorably affected.

Worldwide, species are becoming extinct at an alarming rate because of habitat loss, increasing development, and many other factors. Due to the biogeographic history of the Olympic Peninsula, 33 taxa of rare/endemic plants are known to occur in goat habitat of the park. This alternative would provide the greatest level of assurance that rare and endemic plants would be protected from goat impacts. Since the Olympic Peninsula contains the entire world population of some plant taxa, the effect of this alternative on vegetative species diversity would be positive.

Impacts on Soils

Analysis

Goats change soils, locally decrease vegetative cover, and cause erosion by wallowing, trailing and trampling (Houston et al. 1994b).

Wallowing removes soil surface layers (Pfitsch et al. 1983). Wallows have finer-textured soil near the surface, low organic matter, and larger particles that move downslope. In areas with shallow soils, wallowing displaces the fine materials, leaving scree and gravel. These impacts also cause reduced water-holding capacity, reduced nutrients available for vegetation, increased soil aeration and increased surface temperature. The soil resulting from goat impacts provides less stability for plant regeneration. Soil changes and disturbance cause major shifts in plant community composition around wallow edges (Pfitsch 1981, Reid 1983). Trampling and trailing cause increased sheetwash erosion and displacement of large soil particles (Pfitsch et al. 1983).

Ungulates in other areas alter nitrogen cycles and the soil formation process (Houston et al. 1994b; Day and Detling 1990; Frank and McNaughton 1992; McInnes et al. 1992). It is reasonable to assume that goats may cause similar changes at Olympic.

Elimination of goats would eliminate wallowing and trampling. This would lessen generalized erosion, sheetwash erosion, and associated soil changes. Continued goat impacts to soils would be minimized in about three years. Impacts would not be completely eliminated, especially along the boundary, because of goat dispersal into the park. Few new areas of impact would be created.

Significant soil restoration would eventually occur, although soils recover at a very slow rate, especially in alpine areas where steep topography and cold temperatures inhibit soil genesis (Pfitsch et al. 1983). In some heavily impacted areas, soils could be actively stabilized to aid restoration. Erosion would continue in wallow areas unless the areas were actively restored.

This alternative would meet NPS mandates, policy and management objectives for protection and restoration of native ecosystems to the maximum extent possible.

Although research on goat impacts outside the park is limited, it is reasonable to assume that impacts similar to those documented in the park are also occurring in goat habitat outside the park. Soil impacts would continue on national forest lands, unless elimination of goats from the park eventually caused the goat population outside the park to disappear.

Indirect Effects

Soils protected from goat impacts provide better conditions for plant establishment and growth. Positive effects on soils would have beneficial effects for vegetation and wildlife.

Conclusion

This alternative would result in virtual elimination of goats in the park. Soil impacts would be reduced to the maximum extent possible. Impacts would not be totally eliminated because of goats dispersing from outside the park.

Cumulative Impacts

None anticipated.

Impacts on Visual Resources

Analysis

A visitor survey at Mount Rainier National Park found that approximately 88% of visitors feel the balance of the natural ecosystem is very important or extremely important (Johnson et al. 1992). Visitors to Olympic probably have attitudes similar to those of Mount Rainier visitors. People who appreciate the scenic value of native vegetation and undisturbed soils would be positively affected by this alternative, although restoration would not be complete because of continuing impacts from dispersing goats and slow recovery rates.

The Mount Rainier survey documented that approximately 11% of visitors felt that wildlife should be the most important management priority. Visitors who appreciate the scenic value of goats in the park would be negatively affected by this alternative. Opportunities to view goats would remain on the peninsula outside the park, where maximum potential density has been estimated at approximately 250 goats. Additional viewing opportunities would remain in the Cascade Range, with an estimated population of approximately 7,000 goats (WDFW 1992).

Goat carcasses would be left in place to recycle back into the ecosystem. The presence of carcasses would be unsightly, however any carcasses in highly used areas would be moved to less visible locations.

Indirect Effects

None identified.

Conclusion

Elimination of goats would virtually eliminate the possibility of viewing goats within the park and would increase the possibility of seeing undisturbed native ecosystems.

Effects of this alternative on visual resources would be negative for visitors who value seeing goats more than seeing native ecosystems, while the effect would be positive for visitors who value the visual integrity of native ecosystems more than goat sightings.

Goats could still be viewed outside the park: on the peninsula, elsewhere within Washington, and other locations throughout western North America.

Cumulative Impacts

None anticipated.

Impacts on Wilderness Values

Analysis

The value of wilderness, as defined in the Wilderness Act, lies in its primeval character, its natural and unimpaired condition; its wildness. Exotic goats change ecosystem components and processes within the wilderness portion of ONP. These changes are human-initiated since humans introduced goats.

If this alternative were selected, goat-caused changes affecting wilderness ecosystems and values would be essentially eliminated in three years. Impacts would not be eliminated and wilderness ecosystems would not be fully restored because of the presence of goats dispersing into the area from outside the park.

The use of helicopters and firearms during the elimination and maintenance programs would be a temporary negative impact on wilderness values. This impact would occur for about 5.5 hours on each of three days per week during mid-May to mid-July, and possibly September/October, for a total of 30 days each year during the initial three-year elimination program. Impacts from the maintenance program would occur for several days once every five years. These impacts could be mitigated through timing of operations.

No impacts associated with censusing goat populations would occur with this alternative because no censusing would be conducted.

The scientific value of the park as an ecosystem functioning with minimal human interference would be vastly improved, although not completely restored. This would benefit the American public, as well as agency and independent research scientists.

This alternative would meet NPS mandates, policy and management objectives for protection and restoration of native ecosystems to the maximum extent possible.

Indirect Effects

None identified.

Conclusion

Goats impact wilderness values. Elimination of goats would have a positive long-term effect on wilderness values. Elimination of goats requires use of firearms and helicopters within the wilderness areas. Therefore, the alternative would have a negative short-term impact on wilderness values and experiences during the actual management programs.

Cumulative Impacts

Wilderness resources are dwindling worldwide due to increasing development and commercial uses. This alternative would have a positive effect on the Olympic Wilderness Area. As such, it would benefit efforts to preserve and restore wilderness within a local, regional, and national context.

Impacts on Human Safety

Analysis

Any work in helicopters is inherently dangerous, including the possibility of fatalities. However risks to employees during a shooting program would be much less than during a live-capture program.

The elimination program would involve shooting goats from a helicopter, but the animals would not be recovered as they would during a live-capture program. Therefore, employees would not need to exit the helicopter under hazardous field conditions, such as hover, step-off, toe-in, and one-skid landings in steep terrain.

Safety risks from the elimination program would be of relatively short duration. Employees would be exposed to hazards for three days per week for a total of 30 days each year during the initial three-year elimination program.

The maintenance program, and associated risks, would continue long-term as needed. Risks might increase as experienced employees leave the maintenance program and new employees are gaining experience. On the other hand, development, training, and recurring use of a highly skilled staff would decrease the risks somewhat.

An additional slight risk would be incurred during helicopter flights associated with the vegetation monitoring program. Employees involved in vegetation monitoring would also be exposed to risks associated with working in rugged wilderness terrain (e.g. falls, hypothermia, etc.)

Indirect Effects

None identified.

Conclusion

Although working in helicopters is inherently risky, employees would not need to exit the helicopter rapidly under hazardous field conditions. Risks to employees during a shooting program would be very low relative to any other management technique.

Cumulative Impacts

None anticipated.

Impacts on Values Related to Special Designations

Analysis

The value of biosphere reserves is the conservation of genetic resources in the world's major ecosystems and the opportunity for long-term research on the functioning of those ecosystems. Goats alter the functioning of native ecosystems, thus impairing the integrity of this reserve.

By treaty, law, regulation, and NPS guidelines, world heritage sites are to be managed to avoid any negative impact on the site's integrity and outstanding universal value to mankind. The nomination technical review prepared by the IUCN stated, "The main danger to the integrity of the site is, oddly, one of its attractions--the mountain goat" (IUCN 1981). In a 1987 letter to the park superintendent, the executive officer of the IUCN stated, "In our role as technical advisor to the World Heritage Committee we have been following the goat management issue in Olympic National Park with interest... we would encourage your Service to act to eliminate mountain goats from the World Heritage Site" (Thorsell 1987).

Elimination of goats would essentially cease impacts on the ecosystem, resulting in substantially less impairment of the values related to these special designations. Impacts would not be completely eliminated because of goats dispersing from outside the park. Impacts would be minimized to the maximum extent possible.

This alternative would meet NPS mandates, policy and objectives for management of areas with special designation to the maximum extent possible.

Indirect Effects

None identified.

Conclusion

Elimination of goats would minimize ecosystem impacts, which would have a positive effect on the values associated with world heritage site and biosphere reserve designations.

Cumulative Impacts

Natural areas throughout the world are dwindling because of the increasing pressures of development. World heritage sites and biosphere reserves have been established, at least in part, to preserve remnants which are of universal value to humankind. This alternative would have a positive effect on biosphere reserve and world heritage site values on the Olympic Peninsula. Therefore, it would have a beneficial effect on efforts to preserve and restore such areas within a global context.

Cost

Analysis

The initial elimination program would cost approximately \$337,000 over three years. Costs for the maintenance program would be approximately \$27,000 for one maintenance cycle during the ten year period.

Vegetation monitoring for alternative 1 was estimated at \$455,000 for the first ten years of implementation.

Costs for all alternatives are detailed in appendix E, beginning on page 217.

Energy Requirements

Helicopter use for implementation of this alternative would require approximately 12,530 gallons of Jet A fuel. This fuel consumption estimate includes the elimination and maintenance programs, as well as helicopter support for vegetation monitoring.

It is estimated that the fuel truck associated with helicopter operations might use 1,740 gallons of diesel fuel.

Vehicles used for ground transportation of personnel during implementation of this alternative would use approximately 240 gallons of unleaded gasoline.

Indirect Effects

None anticipated.

Conclusion

Alternative 1 would be the most cost effective alternative to achieve goals for ecosystem protection and restoration. The relative cost per animal would be very low for a shooting program.

Cost of this alternative over the first ten year period would be approximately \$364,000 for operations, including the initial elimination program and the first cycle of the maintenance program; and approximately \$455,000 for vegetation monitoring.

Future costs (beyond the initial ten year period) would be minimal: approximately \$27,000 every five years for the maintenance program.

Cumulative Impacts

None anticipated.

Impacts on Archeological Resources

Analysis

Goats wallow and trample soils and vegetation. Archeological resources on the surface or within the soil can be damaged when soils and vegetation are disturbed. Goat-caused risk of damage to undiscovered archeological sites due to soil and vegetation disturbance would be minimized if goats were eliminated. Some risk would occur due to dispersing goats. Risks under this alternative would be less than under any other alternative.

Both the elimination and maintenance programs would be primarily conducted from helicopters and would not cause ground disturbance, thus these programs would not impact archeological resources.

Indirect Effects

None identified.

Conclusion

Implementation of this alternative does not require activities which would cause ground disturbance outside of developed areas. Therefore, no impacts to archeological resources would be expected during implementation of alternative 1.

Goats could impact archeological resources by disturbing soils and vegetation. Risk of goat-caused damage to cultural resources would be minimized if goats were eliminated within the park.

Cumulative Impacts

None anticipated.

Impacts on the Local/Regional Economy

Analysis

In 1983, goat numbers were high (approximately 1,175 animals on the peninsula) and annual park visitation was 2,874,958. In 1994, goat numbers were much lower (approximately 288 animals) and

annual park visitation was higher (4,261,561) than in 1983. It appears that visitation will continue to increase regardless of goat population trends.

Olympic National Park employment levels would not be significantly affected by this alternative. NPS expenditures for helicopter contracting and for supplies associated with the management programs could have a minor beneficial effect on the regional and local economy.

In 1983 when goat numbers were high on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park. In 1990 when goat numbers were much lower, WDFW also issued 40 goat permits. In 1993, WDFW issued 35 permits (Table 4, page 78). The 1994 goat census estimate (Houston et al. 1994a) was not statistically different from the 1990 census estimate. (Note: Permit information for 1994 was not available when this document went to print, however this information will be included in the FEIS). The number of permits issued for recreational hunting may not be significantly affected unless goat populations outside the park decrease significantly. If goat populations outside the park do not remain viable long-term (50-100 years), goat hunting on the peninsula would eventually cease. The Washington Department of Wildlife (1992) found that an annual average of \$450 was spent per individual big game hunter in Washington. In 1993, 28 goat hunters reported actually hunting on the Olympic Peninsula. If goats were eliminated on the entire peninsula, an estimated annual revenue of \$12,600 would be lost for the local economy. This would be a relatively minor impact on the four counties of the peninsula since total 1990 retail sales were \$440 million in Clallam County alone (Clallam County Economic Development Council 1991).

It is unlikely that non-hunting visitation outside the park would be affected by this alternative. Olympic National Forest employment levels would probably not be affected either.

Indirect Effects

None identified.

Conclusion

Olympic National Park and Olympic National Forest employment and visitation would not be affected by this alternative. Goat hunting could possibly be affected by this alternative, which would have a minor effect on the peninsula economy. Thus, the local and regional economy would not be significantly affected by this alternative.

Cumulative Impacts

None anticipated.

Impacts on Tourism

Analysis

In 1983, goat numbers were high and annual park visitation was 2,874,958. In 1990, goat numbers were much lower and annual visitation was higher (3,514,079). In 1994, the goat population was

estimated at approximately 288 individuals while park visitation was 4,261,561. It is reasonable to assume that visitation will continue to increase in the future, even if goats were eliminated from the park.

Although impacts to tour groups focusing on wildlife viewing and photography cannot be quantified, some impact could occur. If goats were eliminated, it is unlikely that visitors would stop joining wildlife tour groups since many other species of wildlife, including deer and elk, would still be abundant.

Indirect effects

None identified.

Conclusion

In the past, park visitation has increased regardless of goat population numbers. Other species of large mammals would continue to be available for viewing or photographing. It is unlikely that elimination of goats would impact tourism significantly.

Cumulative Impacts

None anticipated.

Impacts on Hunting Outside the Park

Analysis

Recreational hunting is prohibited within the park by legislation and would not be permitted.

In 1983 when goat numbers were high (approximately 1,175 animals) on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park. In 1990 when goat numbers were much lower (approximately 389 goats), WDFW also issued 40 goat permits. In 1993, WDFW issued 35 permits. The 1994 goat census estimate was not statistically different from the 1990 estimate (Houston et al. 1994a). (Note: 1994 hunting statistics were not available when this DEIS went to print, but will be included in the FEIS). The number of permits issued for recreational hunting may not be affected significantly unless goat populations outside the park decrease significantly. Goat hunting on the peninsula would eventually cease if populations outside the park did not remain viable long-term (50-100 years).

Regardless of the viability of goats on the Olympic Peninsula, hunting would likely continue throughout the rest of Washington State. Statewide in 1990, WDFW issued 67 permits for archery-only hunting of goats and 126 permits for goat hunting using any legal weapon. Although Olympic Peninsula permits are not a large proportion of total goat permits issued in the state, the 40 Olympic permits constitute approximately 60% of all archery-only permits issued in Washington.

Indirect Effects

If goat hunting on the peninsula were to cease, it is possible that WDFW could increase the number of archery permits issued elsewhere in the state. This might impact hunting elsewhere within the state.

Conclusion

Impacts on hunting are uncertain. If the goat population outside the park remains viable long-term (50-100 years), this alternative would not likely have much effect on hunting. If the goat population outside the park declines or disappears, goat hunting could be reduced or eventually cease within the next 50 to 100 years.

Opportunities for goat hunting would continue in other states and in areas of Washington other than the Olympic Peninsula. It is estimated that approximately 7,000 goats occur elsewhere in the state, although some of these animals may not be available for hunting because they occur in other national park areas.

Cumulative Impacts

None anticipated.

Impacts on Park Visitor Use and Experience

Analysis

From 1983 through 1994, park visitation increased; annual visitation in 1983 was 2,874,958, while in 1994 visitation was 4,261,561. During the same time period, goat numbers decreased from about 1,175 animals in 1983 to approximately 288 in 1994. Goat management activities varied from a live-capture program in 1988/1989 to no active goat management at all in 1994. There seems to be no correlation between goat management and visitation. It appears that visitor use will continue to increase regardless of goat population numbers or goat management programs.

During the elimination and maintenance programs, some visitors would be impacted because of noise intrusion, temporary closure of some visitor use areas, and the possibility of encountering a goat carcass. Noise and closure impacts during the initial elimination program would be of short duration (5.5 hours on each of three days per week, in May to July and possibly September/October for a total of 30 days each year). Impacts from the maintenance program would continue long-term, but would only last for a few days in early summer once every five years. Both programs would be designed to minimize impacts through timing, temporary closure of local areas, moving carcasses away from trails or high use areas, etc.

The opportunity for goat viewing would be minimized or eliminated in the park, however exotic goats would likely still be present outside park boundaries and native populations would be present for viewing in the Cascades. WDFW estimates that approximately 7,000 goats are present in the Cascade Range (WDW 1992). Johnson (1977) estimates that approximately 100,000 goats occur in North America outside the Olympic Peninsula.

Opportunities for experiencing native ecosystems and rare plants unimpaired by goats would increase substantially, but ecosystems would not be completely restored. Goat nuisance to backpackers would be minimized.

The potential for injury due to goat/visitor encounters would be minimized. Impacts to visitor safety from the actual elimination and maintenance programs would be minimal or non-existent due to temporary closure of some areas to the public.

Indirect Effects

None identified.

Conclusion

This alternative would not be likely to change levels of visitor use. Visitor experiences would be impacted by noise, closures, etc. on a short-term basis during the implementation of the program. Upon completion of the elimination program, opportunities for viewing goats within the park would be essentially eliminated, while opportunities to experience unimpaired ecosystems would increase.

Cumulative Impacts

None anticipated.

Unavoidable Impacts

Impacts on Wildlife

Implementation of this alternative would require the death of up to 500 goats within the park during the initial elimination program, and possibly up to 20 goats per year during the maintenance phase.

It is possible, although not certain, that the entire goat population on the peninsula could disappear within 50-100 years as a result of this alternative. If that were to occur, goat hunting would eventually be eliminated on the peninsula.

Impacts on Vegetation

Short term impacts to some small areas of vegetation would occur at campsites used by vegetation monitoring crews.

Impacts on Visual Resources

Goats would no longer be present to view within the park.

Impacts on Wilderness Values

Wilderness values would be temporarily impacted by helicopter and firearm use during the elimination and maintenance programs.

Impacts on Human Safety

Any work involving helicopters is inherently dangerous, causing a minor level of risk to employees during the elimination and maintenance programs.

Irreversible or Irretrievable Commitment of Resources

Implementation of this alternative would require the death of up to 500 goats within the park during the initial elimination program, and possibly up to 20 goats per year during the maintenance phase. This would obviously be irreversible for those individual animals. On a population level, elimination of goats might not be irreversible because goats may enter the park from adjacent areas or could be introduced to the park again in the future if NPS mandates changed.

Federal funds used to implement the alternative would be irretrievable.

Relationship Between Short-term Uses and Long-term Productivity

On a long-term basis, implementation of this alternative would allow ecosystem processes and natural productivity within the entire park to continue unimpacted by goats. Thirty-three taxa of rare/endemic plants would be protected from goat impacts.

On a short-term basis, use of helicopters and firearms during the elimination and maintenance programs would impact wilderness values and use.

ALTERNATIVE 2. NO ACTION

Impacts on Wildlife Resources

Analysis

Goats. The goat population would likely increase to some equilibrium level, estimated at approximately 1,400 goats within the park (Hoffman and Wright 1987). This estimate is based on census data and availability of potential habitat. The rate at which the population would increase is uncertain. Theoretically, the population would be capable of doubling every three years, however the actual rate of increase would likely be less. Different subpopulations would increase at different rates because of differing population dynamics and environmental conditions across the park. Many density-independent factors which could influence rate of increase are impossible to predict. For example, large forest fires could increase available winter range, or climatic factors (especially winter severity) could kill goats or alter vegetation. For analysis, it is assumed that conditions would remain similar to those in the past 50 years and that goats would increase to approximately 1,400 animals.

Goat populations would likely continue to be managed using recreational hunting within Olympic National Forest. Population numbers there would probably be maintained at approximately current levels.

Goats would not be shot to eliminate or control populations. A few goats could possibly be killed for research or to euthanize individuals, such as a goat hit by a car at Hurricane Ridge or a similar situation.

Alternative 2 would not meet NPS mandates, policy, and management objectives for exotic species.

Other wildlife. A three-fold increase in goats would almost certainly cause more impacts on other wildlife.

Vegetative changes caused by one herbivore may influence the feeding behavior of other herbivores (Houston et al. 1994b; Kreuger 1986; Day and Detling 1990). Exotic goats may affect native herbivores at Olympic.

Goats and other ungulates, such as Roosevelt elk and black-tailed deer, use the same areas in the summer and research has shown that they eat similar species of vegetation. However, since it is unlikely that quantity or quality of food limits ungulate populations in the Olympics during summer, it is also unlikely that these species compete with each other (Houston et al. 1994b). During winter, there is little overlap in area occupied by these ungulates.

Goats and small mammals, such as the endemic Olympic marmot, overlap in habitat usage and possibly compete with each other (Houston et al. 1994b).

Goats would provide a continued, although minor, food source for carnivores.

No impacts to threatened or endangered mammal and bird species would be expected. Helicopter flights would be minimal (for goat censusing once every five years and in support of vegetation

monitoring) and would be planned in consultation with the U.S. Fish and Wildlife Service to minimize effects on marbled murrelets and peregrine falcons.

Indirect Effects

Goat-caused changes in vegetative community structure could impact native rodent populations (Dragavon and Weisbrod 1978).

It seems likely that goat impacts on soils and native vegetative communities would also impact habitat for invertebrates.

Conclusion

The goat population within the park would likely increase to approximately 1,400 animals. Outside the park, the goat population would probably be maintained at current levels by hunting.

Although impacts of goats on other wildlife have not been proven, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Any such impacts on other wildlife would increase under this alternative.

Cumulative Impacts

Goats were not historically present within the park. Eleven individuals were introduced in the 1920s and increased to a high population of approximately 1,175 goats in 1983. During the 1980s goats were live-captured and removed from the park. In 1990, the population was estimated at approximately 389 goats. The 1994 census estimate was not statistically different than the 1990 estimate. If this alternative were selected, the population would probably increase to an equilibrium level of approximately 1,400 animals in the park.

Native populations of goats would remain in the nearby Cascade Mountains (WDFW estimated approximately 7,000 animals in 1992), and elsewhere in the United States and Canada (total number estimated at approximately 100,000 animals [Johnson 1977]).

Impacts on Vegetation Resources

Analysis

Threatened and endangered species. Habitat for Olympic Mt. milkvetch substantially overlaps with habitat considered ideal for goats to reach high densities (Houston et al. 1994b). It is important to remember that the Olympic Mt. milkvetch is a federal category 1 candidate species under the Endangered Species Act, is listed as threatened by WNHP, and the entire known population of this species in the world is only 3,800-4,000 plants (12 subpopulations; 11 of which are within goat habitat of Olympic National Park; the other subpopulation is within goat habitat of Olympic National Forest) (Houston et al. 1994b).

Research has shown that goats injure and kill milkvetch plants by grazing, trampling and wallowing on them. Schreiner documented goat-caused mortality of *Astragalus* plants even at medium goat densities (Houston et al. 1994b). *Astragalus* was grazed in more than half of the subpopulations that were sampled by Schreiner (Houston et al. 1994b). Grazing and trampling impacts by goats are "sporadic, but sometimes intense." He also found that "extensive grazing and trampling of plants at Unicorn Peak in 1987 were entirely attributable to mountain goats" (Houston et al. 1994b). Grazing was evident on up to 72% of the milkvetch plants in some plots in a given year; much of that impact could be classified as severely grazed. Schreiner also documented mortality of *Astragalus* plants due to goat wallowing and recorded 87 wallows within 55 yards (50 m) of milkvetch plots.

An increased number of goats would eat more milkvetch, wallow on more milkvetch plants, and trample more milkvetch plants. This would cause an increase in impacts and threats to individual plants, subpopulations, and the entire population. It is certain that risks would be greater with no action than with any other alternative.

"Risk of extinction increases as populations are fragmented or reduced in number (Pimm 1991). Extinction often involves a combination of forces acting on small, fragmented populations" (Houston et al. 1994b). "Rare, endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g., goats in Hawaii and the Galapagos Islands; Loope et al. 1988)" (Houston et al. 1994b). It is possible that increased goat impacts could cause extinction of the milkvetch at Olympic.

Rare and/or endemic species. Rare plant distribution overlaps goat summer range (Houston et al. 1994b). Thirty-three taxa of rare/endemic plants are known to grow in goat summer range in the Olympic Mountains (Houston et al. 1994b).

At least four endemic species are grazed by goats (Houston et al. 1994b, Pfitsch and Bliss 1985, Pike 1981). One (of those four) endemic species, *Aster paucicapitatus*, is frequently and heavily grazed by goats and was classified as "most preferred" forage for goats by Pfitsch and Bliss (1985); Houston et al. (1994b) called it a "selected" forage species. It is reasonable to expect that other rare and endemic plants are also eaten by goats because goats are generalist herbivores with the capacity to eat most plant species (Houston et al. 1994b).

Rare plants may especially be at risk due to mountain goat grazing "for at least two reasons: 1) mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and 2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants" (Houston et al. 1994b).

Goats have killed rare plants by wallowing and trampling on them (Houston et al. 1994b).

If goat numbers increased, impacts to rare/endemic species from grazing, wallowing and trailing would also increase. Threats to these plants include risks to individual plants, populations, and subpopulations. It is certain that risks would be greater with no action than with any other alternative.

Although goats might not directly kill the last individuals in a population of rare plants, they "may increase the risk of extinction by fragmenting populations or habitats. Risk of extinction increases as populations are fragmented or reduced in number (Pimm 1991). Extinction often involves a combination of forces acting on small, fragmented populations" (Houston et al. 1994b). "Rare, endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g., goats in Hawaii and the Galapagos Islands; Loope et al. 1988)" (Houston et al. 1994b). It is possible that

increased numbers of goats could cause some, or all 33, taxa of rare/endemic plants to become extinct at Olympic if this alternative were selected.

Native Communities. All large grazing mammals modify ecosystems (Crawley 1983). Goats are known to affect native communities by eating plants, trampling plants, and wallowing on plants. These activities alter plant reproductive patterns, growth rates, seedling establishment, and structure (Houston et al. 1994b). These effects change the relative abundance of plants; disturbance oriented and relatively unpalatable species increase as palatable species decrease. Community dominance shifts toward disturbance oriented species (Houston et al. 1994b).

Plant numbers, cover, and the amount of live plant material decreases locally around wallows (Houston et al. 1994b).

Comparative photos have shown that when mountain goat density increases, plant cover decreases (Houston et al. 1994b).

Pike (1981) and Harter (Pfitsch et al. 1983) documented that goat trampling, and possibly grazing, cause a "significant decrease" of moss and lichen cover on rock outcrops.

Soil disturbance caused by goat wallowing and trailing may provide sites for exotic species to invade native vegetation.

If no management action were taken relative to goat populations, goats would greatly increase in number and associated impacts on native communities would also increase significantly.

Small areas of vegetation would be temporarily impacted in campsites used by vegetation monitoring crews. Impacts would be minimized by use of tent platforms and would be of short duration (1-3 weeks in any one site). Full vegetation recovery from these impacts caused by camping would be expected in a very short time. These temporary impacts would be greater under this alternative than the elimination alternatives because extensive vegetation monitoring would be needed for many years.

Although research of goat impacts outside the park is limited, it is likely that impacts similar to those documented in the park are also occurring in goat habitat outside the park. These impacts would continue, and probably increase, on national forest lands.

Indirect Effects

None identified.

Conclusion

This alternative would result in more than a three-fold increase in goat numbers, which would lead to increased impacts on category 1, rare, and endemic vegetation. Individual rare/endemic plants would certainly be lost. Some populations could be lost and extinction of some rare/endemic taxa could occur.

More goats would also cause increased impacts to native vegetative communities.

This alternative would not meet NPS mandates, policy and management objectives relative to protection and restoration of T&E, rare, endemic, and native vegetation.

Cumulative Impacts

The amount of unimpaired native vegetation is rapidly decreasing in the Pacific Northwest because of habitat loss, increased development, timber management practices, etc. As native vegetation becomes more rare, national parks are becoming the last remnants of unimpacted vegetation. This alternative would provide the least amount of protection for native communities and would contribute to the continued decline of native vegetation in a local and regional context.

Worldwide, species are becoming extinct at an alarming rate because of habitat loss, increasing development, and many other factors. Due to the biogeographic history of the Olympic Peninsula, 33 taxa of rare and/or endemic plants are known to occur within goat habitat of the park.

Although goats might not directly kill the last individuals in a population of rare plants, they "may increase the risk of extinction by fragmenting populations or habitats" (Houston et al. 1994b). Goats, as an introduced herbivore, are a stress in addition to all the other factors operating on small, fragmented populations of rare plants. Goat impacts may combine with other effects, such as trampling by hikers or grazing by native herbivores or global climate change or "normal" extremes of weather, leading to eventual extinction of taxa. Some of the ONP rare plants are very rare, i.e. known from 5 or fewer locations within the park. Other plants (endemics) are found on the Olympic Peninsula and nowhere else in the world. Therefore, local extinction of one of these endemic taxa could mean total extinction of that taxa. This would have implications for species diversity on a regional and global level, as well as locally.

Impacts on Soils

Analysis

Goats change soils, locally decrease vegetative cover, and cause erosion by wallowing and trampling (Houston et al. 1994b).

Wallowing removes the finer-textured topsoil (Pfitsch et al. 1983). This results in soil with larger particle size and reduced organic matter, which is more susceptible to displacement downslope. These impacts also cause reduced water-holding capacity, reduced nutrients available for vegetation, increased soil aeration and increased surface temperature. The soil resulting from goat impacts provides less stability for plant regeneration. Trampling and trailing cause increased sheetwash erosion and displacement of large soil particles (Pfitsch et al. 1983).

Ungulates in other areas alter nitrogen cycles and the soil formation process (Day and Detling 1990; Frank and McNaughton 1992; McInnes et al. 1992). It is reasonable to assume that goats may cause similar changes at Olympic.

A three-fold increase in goat numbers would certainly cause more soil impacts. Generalized erosion, sheetwash erosion, alteration of soil processes, and associated soil changes would increase. Soil impacts would be greater with alternative 2 than with the other alternatives.

Although research on goat impacts outside the park is limited, it is reasonable to assume that impacts similar to those documented in the park are also occurring in goat habitat outside the park. Soil impacts would continue, and probably increase, on national forest lands.

This alternative would not meet NPS mandates, policy and management objectives for ecosystem protection or restoration.



Indirect Effects

None identified.

Goat wallowing in a mountain meadow.

Conclusion

This alternative would result in increased numbers of goats on the peninsula, leading to increased soil impacts. Generalized erosion, sheetwash erosion, alteration of soil processes, and associated soil changes would increase. Soil impacts would be greater with alternative 2 than with the other alternatives.

Cumulative Impacts

None anticipated.

Impacts on Visual Resources

Analysis

This alternative would result in an increase of approximately 1,000 goats within the park. Visitors who appreciate the scenic value of goats would be positively affected. In a visitor survey at Mount Rainier National Park, 11% of visitors chose wildlife as the most important management priority (Johnson et al. 1992). Visitors to Olympic are probably similar to Mount Rainier visitors.

Goats damage native ecosystems; more goats would cause more damage. Visitors who appreciate the visual integrity of wilderness areas and the scenic value of native ecosystems would be negatively impacted. The Mount Rainier survey found that approximately 88% of park visitors feel that the

balance of the natural ecosystem is very important or extremely important (Johnson et al. 1990). Many visitors go to both Mount Rainier and Olympic. It can be assumed that Olympic visitors' attitudes are similar.

Indirect effects

None identified.

Conclusion

Effects of this alternative on visual resources would be positive for visitors who value seeing goats more than seeing native ecosystems, while the effect would be negative for visitors who value the visual integrity of native ecosystems more than goat sightings.

Cumulative Impacts

None anticipated.

Impacts on Wilderness Values

Analysis

The value of wilderness, as defined in the Wilderness Act, lies in its primeval character; its natural and unimpaired condition; its wildness. Exotic goats change ecosystem components and processes within the wilderness portion of ONP. These changes are human-initiated since humans introduced the goats. If this alternative were selected, goat-caused changes would increase and continue to negatively affect wilderness ecosystems and values.

Since no action would be taken to reduce or eliminate goats, no impacts related to firearm use would occur during implementation of the alternative.

Census of the goat population would impact wilderness users for a short time once every five years. The census helicopter flights would last for approximately 4.5 hours each day for seven days during July.

The scientific value of the park as an ecosystem functioning with minimal human interference (since humans introduced mountain goats to the system) would be diminished. This would impact both agency and independent research scientists.

This alternative would not meet NPS mandate, policy or management objectives for wilderness protection.

Indirect Effects

None identified.

Conclusion

More goats would cause more impacts on wilderness resources. This alternative would have short-term and long-term negative impacts on wilderness values because goats and the impacts caused by goats are human-caused influences within the wilderness area.

Cumulative Impacts

Wilderness resources within the Pacific Northwest and around the world are diminishing due to increasing development. This alternative would cause increased impacts to the Olympic Wilderness Area. As such, it would have a negative effect on efforts to preserve and restore wilderness within a local, regional, and national context.

Impacts on Human Safety

Analysis

Any work in or around helicopters is inherently dangerous. A slight risk would be incurred by employees involved in helicopter use during vegetation monitoring and goat censusing. This risk would be minimal and short-term.

Employee safety would not be jeopardized during a goat management program because no management action is proposed.

Indirect Effects

None identified.

Conclusion

Risks to employee safety would be minimal with this alternative.

Cumulative Impacts

None anticipated.

Impacts on Values Related to Special Designations

Analysis

The value of biosphere reserves is the conservation of genetic resources in the world's major ecosystems and in the opportunity for long-term research on the functioning of those ecosystems. Goats alter the functioning of native ecosystems, thus impairing the integrity of this reserve. An increased number of goats would cause an increased impact on the ecosystem, resulting in greater impairment of the values related to this special designation.

Olympic National Park was designated as a world heritage site because of its outstanding universal value to mankind. By treaty, law, regulation, and NPS guidelines, these sites are to be managed to avoid any negative impact on the site's integrity. The nomination technical review prepared by the IUCN stated, "The main danger to the integrity of the site is, oddly, one of its attractions--the mountain goat" (IUCN 1981). An increased number of goats would cause an increased impact on the ecosystem, resulting in greater impact on site integrity and greater impairment of the values related to this special designation.

This alternative would not meet NPS mandate, policy or objectives for management of biosphere reserves or world heritage sites.

Indirect Effects

None identified.

Conclusion

Increased numbers of goats cause increased ecosystem impacts. This alternative would have a negative effect on values associated with the biosphere reserve and world heritage site designations.

Cumulative Impacts

Unimpaired natural areas are declining because of increasing pressures associated with civilization. As a result, world heritage sites and biosphere reserves are of increasing value to the people of the world. Increased numbers of goats under this alternative would cause greatly increased impacts to values associated with these designations at Olympic.

Cost

Analysis

There would be no operational costs for goat management under alternative 2.

Regardless of goat management programs, the National Park Service has a responsibility to protect park resources. Vegetation monitoring would be extensive with this alternative because of increased

risks to communities and rare plants caused by increasing goat numbers. Vegetation monitoring during the ten year implementation period would cost approximately \$522,000-\$965,000.

Goat population dynamics would still be an important factor in plant protection. During the ten year implementation period, three goat censuses would be conducted at a total cost of approximately \$63,000.

Costs for all alternatives are detailed in appendix E, beginning on page 217.

Energy Requirements

Helicopter use for implementation of this alternative would require approximately 3,890 gallons of Jet A fuel. This fuel consumption estimate includes the goat population censuses, as well as helicopter support for vegetation monitoring.

The fuel truck associated with helicopter operations would use about 615 gallons of diesel fuel.

Energy requirements for ground transportation of personnel for goat censusing and vegetation monitoring would be approximately 186 gallons of unleaded gasoline.

Indirect Effects

None identified.

Conclusion

Estimated total cost of this alternative over the first 10 year period would be approximately \$1,028,000, including vegetation and goat monitoring. These costs would continue indefinitely.

Impacts on Archeological Resources

Analysis

Goats wallow and trample soils and vegetation. Increased soil and vegetation damage caused by an increased number of goats could damage undiscovered archeological sites. A goat wallow on an archeological site could destroy that site because alpine and subalpine sites are scattered and thin. Increasing numbers of goats would increase the risk of goat-caused damage to archeological sites.

Indirect Effects

None identified.

Conclusion

Risk to undiscovered archeological sites would increase as goat numbers increase.

Cumulative Impacts

None anticipated.

Impacts on the Local and Regional Economy

Analysis

In 1983, goat numbers were high (approximately 1,175 animals on the peninsula) and annual park visitation was 2,874,958. In 1990, goat numbers were much lower (approximately 389 animals) and annual park visitation was higher (3,514,079) than in 1983. By 1994, the goat population was estimated at approximately 288 animals and visitation was up to 4,261,561. It appears that visitation will continue to increase regardless of goat population trends.

Olympic National Park employment levels would not be affected by this alternative.

In 1983 when goat numbers were high on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park (Table 4, page 78). In 1990 when goat numbers were much lower, WDFW also issued 40 goat permits. In 1993, WDFW issued 35 permits. The 1994 goat census estimate (Houston et al. 1994a) was not statistically different than the 1990 estimate. (Note: 1994 hunting information was not available when this DEIS went to print, but will be included in the FEIS). It is reasonable to expect that permits for recreational hunting outside the park would remain stable or increase with this alternative since the goat population on the peninsula would increase.

Indirect Effects

None identified.

Conclusion

Olympic National Park employment and visitation would not be affected by this alternative. Goat hunting would also not be affected. Thus, the local and regional economy would not be affected by this alternative.

Cumulative Impacts

None anticipated.

Impacts on Tourism

Analysis

In 1983, goat numbers were high and annual park visitation was 2,874,958. In 1990, goat numbers were much lower and annual visitation was higher (3,514,079). In 1994, the goat population was estimated at approximately 288 animals and visitation had increased to 4,261,561. It is reasonable to assume that visitation will continue to increase in the future, regardless of goat population levels.

Although impacts to tour groups focusing on wildlife viewing and photography cannot be quantified, some positive impact could occur. More goats would be available for photographing and viewing. It is possible that additional visitors would join tour groups if goats were abundant.

Indirect Effects

None identified.

Conclusion

Total park visitation would be unaffected by this alternative. Visitors wishing to view or photograph wildlife would continue to see goats, and would likely have opportunity to see more goats. Minimal impacts on tourism would be expected from this alternative.

Cumulative Impacts

None anticipated.

Impacts on Hunting Outside the Park

Analysis

In 1983 when goat numbers were high on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park (Table 4, page 78). In 1990 when goat numbers were much lower, WDFW also issued 40 goat permits. In 1993, WDFW issued 35 permits. The 1994 goat census estimate was not statistically different from that of 1990 (Houston et al. 1994a). (Note: 1994 hunting permit information was not available when this DEIS went to press). It is reasonable to expect that permits for recreational hunting outside the park would remain stable or increase with this alternative since the goat population on the peninsula would increase.

Indirect Effects

None identified.

Conclusion

Opportunities for goat hunting outside the park would continue or increase with this alternative.

Cumulative Impacts

None anticipated.

Impacts on Park Visitor Use and Experience

Analysis

From 1983 through 1994, park visitation increased; annual visitation in 1983 was 2,874,958, while in 1994 visitation was 4,261,561. During the same time period, goat numbers decreased from about 1,175 animals in 1983 to approximately 288 in 1994. Goat management activities varied from a live-capture program in 1988/1989 to no active goat management at all in 1993. It appears that visitor use will continue to increase regardless of goat population trends or goat management programs.

Unnatural diversity of wildlife would continue. Opportunities for park visitors to view and photograph goats would increase. At maximum density, goats would be easily viewed in both frontcountry and backcountry situations.

There could be some impacts to visitor safety from increased incidence of visitor/goat interactions. The level of goat nuisance to visitors would increase.

Opportunities to view or photograph rare/endemic plants and undisturbed native plant communities would decrease.

The negative impacts on the recreational or wilderness experience for those visitors who feel that exotic goats should not be present would increase.

Direct noise intrusion from goat management actions would not occur.

Recreational hunting is currently prohibited within the park by legislation and would not be permitted under this alternative.

Indirect Effects

None identified.

Conclusion

It is unlikely that this alternative would affect the level of visitor use. Effects of this alternative on visitor experience could be positive or negative: positive for those visitors who value goats more than native ecosystems and negative for those who value native ecosystems more than goats.

Cumulative Impacts

None anticipated.

ALTERNATIVE 3. ELIMINATE GOATS BY A COMBINATION OF LIVE-CAPTURE AND SHOOTING

NOTE: For impact analysis, it is assumed that a live-capture program would be conducted for one field season before the elimination program would begin. If a live-capture partner does not come forward within the specified time period, then NPS would begin a shooting program in the first field season and impacts would be similar to those for alternative 1.

Impacts on Wildlife Resources

Analysis

Goats. All goats within the park would be eliminated to the extent possible. Goats would be live-captured for one field season, then remaining goats would be shot by authorized representatives. The population would likely decrease rapidly until elimination was achieved in approximately four years. Some subpopulations might exhibit density-dependent reproductive increases during this period, but such responses would not be expected to compensate for removals.

For analysis, it is assumed that the population at the beginning of the live-capture program could contain up to 500 animals. The number of goats that could be live-captured each day would be highly variable. A practical limit to the maximum number of animals which could be caught each day exists because of the very long transport times required to remove goats from remote capture sites within the park interior. This variability would be compounded by factors, such as goat behavior, terrain in which goats are located, and adverse weather conditions (clouds, rain, wind, turbulence, etc.), which cannot be controlled or predicted. Day-to-day capture variability would be expected to generally increase the longer the operation continues. Operations would be modified from those used in 1988/1989 to provide a higher level of human and animal safety. If 30 operational days (good weather, helicopter availability, etc.) are accomplished, and if an average of approximately 3 goats can be captured each day, up to 100 goats would be live-captured. Remaining goats would continue to reproduce during the year of live-capture, adding to the number of goats to be shot. At the start of the shooting program approximately 400 animals would remain.

Some goats would inevitably die during the live-capture program. Capture and handling of any wild animal causes some unavoidable deaths. If 10-20% of the captured goats died (and if 100 animals were captured), approximately 10-20 goats would die during the live capture program.

Approximately 400 goats would be shot during the initial shooting program. An unknown number of additional goats, possibly as many as 20 animals per year, would be shot during the maintenance program. The American Veterinary Medical Association Panel on Euthanasia (1986) states, "...competently performed gunshot is an acceptable method of euthanasia." The report goes on to say that advantages of gunshot are "(1) Euthanasia is instantaneous; and (2) under field conditions, gunshot may be the only effective method available."

Goat dispersal from Olympic National Forest across park boundaries would be likely as long as goats remain in the national forest. Permanent dispersals of 25 to 36 mi (40 - 58 km) have been documented in the Olympics. Houston estimates that up to 20 goats could disperse into the park each year

(Houston et al. 1994b). It is likely that goats from ONF would recolonize the eastern portion of the park, necessitating a long-term maintenance program to keep the park free of goats.

Alternative 3 meets NPS mandates, policy, and management objectives for exotic species management to the extent possible, although elimination would take one year longer than alternative 1.

Other wildlife. The northern spotted owl and marbled murrelet are listed as threatened under the Endangered Species Act. Both birds are associated with old growth forests. Since the live-capture and shooting programs would be conducted in goat summer range, the only impact of the program would be helicopter activity enroute to alpine and subalpine areas. Such activities would be planned in consultation with USFWS to avoid owl and murrelet habitat and would not adversely affect either species.

Helicopter intrusion on wildlife populations would be at a higher level than in Alternative 1 during the first year.

Bald eagles (threatened) and peregrine falcon (endangered) are seasonal predators of small mammals and ground-nesting birds in goat habitat. Both are unlikely to be adversely affected by this alternative.

The Olympic marmot is an endemic ground-dwelling rodent that is common in goat habitat. Goats and marmots potentially compete with each other (Houston et al. 1994b). Removal of the goat population could benefit marmots by reducing soil disturbance and increasing plant foods locally.

Black-tailed deer, Roosevelt elk, and smaller herbivorous mammals and birds occur widely in goat habitat. Where their activities overlap with goats and similar plant foods are used, it is reasonable to assume that such species could benefit from the removal of a possible competitor such as goats.

Impacts on native carnivore populations due to removal of goats would be minimal because alternative native prey species would be available. Scavengers would have a temporary abundance of food locally during the elimination program because of the presence of goat carcasses.

Indirect Effects

It is impossible to predict indirect effects of elimination within the park on future goat population levels outside the park. Two scenarios are possible:

- 1) With the resultant lower overall goat density on the peninsula, it is possible that the population outside the park would not remain viable long-term (more than 50-100 years). In that case, goats might eventually disappear from the peninsula.
- 2) It is also possible that the population outside the park might remain viable indefinitely. The maximum sustainable population for habitat outside the park has been estimated at approximately 200-250 goats (Houston et al. 1994b), although hunting could maintain the population at a lower level.

Other impacts discussed for this alternative assume that a viable population would remain long-term outside the park. If not, the maintenance program would no longer be needed to remove immigrants into the park.

Goats translocated during the live-capture program would likely be released in areas to establish or augment a population for hunting. These animals could be killed by hunters at some point in the future.

Removal of the goat population would likely result in restoration of native vegetation, which could lead to more small mammals and birds locally, providing a somewhat larger prey base for raptorial birds like eagles and falcons.

It seems likely that restoration of soils and native vegetative communities would also improve habitat for invertebrates.

Conclusion

Up to 100 goats would be captured during the live-capture program. It is likely that approximately 10-20% of these animals could die as a result of capture.

Approximately 400 goats would be shot within the park during the initial shooting program. An unknown number of additional goats, possibly as many as 20 animals/year, would be shot during the maintenance program.

The goat population outside the park may or may not remain viable long-term under this alternative.

Although impacts of goats on other wildlife have not been proven, it is likely that goats do affect other wildlife that occupy the same areas (Houston et al. 1994b). Removal of goats, and subsequent ecosystem restoration, could benefit several native wildlife species.

Cumulative Impacts

Goats were not historically present on the peninsula. Eleven individuals were introduced in the 1920s and expanded to a maximum population of approximately 1,175 goats in 1983. In 1990, the population was estimated at approximately 389 goats. The 1994 census estimate was not statistically different from the 1990 figure. During the four-year elimination program proposed in this alternative, the population would be essentially reduced to zero within the park.

Regionally and nationally, the effect on the total population of mountain goats would be insignificant. Native populations of goats would remain in the nearby Cascade Mountains (WDFW estimated approximately 7,000 animals in 1992), and elsewhere in the United States and Canada (total number estimated at approximately 100,000 animals [Johnson 1977]).

Impacts on Vegetation Resources

Analysis

Threatened and endangered species. Olympic Mt. milkvetch is a Federal category 1 candidate species and is listed as threatened by WNHP. Goat habitat overlaps with Olympic Mt. milkvetch habitat (Houston et al. 1994b).

Goats damage and kill milkvetch plants by eating them, trampling them, and wallowing on them (Houston et al. 1994b). Elimination of goats from the park would minimize grazing, trampling and wallowing to the maximum extent possible. Therefore, threats to the milkvetch from goat grazing, trailing, and wallowing would be minimized in approximately four years (at the conclusion of the initial live-capture and elimination programs). Maximum milkvetch population recovery from the presently impacted condition would likely require 25-100 years depending on the site (Schreiner personal communication).

Goat subpopulations would remain on the peninsula outside the park for the near future and possibly indefinitely. Some goats would likely move back into the park from those remaining subpopulations. As a result, elimination of goats in the park would not completely eliminate the threat of goat impacts to milkvetch plants, subpopulations, and populations. The milkvetch occurs in only 12 known subpopulations in the world. Eleven of the subpopulations are within the northeastern portion of the park. This area is most likely to be affected by dispersing goats moving into the park from Olympic National Forest. The twelfth subpopulation occurs within goat habitat in the national forest.

Rare and/or endemic species. Thirty-three taxa of rare and/or endemic plants are known to grow in goat summer range in the Olympic Mountains (Houston et al. 1994b). At least four endemic species are grazed by goats (Houston et al. 1994b; Pfitsch and Bliss 1985; Pike 1981). It is reasonable to expect that goats also eat other rare and/or endemic plants because goats are generalist herbivores capable of eating most plant species (Houston et al. 1994b). Goats have killed rare plants by wallowing and trampling on them (Houston et al. 1994b).

If goats were eliminated from the park, goat grazing, trampling and wallowing would be minimized to the maximum extent possible. Therefore, threats to rare and/or endemic taxa from goats would also be minimized in approximately four years (at the conclusion of the initial live-capture and elimination programs). Threats to these plants include risks to individual plants, populations, and subpopulations. Threats also include the possibility of local extinction of species. It is certain that threats would be less with the elimination alternatives than with any other alternative. This alternative would pose more risk to rare and/or endemic plants than the proposed action because elimination would take longer under this alternative and because some rare and/or endemic plants could be at risk from impacts caused directly by the live-capture program.

Goat-caused impacts would not be totally eliminated because of dispersal of goats from outside the park. This would be especially true along the park-forest boundary, where concentrations of rare and endemic plants are highest. However, impacts would be minimized to the maximum extent possible as a result of management action within the park (i.e., with no management action to reduce goat numbers outside the park). Alternative 1 would minimize the impacts sooner than this alternative.

Native Communities. All large grazing mammals modify ecosystems (Crawley 1983). Goats are known to affect native communities by eating plants, trampling plants, and wallowing on plants. These activities alter plant reproductive patterns, growth rates, seedling establishment, and structure (Houston et al. 1994b). These effects change the relative abundance of plants; disturbance-oriented and relatively unpalatable species increase as palatable species decrease. Community dominance shifts toward disturbance oriented species (Houston et al. 1994b).

Comparative photos have shown that when mountain goat density decreases, plant cover increases (Houston et al. 1994b).

If goats were eliminated within the park, their impacts to native communities would be minimized to the maximum extent possible within approximately four years (at the completion of the initial live-

capture and elimination programs). Impacts would not be completely eliminated in the park because of dispersal of goats from outside the boundary.

Native communities would be restored significantly, but complete restoration would not occur in areas used by dispersing goats. Some heavily impacted areas could be actively rehabilitated to facilitate recovery. Community recovery would take decades in some areas.

Local impacts in goat wallows include decreased plant numbers, cover, and live plant material (Houston et al. 1994b). Soil disturbance caused by dispersing goats may still provide a site for exotic species to invade native vegetation.

Small areas of vegetation would be temporarily impacted in campsites used by vegetation monitoring crews. Impacts would be minimized by use of tent platforms and would be of short duration (1-3 weeks in any one site). Full vegetation recovery would be expected in a very short time. These short-term impacts would be less than with the no-action alternative because goat-related vegetation monitoring would be less intensive and last for fewer years.

Community recovery would take longer with this alternative than with the preferred alternative because elimination of goats would take longer and because impacts caused by the live-capture program would occur for one field season.

Ecosystem impacts outside the park would differ significantly under two possible goat population trend scenarios:

- 1) If goat populations decrease, associated ecosystem impacts would also decrease. If the goat population disappears from areas outside the park, goat impacts would cease and community restoration would eventually occur.
- 2) If goats outside the park increase to the maximum possible population level, ecosystem impacts would also increase.

Indirect Effects

If goats were transplanted into non-native range elsewhere, it is likely that native vegetation in those areas would be impacted by goat wallowing, trampling and grazing.

Conclusion

Elimination of goats within the park would essentially eliminate goat-caused threats to native vegetation, including rare and/or endemic plants. Vegetative recovery would be expected. This alternative provides protection for vegetation and offers a high level of assurance that resources would eventually be protected.

The two elimination alternatives provide the most protection for vegetation resources. There are two primary differences in vegetation impacts between alternative 1 and alternative 3: impacts would be minimized one year sooner in alternative 1 than in this alternative and the live-capture portion of this alternative could cause direct impacts to vegetative communities and rare plants.

Alternative 3 would meet NPS mandate, policy and management objectives for protection and restoration of T&E, rare, and endemic taxa and native vegetation, however not as quickly as possible.

Cumulative Impacts

Locally and regionally, native vegetation has been lost or impacted outside the park due to many factors, such as timber harvest and increasing development. As native vegetation becomes more rare, national parks are becoming the last remnants of unimpacted vegetation. Native vegetative communities would be protected and restored under this alternative. In turn, native wildlife which depends on vegetation would also be favorably affected.

Worldwide, species are becoming extinct at an alarming rate because of habitat loss, increasing development, and many other factors. Due to the biogeographic history of the Olympic Peninsula, 33 taxa of rare and/or endemic plants are known to occur in goat habitat of the park. This alternative would provide some assurance that rare and endemic plants would be protected from goat impacts. Since the Olympic Peninsula contains the entire world population of some plant taxa, the effect of this alternative on vegetative species diversity would be positive.

Impacts on Soils

Analysis

Goats change soils, locally decrease vegetative cover, and cause erosion by wallowing, trailing and trampling (Houston et al. 1994b).

Wallowing removes soil surface layers (Pfitsch et al. 1983). Wallows have finer-textured soil near the surface, low organic matter, and larger particles that move downslope. In areas with shallow soils, wallowing displaces the fine materials, leaving scree and gravel. These impacts cause reduced water-holding capacity, reduced nutrients available for vegetation, increased soil aeration and increased surface temperature (Pfitsch et al. 1983). The soil resulting from goat impacts provides less stability for plant regeneration. Soil changes and disturbance caused major shifts in plant community composition around wallow edges (Pfitsch 1981, Reid 1983). Trampling and trailing cause increased sheetwash erosion and displacement of large soil particles (Pfitsch et al. 1983).

Ungulates in other areas alter nitrogen cycles and the soil formation process (Houston et al. 1994b; Day and Detling 1990; Frank and McNaughton 1992; McInnes et al. 1992). It is reasonable to assume that goats may cause similar changes at Olympic.

Elimination of goats would virtually eliminate wallowing and trampling. This would lessen generalized erosion, sheetwash erosion, and associated soil changes. Continued goat impacts to soils would be minimized in about four years. Impacts would not be completely eliminated, especially along the boundary, because of goat dispersal into the park. Few new areas of impact would be created.

The live-capture program could directly cause minor soil impacts for one field season.

Significant soil restoration would eventually occur, although soils recover at a very slow rate, especially in alpine areas where steep topography and cold temperatures inhibit soil genesis (Pfitsch et

al. 1983). In some heavily impacted areas, soils could be actively stabilized to aid restoration. Erosion would continue in wallow areas unless the areas were actively restored.

Although research on goat impacts outside the park is limited, it is reasonable to assume that impacts similar to those documented in the park are also occurring in goat habitat outside the park. Soil impacts would continue on national forest lands, unless elimination of goats from the park eventually caused the goat population outside the park to disappear.

Indirect Effects

Soils protected from goat impacts provide better conditions for plant establishment and growth. Positive effects on soils would have indirect beneficial effects for vegetation and wildlife.

Conclusion

This alternative would result in virtual elimination of goats in the park. Soil impacts would be reduced to the maximum extent possible. Impacts would not be totally eliminated because of goats dispersing from outside the park.

The two elimination alternatives provide more restoration and protection for soils than the no-action alternative. There are two primary differences in soil impacts between alternative 1 and alternative 3: impacts would be minimized one year sooner in alternative 1 than in this alternative and the live-capture portion of this alternative could cause direct soil impacts.

Alternative 3 would meet NPS mandate, policy and management objectives for protection and restoration native ecosystems, however not as quickly as possible.

Cumulative Impacts

None anticipated.

Impacts on Visual Resources

Analysis

A visitor survey at Mount Rainier National Park found that approximately 88% of visitors feel the balance of the natural ecosystem is very important or extremely important (Johnson et al. 1992). Visitors to Olympic probably have attitudes similar to those of Mount Rainier visitors. People who appreciate the scenic value of native vegetation and undisturbed soils would be positively affected by this alternative, although restoration would not be complete because of continuing impacts from dispersing goats and slow recovery rates.

The Mount Rainier survey documented that approximately 11% of visitors felt that wildlife should be the most important management priority. Visitors who appreciate the scenic value of goats in the park would be negatively affected by this alternative. Opportunities to view goats would remain outside the park. Maximum potential density of goats on the peninsula outside the park has been

estimated at approximately 250 goats. Additional viewing opportunities would remain in the Cascade Range with an estimated population of approximately 7,000 goats (WDFW 1992).

Goat carcasses would be left in place to recycle back into the ecosystem. The presence of carcasses would be unsightly, however any carcasses in highly used areas would be moved to less visible locations.

Indirect Effects

None identified.

Conclusion

Elimination of goats would virtually eliminate the possibility of viewing goats within the park and would increase the possibility of seeing undisturbed native ecosystems. Effects of this alternative on visual resources would be negative for visitors who value seeing goats more than seeing native ecosystems, while the effect would be positive for visitors who value the visual integrity of native ecosystems more than goat sightings.

Goats could still be viewed outside the park: on the peninsula, elsewhere within Washington; and other locations in western North America.

Cumulative Impacts

None anticipated.

Impacts on Wilderness Values

Analysis

The value of wilderness, as defined in the Wilderness Act, lies in its primeval character; its natural and unimpaired condition; its wildness. Exotic goats change ecosystem components and processes within the wilderness portion of ONP. These changes are human-initiated since humans introduced the goats. If this alternative were selected, goat-caused changes affecting wilderness ecosystems and values would be essentially eliminated.

Negative impacts of goats on wilderness ecosystems would be minimized in approximately four years. Impacts would not be eliminated and wilderness ecosystems would not be fully restored because of goats dispersing into the area from outside the boundary.

Helicopters and personnel associated with the live-capture phase of this program would temporarily impact wilderness values because of noise and the presence of humans. This impact would be mitigated by operating on weekdays and using only one helicopter at a time. The impact would occur for eight hours on each of three days per week for a total of 30 days during one field season.

The use of helicopters and firearms during the elimination and maintenance programs would be a temporary negative impact on wilderness values. This impact would occur for 5.5 hours on each of three days per week for a total of 30 days each year during the initial three-year elimination program. Impacts would be during May to July and possibly September/October. The impact could be mitigated through timing of operations. Impacts from the maintenance program would be for several days once every five years.

The scientific value of the park as an ecosystem functioning with minimal human interference would be vastly improved, although not completely restored. This would benefit agency and independent research scientists.

This alternative would meet NPS mandates, policy and management objectives for wilderness protection, although not as quickly as possible.

Indirect Effects

None identified.

Conclusion

Goats impact wilderness values. Elimination of goats would have a positive long-term effect on wilderness values. This alternative requires use of live-capture equipment, firearms and helicopters within the wilderness area. Therefore, the alternative would have a negative short-term impact on wilderness values and experiences during the actual live-capture, shooting, and maintenance programs.

Cumulative Impacts

Wilderness resources around the world are decreasing because of the rapid increase in development. This alternative would have a positive effect on the Olympic Wilderness Area. As such, it would benefit efforts to preserve and restore wilderness within a local, regional, and national context.

Impacts on Human Safety

Analysis

Live-capture Program. A live-capture operation is extremely hazardous. Although live-capture procedures previously used would be modified for increased safety, individuals involved in the program would still be exposed to a high level of risk for 30 days during one year. Even by implementing all possible safety measures, there would still be inherent dangers that could not be mitigated.

Shooting Program. Upon completion of the one-season live-capture program, NPS would initiate the shooting program. This would involve shooting goats from a helicopter, but the animals would not need to be recovered as they would during a live-capture program. Therefore, employees would not need to exit the helicopter under hazardous field conditions, such as hover, step-off, toe-in or one-skid landings in steep terrain.

Any work in and around helicopters is inherently dangerous, including the possibility of employee fatalities. However the risk to employees during a shooting program would be minimal compared to a live-capture program.

Safety risks from the elimination program would be of short duration. Employees would be exposed to hazards for three days per week for a total of 30 days each year during the initial three-year elimination program.

Maintenance Program. The maintenance program, and associated risks, would continue long-term as needed. This program would put employees at risk for a few days in early summer once every five years. Risks might increase as experienced employees leave the maintenance program and new employees are gaining experience.

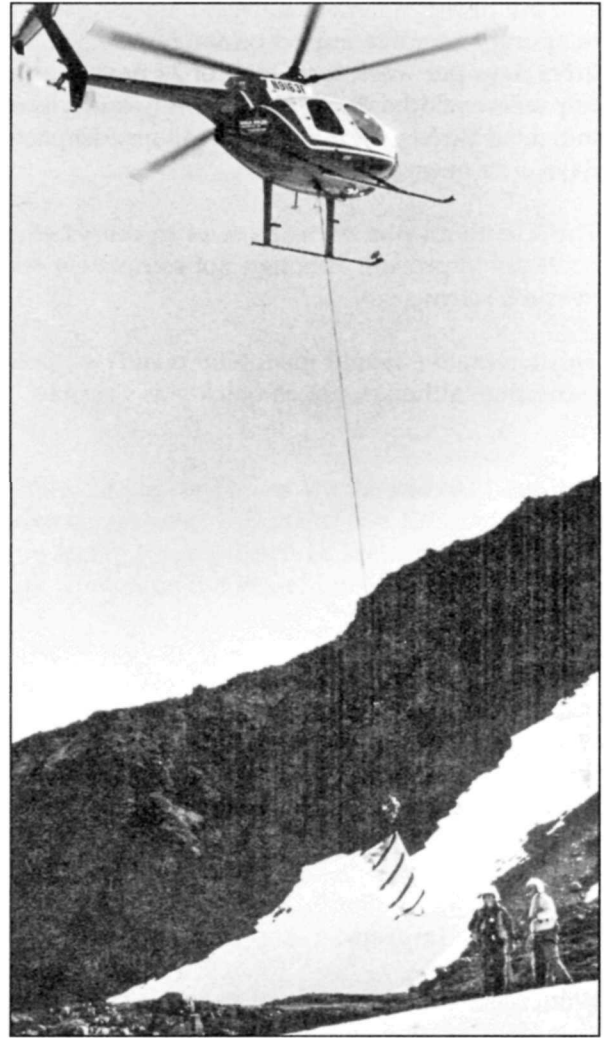
Monitoring. An additional slight risk would be incurred during on-going helicopter flights associated with vegetation monitoring.

Indirect Effects

None identified.

Conclusion

Participants in the live-capture phase of the program would be exposed to a high level of risk for 30 days during one field season.



Transporting goat during live-capture operations.
(Photo: Richard Olson).

Although working in and around helicopters is inherently risky, employees would not need to rapidly exit the helicopter under hazardous field conditions during the shooting program. Although employees would be exposed to risk for 30 days in each of three years during the shooting program, risks during a shooting program would be low relative to any other method of control or elimination.

Cumulative Impacts

None anticipated.

Impacts on Values Related to Special Designations

Analysis

The value of biosphere reserves is the conservation of genetic resources in the world's major ecosystems and in the opportunity for long-term research on the functioning of those ecosystems. Goats alter the functioning of native ecosystems, thus impairing the integrity of this reserve.

Olympic National Park was designated as a world heritage site because of its outstanding universal value to mankind. By treaty, law, regulation, and NPS guidelines, these sites are to be managed to avoid any negative impact on the site's integrity. The nomination technical review prepared by the IUCN stated, "The main danger to the integrity of the site is, oddly, one of its attractions--the mountain goat" (IUCN 1981). In a 1987 letter to the park superintendent, the executive officer of the IUCN stated, "In our role as technical advisor to the World Heritage Committee we have been following the goat management issue in Olympic National Park with interest.... we would encourage your Service to act to eliminate mountain goats from the World Heritage Site" (Thorsell 1987).

Elimination of goats would essentially cease impacts on the ecosystem, resulting in substantially less impairment of the values related to these special designations.

Impacts on the values associated with both special designations would not be completely eliminated because of goats dispersing from outside the park. Impacts would be minimized to the maximum extent possible for management action within the park.

Indirect Effects

None identified.

Conclusion

Elimination of goats would minimize ecosystem impacts, which would have a positive effect on the values associated with world heritage site and biosphere reserve designations.

Both elimination alternatives would have less impacts on these values than the no-action alternative. The primary difference between alternative 1 and alternative 3 is that impacts would continue for an additional year under this alternative to provide for a live-capture operation.

Cumulative Impacts

Unimpaired natural areas are declining worldwide because of the increasing pressures of civilization. This alternative would have a positive effect on biosphere reserve and world heritage site values on the Olympic Peninsula. Therefore, it would have a beneficial effect on efforts to preserve and restore such areas within a global context.

Cost

Analysis

The one-season live-capture program would cost approximately \$215,000.

The initial shooting program would cost approximately \$337,000 over three years.

The maintenance program would be conducted only once during the first ten years of alternative implementation. Costs for this program would be approximately \$27,000 for one maintenance cycle during the first ten year period.

Vegetation monitoring for alternative 3 was estimated at \$455,000 for the first ten years of implementation.

Costs for all alternatives are detailed in appendix E, beginning on page 217.

Energy Requirements

Helicopter use for implementation of alternative 3 would require approximately 17,330 gallons of Jet A fuel. This fuel consumption estimate includes the live-capture, elimination and maintenance programs, as well as helicopter support for vegetation monitoring.

It is estimated that the fuel truck associated with helicopter operations might use about 2,190 gallons of diesel fuel.

Vehicles for ground transportation of personnel would use approximately 780 gallons of unleaded gasoline during the first 10 years of implementation.

Fuel usage for trucks and helicopters transporting live-captured goats once they leave the park to the point of release is impossible to estimate because the location of release is unknown at this time. During past live-capture operations at Olympic, some goats were translocated to other western states.

Indirect Effects

None identified.

Conclusion

Alternative 3 would be the most expensive of the three alternatives. The relative cost per animal is very low for the shooting program, but high for the live-capture program.

Total cost of this alternative over the first ten year period would be approximately \$579,000 for operations, including the initial one-season live-capture program, the subsequent shooting program, and the maintenance program; and approximately \$455,000 for vegetation monitoring. Substantial costs for the live-capture program (approximately \$215,000) may or may not be funded by NPS.

Future costs (beyond the initial ten year period) would be minimal: approximately \$27,000 every five years for the maintenance program.

Impacts on Archeological Resources

Analysis

Goats wallow and trample soils and vegetation. Risk of damage to undiscovered archeological sites due to soil and vegetation damage would be minimized if goats were eliminated. Some risk would occur due to dispersing goats. Risks to archeological sites under this alternative would be less than under the no action alternative, but greater than under the preferred alternative.

Undiscovered archeological resources could be damaged by ground activities during the live-capture program.

Implementation of the shooting and maintenance programs would not cause ground disturbance, thus would not impact archeological resources.

Indirect Effects

None identified.

Conclusion

Soil and vegetation impacts caused by ground operations during the live-capture phase could damage archeological resources.

Implementation of the shooting phases does not require ground operations outside of developed areas. Therefore, no impacts to archeological resources would be expected during these operations.

Goats could impact archeological resources by disturbing soils and vegetation. Risk of goat-caused damage to cultural resources would be minimized if goats were eliminated within the park. Minimizing this risk would take one year longer than under alternative 1.

Cumulative Impacts

None anticipated.

Impacts on the Local/Regional Economy

Analysis

In 1983, goat numbers were high (approximately 1,175 animals on the peninsula) and annual park visitation was 2,874,958. In 1994, goat numbers were much lower (approximately 288 animals) and annual park visitation was higher (4,261,561). It appears that visitation will continue to increase regardless of goat population trends.

In 1988 and 1989, while the most recent live-capture operation was in operation, annual park visitation was 3,519,181 and 3,360,555 respectively. In 1994, no goat management programs were conducted; visitation was 4,261,561. Therefore, it appears that park visitation will continue to increase regardless of active goat management operations.

Olympic National Park employment levels would not be significantly affected by this alternative. Expenditures for helicopter contracting, supplies, etc. associated with the live-capture and shooting programs could have a minor beneficial effect on the economy.

In 1983 when goat numbers were high on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park (Table 4, page 78). In 1990 when goat numbers were much lower, WDFW also issued 40 goat permits. WDFW issued 35 permits in 1993; permit information for 1994 was not available when this DEIS went to press. The 1994 goat census estimate (Houston et al. 1994a) was not statistically different from that of 1990. It is reasonable to expect that permits for recreational hunting may not be significantly affected unless goat populations outside the park decline significantly. If goat populations outside the park do not remain viable long-term (50-100 years), goat hunting on the peninsula would eventually cease. The Washington Department of Wildlife (1992) found that an annual average of \$450 was spent per individual big game hunter in Washington. In 1993, 28 goat hunters reported actually hunting on the Olympic Peninsula. If goats were eliminated on the entire peninsula, an estimated annual revenue of \$12,600 would be lost for the local economy. This would be a relatively minor impact on the four counties of the peninsula since total 1990 retail sales were \$440 million in Clallam County alone (Clallam County Economic Development Council 1991).

It is unlikely that non-hunting visitation outside the park would be affected by this alternative. Olympic National Forest employment levels would probably not be affected either.

Indirect Effects

None identified.

Conclusion

Olympic National Park and Olympic National Forest employment and visitation would not be affected by this alternative. Overall, the local and regional economy would not be significantly affected by this alternative.

Cumulative Impacts

None anticipated.

Impacts on Tourism

Analysis

In 1983, goat numbers were high and annual park visitation was 2,874,958. In 1994, goat numbers were much lower (approximately 288) and annual visitation was higher (4,261,561) than in 1983. It is reasonable to assume that visitation will continue to increase in the future, even if goats were eliminated from the park.

In 1988 and 1989, while the most recent live-capture operation was in operation, annual park visitation was 3,519,181 and 3,360,555 respectively. In 1994, no goat management programs were conducted; visitation was 4,261,561. It appears that park visitation will continue to increase regardless of on-going goat management operations.

Although impacts to tour groups focusing on wildlife viewing and photography cannot be quantified, some impact could occur. If goats were eliminated, it is unlikely that visitors would stop joining wildlife tour groups since many other species of wildlife, including deer and elk, would still be abundant.

Indirect Effects

None identified.

Conclusion

In the past, park visitation has increased regardless of goat population numbers or goat management operations. Other species of large mammals would continue to be available for viewing or photographing. It is unlikely that this alternative would impact tourism significantly.

Cumulative Impacts

None anticipated.

Impacts on Hunting Outside the Park

Analysis

Recreational hunting is prohibited within the park by legislation and would not be permitted.

In 1983 when goat numbers were high (approximately 1,175 animals) on the peninsula, WDFW issued 40 permits for archery hunting of goats outside the park (Table 4, page 78). In 1990 when goat numbers were much lower (approximately 389 goats), WDFW also issued 40 goat permits. WDFW issued 35 permits in 1993. The 1994 census estimate indicated no statistical difference in goat numbers between 1990 and 1994 (Houston et al. 1994a). (Note: 1994 hunting statistics were not available as this DEIS went to press, but will be included in the FEIS). The number of permits issued for recreational hunting may not be greatly affected unless goat populations outside the park decline substantially. If goat populations outside the park do not remain viable long-term (50-100 years), goat hunting on the peninsula would eventually cease.

Regardless of the viability of goats on the Olympic Peninsula, hunting would likely continue throughout the rest of Washington State. Statewide in 1990, WDFW issued 67 permits for archery-only hunting of goats and 126 permits for goat hunting using any legal weapon. Although Olympic Peninsula permits are not a large proportion of total goat permits issued in the state, the 40 Olympic permits constitute approximately 60% of all archery-only permits issued in Washington.

Indirect Effects

If goat hunting on the peninsula were to cease, it is possible that WDFW could increase the number of archery permits issued elsewhere in the state.

Conclusion

Impacts on hunting are uncertain. If the goat population outside the park remained viable long-term (50-100 years), this alternative would not likely have any effect on hunting. If the goat population outside the park declined or disappeared, goat hunting could be reduced or eventually cease within the next 50-100 years.

Opportunities for goat hunting would continue in other states and in areas of Washington other than the Olympic Peninsula.

Cumulative Impacts

None anticipated.

Impacts on Park Visitor Use and Experience

Analysis

From 1983 through 1994, park visitation increased; annual visitation in 1983 was 2,874,958, while in 1994 visitation was 4,261,561. During the same time period, goat numbers decreased from about 1,175 animals in 1983 to approximately 288 in 1994. Goat management activities varied from a live-capture program in 1988/1989 to no active goat management at all in 1994. It appears that visitor use will continue to increase regardless of goat population numbers or goat management programs.

During the live-capture, shooting, and maintenance programs, some visitors would be impacted because of noise intrusion, presence of ground live-capture operations, temporary closure of some visitor use areas, and the possibility of encountering a goat carcass. Impacts during the initial live-capture and shooting programs would be of short duration (five to eight hours per day; three days per week for a total of 30 days each year for approximately four years). Impacts from the maintenance program would continue long-term, but would only last for a few days once every five years. All three programs would be designed to minimize impacts through timing, temporary closure of local areas, moving carcasses away from trails or high use areas, limiting the number of helicopters used, etc.

The opportunity for goat viewing would be minimized or eliminated in the park, however exotic goats would likely still be present outside park boundaries and native populations would be present for viewing in the Cascades. WDFW estimates that approximately 7,000 goats are present in the Cascade Range (WDW 1992). Johnson (1977) estimates that approximately 100,000 goats occur in North America outside the Olympic Peninsula.

Opportunities for experiencing native ecosystems and rare plants unimpacted by goats would increase, but ecosystems would not be completely restored.

The potential for injury due to goat/visitor interaction would be minimized. Goat nuisance to backpackers would be minimized. Impacts to visitor safety from the actual elimination and maintenance programs would be minimal or non-existent.

Indirect Effects

None identified.

Conclusion

This alternative would not be likely to change levels of visitor use. Visitor experiences would be impacted by noise, closures, etc. on a short-term basis during the implementation of the program. Upon completion of the elimination program, opportunities for viewing goats within the park would be essentially eliminated, while opportunities to experience unimpacted ecosystems would increase.

Cumulative Impacts

None anticipated.

List of Preparers

Consultation and Coordination



LIST OF PREPARERS

Many people have participated in the EIS process since it began in 1991. There were several internal agency drafts of the document through the early 1990s. This section lists only those agency employees who have played a major role in the DEIS as released to the public. Many other people who contributed in a review, advisory, or consultation fashion are listed in the "consultation" section.

NAME	TITLE	EDUCATION	EXPERIENCE	ROLE IN THIS DEIS
Gordon Atkins	Outdoor Recreation Planner, NPS Pacific Northwest Regional Office	A.M., Geography; B.A., Geography	13 years NPS; 16 years other federal government	Consultant on NEPA process
Janis Burger	Visual Information Specialist, ONP	B.A., Journalism	12 years NPS	Editor, consultant on document design
Paul Crawford	Natural Resource Specialist, ONP	B.A., Biology	28 years NPS	Consultant on management issues
Catherine Hoffman	Chief, Natural Resource Division, ONP	M.L.S., Plant Ecology; B.A., Botany and Zoology	14 years NPS	Consultant on management issues
Shelley Sparhawk	Natural Resource Specialist, ONP	B.S., Wildlife Biology and Management	17 years NPS	Principal author

CONSULTATION AND COORDINATION DURING DEIS PREPARATION

An Interagency Goat Management Team (IGMT) was established by a Memorandum of Understanding (signed in October, 1991) to address goat management on the entire Olympic Peninsula. This team was composed of personnel from Olympic National Park, Olympic National Forest, and the Washington Department of Wildlife. The National Park Service manages both habitat and wildlife within the park. The Forest Service manages wildlife habitat within Olympic National Forest, while the Washington Department of Fish and Wildlife manages wildlife on national forest lands.

The IGMT first met on January 25, 1991. The team worked together during 1991 and 1992 (a total of 22 team meetings) with a goal to develop an EIS addressing mountain goat management by all three agencies on all Olympic Peninsula goat habitat. Early in 1993, the agencies made a decision to narrow the EIS focus to Olympic National Park only. This decision was made for several reasons. Research on goat populations and impacts has largely been focused within the park. Differences in agency mandates and policies were also reevaluated. Olympic National Forest and Washington Department of Fish and Wildlife continued to work with the park in development of this document, however the other agencies participated as cooperating agencies with special expertise relative to the mountain goat issue on the peninsula. The National Park Service is the lead agency on the EIS. The formal Memorandum of Understanding expired in October 1993 and was not renewed.

The formal EIS process was initiated on October 24, 1991 when the Notice of Intent to prepare an EIS was published in the Federal Register.

The scoping period for this EIS was in the winter of 1992. The purposes of scoping are to identify areas of public concern and to determine the range of actions, alternatives and impacts to be addressed in the document. Specifically, the public was asked to provide input on "1) what should be done to manage mountain goats on the peninsula, and 2) what methods should be used to achieve those management goals" (IGMT 1992).

Four scoping meetings were held January 13-16, 1992. Meetings were in Seattle, Olympia, Bremerton, and Port Angeles, Washington. Over 220 people attended the meetings. The objectives of the meetings were defined as: to provide the public with information about the mountain goat situation in the Olympic Mountains; to review the planning process for the public; to identify issues or concerns that should be addressed in this EIS; and to develop recommendations for goat management on the peninsula.

Written comments were also accepted during the scoping period, as well as throughout the planning process. The first IGMT newsletter included a comment form and encouraged the public to submit comments. Over 600 public responses were received during the scoping period which ended March 30, 1992.

All goat-management issues raised in the scoping comments have been addressed in this DEIS, including:

- Exotic/native status of goats
- Sufficiency of research
- Ethical concerns over killing, mistreating goats
- Costs for goat management actions
- Effects of salt licks on goat impacts
- Preservation of native species, ecosystems, wilderness, and the biosphere reserve
- Goat hunting: some want it to continue, others want it stopped
- Suggestions to change agency mandates (NPS, USFS, or WDFW)
- Suggested strategies for management: retain all goats, retain some goats, eliminate all goats
- Suggested techniques for management: sterilization, introduce or augment predators, live-capture, shooting (by agency representatives), hunting, protect plants, manipulate goat behavior, a combination of techniques.

The NPS National Environmental Policy Act Guideline (NPS 1982) states that "Important environmental issues discussed during consultation should be described whenever conflicts are apparent or whenever issues remain unresolved." There are two areas in which wildlife biologists disagree concerning goat management at Olympic:

Wildlife biologists disagree concerning what effect elimination of goats within the park might have on goat subpopulations outside the park. If goats were eliminated from ONP, the population remaining on the peninsula outside the park may or may not remain viable long-term. In 50-100 years, goats could disappear from the entire peninsula as a result of elimination within the park. It is also possible that the population might remain viable long-term and reach an equilibrium level estimated at approximately 250 goats. This issue is unresolved and there is no way to accurately predict the outcome.

Wildlife experts generally agree that contraceptives would not provide a practical and effective means of control for goats within the park. One problem is achieving a sufficient level of control to protect native ecosystems. However, some wildlife scientists feel that contraceptives would have some applicability, perhaps in combination with lethal methods, for the Olympic goat population. Further discussion of this issue is included in appendix B, beginning on page 181.

A mailing list is maintained for distribution of IGMT newsletters, the DEIS and the FEIS. As of December 1994, the mailing list contained the names of approximately 1,000 individuals and organizations. Persons on the mailing list were kept informed of progress during the EIS process through a series of newsletters. The first newsletter was mailed in January, 1992. The second newsletter was distributed in June of 1992. In May 1993, a press release was distributed to the press and also mailed to individuals and organizations on the goat EIS mailing list.

Additional press releases were sent to the press and the mailing list in March, 1994 and in July, 1994.

In August 1993, the first internal draft of the DEIS was forwarded to the NPS Pacific Northwest Regional Office, the NPS Washington, D.C. office, Olympic National Forest, and Washington Department of Fish and Wildlife for agency review. Park staff conducted a briefing for Department of the Interior and NPS Washington, D.C. office personnel in September of that year.

The second internal agency draft of the DEIS was forwarded to the NPS Regional and Washington (D.C.) offices in January, 1994. A "round-table" meeting of DOI, NPS - Washington D.C., NPS - Pacific Northwest Region, and park staff was held in March of 1994 to discuss document revisions.

A third internal agency draft of the DEIS was forwarded to the NPS Regional and Washington (D.C.) offices in October, 1994. Personnel from NPS - Pacific Northwest Region, DOI Pacific Northwest Office of the Regional Solicitor, and the park met in November to discuss document revisions.

A letter was sent to the U.S. Fish and Wildlife Service in spring, 1993, to confirm information on threatened, endangered species and those proposed for listing relative to the goat management issue. Written confirmation of this information was received in September 1993. A request for an update from USFWS was sent in November 1994, and a response received in January 1995, to ensure that this DEIS is based on the most current information available.

As part of the DEIS preparation process, the following individuals conducted independent assessments of the applicability of contraceptives for control or elimination of goats at Olympic: Dr. Richard A. Fayrer-Hosken (University of Georgia); Dr. Robert A. Garrott (University of Wisconsin - Madison); R. Bruce Gill (Colorado Department of Wildlife Research Center); Dr. David A. Jessup (International Wildlife Veterinary Services, Inc.); Dr. Jay Kirkpatrick (Montana Zoological Society); Dr. Dale R. McCullough (University of California at Berkeley); Dr. Edward D. Plotka (Marshfield Medical Research Foundation); Dr. R. Daniel Thompson (USDA Denver Wildlife Research Center); and Dr. Robert J. Warren (University of Georgia).

As part of the DEIS preparation process, the following individuals conducted independent assessments of information relative to the presence of goats on the Olympic Peninsula prior to the 1925 introduction: Dr. Thomas R. Cox (San Diego State University); Dr. Paul Lawrence Farber (Oregon State University); Dr. Gay Frederick (Royal Provincial Museum, Victoria BC); Dr. Mott T. Greene (University of Puget Sound); Dr. Barbara Lane (Victoria BC, unaffiliated); Dr. R. Lee Lyman (University of Missouri - Columbia); Dr. Brian A. Maurer (Brigham Young University); Dr. Madonna L. Moss (University of Oregon); Dr. H. Duane Smith (Brigham Young University); and Dr. Harold K. Steen (Duke University).

Dr. William Lunch and Dr. Wes Jamison, Department of Political Science at Oregon State University, were consulted concerning ethical considerations relative to the goat management issue.

Dr. Douglas Houston, Research Biologist, National Biological Service, stationed at Olympic National Park, contributed invaluable review and consultation on goat biology and other wildlife issues.

Dr. Edward Schreiner, Research Biologist, National Biological Service, stationed at Olympic National Park, reviewed the drafts and provided inestimable assistance with vegetation issues.

Bruce Moorhead, Olympic National Park Wildlife Biologist, provided valuable information regarding goat biology and management, including contraception and sterilization techniques. Richard Olson, Resource Management Specialist at ONP, assisted with technical aspects of goat management operations, especially the information in appendixes D and E. His assistance is greatly appreciated.

Additionally, the following NPS personnel were consulted during document preparation:

Jacob Hoogland and John Donahue of the NPS Environmental Quality Division in Washington, D.C.

Keith Dunbar, Chief of Planning and Environmental Compliance in the NPS Pacific Northwest Regional Office

Paul Gleeson (Archeologist and Division Chief), Dr. Susan Schultz (Historian), and Jacilee Wray (Anthropologist) of the Olympic National Park Cultural Resources Division

James Harpster and Barb Maynes, Olympic National Park Public Information Officers

The following Olympic National Forest personnel were also consulted during document preparation beginning in 1991:

Colleen Adams, Public Affairs Specialist
Dr. Jan Henderson, Area Ecologist
Benjamin Kizer, Quilcene District Ranger
James Lowrie, Fish and Wildlife Program Manager
James Rodeheaver, Forest Environmental Coordinator
Thomas Sayre, Public Services Officer
Kathleen Snow, Quilcene District Ranger (prior to 9/92)
Joan Ziegltrum, Ecologist

The following Washington Department of Fish and Wildlife personnel also were consulted:

David Brittell, Assistant Director, Wildlife Management Program
Edward Isenson, Information and Education Specialist
Rolf Johnson, Big Game Program Manager
Dr. Thomas Juelson, Manager, Non-game Division
Jack Smith, Region 6 Wildlife Program Manager
George Tsukamota, Manager, Game Division
Doug Zimmer, Information and Education Specialist

John Farrell, Department of the Interior, Office of Environmental Policy and Compliance, was also consulted during preparation of this DEIS.

*List of Agencies, Organizations, and Persons
to Whom Copies of the Statement Will Be Sent*

The initial distribution of this DEIS will include:

Federal Agencies and Congressional Representatives

Animal and Plant Health Inspection Service,
 Animal Damage Control (Department of Agriculture)
Environmental Protection Agency
National Biological Service
Office of Aircraft Services (Department of the Interior)
Representative Norm Dicks
Senator Slade Gorton
Senator Patty Murray
U.S. Fish and Wildlife Service (Department of the Interior)
U.S. Forest Service (Department of Agriculture)

State or Local Agencies and Representatives

Colorado Division of Wildlife
Rep. Jim Buck
Rep. Jim Hargrove
Rep. Lynn Kessler
Washington Department of Ecology
Washington Department of Natural Resources
Washington Department of Fish and Wildlife
Washington State Office of Environmental Education
Clallam County Commissioners
Grays Harbor County Commissioners
Jefferson County Commissioners
Mason County Commissioners
Mason County PUD No. 3
City of Aberdeen
City of Forks
City of Hoquiam
City of Port Angeles
City of Port Townsend

Indian Tribes

Hoh Tribal Business Council
Jamestown S'Klallam Tribe
Lower Elwha S'Klallam Tribe
Makah Indian Tribal Council
Point No Point Treaty Council
Port Gamble S'Klallam Tribe
Quileute Tribal Council
Quinault Indian Nation
Skokomish Tribal Council

Organizations

A.W.A.R.E. (Des Plaines, IL)
Admiralty Audubon Society (Pt. Townsend, WA)
Alliance for the Prevention of Animal Abuses (S. Milwaukee, WI)
Ancient Forest Rescue (Boulder, CO)
Animal Emancipation Inc.
Animal Rights Foundation of Florida
Animal Welfare Institute (Washington, D.C.)
Animal Protection Institute (Sacramento, CA)
Associated Press (Seattle)
Backpacker Magazine
Bellingham Herald
Black Hills Audubon Society (Olympia, WA)
Brigham Young University, Department of Zoology
Cascade Mt. Backpackers (Stevenson, WA)
Clallam County Economic Development Council
CNN (Seattle)
Compassionate People for Animals (Commerce, TX)
Daniel J. Evans and Associates (Seattle)
Daniel J. Evans Library, The Evergreen State College
Deaconess Research Institute
Echo Lake Naturalists Club (Gillette, NJ)
Envirotest, Inc. (Monroe, WA)
Everett Herald
Forest History Society
Friends of the Earth
Fund for Animals
Georgia Earth Alliance
Grays Harbor Economic Development Council
Greater Ecosystem Alliance (Bellingham, WA)
Harvard University, Graduate School of Arts and Sciences
Helicopter Game Management, Inc. (Salt Lake City, UT)
Holland Library, Washington State University
INFOTEC Research, Inc. (Seattle)
International Order of Rocky Mountain Goats
Izaak Walton League of America
John D. Glann Library, Peninsula College

KAPY Radio (Port Angeles)
 KBWK/KAYO Radio (Aberdeen, WA)
 KCMU Radio (Seattle)
 KCTS - 9 (Seattle)
 KGHO (Hoquim, WA)
 KGY Radio (Olympia)
 KING Television/Radio (Seattle)
 KIRO Television/Radio (Seattle)
 KITZ Radio (Silverdale, WA)
 KJR Radio (Seattle)
 KKMO Radio (Tacoma)
 Klahhane Club (Port Angeles, WA)
 KMAS (Shelton, WA)
 KMPS Radio (Seattle)
 KOMO Television/Radio (Seattle)
 KONP Radio (Port Angeles)
 KPLU (Seattle)
 KQEU Radio (Olympia)
 KSTW - Channel 11 (Tacoma)
 KUOW Radio (U. of WA)
 KVAC/KLLM Radio (Forks, WA)
 KVOS TV (Bellingham)
 KXRO/KDUX Radio (Aberdeen, WA)
 Lasher, Holzapfel, Sperry, and Ebberson (Seattle)
 Longview Daily News
 Manitoba Animal Alliance
 Marshfield Medical Research, Inc.
 Marysville High School (Marysville, CA)
 Michigan State University, Department of Park and Recreation Resources
 Morristown-Hamblen Humane Society (Morristown, TN)
 National Geographic Society
 National Public Radio (Washington, D.C.)
 National Audubon Society
 National Parks and Conservation Association
 National Rifle Association
 National Wildlife Federation
 National Park Foundation
 Native Plant Society of Oregon
 New York University, Department of Films and TV
 Newberry Science Academy (Chicago, IL)
 North Cascades Institute
 North Seattle Community College
 Northland Cable News (Port Angeles)
 Northwestern University, Center for Urban Affairs and Policy Research
 Olympic Park Associates
 Olympic Park Institute
 Olympic Peninsula Audubon Society
 Olympic College (Bremerton, WA)
 Olympic Natural Resources Center
 Olympic Outdoor Sportsmen's Association
 Oregon State University, Department of History

Oregon State University, Department of Political Science
Pacific Northwest Magazine
Pacific Northwest Trail Association
Pack and Paddle (Port Orchard, WA)
Peninsula Wilderness Club
Peninsula Daily News (Port Angeles, WA)
Peninsula Herald - Forks Forum
Pinellas County (FL) Animal Protection Association
Port Angeles Library
Port Townsend Public Library
Port Townsend Leader
Predator Project (Bozeman, MT)
Recreational Equipment, Inc.
San Diego State University, Department of History
Seattle Times
Seattle Audubon Society
Seattle Public Library
Seattle Post-Intelligencer
Sequim Gazette
Shelton-Mason County Journal
Sierra Club - Cascade Chapter
Sierra Club Legal Defense Fund
Sierra Club
Society for the Prevention of Cruelty to Animals (Pittsburgh)
Spokane Spokesman Review
Sunset Magazine
Tacoma News Tribune
Tacoma Public Library
Taurus Productions (Colorado Springs, CO)
The Bremerton Sun
The Aberdeen Daily World
The Paideia School (Atlanta, GA)
The Chronicle (Port Angeles, WA)
The Nature Conservancy
The Olympians
The Wilderness Society
The Mazamas
The Ark Trust
The Humane Society of the United States
The Mountaineers
The Animals' Agenda
The Olympian (Olympia)
The University of Puget Sound
TNT (Los Angeles)
United Press International (Seattle)
University of California, College of Natural Resources
University of Denver, Dept. of Biological Sciences
University of Georgia, Department of Large Animal Medicine
University of Georgia, School of Natural Resources
University of Maryland
University Of Missouri, Department of Anthropology

University of Oregon, Department of Anthropology
University of Texas, Philosophy Department
University of Washington, Department of Botany
University of Wisconsin, Department of Wildlife Ecology
University Libraries, University of Washington
USA Today (Seattle)
Utah State University, Ecology Center
Wall Street Journal
Washington Wilderness Coalition
Washington Native Plant Society
Washington Environmental Council
Washington Trails Association
Washington State Bowhunters
Washington Fishing and Hunting (Seattle)
Washington State University, Natural Resource Sciences
Washington State Sportsman's Council
Western Washington University, Huxley College of Environmental Studies
Winley Foundation (Millbrook, NY)

Individuals

The complete list of individuals to which the DEIS will be sent is too large to include here, but is available on request from Olympic National Park.

A copy of the DEIS will also be available for public review at the following locations:

- Olympic National Park Headquarters, Port Angeles, WA
- Olympic National Forest Supervisors Office, Olympia, WA
- National Park Service Pacific Northwest Regional Office, Seattle, WA
- U.S. Forest Service Pacific Northwest Region Office, Portland, OR
- National Park Service Washington, D.C. Office
- Other NPS Offices: Anchorage, AK; Boston, MA; Omaha, NE, Atlanta, GA; San Francisco, CA; Santa Fe, NM; Philadelphia, PA; Denver, CO

Public and Other Agency Comment and Response

This section will be completed in the FEIS based on comments received during the DEIS comment period.

Appendixes



APPENDIXES

- A. Definitions/Glossary
- B. Summary of Research
- C. Previous Management Actions
- D. Explanation of Capture or Management Techniques
- E. Information on Estimated Cost of Alternatives
- F. Excerpts from Exotic/Native Review Materials
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- H. Discussion of Ethical Concerns
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APPENDIX A. DEFINITIONS/GLOSSARY

The following terms are defined as used in this DEIS.

ALPINE: high elevation lands above the upper elevations of tree growth.

AUTHORIZED REPRESENTATIVES: government employees or those acting under the direct supervision of government employees.

BIOBULLET: a remotely deliverable ballistic implant used to deliver immunocontraceptives to animals. "The biobullet is a hollow, 0.25-caliber bullet manufactured from compressed food-grade material...which contains a freeze-dried contraceptive vaccine or steroid hormone... designed to lodge in the muscle.... Once the biobullet is lodged, degradation occurs within 24 hours and the agent, in this case a contraceptive, is released..."(Warren et al. 1992).

BIOCENTRISM: centered on the biotic community.

BIOGEOGRAPHY: study of the geographic distribution of plants and animals (i.e., goats).

BIOMASS: live plant material, both above ground level and below ground (Schreiner personal communication).

CAPTURE MYOPATHY: physiological response of an animal to physical exertion, psychological stress and hyperthermia caused by live-capture. This stress leads to a rapid change in the animal's blood chemistry causing a break down of skeletal and cardiac muscle that often results in death.

CARRYING CAPACITY: the equilibrium reached eventually between goats and their food supply. Represents the maximum sustainable population. At this level goats will not starve, but they WILL impact ecosystem components and processes. Also called ecological carrying capacity. (Houston personal communication).

CATEGORY 1: species for which the U.S. Fish and Wildlife Service has sufficient information to support the biological appropriateness of proposing to list as endangered or threatened. Proposals have not yet been issued because they have been precluded at present by other listing activities; proposals are anticipated. NPS Natural Resources Management Guidelines state that, to the greatest extent possible, these taxa should be managed as if they were already listed. (NPS 1991).

CATEGORY 2: species for which USFWS has information that indicates proposing to list as threatened or endangered is possibly appropriate, but conclusive data on biological vulnerability and threat are not currently available to support proposed rules (NPS-1991).

CENOZOIC: in geologic time, the most recent era. The Cenozoic began approximately 65 million years before present and contains the Tertiary and Quaternary periods.

CONTRACEPTION: reversible inhibition of reproductive success (Warren et al. 1992).

COOPERATING AGENCY: as used in this document, means any federal agency other than a lead agency which has special expertise with respect to any environmental impact involved in a proposal A state agency of similar qualifications may by agreement with the lead agency become a cooperating agency (40 CFR § 1508.5).

ECOSYSTEM: a system of living organisms that interact with the environment and each other (NPS 1991).

ELIMINATE: to remove all goats from a specified area.

ENDEMIC: a species that is naturally confined to a particular region and has a restricted geographic distribution. A narrow endemic is found only in a small geographic area such as the Olympic mountains (Schreiner et al. 1993). Endemics and narrow endemics are not found anywhere else in the world.

EQUILIBRIUM: see definition for "carrying capacity".

EXCLOSURE: a fenced area to exclude grazing.

EXOTIC: a species occurring in a given place as a result of direct or indirect, deliberate, or accidental actions by humans (NPS 1988, 1991).

FORB: any herb that is not a grass, sedge or rush.

GRAMINOID: pertaining to plants in the *Gramineae* family, i.e. the grasses.

GUIDELINES: documents created by the agency to guide the actions of park managers so that management activities planned and initiated at field areas comply with federal law and regulation and Department of the Interior and NPS policy (modified from NPS 1991; see also NPS 1982).

HELI-JUMPING: a helicopter "landing" in which no part of the helicopter is in contact with the ground because the slope is too steep, i.e., the passenger must jump off of the hovering helicopter. (Note: step-off landing is when the helicopter is close to the ground, whereas in heli-jumping the helicopter is higher off the ground.)

HERBIVORY: any interaction between an herbivore and its environment. For mountain goats, herbivory includes wallowing, trailing, trampling, grazing, altering nutrient cycles (through excrement), etc. (Houston, Schreiner personal communication).

HOLOCENE: in geologic time, the most recent epoch of the Quaternary Period of the Cenozoic Era. The Holocene began approximately 10,000 years before present.

IMMUNOCONTRACEPTION: contraception using introduced antigens to trigger the body's own immune system to suppress reproduction (personal communication Moorhead).

LIPOSOMES: fats and other closely related compounds.

MYOPATHY: see definition under "capture myopathy".

MICROTINE: derived from the genus name *Microtus*, although used as a general term to refer to small rodents.

MORPHOLOGY: the study of external form and structure.

NATIVE: a species that occurs and evolves naturally without human intervention or manipulation (NPS 1988, 1991).

NON-LETHAL METHODS: reduction/elimination/limitation methods which are not intended to be lethal for the goat. Although the intent is not to kill the animals, some level of goat mortality (up to approximately 20%) is unavoidable. Non-lethal methods include contraception, sterilization and live capture/translocation.

ONE-SKID LANDINGS: a helicopter "landing" in which only one skid is in contact with the ground because the slope is too steep for a normal landing.

PLEISTOCENE: in geologic time, the first epoch of the Quaternary Period of the Cenozoic Era. The Pleistocene began approximately 2-3 million years before present.

POPULATION: *Vegetation* - a group of individuals of a species that are geographically close enough together to share a common gene pool, i.e., that can and do interbreed (NPS 1991).

Animals - a group of individuals of one species that are found in a distinct portion of the species' range and that interbreed and have a common set of genetic characteristics (NPS 1991).

POPULATION PARAMETERS: a known characteristic of a population. Examples of parameters are density, number of individuals, sex ratios, etc.

PREFERENCE AUTONOMY: the ability of an individual to self-govern based on the individual's own desires.

QUATERNARY: in geologic time, the most recent period of the Cenozoic Era. The Quaternary began approximately 3 million years before present and includes the Pleistocene and Holocene Epochs.

RARE SPECIES: any species which is considered restricted and limited throughout all or a significant portion of its range (NPS 1991).

REDUCE AND LIMIT: reduction of goat densities to a specified level below that which would occur without human intervention; to maintain the specified lower density. Elsewhere often called "population control."

RUDERAL: disturbance-oriented, or disturbance-"liking", plant (Grime 1979).

SCOPING: an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR § 1501.7). The process includes public involvement in identifying issues.

SHEETWASH EROSION: when precipitation exceeds the water-holding capacity of the soil, water flows in an irregular sheet across the ground and carries soil particles downslope.

SHOOTING BY AUTHORIZED REPRESENTATIVES: shooting conducted by government employees or under the direct supervision of government employees. This does not include recreational hunting.

SPECIES: groups of interbreeding natural populations that are reproductively isolated from other such groups (Houston et al. 1994b).

STANDING CROP: only that live plant material that is above ground (Schreiner personal communication).

STEP-OFF LANDING: a helicopter "landing" in which no part of the helicopter is in contact with the ground because the slope is too steep, i.e., the passenger must "step off" of the helicopter which is hovering close to the ground. (Note: step-off landing is when the helicopter is close to the ground, whereas in heli-jumping the helicopter is higher off the ground.)

STERILIZATION: permanent inhibition of reproductive success (Warren et al. 1992).

SUBALPINE: the area near and above the upper limit of contiguous closed forest and below the upper limit of tree growth; typically a mosaic of tree patches and meadow communities.

SUBPOPULATION: *Goats* - those animals associated with a particular large landform (e.g., a mountain massif such as Mt. Olympus) where goat movement within the landform is frequent compared to movements (dispersals) to adjacent areas (Houston personal communication).

Plants - discreet groups of individuals that are geographically isolated from each other (Schreiner personal communication).

TAXA: plural of taxon. Taxon refers to an individual organism's taxonomic designation. This is a general term which could mean species, subspecies, and/or variety level designation. A helpful illustration might be the term "publications" which can mean books, magazines, etc., just as "taxa" can mean species, subspecies, etc.

THERMOREGULATION: control of body temperature.

THREAT: a potential for adverse impact.

TIERING: refers to the coverage of general matters in broader environmental impact statements with subsequent narrower statements of environmental analyses incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared (40 CFR § 1508.28).

TOE-IN LANDING: a helicopter "landing" in which only the front part of the skids is in contact with the ground because the slope is too steep to land normally.

UNGULATE: refers to a group of hoofed, herbivorous mammals that are specialized for cursorial (i.e., running) locomotion. Includes members of the taxonomic orders Perissodactyla (horses and rhinos) and Artiodactyla (pigs, camels, deer, antelopes, mountain goats).

UTILITARIANISM: the doctrine that the worth of something is determined by its utility and that the purpose of any action should be to bring about the greatest good for the greatest number of individuals.

VASCULAR PLANT: plants containing conducting tissue, i.e. xylem and phloem, for the movement of sap.

VIALE POPULATION: a population with adequate numbers and dispersion of reproductive individuals to ensure its continued existence over time.

WALLOW: *noun* - an area which goats have pawed the soil and thrown the soil on themselves, i.e., taken a "dust bath."

verb - to take a "dust bath."

APPENDIX B. PAST RESEARCH AND PUBLICATIONS

This section provides a brief summary of past research and publications relating to goats on the Olympic Peninsula. These findings provided the basis for the information described in the "Environmental Consequences" section of this DEIS.

Each project is described chronologically by date of publication within each agency section. Descriptions are brief because of the voluminous material. Full citations for references are found in the "References" section. For any unpublished research summarized here, copies of the complete reports are available from Olympic National Park.

An index of references included in this section is provided here to assist the reader in finding a specific research summary.

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National Park Service

DATE: 1960

PRIMARY INVESTIGATOR(S): B. James Jokerst

TOPICS: population parameters and distribution

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Censusing was conducted by foot throughout known or suspected goat habitat within the park. Information was also gathered by interviewing other people concerning goat observations. A dead goat was autopsied, but cause of death could not be determined.

RESULTS: The main areas of goat distribution in the park were Baldy Ridge (and the head of Hughes and Barnes Creeks), Klahhane Ridge/Heather Park, Lake Constance/Constance Pass, and Mt. Lincoln/Flapjack Lakes. Subpopulations were estimated at 30-35 goats in the Baldy Ridge area, 25-30 goats on Klahhane Ridge, and 10-15 goats at Lake Constance.

REFERENCES: Jokerst 1961

DATE: 1962 -1964

PRIMARY INVESTIGATOR(S): Larry C. Lack and Ted Kerstetter

TOPICS: population parameters, goat behavior

GEOGRAPHIC LOCATION: Klahhane Ridge, Baldy Ridge, SE portions of ONP

DESCRIPTION: Visual observations of goats and vegetation used by goats throughout ONP were described. Vegetation transects were established on Klahhane Ridge. Salting stations were placed on Klahhane Ridge and Baldy Ridge to determine if goats have a preference for plain, iodized, or mineralized salt. An aerial survey of Klahhane Ridge and Baldy Ridge was made in 1964.

RESULTS: In July, 1963, 35 goats were observed on Klahhane Ridge and Lack estimated the population at 35-45 goats. In February 1963, 29 goats were observed on Baldy Ridge and the "herd is estimated to be between 30 and 40 animals." Twins were observed on Klahhane both years, while no twins were seen on Baldy Ridge.

On the 1964 aerial survey, 36 goats were counted on Klahhane Ridge and four on Baldy Ridge.

No results from the vegetation transects or salting station were included in the reports, although Lack did note that Klahhane Ridge showed very heavy goat use.

REFERENCES: Lack 1962-1964

NOTE: The IGMT sent a letter to Larry Lack in late summer, 1992, requesting any additional documentation from his work on mountain goats in the Olympic Mountains. No response was received.

DATE: 1969

PRIMARY INVESTIGATOR(S): Bruce Moorhead

TOPICS: population dynamics and dispersal

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: This project consisted primarily of literature review and extensive foot surveys throughout the park.

RESULTS: "The present distribution is characterized by at least four population centers...outlier bands from these population centers occur in three locales just outside the eastern boundary of the park...each of the nuclei groups in the park has approximately 25 to 50 individuals. The largest group observed (53) was on Mount Angeles.... The total population is estimated at 250 to 300 and increasing slowly." Goats were sighted in the remote interior of the park. "This suggests that most subalpine and alpine sites have either been visited by transient goats or are being colonized and used in some regular manner." Concern over the possible impacts of goats on native plant communities and endemic species/varieties was raised.

REFERENCES: Moorhead 1969

DATE: 1970-1976

PRIMARY INVESTIGATOR(S): Bruce Moorhead

TOPICS: population parameters, vegetation, goat removal

GEOGRAPHIC LOCATION: park-wide, Mt. Angeles

DESCRIPTION: These early studies included censuses to determine population numbers and distribution within the park, as well as studies to identify habitats used by goats and determine impacts of goats on vegetation.

RESULTS: Goat habitat throughout the park was mapped. 400,000 acres (1,619 km²) in the park were occupied by goats at that time. Dispersal in easterly and southerly directions from the point of introduction was documented. Primary population centers were identified on Mt. Angeles and Mt. Constance, with five lesser activity centers throughout the park and south of the park identified.

In 1971, the total park population was estimated at 300-400 goats. By 1974, the park-wide estimate was 500+ animals. Overall population on the peninsula was estimated at approximately 1,000 animals in 1977, indicating an average density of 1.4 goats per square mile (.5 goat/km²). Estimates of 180 goats on Mt. Angeles were calculated. A population of 79 goats on Klahhane Ridge was estimated. A

density of 53 animals per square mile (20 goats/km²) on the goat summer range was documented. The ratio of 80 kids:100 adult females indicated a high reproductive rate. Population estimates signify a net annual increase of 20 animals per year (2%) since introduction.

In cooperation with Washington Department of Game, a total of 27 goats were relocated from Klahhane to other areas of the state and 34 goats were tagged.

Damage due to goats was documented on Mt. Angeles. Fifty-plus goat trail nets per acre were recorded. Large (30 ft or 9 m dia./12 in or 30 cm deep) trampled/pawed areas in campsites and at salt sites were documented. Impacts from heavy grazing on endemic *Senecio websteri* and from goat trampling on endemic *Viola flettii* and *Campanula piperi* were discovered.

REFERENCES: Moorhead 1973, 1976 and 1977

DATE: 1976-1977

PRIMARY INVESTIGATOR(S): Ingrid C. Olmsted

TOPICS: vegetation, soil

GEOGRAPHIC LOCATION: Klahhane Ridge

DESCRIPTION: Olmsted looked at impacts to plant cover, species composition, and soils from goats.

Eight large exclosures and 13 small exclosures were established in 1977. Percent cover by species was documented in the exclosures and compared with areas outside the exclosures.

Wallows were measured.

Fecal material and one rumen sample were collected.

RESULTS: Vegetative cover in areas least used by goats was consistently higher than in heavily used areas. As an example, dry grass/forb communities in south-facing meadows exhibited 66% cover in least used areas versus 10-35% cover in areas heavily used by goats.

Changes in species composition and reduction of plant flowering in goat use areas was documented.

Documented goat impacts to soils included actual removal of soil and loss of soil structure. Soil bulk densities (grams of soil per cubic centimeter) increased in areas disturbed by goats.

REFERENCES: Driver et al. 1977; Olmsted 1979

DATE: 1977-1979

PRIMARY INVESTIGATOR(S): Victoria Stevens

TOPICS: goat behavior, habitat, density

GEOGRAPHIC LOCATION: eastern Olympic Peninsula, ONP and ONF: Klahhane Ridge, Grand Valley, Grey Wolf Ridge, Mt. Constance/Mt. Mystery, LaCrosse Pass/Marmot Lake, and Sawtooth Ridge.

DESCRIPTION: Marked goats of known age/sex were observed to document habitat utilization on Klahhane Ridge. Extensive ground surveys were conducted of all six subpopulations. Habitat utilization information from Klahhane was used to define good goat habitat, then satellite photos were analyzed to classify potentially good goat habitat in the other five areas.

RESULTS:

Habitat utilization:

Eighty-two percent of all observations were of only two activities, feeding and bedding. Peaks of feeding occurred in the early morning and in the evening, while peaks of bedding occurred at night and mid-day. All other activities (wallowing, licking minerals, traveling, etc.) generally followed the daily activity hours of feeding.

Open meadows, slide rock and open scree areas are the most important for feeding. Rocky bluffs are important for escape. Snow, bare ground, and coniferous areas are used primarily for thermoregulation, although ground cover under conifers is an important food source during the hot, dry portion of summer.

Habitat utilization was also evaluated with regard to slope, aspect, elevation, cohort use, and climatic factors.

One of the subpopulations studied is located primarily outside the park during the entire year. Two other subpopulations with summer ranges within the park, spend much of the winter outside the park.

Goat density:

Relative density of goats was calculated for each of the six areas. Goat density was highest on Klahhane Ridge and lowest on Grey Wolf Ridge. Mt. Constance and Sawtooth Ridge were relatively dense.

During the five-year study, subpopulations on Klahhane Ridge and the northeast portions of the peninsula have remained stable in population size. In contrast, subpopulations on the interior and southeast portions of the peninsula have grown significantly larger.

Goat density did not appear to be linked to distance from point of introduction. This suggests that habitat quality is the most important factor determining density of subpopulations.

Potential goat habitat:

Satellite imagery had limited application for habitat classification in the Olympics, given the level of technology available at the time of this study. However, some conclusions on a coarse scale could be made based on this analysis. It did not appear that any other area of Olympic National Park has habitat likely to support the high density of goats found on Klahhane Ridge.

REFERENCES: Stevens: 1977, June/July 1978, July-September 1978, June/July 1979, July-September 1979; Stevens 1979; Stevens and Taber 1980, 1981

DATE: 1978

PRIMARY INVESTIGATOR(S): John A. Dragavon and A.R. Weisbrod

TOPICS: goat impacts on small mammals

GEOGRAPHIC LOCATION: Klahhane Ridge

DESCRIPTION: This was a short pilot study in which small mammals were trapped (along grids) within two plant communities: the *Festuca-Phlox*-scree slope community which received extensive use by goats and the *Artemesia-Festuca-Elymus* community which received much less goat use. Data on plant communities at the grid sites was also collected.

RESULTS: Although the study was very limited in scope, some preliminary conclusions were drawn. In the Fescue-Phlox community, "mammal distributions were skewed away from the heavier goat use areas and that small mammal richness was possibly quite low." In the *Artemesia-Festuca-Elymus* community, vegetation was taller, more lush, and more dense. More types of small mammals were found in this community. It was suggested that the effects of goats on plant species diversity and cover, as well as on physical characteristics such as vegetation layers may affect small mammal presence and distribution.

REFERENCES: Dragavon and Weisbrod 1978

DATE: Data from 1925-1975

PRIMARY INVESTIGATOR(S): Bruce B. Moorhead and Victoria Stevens

TOPICS: history of introduction/dispersal

GEOGRAPHIC LOCATION: Olympic Mountains - ONP/ONF

DESCRIPTION: Historical data about goat releases were compiled using ONP files, ONF files, local newspaper reports, and communication with long-time residents and mountaineers, park rangers, state wildlife agents, ONF personnel, and visitors. Some recent (1970s) census information is used, but the primary emphasis is on historical documentation.

RESULTS: No data were found documenting occurrence of goats on the Olympic Peninsula prior to introduction in the 1920s.

Information concerning the introductions and subsequent dispersal is discussed.

The report concludes, "Introduction of mountain goats by man in this century has successfully established a population on the Olympic Peninsula. Their dispersal had coincided with rock outcrops of the Crescent Formation, which surrounds the inner Olympic Mountains on three sides and, in

general, has less snow than the interior mountains. Goats are now found in over 700 square miles (1,813 km²)."

REFERENCES: Moorhead and Stevens 1979

DATE: 1977-1981

PRIMARY INVESTIGATOR(S): Victoria Stevens

TOPICS: population parameters/dispersal

GEOGRAPHIC LOCATION: nine subpopulations in ONP and ONF: Klahhane Ridge, Royal Basin, Lake Constance, Anderson Pass, Sawtooth Ridge, Mt. Elinor, Appleton Pass, Glacier Meadows, and the Bailey Range

DESCRIPTION: Over a five-year period, 237 individual goats were marked, measured and monitored. "Observations of the reproductive success of individuals as well as overall population processes of each sub-population were made to illuminate the process of dispersal and its relationship to demographic vigor and population dynamics," (Stevens 1983).

RESULTS:

Demographic vigor:

Decline of demographic vigor of the subpopulation on Klahhane Ridge during the study period was documented. Decreased horn growth during the first 1.5 years of life, increased winter mortality of adults, and a decrease in summer levels of fecal nitrogen all indicated steadily decreasing amounts of available nutrients per individual. This declining vigor was probably caused by a combination of climatic factors and high goat density.

"The comparison between Klahhane Ridge and the rest of the observed sub-populations shows, in almost every measure, that the average condition of individuals off-Klahhane is better than those on-Klahhane. The most striking difference is in reproduction. Overall reproduction is higher off-Klahhane Ridge because of a higher rate of individual fecundity, lower age of sexual maturity, and higher twinning rate. The trend in size measurements was toward a larger size off-Klahhane including skeletal length, weight of females, and weight of kids. And finally, fecal nitrogen values when available, were consistently higher off-Klahhane."

Dispersal:

The rate of dispersal was over 10% for the Klahhane Ridge sub-population, as compared with 1% for the other subpopulations combined. Dispersal occurred at all population densities, but increased when competition for nutrients became more intense. Increased competition can occur when population density increases or when environmental factors, such as climate, lead to decreased availability of nutrients.

"A larger percentage of males disperse than females (19.6% vs. 5.5%), and a larger percentage of juveniles disperse than mature individuals (17.6% vs. 4.6%)," (Stevens 1983). Topography and resource limitation appear to determine direction of dispersal. Dispersal distances were recorded from 10-34 mi (16-54 km) straight line distance. Dispersing females were found to be below average in physiological

condition, but improved in a new range. However in younger cohorts, dispersers were in better condition than non-dispersers.

REFERENCES: Stevens and Taber 1980, 1981; Stevens 1983

DATE: 1978-1982

PRIMARY INVESTIGATOR(S): W.A. Pfitsch, R.S. Reid, J. Harter, D.K. Pike, and L.C. Bliss

TOPICS: vegetation, soils

GEOGRAPHIC LOCATION: Klahhane Ridge, Tyler Peak, Hurricane Hill

DESCRIPTION: These studies investigated "the impact of mountain goats upon soils and soil stability, upon plant communities and their net annual production, upon three species known to be selected in grazing, and upon the establishment and maintenance of plant species relative to dusting sites," (Pfitsch et al. 1983). Exclosures were used as part of the vegetation studies.

RESULTS:

Meadow disturbance: In comparing Klahhane Ridge (high goat use) with Tyler Peak (low goat use), "The Klahhane meadow has a greater proportion of disturbed surfaces of all particle sizes than the meadow of low goat use at Tyler Peak. About 34% of the Klahhane meadow is bare and most of this is obviously derived from intensive utilization by mountain goats. In contrast, only about 9% of the Tyler meadow is bare with obvious disturbance accounting for <3%.... Disturbance on Klahhane has resulted in a decrease in plant cover exposing a greater proportion of fine soil and fine scree. In contrast, the dominant bare surface material at Tyler is undisturbed organic matter...mosses and lichens occurred in 86% of the Tyler plots for >11% cover, but only in 33% of the Klahhane plots for <1% cover," (Pfitsch et al. 1983).

Soil Descriptions: "Goat activities remove plant cover which enhances soil erosion, causing the loss of the organic topsoil. The resulting soil has better drainage and aeration but is less able to hold nutrients and to stabilize the ground surface. The soil also provides less stability and nutrients needed for plant regeneration," (Pfitsch et al. 1983).

Wallow dynamics: Over 70 wallows greater than one square meter were documented in the Phlox-fescue meadow on Klahhane. Wallow complexes up to 2,575 ft² (230 m²) were measured. Soil displacement up to 59 ft (18 m) down slope from wallows was documented (Pfitsch et al. 1983).

"Current conditions on Klahhane Ridge indicate a trend towards increasing soil erosion and habitat destruction and provide a model of future conditions for other areas of the park subject to increasing concentrations of goats," (Pfitsch et al. 1983).

Meadow Sheetwash Erosion: Evidence was found to hypothesize that the Klahhane Ridge meadow is most susceptible to erosion in early and late summer, which coincides with the period of most intensive use by goats (Pfitsch et al. 1983).

Soil Moisture: "Disturbance by mountain goats in the meadow did not appreciably change the moisture regime or water holding capabilities of the soil although trends are indicated. The primary effect of goat-induced disturbance is a loss of topsoil...."

Grazing Utilization: Goats utilized all nine subalpine and alpine plant communities in one study area. Generally, meadows on the north side of the ridge all had high grazing frequency and intensity. In a large south-facing meadow near the top of Klahhane Ridge, evidence of grazing was recorded on most species, with more than 25% of the individuals in six species grazed (Pfitsch 1981). Unstable herb meadows on the south side also had high frequency and intensity values. Heavy grazing on two preferred species, *Carex spectabilis* and *Festuca idahoensis*, was documented. No correlation between net primary production and grazing use was found (Pfitsch et al. 1983). Concentrated goat grazing and trampling caused reduced species density in Phlox-fescue meadows on Klahhane. Total plant cover was also lower on Klahhane Ridge than on low goat use areas. The most limiting factor for goats during the snow-free season is availability of forage on the north slopes in midsummer. Exclosure studies demonstrated that plant recovery occurred following exclusion of goats.

Effects on three unique plant species: Two endemic species, Piper's bellflower (*Campanula piperi*) and Webster's senecio (*Senecio neowebsteri*), and an Olympic Peninsula/Vancouver Island endemic, Olympic aster (*Aster paucicapitatus*), had significantly reduced leaf length, flower production, and growth (cover and biomass) when grazed by goats. Grazing removed 65% of aboveground net production of Webster's senecio plants.

Patterns of juvenile mortality: Goat activities caused substantial mortality in seedlings growing in bare soil. The mortality was primarily caused indirectly by changes in the microenvironment and shifts in distribution of microsites available for seedling establishment. In areas where seedlings grew under *Phlox diffusa*, there was no discernible goat impact on juvenile mortality.

Plant life histories: For colonizing species, such as *Phacelia*, *Erysimum*, and *Achillea*, goat disturbance increases the number of bare ground sites available for colonization. Non-colonizing species, such as *Festuca idahoensis*, decrease in density with increasing goat use because of their inability to establish on bare sites. Goat impacts can be expected to alter species composition over the long-term. "Overall, species density should decrease because there are fewer species able to colonize goat disturbed areas than there are species able to exist in closed vegetation," (Pfitsch et al. 1983).

REFERENCES: Pike 1981; Pfitsch 1981; Pfitsch et al. 1983; Reid 1983; Pfitsch and Bliss 1985

DATE: 1981

PRIMARY INVESTIGATOR(S): Bruce Moorhead, Thomas E. Besser, DVM and William G. McGaffey

TOPICS: control techniques

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Discussion of an experimental surgery to attempt tubal ligation in the field at Olympic National Park. The surgery was conducted on September 15, 1981, and was unsuccessful for reasons which are explained below. The goat was euthanized.

Other possible sterilization methods are also discussed and evaluated as they apply to goat management in the Olympics.

RESULTS: Several non-surgical and surgical techniques were evaluated.

-Non-surgical chemical sterilization by oral administration, injection, and intravaginal implant were evaluated. None of the methods were judged feasible for wild goat populations.

-Non-surgical cervical closure was eliminated because of uncertainty concerning placement and retention of the device and the probability of uterine infection.

-Non-surgical use of an intrauterine device (IUD) was evaluated, but eliminated for use on mountain goats due to the small anatomy and anestrus condition of goats at season of live capture.

-Caslick's operation, "the apposition and suturing of the vulvar mucosal edges" (Besser and McGaffey 1981), was considered inappropriate for use in wild goat populations due to the likelihood of tearing of the sutures and subsequent infection.

-Tubal ligation was attempted unsuccessfully in the field. Due to mountain goat anatomy, the oviducts were not accessible for clipping without using numerous incisions in different locations on the abdomen. Limitations of field surgery on wild goats preclude more than one incision.

- Ovariectomy or "spaying" was hypothesized to be a possible procedure for use on goats. This procedure would, however, alter hormonal influences on goat social behavior.

-A combination of ovariectomy of one ovary and tubal ligation of the other might be possible given the information on goat anatomy gained during the attempted tubal ligation.

-Surgical steroid implants were discussed. Costs, staffing requirements, and short-term effectiveness seemed to make this procedure unpractical for wild goat populations, but further testing was recommended. NOTE: further testing of surgical steroid implants was conducted by Hoffman and Wright (See Hoffman and Wright 1987 on page 172; Aho et al. 1982, 1983; Houston et al. 1984).

REFERENCES: Besser and McGaffey 1981; Moorhead 1981

DATE: 1981-1984

PRIMARY INVESTIGATOR(S): D. Houston, B. Moorhead, E. Schreiner, R. Starr, R. Olson, and J. Aho

TOPICS: population parameters, vegetation, capture/removal

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: The four-year experimental management program included goat population studies, vegetation studies, and management projects related to goat management. Management projects included live-capture/relocation and research on sterilization.

Four age determination techniques were tested: cementum rings, horn rings, incisor replacement, and premolar/molar eruption.

Four indicators each of growth and condition were studied: body length, weight, horn length, and length of metatarsal bone for growth; depth of subcutaneous fat, kidney fat index, percentage of femur marrow fat, and adrenal gland weight for physiological condition.

RESULTS: Results were reported on an annual basis. These studies provided a great deal of basic information on the goat populations, much of which was also included in published reports listed in this section.

1981:

Population studies: Total pre-removal goat population on Klahhane Ridge was estimated, by aerial and ground census, at 244 animals. Fifty-two goats were removed from this area in 1981. The post-removal population estimate, again from censusing, was 186 animals. In October, the ratio of adult males to adult females was 0.63; the ratio of kids to adult females was 0.27. Six adult females were collected to determine pregnancy rate and physical condition. Only 17% were pregnant. Age determination using cementum rings was tested and found to accurately indicate age.

Vegetation studies: Cover, biomass, and species composition data were collected within four exclosures and paired unexclosed areas on Klahhane Ridge. Thirty historical photograph camera sites were relocated and approximately half of the comparative photos were taken. Data on wallows and soil erosion were collected.

Fifty-three vegetation plots and 20 soil pits were sampled in Royal Basin.

It was not possible to draw conclusions from only one year of data. Analysis of trends was postponed until subsequent years of data could be included.

Goat management: Fifty-two goats were captured on Klahhane Ridge and transported to other ranges in Washington, Nevada, and Utah. All the goats were captured using a dropnet with salt bait. Total cost of the operation was \$21,130 or \$406 per goat.

Field chemical immobilization was attempted on 16 adult female goats. Thirteen of the attempts were successful. One animal was immobilized successfully, but later euthanized because of surgical complications during an attempted tubal ligation. "About 87% of 15 immobilizations (omitting the euthanized animal) were carried out satisfactorily. Given the precipitous terrain favored by goats and a drug induction time of around eight minutes, we anticipate 10-15% of all attempted immobilizations of adult goats will fail," (Aho et al. 1982).

The attempted tubal ligation is described and evaluated elsewhere in this section (see page 162).

1982:

Population studies: The 1982 total pre-removal population on Klahhane Ridge was estimated to be 176 goats, while the post-removal estimate was 126 animals.

Results of winter ground counts of the Baldy Ridge subpopulation from 1955-1983 were compared. The number of goats counted in this subpopulation decreased during this time period. It was suggested that ecological carrying capacity (the maximum sustainable population) for goats declined as forest cover increased after several fires in the area.

Sixty-three goats were live-captured from the Klahhane, Royal Basin, and Mt. Anderson subpopulations. Information on weight, body length, girth, and first horn ring was collected.

Vegetation studies: Although conclusions regarding overall effects of goats on plant communities could not be drawn on only two years of data, some conclusions on specific species could be reached. Idaho fescue (*Festuca idahoensis*) increased significantly in cover within the exclosures in all three areas where it was a major species and showed no change outside the exclosures. This may indicate recovery from goat impacts. Yarrow (*Achillea millefolium*) is a disturbance oriented species. "The general trend seems to be that this species is increasing outside the exclosures while remaining unchanged or decreasing inside.... These results are consistent with the hypothesis that mountain goats have significantly disturbed the vegetation of the Klahhane Ridge area," (Aho et al. 1983). The pattern of cover and biomass within and outside the exclosures indicate that woolly sunflower (*Eriophyllum lanatum*) "has been adversely affected by mountain goats, and is recovering since their exclusion. The nature of goat impact on this species is unknown; since it has not been indicated as preferred forage, it may be that it is highly sensitive to trampling," (Aho et al. 1983).

Data on wallows and soil erosion were collected, however another year of data was needed before results could be presented.

Goat management: Fifty-one goats were live-captured and relocated from Klahhane Ridge in 1982. Dropnets were used to capture 47 of these, while four were chemically immobilized. Drug capture was estimated to be impractical and unsafe on slopes steeper than 30°. Peak salt attraction was found to coincide with the most rapid subalpine plant growth (late June/early July).

Three female goats were implanted with silastic skin implants of megestrol acetate (MGA) in 1982. The goats were from Hurricane Hill and Anderson Pass. Goats were captured using a foot snare with human urine for bait.

1983:

Population studies: Total population of goats was estimated at $1,175 \pm 171$ (SE) goats (see page 1). On Klahhane Ridge, total pre-removal population was estimated at 147 animals, while post-removal was estimated at 85. The response of the Klahhane subpopulation to controlled removals was used to test several theories of harvest management. Harvestable surplus models are clearly not appropriate for this subpopulation, however the appropriate model could not be determined.

Growth and condition data were collected on 60 goats from the Klahhane, Mt. Appleton, Blue Mt., and Mt. Dana subpopulations.

Seasonal food habits of goats on Klahhane were examined using pellet samples. "Grasses and grasslike plants comprise nearly 75% of June-November diets; shrubs and conifers predominate during winter. Idaho fescue and sedge dominate summer-autumn diets. Phlox, western yew, Oregon grape, and various mosses appear to be important components of winter diet," (Houston et al. 1984).

"These preliminary results indicate that the endemic plants, individually and as a group, are only incidentally important in the diet of mountain goats. Other plant species, in the aggregate, determine goat densities. Studies of other ungulates have shown that this is precisely the quantitative relationship required for herbivores to have a substantial influence on the distribution and abundance of relatively uncommon, but palatable, plant species," (Houston et al. 1984).

Vegetation studies: In Phlox-Fescue and unstable herb meadow communities, trends in grazing levels were negatively correlated with trends in cover of Idaho fescue. As grazing decreased, cover of Idaho fescue increased and vice versa.

In general, data suggested "that plant growth is related more to summer precipitation and length of the snow free season than goat densities," (Houston et al. 1984).

Exclosure data were difficult to interpret because of decreasing goat densities on Klahhane Ridge (outside the exclosures) and potential microclimatic alterations related to the fences. However, responses of *Achillea millefolium* and *Erysimum arenicola* were most likely caused by elimination of grazing. Both species, colonizers of disturbed areas, increased where goats were present and decreased where goats were absent. *Orthocarpus imbricatus* and *Eriophyllum lanatum* increased both outside the exclosures and, to a lesser extent, inside. Both climate and decreasing goat disturbance are probably related to the response of these two species.

Results of soil erosion studies were reported in Pfitsch et al. (1983), also summarized in this section.

Four photographic comparisons were presented. Increases in bare soil and some species composition changes are evident from the photos. Some of the changes can be attributed to goats, however human trampling and climatic factors may contribute to some of the changes.

Goat management: Fifty-two goats were captured and relocated from Klahhane Ridge in 1983.

An additional eight goats were captured on Mt. Dana, Mt. Appleton, and Blue Mt. to evaluate feasibility and effectiveness of five live-capture techniques for use on more "wild" goats in the interior of the park. An experiment simulating aerial shooting was also conducted. Results from this portion of the study are summarized under Olson (1983) in this section.

Silastic implants were placed in eight female goats to field test the technique. Tubal ligations using laparoscopy were performed on two adult females. The report summarized "After two years of attempts to experimentally sterilize goats, certain conclusions are evident. Any technique of fertility control, no matter how medically sophisticated, is primarily dependent on the likelihood and efficiency with which goats can be obtained. It is not clear that enough females could be captured in a small population, much less a large one, to effect a decline or control on numbers," (Houston et al. 1984).

1984:

Population studies: "Essentially, all of the park's alpine and subalpine areas are occupied during the summer by goats. Goats occupy between 30% and 40% of the park...as year-round range.... There are few indications...of significant declines in unmanipulated populations. Most subpopulations appear to be stable in number while others appear to be increasing. Overall, goats occurring within the park are in 'good health'. Predators do not appear to be a major cause of mortality," (ONP 1985).

On Klahhane Ridge, "The late summer population of 1984 was 50-60 goats. Preliminary analysis suggests that growth rates of kids, yearlings, and two-year olds increased substantially as the population was reduced. Survival of yearlings and the production of twin births have increased somewhat, but, overall, the population has shown very little response to harvest (i.e., overall birth rates have not increased dramatically)," (ONP 1985).

Vegetation studies: "Measurements have shown that as the goat population was reduced (from 230 in 1981 to 50-60 in late 1984) the variety, abundance and production of key plant species were substantially altered. Comparing 1979 with 1984, total plant cover increased by 95%. Idaho fescue (*Festuca idahoensis*), a species favored by goats, increased its abundance by 104%. Bare soil decreased by 63%. Most of these changes occurred during the latter stages of the goat removal project. Between 1983 and late 1984, plant cover increased 50%; Idaho fescue increased 221%, and bare soil decreased 43%" (ONP 1985).

One enclosure was removed in 1983 and the site was re-examined one year later. "Total plant cover experienced a 40% decrease, Idaho fescue diminished 78% and bare soil exhibited an increase of 40%. Wallflower (*Erysimum arenicola*), a species which typically occupies disturbed sites, showed a 50% increase in abundance," (ONP 1985).

"Almost all of these changes in the plant community are directly attributable to goats," (ONP 1985).

"Two endemic species, Piper's bellflower (*Campanula piperi*) and Webster's senecio (*Senecio neowebsteri*), and one near endemic, Olympic Mountain aster (*Aster paucicapitatus*), were studied for their response to grazing by goats. Production of foliage was reduced between 20% and 60% depending on site characteristics as well as grazing intensity. Flower production for all three species was drastically reduced by grazing" (ONP 1985).

Impacts to soil and vegetation from trampling and wallows were evaluated. Displacement of 45 tons (41 megagrams) of soil from one large wallow was documented. The average soil loss from seven other wallows was 1.3 tons (1.2 megagrams). "More than 70 wallows were found in one 10-acre [4.05 ha] area on Klahhane Ridge. Wallows are common features in goat habitat throughout the park," (Olympic National Park 1985). Trampling or impacts from goat activity at human urination sites (because of the animals' salt cravings) were more widespread. "In some sample plots on Klahhane Ridge, more than 50% of the plants have been eliminated and trampling-resistant or disturbance-oriented species have become dominant" (ONP 1985).

Goat management:

Three methods of sterilization were field tested. Silastic implants of MGA, tubal ligation, and vasectomy were tested. "None of the methods have been found to be effective as a principal means of population control. While silastic implant surgery can be performed under backcountry conditions, the difficulties of capturing and treating enough animals of the right sex and age within a relatively short period of time cannot be overcome. Ligation and vasectomy are not feasible since both require trained veterinary personnel and operating room conditions..." (ONP 1985).

Goat removal techniques tested were foot snare and drop net at baited site, drive net, net gun, chemical immobilization, and shooting. "While all live removal methods worked to some degree, none singly or in combination proved to have the potential to substantially affect the park's goat problem. Success with each technique depended on a very narrow range of conditions. All were severely restricted by terrain and weather. Shooting was tested on a very limited scale since its effectiveness is well documented by a variety of wildlife control programs worldwide" (ONP 1985).

REFERENCES: Aho et al. 1982, 1983; Houston et al. 1984; Olympic National Park 1985; Moorhead 1983

DATE: 1983

PRIMARY INVESTIGATOR(S): D.B. Houston, B.B. Moorhead, R.W. Olson

TOPICS: population parameters

GEOGRAPHIC LOCATION: range-wide: all goat summer habitat in Olympic mountains - ONP and ONF

DESCRIPTION: This was the first extensive aerial census of goats in the Olympic mountains. In 1981, 1982, and 1983, aerial censuses were conducted on Klahhane Ridge before and after a known number of goats were removed. This enabled evaluation of census efficiency.

RESULTS: The total goat population was estimated at 1175 ± 171 (SE). Census efficiency was calculated at 66% for Klahhane Ridge.

REFERENCES: Houston et al. 1983, 1986a

DATE: 1979-1983

PRIMARY INVESTIGATOR(S): James W. Foster, Bruce B. Moorhead, and Timothy A. Reichard

TOPICS: control techniques

GEOGRAPHIC LOCATION: not applicable

DESCRIPTION: Live-capture and translocation of 169 goats were examined and medical considerations/protocol were discussed.

RESULTS: Five juvenile goats were captured and transported to Woodland Park Zoo in 1979. Of these, two goats died of capture myopathy.

Nine goats were captured and transported to Woodland Park Zoo in 1980. Three of these animals also died of capture myopathy.

A medical protocol was developed based on information gained in the 1979 and 1980 capture programs. Medical considerations included capture myopathy, parasitism, and bacterial infections. Using these protocol, 155 goats were captured and translocated to the wild in Washington, Nevada, Utah and Idaho. One mortality occurred during capture and no additional deaths were reported after translocation.

REFERENCES: Foster et al. 1983

DATE: 1983

PRIMARY INVESTIGATOR(S): Richard W. Olson, Jr.

TOPICS: control/removal methods

GEOGRAPHIC LOCATION: Mt. Dana, Mt. Appleton, Blue Mt.

DESCRIPTION: "The purpose of the experimental project was to obtain preliminary data and field experience on the feasibility of capture or removal of non-native mountain goats from wild, dispersed, and remote sub-populations in Olympic National Park.... The following techniques were attempted:

1. Foot snaring at established or temporary bait sites.
2. Drop netting at established or temporary bait sites.
3. Capture with net gun.
4. Capture through chemical immobilization using dart gun.
5. Capture using drive nets and helicopters....

In addition to capture, three biological specimens were collected by shooting with high-powered rifles from helicopters. Necropsies were performed as part of other research projects. A simulated aerial shooting experiment was conducted to observe animal behavior. Information on the feasibility, probable costs, and operational constraints of aerial shooting were indirectly obtained. An attempt was made to identify and completely remove an entire, discrete subpopulation to permit study of the effects such a removal has on reproduction, migration, and habitat recovery," (Olson 1984).

RESULTS:

Foot snare/drop net: Bait sites were established using trace-mineral salt blocks in 1982 and 1983 to condition goats to use these areas. Life-size plywood decoys were tried near bait sites. In spite of all efforts, goat use of bait sites was infrequent and unreliable. Capture using foot snare/drop net was not attempted due to the failure of baiting.

Net gun: One goat was captured by a ground team using the net gun. The goat was slightly injured during capture and no other ground net gun captures were attempted. Use of the net gun from a helicopter was judged too risky after ground testing the equipment.

Chemical immobilization: Attempts were made to capture goats using chemical immobilization administered from the ground, however it was not possible to approach close enough to permit effective use of dart guns. Three goats were successfully captured using aerial darting at Mt. Appleton and Blue Mt., however "despite the favorable terrain, recovery of immobilized animals ranged from easy to difficult and even dangerous," (Olson 1984). Aerial darting was not attempted in other areas because the steep terrain precluded landing to recover the immobilized goats. "The average cost to capture a goat...by chemical immobilization was \$706.00, including transportation costs," (Olson 1984). The conclusion was, "Aerial darting and immobilization with M-99 was found to be the most effective capture technique attempted. However, it is expensive on a per animal basis and there is some risk to animal safety," (Olson 1984).

Drive net: "Drives were initiated on 13 different groups of goats. A total of six goats were brought to the nets. Four were captured," (Olson 1984). This study showed that it was not possible to drive groups of goats. Whenever driving a group was initiated, the group broke apart and only an individual could be driven. "The most surprising revelation was just how close the aircraft had to approach the animals to move them under control. The drives involved maximum performance flights at low elevation. Terrain obstructions would frequently hinder efficiency. Driving requires an extremely skilled pilot and observer," (Olson 1984).

The average cost per animal to capture a goat by drive net was \$937.50. This is, however, misleading because pre-capture preparation, transportation of personnel and equipment are not included. The

report concluded that non-selectivity of this method and problems associated with goat and human safety are important limitations on the use of drive netting.

Collection of biological specimens and simulated aerial shooting: Three goats were shot to collect biological information, two from Mt. Dana and one from Mt. Appleton. Additionally, a simulation of aerial shooting was conducted to collect cost and feasibility information. No animals were actually shot during the simulation, but eight goats were 'pseudo-shot'. Average cost per animal was \$37.88 including helicopter ferry time. The conclusion was "Mountain goats in dispersed interior populations can be rapidly, efficiently, and humanely shot with high-powered rifles from helicopters," (Olson 1984).

REFERENCES: Olson 1984

DATE: 1978-1983

PRIMARY INVESTIGATOR(S): Michael Hutchins

TOPICS: goat behavior

GEOGRAPHIC LOCATION: Klahhane Ridge, captive goats at Woodland Park Zoological Gardens in Seattle.

DESCRIPTION: Mother-offspring relationships were examined in both a free-roaming population of goats within the park and in a captive population at Woodland Park Zoo. All aspects of the relationship were studied, including parturition, early maternal behavior, kid mortality, nursing, kid growth rates and other social behavior between mother and offspring. Mother-yearling and mother-two-year-old relationships were also documented.

RESULTS: A large amount of basic data on behavior and reproductive biology of goats was collected. Much of this information was incorporated in the DEIS section on goat biology.

"When females failed to reproduce in consecutive years, they retained and continued to care for older offspring.... Higher rates of offspring retention were correlated with high population densities and low reproductive rates, suggesting that as females become incapable of reproduction, they switch to a strategy of extended care for existing offspring," (Hutchins 1984).

REFERENCES: Hutchins 1984

DATE: 1982-1983

PRIMARY INVESTIGATOR(S): J.W. Foster, S.W.J. Seager, B.S.Marts and B.B.Moorhead

TOPICS: control methods

GEOGRAPHIC LOCATION: Appleton Pass

DESCRIPTION: The applicability of laparoscopic surgery for sterilization of goats was examined in the field.

RESULTS: Week-long attempts to surgically sterilize female goats at a drop-net capture site at Appleton Pass in July, 1982-1983, were largely unsuccessful due to inclement weather and a lack of bait interest by animals. One adult male goat was finally captured and vasectomized on-site by laparoscopic surgery. Two female goats were then captured at Appleton Pass in September, 1983, by helicopter darting and flown to a temporary surgical area at park headquarters where tubal ligations were successfully performed by laparoscopic surgery. The two goats were then released back into the field. Results and field experience suggested that laparoscopy was bio-medically feasible but neither practical nor safe in the field due to the need to individually capture animals in rugged terrain and conduct slow, costly and complicated invasive surgery.

REFERENCES: Seager et al. 1984a, 1984b

DATE: June 18-28, 1985

PRIMARY INVESTIGATOR(S): Mel Cain

TOPICS: live-capture techniques

GEOGRAPHIC LOCATION: upper Elwha, Dosewallips and Quinault River drainages, including Mt. Dana, Mt. Scott, Mt. Ludden, Lone Tree Pass, Mt. Pulitzer, Mt. Childs, Mt. Wilder, Chimney Peak, Sentinel Peak, Mt. Claywood and Mt. Anderson

DESCRIPTION: A trial use of a helicopter-based net gun capture operation conducted by Mel Cain was strongly recommended by The Fund for Animals. Cain had been involved in successful live-capture of feral goats at San Clemente Island, California. The Olympic capture operation was conducted under contract with the NPS.

Several objectives were established for the project:

- To capture as many goats as possible. The test would run as long as efficiency, safety, and funding would allow.
- To test the technique under a wide variety of situations: different goat densities, slope, and vegetation types.
- To prevent accidents/injury to personnel and to minimize goat mortality and injury.
- To evaluate the technique for continued use at Olympic.

RESULTS:

During seven days of actual capture operations, 79 shots were taken with the net gun. Sixty-four goats were captured and 56 were successfully transplanted outside the park.

During the first two days of the project (6/18 and 6/19) capture-related mortality was 16% (3 of 19 goats), and 76% of the surviving goats received capture-related injuries. The capture operation was

suspended for one day to re-evaluate procedures. Several problems were noted and procedures were modified.

During the remaining five days of the operation, capture-related mortality was 13%, while 66% of handled animals were injured.

The project was evaluated for cost-effectiveness. Total cost of the operation was \$1,061.98 per successfully transplanted animal. This cost estimate might have been relatively low because weather was very good during the operation and most of the captures in this project were easily obtainable goats (i.e., in areas of high goat densities, sparse vegetation, and relatively easy terrain).

James W. Foster, DVM, observed and evaluated the operation on June 22. His report concludes, "The teamwork and skill of the helicopter pilot and the net gun operator is to be commended... the medical processing team was well trained, caring and efficient. The philosophical differences between these two teams becomes immediately apparent and remarkable however when one observes the gentle care given at Dodger Pt. in contrast to the careless handling by the capture team.... Since the processing team consists of ONP personnel and the capture team does not, one must assume that the former represents the park's humane philosophy and the capture team is either unwilling to listen or has not been adequately informed of the parks standards or objectives."

REFERENCES: Foster 1985; Personal communication with involved NPS staff

DATE: 1982-1987

PRIMARY INVESTIGATOR(S): Roger A. Hoffman and R. Gerald Wright

TOPICS: population modeling, control/removal methods

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: The study contained two major components: computer modeling and field testing of fertility control techniques.

Population parameters of park mountain goats were modeled. The model was then used to test the effectiveness of a variety of removal and fertility control scenarios. Removal scenarios tested included annual removals of 25, 40, 50, 60, 75, and 100 animals; removals occurring in May and in August; random removals and systematic removals starting in the northwest corner of the park and working south and east from that point. Fertility control scenarios included contraceptive treatment of 25 to 140 female goats each year using treatment effectiveness ranging from one to five years. The male sterilization models varied the number of males treated each year, the number of females bred by a particular male each year, and the length of time a given male was dominant.

In the field portion of the study, two fertility control techniques were tested. Eleven females were implanted with megestrol acetate, while five males were chemically vasectomized. The animals were radio collared and located annually to determine reproductive status.

NOTE: Hoffman and Wright used the term "sterilize" for all fertility control treatments he used, however under the definitions used in this DEIS (from Warren 1992) Hoffman and Wright's treatment of female goats would be considered a "contraceptive" since it was not permanent. The male

vasectomies would still be considered a "sterilant." Bracketed terms in the following summary of results correspond to the DEIS definitions.

RESULTS: In the removal modeling portion of the study, "The comparisons showed that month of year had little effect on the results of either random or systematic removals. Comparing the effects of the number removed per year showed that greater number of goats removed per year resulted in fewer years to elimination. Comparing the two techniques of removals for each time of year showed a somewhat greater efficiency for the systematic removals than for the random removals. This was especially pronounced for the lower levels of removals," (Hoffman and Wright 1987). Removals of any less than 50 goats/year (from an initial population of 1000 animals) for 20 years would not have any significant long-term impact on the population (Hoffman and Wright 1987).

The sterilization [and contraception] portion of the modeling study showed that, for females, "the longer the treatment effectiveness or the more females sterilized [i.e., treated with contraceptives] each year, the sooner the population was controlled. It was interesting to note however, that beyond a certain point, little more was gained for the increased effort," (Hoffman and Wright 1987). Hoffman also found through modeling that if the population contained approximately 600 female goats initially and 100 were treated with contraceptives every year, it would take approximately 30 years to eliminate the population (assuming 100% of the treated females remained infertile for one year). He noted that even if it were possible to treat 100% of the goats, it would still take 12-15 years to eliminate the population.

The maximum sustainable population for habitat within the park was estimated at 1,402 goats. This estimate was based on census data and availability of potential goat habitat.

The male sterilization models demonstrated "...the effectiveness of the management increased with the number sterilized each year. In addition, the longer the sterilized males were dominant and the more females each male breeds in a given year, the more effective the program. However, these parameters cannot, of course, be manipulated in a wild population of mountain goats," (Hoffman and Wright 1987).

The field contraception results for female goats were examined in two ways. Comparison of treated females having kids to proportion of non-treated females producing young showed treated females had a 10.0% kidding rate, while non-treated females had a rate of 68.1%. Comparison on a subpopulation level showed the treated subpopulation's reproductive rate was 33.3% and 25.0%, for 1985 and 1986 respectively, while the un-treated subpopulation rate was 74.8% and 65.4%. "This shows that the technique would be quite effective in reducing the reproductive rate for an entire subpopulation if 60-70% of the females in that subpopulation are sterilized [treated with contraceptives]," (Hoffman and Wright 1987).

Of the five sterilized male goats, four were still alive for the next rut (one was apparently killed in an avalanche). All four engaged in rutting activity. Comparing subpopulation size and reproductive rates before and after treatment, no decreases were found. "It was not possible to determine whether the treated males were in fact sterile. This would have required the recapture of these individuals, and an analysis of sperm.... The wide movement of the mature males during the rut was believed to be the most probable cause for the inability to show a treatment effect. It is also possible that more multiple inseminations occur in the mountain goat than previously believed," (Hoffman and Wright 1987).

REFERENCES: Olson et al. 1985; Hoffman and Wright 1987; Hoffman and Moorhead 1987; Hoffman and Wright 1990

DATE: 1984-1985

PRIMARY INVESTIGATOR(S): D.B. Houston, C.T. Robbins, C.A. Ruder, and R.G. Sasser

TOPICS: goat biology, monitoring techniques

GEOGRAPHIC LOCATION: wild goats from ONP; captive goats at Washington State University

DESCRIPTION: Samples of blood sera were collected from ten captive and eight wild goats to determine if an antigen that crossreacts with antisera to bovine pregnancy-specific protein B (PSPB) is present. The goal was to ascertain if PSPB can be used to monitor pregnancy status of wild goats as part of population dynamics study.

RESULTS: Measurement of PSPB provided a reliable diagnosis of pregnancy in mountain goats.

REFERENCES: Houston et al. 1986b

DATE: 1979-1985

PRIMARY INVESTIGATOR(S): E. Schreiner

TOPICS: vegetation

GEOGRAPHIC LOCATION: Klahhane Ridge and Deer Park

DESCRIPTION: "The Klahhane Ridge goat population was reduced by about 80% from 1981-85.... It was hypothesized that these removals would be associated with: (1) an increase in the percent cover and productivity of plant species preferred by goats, and (2) a decrease in the percent cover and productivity of disturbance-oriented plant species. The combined increase in preferred species and the decrease in disturbance-oriented species is defined as plant community 'recovery' in the direction of pre-goat vegetation," (Schreiner 1987). In this study, existing plots (established in 1979) and existing exclosures (installed in 1980) were re-examined, new permanent plots were established, and photographs were examined to document changes in vegetation.

RESULTS: "Reductions in goat density...were associated with increases in cover of preferred forage species and decreases in cover of disturbance-oriented species. The greatest changes occurred in areas where goat use was initially high but substantially reduced."

"Where goat use was initially high but then reduced, *Festuca idahoensis* and mosses and lichens increased while *Achillea millefolium* decreased. Initial high-use areas where goat use was not reduced exhibited few changes. Moderate-use areas exhibited few changes; these primarily in the cover of mosses. Low-use sites either did not change or exhibited an increase in moss cover. An increase in litter occurred on some areas of initially high goat use.... Goat density was reduced from [.03/acre] 0.077/ha to [.005/acre] 0.012/ha before measurable changes in plant cover took place. Even where all goat use was eliminated by exclosures, six years were required before significant community realignment occurred. Complete recovery of plant communities will be delayed considerably if goats are not eliminated. It is estimated that 10-20 years will be required for plant community recovery in

the absence of goats, and that time may be doubled if goat populations are maintained at low levels. Wallows, severely disturbed sites, and highly preferred sites, will not fully recover as long as goats are present on Klahhane Ridge," (Schreiner 1987).

REFERENCES: Schreiner 1987; Burger 1989 NOTE: All of Schreiner's vegetation research has undergone individual academic reviews during preparation for publishing the goat management monograph (i.e., Houston et al. 1994b).

DATE: 1977-1984

PRIMARY INVESTIGATOR(S): D.B. Houston and V. Stevens

TOPICS: population parameters

GEOGRAPHIC LOCATION: Klahhane Ridge

DESCRIPTION: Changes in population dynamics and physical condition of goats were examined following an experimental management program in which goats were removed from the subpopulation.

RESULTS: "The goat population showed density-dependent responses in the production and recruitment of kids, in minimum breeding ages, and in litter size. These shifts in dynamics were associated with increases in live weights and, possibly, fat reserves. The density-dependence shown was insufficient to compensate for removals that approximated the initial production of young, and goat numbers declined precipitously."

The documented changes suggest a subpopulation that is limited by the quantity and quality of winter food supply.

REFERENCES: Houston and Stevens 1988

DATE: 1985-1988

PRIMARY INVESTIGATOR(S): Thomas N. Kaye

TOPICS: vegetation

GEOGRAPHIC LOCATION: NE portion of ONP

DESCRIPTION: The purpose of this study was to acquire information concerning the ecology of individual plants, the reproductive ecology, and population dynamics of the Olympic Mt. milkvetch, a rare plant endemic to the Olympics. The effect of goats on populations was also examined.

RESULTS: "The effect of mountain goats on plant survival depended on whether plants were grazed or trampled in goat wallows. In 1987, 78.8% of the non-seedling plants monitored (in two plots) were grazed to some degree. This had little effect on plant survival, however...On the other hand, many (25.5%) reproductive plants that were grazed in 1987 resprouted as vegetative plants in 1988, but no

ungrazed reproductive plants regressed this way. Goat wallows, though less common, were more likely than grazing to kill *Astragalus australis* var. *olympicus* plants." A total of 168 wallows were counted within 164 ft (50 m) of two populations of milkvetch. Only four population centers of this species occur in the world and all are located within the NE portion of Olympic National Park in the alpine and subalpine zones (Kaye 1989).

REFERENCES: Kaye 1989

DATE: 1981-1984

PRIMARY INVESTIGATOR(S): D.B. Houston, C.T. Robbins, and V. Stevens

TOPICS: goat biology

GEOGRAPHIC LOCATION: Klahhane Ridge, Washington State University

DESCRIPTION: Growth rates (body mass and sexual maturity) were compared in wild and captive mountain goats.

RESULTS: In captive goats, body mass increased more quickly than in wild goats. Dimorphism in mass was especially apparent in captive goats after age two, while in wild animals it was not pronounced until age four. Wild males reached maximum mass at five years and wild females at three or four years. Both captive and wild animals showed pronounced seasonal periodicity in growth.

Generally, captive goats reached sexual maturity at an earlier age than wild goats. In local areas where wild goats were still colonizing their range, age of sexual maturity was similar to captive animals.

REFERENCES: Houston et al. 1989

DATE: 1972-1984

PRIMARY INVESTIGATOR(S): Victoria Stevens and Douglas B. Houston

TOPICS: goat biology monitoring techniques

GEOGRAPHIC LOCATION: ONP

DESCRIPTION: Accuracy of techniques for determining age of wild goats was compared. The two techniques used were counts of annuli of horns and patterns of tooth replacement.

RESULTS: Age estimates using horn rings and incisor replacement were equally accurate for goats less than five years old. Accuracy declined in estimates of older individuals. Male horns were more accurately aged than females. In resource-limited populations, such as on Klahhane Ridge, some females do not form true horn rings.

REFERENCES: Stevens and Houston 1989

DATE: data from 1915-1990

PRIMARY INVESTIGATOR(S): J. Burger, D. Houston, E. Schreiner

TOPICS: vegetation and soil

GEOGRAPHIC LOCATION: Mt. Angeles/Klahhane Ridge area

DESCRIPTION: Historic and recent photographs were compared to document soil and vegetation trends over time. Differences in nine factors were tallied for each community: total plant cover, percent cover of disturbance-oriented species, cover of plants indicating community stability, cover of shrubs, number of trees and tree height, cover of bare ground or rock, number of goat trails or wallows, cover of relatively fine soils and pebbles, and soil erosion or deposition. Sixty-six photographic pairs were used. Photographs cover the time periods before goat introduction, through the population peak, and after control programs reduced goat numbers. Meteorological data were analyzed to aid in determining cause of vegetation changes.

RESULTS: "Results of the photographic comparisons showed that both introduced goats and climate have influenced vegetation and soils in the Klahhane Ridge area. Climatic changes were reflected by subalpine fir invasion of heath-shrub communities which make up about 7 percent of that portion of the goat summer range mapped by Pfitsch (1981). An additional 2 percent of the area was mapped as the Late Snow community type which exhibited no changes due to goats or climate. Changes in communities where vegetation was lost and then regained paralleled changes in goat density. Climate was largely ruled out as driving the major changes in these community types.... Moreover, photographic comparisons documented changes in the relative abundance of plant species as mountain goat densities *increased*," (Schreiner et al. 1993).

REFERENCES: Burger 1989; Schreiner et al. 1993

DATE: 1987-1988

PRIMARY INVESTIGATOR(S): Brad Carlquist

TOPICS: goat management

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: This study examined socio-political development of the goat management program at Olympic National Park through 1988. Particular emphasis was placed on the 1987/1988 environmental assessment process.

RESULTS: The thesis concluded that the 1987 environmental assessment process was a success due to NPS emphasis on scientific research, interagency cooperation, and public participation. Compromises perceived necessary by managers to reconcile conflicts with concerns of public interest groups were described. The importance of future interagency coordination of goat management on the Olympic Peninsula was stressed.

REFERENCES: Carlquist 1989, 1990

DATE: 1988-1989

PRIMARY INVESTIGATOR(S): Richard W. Olson, Jr. and Arthur T. Sandison

TOPICS: capture techniques

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Modifications of hand-held net-guns to use in helicopter-assisted capture of goats are described and evaluated.

RESULTS: The modifications increased efficiency and user safety when using hand-held net-gun canisters in helicopter capture operations.

REFERENCES: Olson and Sandison 1990

DATE: 1990

PRIMARY INVESTIGATOR(S): Gary E. Machlis, Seth Tuler, and Roger Kasperson

TOPICS: control/removal methods (safety)

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Personnel risks associated with helicopter-dependent live capture of mountain goats at Olympic National Park were evaluated using social science techniques.

RESULTS: "Hazards unique to this project include physical harm from jumping out of a hovering helicopter, possible helicopter accidents during toe-in and one-skid landings, falls while crossing rough terrain, helicopter crashes during dangerous flying conditions, accidents while using the net-gun, injury while restraining a goat, and accidental exposure to chemical immobilization agents...The most important of the physical hazards to personnel are death or severe injuries that can result to capture team members. These may occur during helicopter accidents and their greatest risk is during pursuit and landing/hovering operations. Because most of the operations occur in the backcountry, any search and rescue attempts will be difficult and delayed, which can exacerbate the consequences."(Machlis et al. 1990) Although suggestions are included to enhance safety, reliability,

and performance, the report states that "...the technical task demands performance that clearly pushes personnel and equipment to their physical, mental, and mechanical limits. It is not a task with significant buffer or 'forgiveness'."

REFERENCES: Machlis et al. 1990; Tuler et al. 1992

DATE: 1990

PRIMARY INVESTIGATOR(S): Robert Peterson, Bill Hinkle, Dick Erickson, and Randy Smith

TOPICS: control/removal methods (safety)

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Personnel from the Department of the Interior Office of Aircraft Services visited Olympic National Park to review technical aviation aspects of the goat live capture program.

RESULTS: "The project's aviation activities involving (single-skid and toe-in landings) have reached a point at which the degree of risk to park personnel for serious injury or fatality is high. A number of factors support this view, with these having the greatest weight:

- The helicopter is at its extreme limit of performance capability with no margin available to deal with adverse environmental conditions, error or mechanical problems.
- Mountain winds and weather conditions in Olympic National Park are unpredictable and frequently severe.
- The available goat population remaining to be dealt with occupies some of the parks most difficult terrain.

Consequently, based on aviation safety, it is my recommendation that you not attempt further helicopter operations utilizing single-skid or toe-in landings for capture and removal of mountain goats. The existing conditions of population distribution, terrain, weather, and helicopter performance simply make the risk unacceptable," (Peterson 1990).

REFERENCES: Peterson 1990

DATE: 1987-1990

PRIMARY INVESTIGATOR(S): Bruce B. Moorhead

TOPICS: control/removal methods

GEOGRAPHIC LOCATION: not applicable

DESCRIPTION: A summary of new information concerning immuno-contraception as related to mountain goat management at Olympic National Park is presented. Information is from the 1987 conference "Contraception in Wildlife" and from discussions with Dr. Seal (University of Minnesota), Dr. Warren (University of Georgia), and Dr. Reeves (Washington State University).

RESULTS: Six problems with application of immuno-contraceptives in wild goat populations at Olympic are identified:

- Antigen form limits remote delivery
- Undesirable side-effects
- Single treatment for both sexes is not yet available
- Booster shots are necessary.
- Vaccine quality control
- Treatment of entire goat population is not possible

It was concluded that contraceptive techniques which are practical and effective for use in Olympic's mountain goats are not currently available and will not be for at least another five years or more.

REFERENCES: Moorhead 1990

DATE: 1990

PRIMARY INVESTIGATOR(S): D.B. Houston, B.B. Moorhead, and R.W. Olson

TOPICS: population parameters

GEOGRAPHIC LOCATION: range-wide: all goat summer habitat in Olympic Mountains - ONP and ONF

DESCRIPTION: An aerial census was conducted in July 1990 to estimate total population of goats on the peninsula. These data could then be compared to the July 1983 helicopter census results. The 1983 census estimate was $1,175 \pm 171$ (SE) goats. Since that time, known goat removals on the peninsula (NPS removals, legal hunting, and illegal harvest) totalled 326 animals.

RESULTS: The 1990 census yielded a population estimate of 389 ± 106 (SE). The two population estimates (1983 and 1990) differ significantly and it was concluded that populations have declined substantially during that time. Marked differences were found between counts in five of the seven areas censused in both years. Group size and estimated kid/older goat ratios did not differ significantly between counts.

Several possible explanations for the large decline in goat numbers are proposed, however readers are cautioned that the large standard errors inherent in the estimates may lead to a misleading evaluation of the actual population change.

REFERENCES: Houston et al. 1991a

DATE: 1981-1990

PRIMARY INVESTIGATOR(S): Douglas B. Houston, Edward G. Schreiner, Bruce B. Moorhead, and Richard W. Olson

TOPICS: ONP goat management

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION/RESULTS: Provides a concise summary of National Park Service goat research and management at ONP during the 1980s, including the experimental management program under the 1981 EA and the operational management program under the 1987 EA.

REFERENCES: Houston et al. 1991b

DATE: 1992/1993/1994

PRIMARY INVESTIGATOR(S):

1992, 1993, 1994: Dr. Robert J. Warren, Dr. Richard A. Fayrer-Hosken, Dr. Robert A. Garrott, Dr. David A. Jessup, and Dr. Jay F. Kirkpatrick

1994 only: Dr. Edward D. Plotka, Dr. Dale R. McCullough, R. Bruce Gill, and Dr. Dan Thompson

TOPICS: control/removal methods

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION:

1992: "A five-member panel of scientists (wildlife biologists, reproductive physiologists, and veterinarians) conducted an independent, on-site review to evaluate the potential for contraceptives to eliminate or control mountain goats in Olympic National Park. All panel members were experienced in experimental applications of the latest contraceptives to free-ranging wild or feral animal populations," (Warren et al. 1992).

1993: Dr. Kirkpatrick, a member of the 1992 panel, wrote to the Interagency Goat Management Team in February 1993. This letter states, "In summary, I believe the [IGMT] newsletters have projected an unnecessarily negative view of contraception, that there has certainly been use of the report in contexts other than it was written (elimination vs control), and that technically the report is already outdated. Thus, if the subject of contraception is to be addressed and considered in the final decision-making process, the information should be updated and framed accurately in the proper context" (Kirkpatrick 1993).

In April 1993, the park requested a follow-up report from the panel covering any new advancements in wildlife contraception/sterilization. The follow-up report, which was prepared by Dr. Warren in August 1993, is summarized below.

Dr. Jessup, another member of the 1992 panel, wrote to Olympic National Park in June 1993. Dr. Jessup states, "Contraception will not eliminate mountain goats within the park. Lethal shooting may not accomplish that goal either, however, as a remnant population will apparently remain on the private and USFS land on the periphery of the park.... I do believe the (sic) contraception, even limited to those currently available...has potential to help control mountain goat populations...I respectfully suggest that you and your staff consider combining several tools including local population reduction by shooting and/or removal in sensitive areas, and contraception with the goal of reducing and controlling mountain goat populations" (Jessup 1993).

1994: During final preparation of this DEIS, in 1994, members of the original panel were asked for individual, independent assessments regarding the applicability of contraceptives in the elimination or control of mountain goats within Olympic National Park. This final review was to ensure that the most up-to-date wildlife fertility control information would be included in the DEIS.

Four additional scientists were also asked for independent, individual assessments of the applicability of contraceptives for control or elimination of goats in the park. These individuals were asked to consider the 1992 panel report and the 1993 follow-up report, as well as any information which they were aware of regarding new developments in wildlife contraception.

RESULTS:

1992 report:

"The panel concluded that there currently are no remotely deliverable contraceptives or sterilants available that have been proven to provide long-term infertility or permanent sterility in mountain goats. Even if such contraceptive or sterilant agents were available, the panel believes treating mountain goats in the park with these agents would represent a very expensive, never-ending program that, at best, would only partially control the population. Therefore, despite the fact that each member of the panel is personally committed to developing non-lethal control techniques for wildlife, they came to the unanimous conclusion that lethal shooting appears to be the only feasible option for use in eliminating mountain goats in Olympic National Park. Indeed, even with the use of lethal shooting, it likely will be very expensive and difficult to totally eliminate goats from the park."

".... Destruction of individual animals with a firearm is an effective population control option. When carried out properly by a marksman, shooting from a helicopter, although not popular with the public, can be considered humane. Treatment is obviously permanent, costs are relatively low, effectiveness is high, and hazards to NPS personnel are minimized (because effective ranges are greater than for dart guns). Lethal shooting also can avoid several issues of concern, such as side effects to non-target animals, FDA approval, annual retreatment with contraceptives, and helicopter prop-wash interference with dart delivery. The single disadvantage to shooting is public reaction to the destruction of goats."

"It is likely that research developments within the next 10-20 years may provide a 'one-shot' permanent sterilant that may be applicable for mountain goat management in ONP. However, even if such a sterilant is developed in the future, it will likely never eliminate mountain goats from ONP. Indeed, even with the use of lethal shooting, it will likely be very expensive and difficult to totally eliminate mountain goats from ONP."

"The panel would like to commend the NPS staff at ONP for their past research and management efforts with mountain goats. The panel was extremely impressed by the level of commitment demonstrated by these professionals. For numerous years, and often under conditions of great personal risk, they have attempted to apply non-lethal procedures, which were both expensive and experimental, in their efforts to control the mountain goat population in the most humane manner possible," (Warren et al. 1992).

1993 follow-up:

"Our [original 1992] report very thoroughly detailed these practical, field-level, population-level, safety, and budgetary considerations.... It is only because of the 'real world' considerations...which likely are unique to Olympic National Park, that a recommendation against the use of contraceptives

in this park is justified.... Concerning the matter of significant advancements in the area of wildlife immunocontraception, yes there have been major advancements in this area. However, these advancements probably do not improve the potential applicability of contraceptives in the elimination or control of mountain goats from Olympic National Park because of the 'real world' considerations...." (Warren 1993).

1994 reports

A summary matrix of the nine 1994 reviews is presented after the individual summaries of each review.

Dr. Richard A. Fayrer-Hosken -- "In summary, as I see current information, immunocontraceptives can not eliminate the mountain goat population from Olympia (sic) National Park. Furthermore, considering the applications of the current technology to the mountain goat population in Olympia (sic) National Park, I believe that the goat population could not be significantly reduced by current immunocontraceptive technology" (Fayrer-Hosken 1994).

Dr. Robert A. Garrott -- "...I believe the January 1992 report of the Scientific Panel accurately represents the 'state of the art' in wildlife contraceptive technology for management of free-ranging populations at the present time.... The basic difficulty with the application of contraceptives to control the mountain goat population in Olympic National Park are the lack of a long-duration contraceptive agent or sterilant that can be delivered remotely and the extremely difficult logistics of administering any agent to a sizable fraction of the population...it is not likely that advances in the foreseeable future will extend the duration of the [PZP] vaccine beyond 2 breeding seasons. It is conceivable that an intensive (and expensive) treatment regime with such a vaccine, should it become available, could reduce the **growth rate** of the mountain goat population... However, I believe it is unrealistic to expect current contraceptive technologies or those that may become available in the near future to effectively **reduce** the goat population" (Garrott 1994).

R. Bruce Gill -- Gill asked Dr. Dan L. Baker, also of the Colorado Division of Wildlife, to review the material and they prepared a joint response. "We believe the review panel correctly concluded that the **current state of contraceptive technology** favors lethal methods over nonlethal methods to **control** numbers of mountain goats in Olympic National Park. We doubt seriously that either lethal or nonlethal methods will **eliminate** mountain goats from Olympic National Park unless the efforts are intensive and sustained. Costs of control can be expected to increase in a nonlinear fashion as the density of mountain goats decreases...."

"Research is currently underway which, if successful, could significantly alter the conclusion that the lethal methods are the preferred control/extermination option. For example, if researchers succeed in developing immunocontraceptives which can sterilize individual animals with a single injection which sterilizes for the reproductive lifetime of the animal, efficacy of contraceptive treatments increases significantly. In our own research with hormonal toxins, we are on the threshold of producing an effective contraceptive which will sterilize treated individuals for a lifetime with a single injection. It looks like the amount of contraceptive will be minute enough to encapsulate the drug into "biobullets" which can be remotely delivered. These developments suggest that the conclusions of your review ought to be considered very tentative."

"We too have evaluated efficacy of different contraceptive treatment alternatives with simulation models. Briefly, we find unless we assume that a single contraceptive treatment endures for the reproductive life of the individual, no contraceptive treatment efficaciously reduces population density

or controls population growth. However, if you assume lifetime efficacy of a single treatment, the most effective alternative was the combination of **both** lethal and nonlethal control strategies."

"We did not evaluate directly the possibility of using contraceptives to exterminate a population, but our simulations did indicate the use of contraceptives was a more risky alternative than lethal culling because time lags in the ability of a population to rebound from contraceptive treatments were significantly longer than when lethal controls were used. It is possible that lethal culling combined with nonlethal contraceptives would be more efficacious than either lethal culling or contraceptives alone to **exterminate** a population" (Gill and Baker 1994).

Dr. David A. Jessup -- "... I respectfully suggest that you and your staff consider combining several tools including local population reduction by shooting, and/or removal in sensitive areas, and contraception (using either ZP vaccine, norgestomet biobullets, or both) with the goal of reducing and controlling the mountain goat populations. Given the low recruitment rate the ONP mountain goats are showing, I really believe that this could be accomplished" (Jessup 1994).

Dr. Jay F. Kirkpatrick -- "There were two primary conclusions in the original report. These were (1) that the elimination of goats was not possible by means of contraception, and (2) that there were existing techniques and others on the near horizon that *might* have application in the *control* of goats in ONP. I believe these two conclusions are still valid" (Kirkpatrick 1994). Kirkpatrick described seven new developments in wildlife contraception. All seven are in the development stage and would require additional research to determine any applicability to Olympic goat populations. "Some or all of these seven advances or advanced research may all have a bearing on the ability to control mountain goat populations in ONP.... I do not wish to imply that any of these advances will actually provide a solution to the problems at hand but they do, in my considered opinion, have *potential* for control until demonstrated otherwise. The problems of delivering wildlife contraceptives to large free-roaming ungulates are not trivial and there are as many small technological problems to be overcome as major pharmacological (sic) problems" (Kirkpatrick 1994).

Dr. Dale R. McCullough -- "I endorse the conclusions of the January, 1992 report... This panel included a good mix of scientific expertise, and all members are well-established, respected workers in their respective fields. I believe the panel did a thorough review of the contraceptive and control issues, and their conclusions are the best statement of possibilities given current technology and the circumstances of delivery under conditions at ONP....I am not optimistic for the rapid advance of contraception to control wild, free-roaming populations of animals.... There is no doubt that contraceptive approaches have been and can be successfully applied to zoo and zoological park animals, and small, relatively tame populations that can be easily approached. They probably also can be applied successfully to populations that can be rounded up such as feral horses and bison, although they have not yet been applied on an operational basis. Beyond these categories, however, attempts are few and successes even fewer. I believe it is fair to say that no clear-cut cases of sustained success of control of a moderately large, truly wild population of large mammals can yet be cited. It is virtually certain that the technology of contraception will advance rapidly in the next decade. However, this is not the bottleneck. The intractable problem is delivery under field conditions, and actually achieving the desired control....I agree...that contraception cannot achieve elimination of mountain goats from ONP. I also agree with the panel that some control can be achieved by contraception but... the critical question is the degree of control, and the feasibility of using contraception to achieve ONP's objective of reversing impacts on native plant species. Contraception is extremely slow and inefficient at reducing populations that are already too abundant.... In a contraception program, an inordinately high proportion of females must be treated.... And, because animals are not removed from the population by the treatment, one must await natural mortality of adults to result in a gradual decline in population size. Therefore, it takes a massive contraceptive effort to achieve a minimum of reduction...This level of reduction is almost certainly not

sufficient to achieve the stated goals of goat control in ONP. Therefore, by itself contraception will not achieve the desired control unless some breakthrough in delivery in the field allows easy treatment of a large proportion of the population."

"Goats could be eliminated by lethal shooting from critical areas in the center of the park. A combination of initial reduction by lethal shooting and control by contraception and lethal shooting, if necessary, could be applied on the edges of ONP where ingress is likely."

"Projectile darts and biobullets, which usually have been thought of as benign, actually inflict wounds and trauma. They forcefully penetrate the flesh to a depth of several inches with a projectile that is anywhere from one-quarter to one-half inch in diameter.... It is true that most animals recover quickly with no lasting effects provided the projectile strikes a large muscle mass. Nevertheless, secondary infections are possible, and the projectile does inflict pain and suffering. Humane considerations do require that these effects be taken into account, especially if repeated (e.g., annual) treatments are required. Such procedures, if performed on laboratory animals, would surely call for anesthetization...."

"...control by lethal shooting is... a never-ending task, but the efficiency of the method requires a fraction of the cost and time as the same degree of control achieved by contraception. Advances in contraception technology will surely make population control by contraception more efficient in the future. But at present, annual inoculation is required for control... this is an onerous job, requiring a great deal of helicopter operation. The risk of helicopter crashes also increases greatly. It is important to acknowledge that improbable risks, if repeated often enough, become inevitabilities..."

"Reproductive intervention is new. We do not know its evolutionary consequences. We know that natural selection works not so much through survival as through reproductive success. By changing the reproductive success of individuals through contraceptive means, humans can easily, inadvertently, and artificially direct selection to the detriment of the long-term viability of the population.... what degree of intrusion by humans in natural processes can occur without reducing a wild population to essentially a domesticated species?" (McCullough 1994).

Dr. Edward D. Plotka -- "In summary then, I believe that the conclusions the panel you convened in 1991 and whose comments were updated in the letter from Dr. Warren on August 31, 1993 are still appropriate. That is, current contraceptive measures have very little chance of ever eliminating goats from the park. However, under certain conditions, one or more of the techniques described in the 1991 report could help control the size of the populations. A combination of shooting to reduce the size of the herds to an acceptable level along with implementing one or more contraceptive methods (depending on ability to deliver the contraceptive to animals in a particular area of the park), has a strong possibility of maintaining the populations at some acceptable level. Keep in mind, however, that at present, any remotely deliverable contraceptive has to be readministered at least every year to maintain efficacy. And, although several different contraceptive measures suppress reproduction in captive populations, to my knowledge, none have been proven effective in controlling growth of free-ranging populations" (Plotka 1994).

Dr. R. Daniel Thompson -- "Based on current technology relative to wildlife contraceptive development, I believe the conclusions reached in the reports (Warren et al. 1992; Warren 1993) are still valid" (Thompson 1994).

Dr. Robert Warren -- "I have... reconsidered the conclusions in the original final report. My opinion remains unchanged... to my knowledge, we are no closer to having a proven, one-shot, permanent sterilant available for field application than we were back in 1992...You'll recall that our report did not

eliminate the possibility of contraceptives providing limited control over mountain goat populations in ONP. However, the report very thoroughly detailed the practical, field-level, population-level, safety, and budgetary limitations that exist at ONP.... Given these concerns for safety, cost, and practicality, my opinion also remains unchanged on the use of contraceptives in controlling mountain goat populations in ONP. In reaching my opinion, I also considered that the level of control attainable with contraceptives may not be sufficient for you to achieve your objectives of preservation of unique floral communities... Dr. Jay Kirkpatrick has informed me of his recent results from field trials with the PZP vaccine in white-tailed deer in island situations... and large penned areas... However,... these conditions obviously are very dissimilar to the unique field conditions at ONP" (Warren 1994).

Table 5. Summary of Contraception Reviews

Reviewer	If the objective is elimination, is contraception and/or sterilization applicable?
Dr. Richard Fayrer-Hosken	"In summary, as I see the current information, immunocontraceptives can not eliminate the mountain goat population from Olympia [sic] National Park."
Dr. Robert Garrett	Concurs with 1992/1993 panel findings
R. Bruce Gill and Dr. Dan Baker	"We doubt seriously that either lethal or nonlethal methods will eliminate mountain goats from Olympic National Park unless the efforts are intensive and sustained."
Dr. David Jessup	No specific comment
Dr. Jay Kirkpatrick	Concurs with 1992/1993 panel findings. "... <i>elimination</i> of goats via contraception will not work."
Dr. Dale McCullough	Concurs with 1992/1993 panel findings. "Contraception cannot achieve elimination of mountain goats from ONP."
Dr. Edward Plotka	Concurs with 1992/1993 panel findings. "...contraception will not eliminate goats in the park for a very long time." "...current contraceptive measures have very little chance of ever eliminating goats from the park."
Dr. R. Daniel Thompson	Concurs with 1992/1993 panel findings
Dr. Robert Warren	Concurs with 1992/1993 panel findings

Reviewer	If the objective is control, is contraception and/or sterilization applicable?
Dr. Richard Fayrer-Hosken	"... I believe that the goat population could not be significantly reduced by current immunocontraceptive technology." Control (i.e., decrease in population) is "not an achievable goal with immunocontraception." Control (i.e., stabilization of population) is "probably not an achievable goal with immunocontraception considering the unique conditions" in the park.
Dr. Robert Garrett	Concurs with 1992/1993 panel findings.
R. Bruce Gill and Dr. Dan Baker	"We believe the review panel correctly concluded that the current state of contraceptive technology favors lethal methods over nonlethal methods to control numbers of mountain goats in Olympic National Park."
Dr. David Jessup	"...I respectfully suggest that you and your staff consider combining several tools including local population reduction by shooting and/or removal in sensitive areas, <u>and</u> contraception (using either ZP vaccine, norgestomet biobullets, or both) with the goal of <u>reducing</u> and <u>controlling</u> the mountain goat populations."
Dr. Jay Kirkpatrick	Concurs with 1992/1993 panel findings. "... <i>control</i> might be possible."
Dr. Dale McCullough	Concurs with 1992/1993 panel findings. "...I am not optimistic for the rapid advance of contraception to control wild, free-roaming populations of animals....no clear-cut cases of sustained success of control of a moderately large, truly wild population of large mammals can yet be cited....The intractable problem is delivery under field conditions and actually achieving the desired control." "The critical question is the degree of control, and the feasibility of using contraception to achieve ONP's objective of reversing impacts on native plant species." "...by itself contraception will not achieve the desired control unless some breakthrough in delivery in the field allows easy treatment of a large proportion of the population." "Goats could be eliminated by lethal shooting from critical areas in the center of the park. A combination of initial reduction by lethal shooting and control by contraception and lethal shooting, if necessary, could be applied on the edges of ONP where ingress is likely."
Dr. Edward Plotka	Concurs with 1992/1993 panel findings. "...under certain conditions, one or more of the techniques described in the 1991 report could help control the size of the populations."
Dr. R. Daniel Thompson	Concurs with 1992/1993 panel findings.
Dr. Robert Warren	Concurs with 1992/1993 panel findings. "...the level of control attainable with contraceptives may not be sufficient for you to achieve your objectives of preservation of unique floral communities in ONP."

Reviewer	Emerging Contraceptive/Sterilization Technology
Dr. Richard Fayrer-Hosken	"There are no published, controlled reports of successful immunocontraceptive administration to feral ruminants from helicopters in extremely rugged mountainous terrain for an extended period of time."
Dr. Robert Garrett	"At present, the only remotely-deliverable contraceptive agent that has been studied and evaluated to any significant extent is the PZP vaccine....Although the vaccine has not been tested in mountain goats, in all [sic] likelihood, it would be effective. However, at present the PZP vaccine is a short-term contraceptive agent with a maximum effective duration of less than 1 year. In my opinion, this makes the vaccine impractical for managing the mountain goat population in Olympic National Park....it is not likely that advances in the foreseeable future will extend the duration of the vaccine beyond 2 breeding seasons."
R. Bruce Gill and Dr. Dan Baker	"...if researchers succeed in developing immunocontraceptives which can sterilize individual animals with a single injection which sterilizes for the reproductive lifetime of the animal, efficacy of contraceptive treatments increases significantly. In our own research with hormonal toxins, we are on the threshold of producing an effective contraceptive which will sterilize treated individuals for a lifetime with a single injection....These developments suggest that the conclusions of your review ought to be considered very tentative."
Dr. David Jessup	"...the norgestomet biobullet which we were testing on [seven captive] black-tailed deer was 100% successful in contracepting our test does for one year." Jessup stated, "A female mountain goat at Woodland Park Zoo... treated with a norgestomet biobullet in 1992 also did not show estrus behavior or conceive." However, an enclosed letter from the zoo stated that the norgestomet hormone was surgically implanted in this captive goat.
Dr. Jay Kirkpatrick	"There have been several new developments in wildlife contraception..." 1) "...the remote delivery of the synthetic steroid Norgestomet in biobullets to black-tailed deer...it has not yet been tested in goats...The one problem is that Ballistivet, the company that produces the biobullet, has gone into bankruptcy and the availability of those bullets is in question." 2) "...the oral delivery of a synthetic steroid, melengestrol acetate (MGA) to barasinga, axis deer, and blackbuck at the Bronx Zoo." The MGA was incorporated into grain feed that had to be ingested every day. 3) "Another possible approach ...might be found in ...a project on the contraception of mule deer in Oakland, CA, using a GnRH vaccine....This work has not been published and the vaccine has not been tested in Capridae..." 4) "A fourth advance is the testing of the PZP vaccine in members of Capridae." PZP has been tested in West Caucasian tur, ibex, Mouflon Sheep, Barbary sheep, and mountain goats, all in zoos. Results are not yet available for tests in captive mountain goats. 5) "...still in the development stage is the conversion of the PZP vaccine ...currently testing a fourth-generation form of the vaccine.... This would permit the remote administration of the vaccine and at least a full year of contraception and ultimately 2-3 years of protection." 6) "...recombinant [sic] forms of the PZP vaccine are being examined for possible oral delivery for white-tailed deer." 7) "...the development of 'marker' darts, which are capable of delivering a vaccine and leaving a paint mark on the animal." "I do not wish to imply that any of these advances will actually provide a solution to the problems at hand but they do, in my considered opinion, have <i>potential</i> for control until demonstrated otherwise."

Reviewer	Emerging Contraceptive/Sterilization Technology
Dr. Dale McCullough	Mentioned advances in use of PZP vaccine. Then went on to say, "Nevertheless, I am not optimistic for the rapid advance of contraception to control wild, free-roaming populations of animals." "I was a close observer of the failure... to control the Angel Island deer population despite the fact that MGA surgical implants proved to suppress reproduction in the treated females for a minimum of five years. It was simply impossible to treat a sufficient proportion of the females to achieve control." Also discussed humane issues associated with use of projectile darts and biobullets (see comments section of this table).
Dr. Edward Plotka	"A combination of shooting to reduce the size of the herds to an acceptable level along with implementing one or more contraceptive methods (depending on ability to deliver the contraceptive to animals in a particular area of the park), has a strong possibility of maintaining the populations at some acceptable level. Keep in mind, however, that at present, any remotely deliverable contraceptive has to be readministered at least every year to maintain efficacy. And although several different contraceptive measures suppress reproduction in captive populations, to my knowledge, none have been proven effective in controlling growth of free-ranging populations."
Dr. R. Daniel Thompson	"Recent research findings at Denver Wildlife Research Center indicate that immunocontraceptive vaccines can be encapsulated in liposomes and formulated into baits that prevent reproduction in rats. Perhaps this technology could be used to orally administer immunocontraceptive vaccines (e.g., PZP and/or GnRH) to control mountain goats at the Park."
Dr. Robert Warren	"Dr. Jay Kirkpatrick has informed me of his recent results from field trials with the PZP vaccine in white-tailed deer in island situations (Fire Island National Seashore) and large (about [148 acres] 60 ha) penned areas in Front Royal, Virginia. However, none of these studies have yet been published, and these conditions obviously are very dissimilar to the unique field conditions at ONP."

Reviewer	Additional Comments
Dr. Richard Fayrer-Hosken	Caveats relative to applicability of immunocontraceptives for control or elimination of goats include requirement for annual booster and treatment of more than 70% of the population.
Dr. Robert Garrott	"The basic difficulty with the application of contraceptives to control the mountain goat population in Olympic National Park are the lack of a long-duration contraceptive agent or sterilant that can be delivered remotely and the extremely difficult logistics of administering any agent to a sizable fraction of the population." "...it is not likely that advances in the foreseeable future will extend the duration of the [PZP] vaccine beyond 2 breeding seasons. It is conceivable that an intensive (and expensive) treatment regime with such a vaccine, should it become available, could reduce the growth rate of the mountain goat population in Olympic National Park. However, I believe it is unrealistic to expect current contraceptive technologies or those that may become available in the near future to effectively reduce the goat population."
R. Bruce Gill and Dr. Dan Baker	"Costs of control can be expected to increase in a nonlinear fashion as the density of mountain goats decreases...." "We too have evaluated efficacy of different contraceptive treatment alternatives with simulation models. Briefly, we find unless we assume that a single contraceptive treatment endures for the reproductive life of the individual, no contraceptive treatment efficaciously reduces population density or controls population growth. However, if you assume lifetime efficacy of a single treatment, the most effective alternative was the combination of both lethal and nonlethal control strategies."
Dr. David Jessup	None
Dr. Jay Kirkpatrick	"The problems of delivering wildlife contraceptives to large free-roaming ungulates are not trivial and there are as many small technological problems to overcome as major pharmacological [sic] problems."
Dr. Dale McCullough	"Projectile darts and biobullets, which usually have been thought of as benign, actually inflict wounds and trauma... secondary infections are possible, and the projectile does inflict pain and suffering. Humane considerations do require that these effects be taken into account, especially if repeated (e.g., annual) treatments are required. Such procedures, if performed on laboratory animals, would surely call for anesthetization." "...a contraception program for population control is a never-ending task. Indeed, control by lethal shooting is also a never-ending task, but the efficiency of the method requires a fraction of the cost and time as the same degree of control achieved by contraception." "...at present, annual inoculation is required for control by PZP immunization. This is an onerous job, requiring a great amount of helicopter operation. The risk of helicopter crashes also increases greatly. It is important to acknowledge that improbable risks, if repeated often enough, become inevitabilities..."
Dr. Edward Plotka	"The [1992] committee appropriately pointed out that the terrain does not lend itself to easy and safe delivery of contraceptive agents and the 'real world' considerations 'recommend against' using contraceptives as a long term solution..."
Dr. R. Daniel Thompson	None
Dr. Robert Warren	"...we are no closer to having a proven, one-shot, permanent sterilant available for field application than we were back in 1992." "...the [1992] report very thoroughly detailed the practical, field-level, population-level, safety, and budgetary limitations that exist in ONP."

REFERENCES: Warren et al. 1992; Warren 1993; Fayrer-Hosken 1994; Garrott 1994; Jessup 1994; Kirkpatrick 1994; McCullough 1994; Plotka 1994; Thompson 1994; Warren 1994

DATE: 1981-1992

PRIMARY INVESTIGATOR(S): E. Schreiner, A. Woodward, and M. Gracz

TOPICS: vegetation, soils

GEOGRAPHIC LOCATION: goat summer range within ONP

DESCRIPTION: "...to extend understanding of the interactions among mountain goats, vegetation, and soils in time and space. We also examined relations between plant communities and other herbivores on the [107,490 acres] 43,500 ha of land free of glacial ice above [5,000 ft] 1,520 m (i.e., goat summer range) and tested two general null hypotheses:

1. Reducing mountain goat densities will not result in changes to the relative abundance of plant species.
2. Mountain goats pose no threat to the long-term persistence of rare plants.

Independent study methods used during the investigations included: 1. Extensive surveys of vegetation composition and herbivore use in areas of high, medium and low goat density... 2. Permanent plots to quantify plant community responses to intentional reductions in goat density... 3. A qualitative assessment of changes documented by repeat photographs to examine the effects of climate, human use, natural disturbance, and mountain goats on vegetation and soils over a 70-year period... 4. Measures of the general distribution, abundance, and trends in rare plants and a rare endemic (Olympic Mountain milkvetch, *Astragalus australis* var. *olympicus*) to evaluate the effects of goats on the long-term persistence of these taxa...." (Houston et al. 1994b).

RESULTS: "Plants and herbivores are inescapably linked. The type and magnitude of the interactions between herbivores and plants depend on the food habits, behavior, and abundance of the herbivore, the growth form and physiology of the plants, and the dynamics of ecosystem processes where the herbivores and plants co-occur (Harper 1977; Crawley 1983; Abrahamson 1989). Herbivore populations have direct and indirect effects on individual plants, and indirect effects on plant communities and ecosystem processes (Floate 1981; Begon et al. 1986)."

"The direct influence of herbivores on individual plants is relatively straightforward. Plants either lose a portion of their biomass or sustain tissue injuries from being consumed or trampled (Caughley 1976; Harper 1977; Floate 1981; Crawley 1983). Wallowing, especially by large herbivores, also may damage plant tissue; death of the plant often results when it is directly under the herbivore (Polley and Wallace 1986; Begon et al. 1986). Burrowing tends to cause root injuries, burial of plant parts and, presumably death if the plant is directly in the path of the larger burrowing animals (Platt 1975; del Moral 1984; Kreuger 1986; Coffin and Lauenroth 1988; Whicker and Detling 1988)."

"Indirect effects of herbivores on individual plants, communities, and ecosystem processes are legion. Herbivores may alter plant growth form and reproductive output (Islam and Crawley 1983; Paige 1992), or cause individuals to produce tannins as secondary compounds to deter herbivory (Harper 1977; Rhodes 1985). Wallowing and burrowing expose bare mineral soil which alters community

composition in favor of ruderal plant species (Platt 1975; del Moral 1984; Pfitsch 1981; Polley and Wallace 1986; Whicker and Detling 1988). Relative abundance of plant species in the community may be altered because herbivores forage selectively (Ellison 1960; Anderson and Loucks 1979; McNaughton 1979; Day and Detling 1990; McInnes et al. 1992). A subtle but important effect of herbivores on ecosystem processes also results from redistribution of nitrogen in soils caused by urine and fecal deposition (Begon et al. 1986; Reuss and McNaughton 1987; Coffin and Lauenroth 1988; Day and Detling 1990; Seagle et al. 1992; Frank and McNaughton 1992). Deposition of nitrogen in feces may alter the rate nitrogen is cycled through the ecosystem which in turn may affect the productivity of plant communities (Cargill and Jeffries 1984)."

"Our work demonstrated that introduced mountain goats have indirect and direct effects on the vegetation of the Olympic Mountains, a finding held in common with all other studies of ungulate grazing systems. We have no reason to believe that the general biotic effects of goats on the vegetation of the Olympics differs appreciably from mountain goat grazing systems where the animals are native. Nonetheless, changes in the park's vegetation have been substantial and the status of rare plant populations is of concern."

"Mountain goats modified the relative abundance of plants in subalpine plant communities of the Olympics; disturbance-oriented species such as *Achillea millefolium* increased with heavy grazing and selected species such as *Festuca idahoensis* decreased. Mountain goats likely changed the competitive relations between these two species because a laboratory study demonstrated that *Festuca* was the stronger competitor except when clipped (del Moral 1985). Changes in plant cover of these two species were also visible in comparative photographs and were reported from the exclosure studies of Pfitsch and Bliss (1985) and Schreiner (1987)."

"Modifications of plant communities also occurred without necessarily changing competitive interactions among plant species; cover of selected and nonselected plant species changed at Mount Dana but this did not change community dominants. Cover of dominant, strongly competitive species such as *Carex spectabilis* did not always respond to lowered goat density. This does not necessarily mean that *C. spectabilis* was unaffected by goats. *Carex spectabilis* is highly productive (Kuramoto and Bliss 1970; del Moral 1983, 1984, 1985) and may have compensated for loss of grazed plant tissues. Graminoid species are well-known for their compensatory response to grazing (McNaughton 1979; Begon et al. 1986)."

"Additionally, mountain goats influenced the vegetation of Olympic National Park by wallowing. Wallows disturbed soils and created mineral substrates for colonization by plants. Studies of Klahhane Ridge goat wallows (Pfitsch 1981; Reid 1983) and bison wallows (Polley and Wallace 1986) showed that disturbance-oriented plants dominated wallow edges and that these disturbed sites differed from surrounding vegetation. We documented presence of wallows in all study areas. On Klahhane Ridge we noted disturbance-oriented species invaded wallow edges as they probably did elsewhere. Such a result is to be expected since Olympic subalpine and alpine plant communities are particularly sensitive to soil disturbance (Bell and Bliss 1973; Schreiner 1974; Belsky and del Moral 1982; del Moral 1984). Some investigators believe that physical disturbances associated with herbivory may be more important than grazing (Harper 1977; Floate 1981)."

"Incidentally consumed forage species may suffer intensive grazing at either high (Futuyama and Wasserman 1980) or low (Houston 1982) herbivore densities. These forages may be eliminated because they exert no feedback control on herbivore population size. In a hypothetical one herbivore-one plant species system, the herbivore and plant must reach a dynamic equilibrium or the herbivore goes extinct (Caughley 1982). Further, in a one herbivore-two plant system (assuming that the two plant populations have different growth rates), 'The extinction of one of the two plants is a direct

consequence of its sharing the area with the other.... It goes extinct when sharing the area because the herbivore numbers and hence grazing pressure are maintained at a higher level than would be possible if the slower growing plant were the only food available' (Caughley 1982:311). Thus, rare plants may be at risk due to mountain goats for at least two reasons: 1) mountain goat population densities likely are not controlled by plant abundance on summer ranges (Houston and Stevens 1988), let alone rare plant abundance, and 2) goats are generalist herbivores with the capacity to consume most plant species, including rare plants."

"We remain concerned about the long-term persistence of rare plants in mountain goat habitat. We note that the *effects of goats on individual plant taxa may be severe or potentially severe, especially for taxa with very restricted distributions (i.e., those that occur in <5 subpopulations)*. Rare, endemic plants have been driven to extinction or near extinction elsewhere by introduced herbivores (e.g., goats in Hawaii and the Galapagos Islands; Loope et al. 1988)."

"Our studies represent only a small part of the total picture of mountain goat herbivory. Recent studies demonstrate that ungulates alter nitrogen cycles and soil formation processes (Day and Detling 1990; Frank and McNaughton 1992; McInnes et al. 1992). Moreover, vegetative changes wrought by one herbivore may influence the feeding behavior of other herbivores (Kreuger 1986; Day and Detling 1990). Given the relationship between site productivity and the degree of interspecific plant competition in Olympic subalpine vegetation (del Moral 1983, 1985), mountain goats are likely to have a far greater influence on individual plants, communities, and ecosystem processes than we have demonstrated here," (Houston et al. 1994b).

REFERENCES: Schreiner et al. 1993; Houston et al. 1994b NOTE: All of Schreiner's vegetation research has undergone individual academic reviews during preparation for publishing the goat management monograph (i.e., Houston et al. 1994b).

DATE: 1994

PRIMARY INVESTIGATOR(S): Richard W. Olson

TOPICS: safety/risk assessment

GEOGRAPHIC LOCATION: not applicable

DESCRIPTION/RESULTS: This paper was delivered at a conference of The Wildlife Society in 1994. The paper summarizes the 1988/1989 goat live-capture program at ONP and discusses risks posed by such an operation and reasons for suspending or terminating capture efforts.

"Risks in mountain goat capture can be divided into two types: Objective and subjective hazards (Olson 1994).

"Objective hazards are those of the working environment over which managers have no control such as weather, topography, and remoteness" (Olson 1994).

"In contrast, subjective hazards are those which originate from what I call personal or organizational foibles or which are attributes of the technical task of capture" (Olson 1994).

Olson explains that there are critical helicopter performance limitations during capture operations. Certain conditions of altitude and speed must be maintained in order to be able to land safely in the event of engine failure, even when suitable landing areas are available. The emergency landing technique for helicopters with engine failure is called "autorotation". "Simply put, if you are flying slow you must have altitude; if you're flying low, you must be moving fast" (Olson 1994). If you are flying a helicopter low and slow, the pilot cannot execute an autorotation, even if the helicopter happened to be flying over a perfect landing spot when the engine failed. Most wildlife live-capture operations require flying low and slow for extended periods of time. Therefore, the capture operations are flying at (or beyond) the limits of helicopter safety most of the time, especially in the extreme terrain of the Olympics.

In live-capture operations, one can eliminate or mitigate exposure to subjective hazards, but exposure to objective hazards can only be minimized.

Olson suggests some conditions that might lead to a decision to suspend or terminate a live-capture operation: "A marked increase in mean search time; Capture mortality exceeds 10%; Notification of post-translocation medical complications or mortality; Recurring 'near-miss' incidents; Any sort of serious personnel injury or accident; steadily declining catch per unit effort; Pilot or capture team fatigue; Evidence of degraded helicopter performance" (Olson 1994). Any of these factors indicates that the effective limits of live-capture have been reached.

REFERENCES: Olson 1994

DATE: 1981-92

PRIMARY INVESTIGATOR(S): D.B. Houston, E.G. Schreiner, N.M. Buckingham, V. Stevens, B.B. Moorhead, A. Woodward, J.E. Burger, M.B. Graz, R.A. Hoffman, R.W. Olson, S. Schultz

TOPICS: goat biology, goat management, goat impacts

GEOGRAPHIC LOCATION: Olympic National Park

DESCRIPTION/RESULTS: This National Park Service monograph is a compilation of all research and management related to mountain goats within Olympic National Park. The publication discusses biogeography of the Olympic Peninsula; mountain goat population biology including history, distribution, abundance, demography, habitat relations, social behavior, physiological ecology and interspecific relations; mountain goat herbivory; and mountain goat management.

The monograph received extensive review within NPS and the National Biological Service. In addition, three anonymous reviewers were selected by Dr. Paul Vohs, editor, Information Transfer Division, National Biological Service.

REFERENCES: Houston et al. 1994b NOTE: All of Schreiner's vegetation research has undergone individual academic reviews during preparation for publishing this monograph.

DATE: July, 1994

PRIMARY INVESTIGATOR(S): D.B. Houston, R.W. Olson, R.A. Hoffman, B.B. Moorhead

TOPICS: population census

GEOGRAPHIC LOCATION: peninsula-wide

DESCRIPTION: Houston conducted a helicopter census of mountain goats in goat summer habitat of the Olympic Mountains, using the stratified random block design as described in Houston et al. 1986a and 1991. This is the same census design used for the two previous censuses.

RESULTS: The population was estimated "... at 288 ± 32 (SE) goats. Confidence limits are ± 63 goats, thus with 95% certainty the true value of the population estimate lies between 225-351 goats. The 1994 estimate did not differ significantly from the 1990 census. ... **Caution must be used in interpreting the overall results** of the census ... because the 1994 count was conducted during a period that included record high temperatures for the Puget Sound region. Maximum outside air temperatures recorded from the aircraft during the census were significantly higher in 1994 compared to 1990 ... Goats are known to be sensitive to high ambient temperatures and may seek relief in forests (Stevens 1979). Forest habitat occurs mostly below the [5,000 feet] 1,520 m lower boundary of the census zone. Several days prior to the count we received credible reports of 10 goats in the Buckhorn Unit, 6 - 8 goats at Lake Constance, and 9 on Klahhane Ridge. During the census we tallied 0, 1, and 1 goat in these respective areas. Differences may have reflected the effects of high temperatures on goat distribution" (Houston et al. 1994a).

REFERENCES: Houston et al. 1994a

U.S. Forest Service

DATE: 1954

PRIMARY INVESTIGATOR(S): unknown

TOPICS: population estimates

GEOGRAPHIC LOCATION: all national forests within state of Washington

DESCRIPTION: Goat population was estimated for all forests and ranger districts in Washington.

RESULTS: The Quilcene District of Olympic National Forest had an estimated population of 50-75 goats. No goats were reported in any other ranger districts on the peninsula, however a population estimate of 200 goats $\pm$ within Olympic National Park was noted.

REFERENCES: U.S. Forest Service 1954

DATE: 1982-1983

PRIMARY INVESTIGATOR(S): Jan Henderson

TOPICS: vegetation, soil

GEOGRAPHIC LOCATION: eastern ONF: Cruiser, Pershing, Tyler Peak, Iron Mt., and Welch Peak

DESCRIPTION: The study was initiated to determine impacts of a proposed WDW salting program: "1)impacts of salt on native vegetation 2)impacts of goats attracted to the salt on native vegetation 3) impacts of salt and goats on candidate threatened or endangered plant species or other potentially sensitive species.... The intent was to determine if 'safe' salting sites could be found rather than to measure the impact of goats and salt on plants." Study sites were selected "with the prime criterion to choose sites which should show minimal impact to the resource." Twenty-five pound (11 kg) salt blocks were broken up and left at the five study sites in 1982. Baseline data on soils and vegetation were collected at the time of salt placement.

RESULTS: The Cruiser site showed severe damage by goats and salt after one year. "Plant cover was removed from an area of about 225 square feet [21 m²] and reduced throughout most of the plot. The number of species was reduced from 38 to 22 and a large pit in the soil was opened up." This site was checked again in 1984. No significant change in site conditions were noted at that time (personal communication J. Henderson 9/14/92).

At the Pershing plot, Henderson states, "After one year of study there has been minimal impact on the plant community by goats or salt." Plants within 10 ft (3 m) of the salting location were killed. The number of plant species within the entire plot was reduced from 32 to 24. Soil was excavated in the salting site. Salt amounts up to 20 ft (6 m) from the plot center were 10 times those before salting. The salt leaching effect extended beyond 20 ft (6 m) from the center of the plot. The other three plots were not resampled.

REFERENCES: Henderson 1984

Washington Department of Wildlife

DATE: 1939-1940

PRIMARY INVESTIGATOR(S): Niilo A. Anderson

TOPICS: goat biology, history

GEOGRAPHIC LOCATION: goat range within Washington state

DESCRIPTION: The study focused on documentation of general mountain goat biology. Goat populations in the Cascade range were studied. Goats in the Olympics were not included in the study.

RESULTS: Although Olympic populations were not studied, the goat biology information collected in the Cascades has some general application to Olympic goats. Also, the report provides a historical

perspective on the introduction of goats to the Olympics. "No mountain goats are native to the Olympic Mountains, but two forms have been planted there and are reported to be increasing in numbers. Of these, four animals of the form Oreamnos americanus columbiae were introduced from Banff, Alberta, in 1924, and eight animals of the Oreamnos americanus kennedyi group were introduced from Alaska and released in 1929 and 1930," (Anderson 1940).

REFERENCES: Anderson 1940

DATE: 1959-1960

PRIMARY INVESTIGATOR(S): Homer Brent

TOPICS: population estimates

GEOGRAPHIC LOCATION: park-wide

DESCRIPTION: Goat counts were conducted from helicopter in September of 1959 and 1960.

RESULTS: In 1959, 30 goats were counted on Baldy Ridge, Mt. Angeles, Hurricane Ridge, and Mt. Constance. Storm King was checked, however no goats were found.

During the 1960 count, 21 goats were seen in the Baldy Ridge, Mt. Angeles, Hurricane Ridge, and Mt. Constance areas, while no goats were observed on Storm King.

REFERENCES: Washington Game Department 1960

DATE: 1959-1965

PRIMARY INVESTIGATOR(S): L. A. Wadkins

TOPICS: population dynamics

GEOGRAPHIC LOCATION: goat range within Washington state

DESCRIPTION: Goat population data were compiled through hunting information and field observations by state biologists.

RESULTS: The majority of the information is on populations in the Cascades. In 1961, an estimate of approximately 300 goats is given for the Olympic Peninsula in six population centers. One, or possibly two, populations were shown in Olympic National Forest. The remainder were within Olympic National Park.

REFERENCES: Washington Game Department 1965

DATE: 1967-1993

PRIMARY INVESTIGATOR(S): Rolf L. Johnson

TOPICS: hunting statistics, population dynamics

GEOGRAPHIC LOCATION: hunted goat populations on the peninsula

DESCRIPTION: Annual harvest information is compiled for all goat units in the state. Goat hunting (archery only) was established on the peninsula in 1967.

RESULTS: An average of 24 people hunted goats on the peninsula each year from 1967 through 1993. Goat harvest on the peninsula for the same time period averaged eight goats per year (3.8% of total goat harvest in the state). For archery-only units, the peninsula accounted for an average of 47% of the statewide harvest.

During 1967 through 1979, only 1-3.5% of goat permits authorized in the state were for the Olympic Peninsula. A similar percentage of the state's goat hunters actually hunted on the peninsula. The 1990 hunt on the peninsula accounted for 18% of the permits authorized in the state and 18.5% of goat hunters in the state.

REFERENCES: Johnson 1967 - 1990; Johnson 1983

DATE: 1979-1980

PRIMARY INVESTIGATOR(S): Rolf L. Johnson

TOPICS: goat population dynamics

GEOGRAPHIC LOCATION: eastern ONF: Iron Mountain and Charlia Lakes

DESCRIPTION: During 1979 and 1980, 22 goats were captured and marked. The project objectives were to determine population numbers and to document migration or emigration. Blood and fecal samples were collected to gather baseline parasite/herd health data.

RESULTS: Four of the goats captured at Iron Mountain and Charlia Lakes had been previously captured at Klahhane Ridge or Mt. Constance within Olympic National Park.

In 1981, the goat population within Olympic National Forest was estimated at 150 animals. Population structure was determined: 80 kids/100 adult females; 120 yearlings/100 adult females; and 20 adult males/100 adult females. Mean age of goats captured was 1.7 years. "This age structure is certainly an indicator of high survival of younger animals," (Johnson 1983).

Fecal analysis of the goats revealed the following parasites: 98% of samples contained *Eimeria*; 91% contained *Strongyles*; 61% contained *Nematodirus*; 51% *Parelaphostrongylus* and 11% contained *Trichuris*. *Capillaria*, *Protostrongylus*, and *Skrjabinema* were found in 5% or less of the fecal samples (Johnson 1983).

All of the goat blood samples contained *Ostertagia* and *Protostrongylus*. None of the blood samples contained *Capillaria*, *Skrjabinema*, *Thysanosoma*, or *Trichostrongylus*. 63% contained *Chabertia*. *Eimeria* was found in 88% of Olympic samples. *Nematodirus* was documented in 50% of blood samples. 38% of Olympic samples contained *Oesophagostomum*, while 25% contained *Trichuris* (Johnson 1983).

Only one helicopter survey of marked goats was conducted in the Olympic National Forest tagging area. In August 1981, 33 animals were counted. The population was estimated at 45 adults and seven kids. It was estimated that the census accounted for 63% of goats within the survey area (Johnson 1983).

REFERENCES: Johnson 1980; 1983

DATE: 1981

PRIMARY INVESTIGATOR(S): Rolf Johnson and Bruce Moorhead

TOPICS: capture techniques

GEOGRAPHIC LOCATION: Washington State, especially Klahhane Ridge (ONP)

DESCRIPTION: Techniques used to capture mountain goats within Washington are discussed, with emphasis on dropnetting conducted within Olympic National Park.

RESULTS: Techniques used to capture goats successfully in Washington state included Clover traps, rope snares, and dropnets.

In 1981, 52 goats were captured by dropnet in Olympic National Park. This technique was effective in capturing goats on Klahhane Ridge where the animals were fairly tame and densities were high. However, dropnets were less effective in the Cascade mountains where goats are more cautious and densities are lower.

REFERENCES: Johnson and Moorhead 1982

DATE: late 1970s/early 1980s

TOPICS: salt sites

GEOGRAPHIC LOCATION: Iron Mt., Upper Gargoyle/Boulder Ridge Saddle and others

DESCRIPTION: At least two salt sites were established by WDW within Olympic National Forest for management/research purposes. Salt blocks were placed directly on the ground. It is likely that goats still utilize the area due to higher salt levels remaining in the soil. Although no longer actively salted by WDW, it is possible that the sites are maintained on an informal and unofficial basis by the public.

Rolf Johnson (1983) states, "During the current study, salt was packed into several potential trapping sites (throughout Washington State).... Mountain goats in the Olympics have a much greater craving

for salt (than goats in the Cascades and eastern Washington) and usually found each artificial salt lick within two weeks."

REFERENCES: Johnson 1983; Personal communication with staff

DATE: 1985

PRIMARY INVESTIGATOR(S): H. Max Zahn, Rolf Johnson, Al Rasmussen, et al.

TOPICS: population estimates

GEOGRAPHIC LOCATION: eastern portions of ONF

DESCRIPTION: Goat populations were surveyed on the forest during July and August 1985. An aerial census of goats in the Silver Lake Area was conducted on August 9 and 10, 1985.

RESULTS: Goats were observed in the following areas: Tyler Peak, Silver Lake, Mt. Cruiser, Mt. Washington, Mt. Elinor, Mildred Lakes, Mt. Church, Capitol Peak, Dry Mountain, Mt. Tebo, Mt. Henderson, and Mt. Skokomish. A total of 69 animals were counted. The counts were considered low due to a shift in goat habitat use because of unusually dry weather and poor visibility because of inclement weather during the survey.

In Goat Unit 43 (Silver Lake Area) 32 goats were seen and Rolf Johnson estimated the population at 80 to 100 goats.

REFERENCES: Johnson 1985; Zahn 1985

PRIMARY INVESTIGATOR: Allen W. Rasmussen

As part of the EIS process, the IGMT sent a letter to Mr. Rasmussen in 1992 requesting any documentation he might have relative to mountain goat research on the peninsula. In a September 26, 1992 letter to the Superintendent of Olympic National Park, Mr. Rasmussen stated that all reports concerning research he was involved with were submitted to WDW. He stated that he maintains personal files on Olympic mountain goats, but refused to make these files available for use in the planning process.

Other Research

DATE: 1855-1949

PRIMARY INVESTIGATOR(S): Victor B. Scheffer

TOPICS: history of introduction/dispersal, population parameters

GEOGRAPHIC LOCATION: Olympic Peninsula

DESCRIPTION: This report is a general description of wildlife populations, including goats, on the peninsula and related historical accounts.

RESULTS: Wildlife population estimates are included for mountain goats on the peninsula. For 1918-1924, no goats are reported; 1925-1929, 2 goats; 1930-1934, 7 goats, and 1935-1939, 13 goats.

The introduction of mountain goats to the peninsula in the 1920s is described. The report states that in 1949 "Goats are now distributed around two centers, the major one at Storm King and the minor one near the southeast corner of the Olympic Park. The extremes of the range are about 50 miles apart."

REFERENCES: Scheffer 1949

DATE: 1981

PRIMARY INVESTIGATOR(S): Nelsa M. Buckingham

TOPICS: vegetation

GEOGRAPHIC LOCATION: northern Olympic National Park

DESCRIPTION: This report contains information relating to populations of four special taxa of plants: *Astragalus cottonii* (later taxonomically reclassified as *A. australis* var. *olympicus*), *Oxytropis viscida*, *Senecio neowebsteri*, and *Synthyris pinnatifida* var. *lanuginosa*. The report was prepared for the Washington Natural Heritage Program.

RESULTS: Results are presented by species.

Astragalus cottonii: "Only four *Astragalus* sites were located, and only two of these represent established populations. It is known only from a very limited area in the north Olympics, where its total extent and existence is minimal and precarious.... With goats, deer, rabbits, and marmots present on the sites, it would appear that *Astragalus* is generally avoided by the larger animals.... Action should be taken to prevent habitat damage arising from preventable causes such as increased human or goat use.... The survival of *Astragalus cottonii* appears to be in precarious balance."

Oxytropis viscida: "Management should probably treat *O. viscida* with the special consideration given endemics (...with respect to preventing increased human or goat impact)...*Oxytropis* may be in a precarious survival balance." *Oxytropis* plants were documented in seven sites.

Senecio neowebsteri: Six populations were documented. The data sheet for one population notes "...greatly reduced seed production (due to insect damage) combined with existing goat impact might tip the balance toward extinction for this population."

Synthyris pinnatifida var. *lanuginosa*: This plant was documented at eight locations. "Animals appear to have limited influence on Synthyris.... It would appear that Synthyris is limited primarily by habitat availability. Therefore the only recommendations made concern the protection of existing habitat."

REFERENCES: Buckingham 1981

APPENDIX C. PREVIOUS NPS MANAGEMENT ACTIONS

NPS Environmental Assessments

Two environmental assessments leading to subsequent goat management programs were previously prepared by Olympic National Park.

Experimental Management Program

The 1981 environmental assessment concerned initiation of an experimental management program. The decision called for "annual removal of 50-60 goats from the Klahhane Ridge subpopulation during each of the next three years, and to establish a few goat-free areas, such as at Glacier Meadows or Flapjack. The effects of these actions will be monitored. Action toward further removals will be based upon research results..." (ONP 1981).

This management program was conducted during the early 1980s and contained several different components to evaluate capture techniques, sterilization procedures, to document impacts to vegetation and soils from goats, and to track population dynamics and trends. The results from the various projects of this program are presented in the research summary (appendix B, beginning on page 153).

Operational Management Program

The environmental assessment prepared in 1987 (ONP 1987) examined alternatives for mountain goat management and identified a preferred alternative of a goat-free core area with goat numbers controlled on the park periphery. Control methods included removal of as many goats as possible by live-capture/relocation followed by a shooting program to eliminate remnant populations in the core area and to prevent migration into goat-free areas. Live-capture and relocation would be used exclusively for the first three years. Park managers established goals for removal of 80 goats in 1988 and 120 goats in 1989. These goals were based on funding and personnel commitments. An additional goal was that capture-related mortality should not exceed 5%. Once captured goats left the park, relocations were coordinated by the Washington Department of Wildlife.

The operational management program which implemented the preferred alternative was initiated in 1988. The goal of removal of 80 goats was met in 1988 with capture mortality of 8.7%. Seventy-two of these goats were captured using chemical immobilization with darts discharged from a helicopter, while the remaining eight were caught with a netgun fired from a helicopter. Ninety-one percent of the animals were successfully relocated off of the peninsula. Capture operations began on May 20 and concluded on July 19. Actual capture attempts were possible on 34% of the days. The remainder of days were not suitable for goat operations due to poor weather, weekends (higher visitation), logistical delays, and conflicting ranger or helicopter duties (particularly emergencies).

During the second year of the operational management program, 67 goats were removed with 19% mortality. Fifty-four animals were successfully transferred to receiving agencies. The capture operation was conducted from June 21 through July 26. Flights took place on only 13 days. Poor weather, unscheduled aircraft maintenance and lack of a recipient agency precluded captures on the other days. On days when helicopter use was possible, capture success was limited by lack of goats

observed on flights and a large amount of aircraft time was expended in looking for animals. During 1989, park goats were in dispersed, low or medium density subpopulations.

Extensive written protocol and procedures were developed during the operational management program. These included project organizational charts, medical protocol for handling goats, protocol for accidental human exposure to Carfentanyl (a drug, used in darts, for immobilizing goats), equipment operating procedures, and annual operation summaries.

After the 1989 season, the operational management program was reevaluated and discontinued for several reasons:

-A risk analysis was conducted by Clark University and the University of Idaho. The report (July 1990) offered suggestions to enhance safety, however it also concluded, "the technical task demands performance that clearly pushes personnel and equipment to their physical, mental, and mechanical limits. It is not a task with significant buffer or 'forgiveness'" (Machlis et al. 1990, Tuler et al. 1992). "Pilots flying these missions said that they were often pushing their physical and experiential limits and the helicopter's performance limits. Helicopter landings were frequently required on steep slopes. Gusts of wind, up and down drafts and loose rock increased the danger of an accident during required full-power landings. In areas in which operations usually occurred, rotor clearance from obstruction, e.g., ledges or rock out-croppings, was often minimal." (Tuler et al. 1992) If a mechanical malfunction occurs, there is usually no flat, safe spot for an emergency landing in the Olympics.

-Early in 1990, the Department of Interior Office of Aircraft Services (OAS) prohibited one-skid, toe-in, and step-out helicopter landings unless essential for program accomplishment. In April, 1990, the park submitted a memo to the NPS Pacific Northwest Regional Office stating that these types of landings were essential for mountain goat live capture operations (Finnerty 1990). The memo requested Regional approval and assistance in obtaining final approval by OAS. OAS personnel visited Olympic National Park in May, 1990, to review technical aviation issues concerning the live capture program. The OAS report (Peterson 1990) states, "...the project's aviation activities involving [one-skid, toe-in, and step-out landings] have reached a point at which the degree of risk to park personnel for serious injury or fatality is high... it is my recommendation that you not attempt further helicopter operations utilizing single-skid or toe-in landings for capture and removal of mountain goats. The existing conditions of population distribution, terrain, weather, and helicopter performance simply make the risk unacceptable." These hazards were present during both of the management programs, however as goat densities declined capture attempts in increasingly difficult terrain were necessary and risks increased.

-Increases in goat capture-related mortality (from 8.75% in 1988 to 19% in 1989) were noted. The increased mortality was attributed to decreasing goat densities because at lower densities goats are more difficult to locate, and capture attempts are made in more hazardous terrain. The increased level of mortality is unavoidable at lower densities and the program may have been reaching the limits of using live-capture as a means of controlling goat populations at Olympic.

-Research indicates that rare plant taxa are concentrated in goat habitat along the park periphery and that goat populations are impacting native plant communities throughout the park. Control of goat densities within narrowly defined limits in perpetuity may not be possible due to precision of goat population and vegetation data required. Thus, the control program selected in the 1987 EA would not meet the park goal to protect or restore rare plants and ecosystems.

Artificial Salt Bait Sites Within Olympic National Park

During the EIS scoping process, the public identified a need for more information concerning the role of artificial salt licks on peninsula goat populations. Only salt sites within the park are discussed here. Salt licks outside the park are addressed in the WDFW and ONF portions of the research summary found in appendix B, beginning on page 153.

Sites on Klahhane Ridge

The ONP 1983 Mountain Goat Ecology and Management report stated that salt interest by goats was initially evident on Klahhane Ridge in the mid-1960s. Larry Lack placed temporary salt stations on Klahhane Ridge and Baldy Ridge in the early 1960s to determine if goats have a preference for plain, iodized, or mineralized salt. It is also possible that the public had been placing salt as bait for photographing or viewing goats on Klahhane Ridge in the 1960s. A salt bait site was established on the crest of Klahhane by park management in 1972 for live capture using foot snares and drop nets. This site was maintained throughout the experimental management program. Salting was discontinued at this site in 1984. During the early years, salt was placed directly on the ground. Leaching into the soil likely caused a long-term attraction for goats. From 1981 through 1984, salt was placed in a large rubberized tub to minimize leaching. Management use of salt baits was discontinued in 1984.

Sites in Other Areas of ONP

In the late 1970s, temporary salt baits were used to foot-snare goats in the Royal Basin area.

During the experimental management program, temporary salt bait sites were tried for various time periods in eight locations: Appleton Pass (2 summers), Mt. Dana (2 years), Mt. Ferry (1 summer), Ludden Peak (1 summer), Ice River Glacier on Mt. Olympus (1 summer), Mt. Carrie (2 summers), Mt. Constance (a few weeks), and Anderson Glacier Moraine (a few weeks). Salt was placed in rubber tubs at all sites and was removed in the fall. These salt sites were not successful for live capture operations because goat use was minimal or non-existent. Management use of salt baits was discontinued in 1984.

The ONP 1983 Mountain Goat Ecology and Management report lists fifteen sites of recorded salt interest by goats: Klahhane Ridge, Hurricane Hill, Appleton Pass, Royal Lake, Anderson Glacier, Mount Carrie, Mount Ferry, Glacier Meadows, Moose Lake, Sunnybrook Meadows, Constance Pass, Lake Constance, Dosewallips Campground, Home Sweet Home, and Flapjacks Lakes. In spite of recorded interest in salt, baiting resulted in goat captures at just five of these sites and only one goat was captured at Appleton Pass and Hurricane Hill.

Relationship to Goat Impacts

On Klahhane Ridge, goat impacts increased in an area immediately surrounding (within about 165 ft or 50 m) the salt site. However, the salt did not increase goat densities in the Klahhane Ridge subpopulation either seasonally or year-round. Studies of 130 tagged goats on Klahhane Ridge showed that most were residents of the area. They did not come from afar to consume salt for a few weeks in summer. The location of the salt site had no effects upon overall goat densities on Klahhane Ridge or on the studies of goat/vegetation relationships, since the nearest sample unit used in the

vegetation studies was located about .5 mi. (.75 km) distant (D. Houston and E. Schreiner, personal communication).

In areas of the park other than Klahhane Ridge, goat use of salt sites was minimal. Impacts directly associated with salt sites was, therefore, also minimal.

It is important to note that Schreiner's 1993 report on vegetation states that "No plots were placed near sites where salt had attracted goats."

APPENDIX D. EXPLANATION AND COMPARISON OF MANAGEMENT TECHNIQUES

Each management technique is described and evaluated in the first section of this appendix. A chart comparing the techniques follows.

Passive Techniques

Rope Snare

Description. A "noose" of braided rope is placed atop a circle of small stones near where animals naturally congregate or can be attracted by a bait of salt or urine (such as in the vicinity of popular backcountry campsites). Several rope snares may be setup around the central baited area to increase the chances of capture. Personnel wait for an animal to insert a leg into a snare. The noose is then closed with a rapid pull on the rope. The rope is kept taut while personnel finish capture using physical restraint. The technique is most effective on high-density populations of "semi-tame" animals which are habituated to the presence of people in the backcountry. It is difficult and dangerous to capture large, mature males using this method. The technique is most effective during the peak period of goat attraction to salt and minerals (late spring, early summer).

Uses at Olympic. This technique has been used extensively to capture individual goats for tagging, measurements, or other research related to population and distribution studies. In these situations, the animal is only handled briefly prior to release. The technique is well-suited to this use, as the equipment is minimal and lightweight.

When used in capture/translocation projects, the technique involves the same level of handling and transportation equipment as drop netting, but only captures one goat at a time. It is difficult to manage possible medical problems with goats captured by this method that will have to be held for extended periods of time. As with all "bait and wait" techniques, this capture method is relatively inefficient.

Potential for Future Use. Limited to none.

Other Traps and Snares

Description. Padded leg-hold traps and a wire bear snare (or Aldrich snare) were tried experimentally during passive capture operations conducted at Klahhane Ridge. Both types of traps were set along goat travel routes and trails in the vicinity of the main drop net site. There was a tendency for goats to become "trap shy" and avoid the drop net, yet these animals still remained in the area. The traps were set to intercept these animals. Anchor ropes were used to connect the traps to fixed features (trees, rocks). A rubber bungee cord was incorporated into the anchor rope to prevent animal injury. Neither type of trap was successful; no goats were captured.

Uses at Olympic. These techniques were tried on a limited, experimental basis and then abandoned.

Box traps (clover-type) have been used on a limited basis to capture mountain goats in other areas of the west. They are less efficient than other available passive techniques, and have not been used at Olympic.

Potential for Future Use. None.

Drop Net

Description. A square, 40 ft. x 40 ft. (12 x 12 m), large-mesh nylon net is suspended with four 6.5 ft. (2 m) corner poles and a 16 ft. (5 m) tall center pole over a bait site. Trace mineral salt blocks are commonly used for bait. A triggering device, either manual, electrical, or explosive (blasting caps) allows nearby personnel to release the suspended net when suitable animals walk beneath it. The net entangles the animals until personnel complete capture using physical restraint. A number of animals can be captured at once and nannies with kids can often be captured together. Drop netting is one of the safest capture techniques. Serious injuries to animals are very rare. The technique is practical and cost-effective when used on high-density, "semi-tame" populations accustomed to using a long-established salt or bait site. The equipment is bulky and heavy. A very large crew of experienced personnel is needed to restrain and subsequently move, process, and care for the animals until transported.

Uses at Olympic. Used extensively on the very high-density goat population on Klahhane Ridge. Attempted elsewhere on other subpopulations with no success due to the need to establish a bait site and gradually condition animals to human presence to prevent "trap shyness."

Potential for Future Use. Probably applicable on a very limited basis at sites of suspected high goat density. Expense and inefficiency are limiting factors to park-wide management programs.

Active Techniques

Net Gun (Ground)

Description. A three-barreled, shoulder-fired net gun was used to stalk individual animals until they were within range. The effective range of this particular net gun was approximately 32 ft. (10 m). The three barrels could be rotated to obtain different deployment patterns of the nylon mesh nets. The gun is very heavy and is not practical for use in the field on free-roaming animals.

Uses at Olympic. Used on a very limited basis during experimental capture trials in the early 1980s.

Potential for Future Use. None. Ground-stalking of mountain goats is impractical due to terrain hazards, lack of vegetative cover for personnel, and the ease with which animals can evade personnel on foot.

Net Gun (Aerial)

Description. The four-barreled Coda^R net gun fires a square net of varying mesh sizes. A fiberglass canister holds the net between the outward angled barrels. Weights from the net corners are inserted into the barrels. A blank .308 caliber charge propels the weights and deploys the net over a fleeing animal. When used for helicopter-assisted capture, the gunner sits behind the pilot with the aircraft door removed. Upon locating a suitable animal, the aircraft is used to maneuver the animal into position for netting. Terrain obstacles and aircraft performance constraints often limit the potential for capture of any specific animal. There is a potential hazard from the deploying net, which can strike the aircraft's rotors or entangle skids. The gunner waits until the pilot has positioned the aircraft to obtain the proper alignment relative to the animal. After the net gun is fired, personnel must immediately exit the aircraft to finish capture using physical restraint.

Uses at Olympic. This technique was used extensively during the operational management period. It is the second technique of choice for live-capture (following chemical immobilization). Its use is limited by several factors: 1) Many goats in Olympic are typically in locations where netting is not practical or prudent. 2) Because the net entangles the animal, the capture area must be free of cliffs or other terrain hazards. 3) Since personnel must exit the aircraft immediately after the net is deployed, suitable landing sites or the use of high-risk one-skid, toe-in, or heli-jumping techniques must be employed. 4) Physical restraint on large adult goats by one person in steep, rocky terrain is difficult. One person may be unable to complete restraint, apply hobbles, and prepare a large male for subsequent transport. There is high potential for personnel and goat injuries, except under ideal conditions. 6) The use of the net gun requires highly-trained and experienced personnel. It is very labor-intensive and fatiguing.

Potential for Future Use. In certain instances, the net gun is a very efficient capture technique. In early summer, animals pursued onto snowfields and glaciers may be easily and safely netted. There is no wasted aircraft time (as compared to chemical immobilization) because animals can be rapidly located and netted, or the pursuit aborted in favor of another animal. The minimal effective range of the gun limits applications to moderate slopes, which does not coincide with summer goat range in the Olympics.

Chemical Immobilization (Aerial)

Description. A helicopter is used to locate animals and serve as an aerial darting platform. A .22 caliber blank dart rifle firing a percussion-type syringe dart is used with a variety of chemical immobilizing agents. Animals are typically darted in the large muscle group of the hip. Drug induction takes an average of two minutes; induction time may increase if the animal is excited and has been chased for prolonged periods prior to darting. During the drug induction phase, the helicopter is used to maneuver the animal away from terrain hazards. When the animal becomes immobilized, personnel off-load from the aircraft and prepare the animal for transport. This need to quickly access the animal often results in the use of procedures to exit the helicopter which are very hazardous for employees. The animals are typically flown unconscious to a frontcountry staging area where they are revived using the appropriate antagonist drug.

The same limitations on helicopter landings as listed under aerial net gun apply to aerial chemical immobilization. An additional hazard for personnel is the potent narcotic immobilizing drugs. The preferred drug, carfentanil citrate, has an estimated clinical potency 10,000-15,000 times that of morphine. Highly toxic to humans, these substances require careful handling and storage. Protective

equipment and an emergency medical protocol with evacuation plan are required to protect the safety of crew members.

Uses at Olympic. This is the live-capture technique of choice. Most of the animals removed during the experimental and operational management programs were captured using this technique. It can be used in a variety of terrain and population density. The immobilizing agents have a wide dosage allowance, making them relatively safe for the animal. Some injuries and mortality can occur during the drug induction phase, especially if the animal is in steep terrain. As animals become anesthetized, the ability of the helicopter to influence their behavior is diminished.

Potential for Future Use. Limited. The operational management program was cancelled in 1989 at least in part due to the high level of risk for employee injury or fatality using this technique. Since then, the DOI Office of Aircraft Services has prohibited the use of one-skid, toe-in, and heli-jumping techniques. Future implementation of this technique would require modifications of procedures to eliminate the use of one-skid, toe-in, or heli-jumping techniques. This would mean more elapsed time before personnel could safely reach drugged animals. In some steep terrain, aerial chemical immobilization could not be used without the hazardous helicopter exits.

As goat densities decrease, the technique becomes less efficient and more costly to apply on a population-level, because search times greatly increase. Animals may become habituated to helicopter pursuit and become more wary over time. Animal mortality can unavoidably increase as more capture attempts are made in marginal circumstances of steep, mountainous terrain. In addition, the limitations of available immobilizing agents (as to induction time) make large-scale application of this technique on dispersed, low-density goat populations problematical.

Chemical Immobilization (Ground)

Description. This technique uses the same equipment and general procedures as aerial chemical immobilization, except animals are stalked by personnel on foot.

Uses at Olympic. Used on a limited basis to capture individual animals for research purposes, such as sterilization or contraceptive trials.

Potential for Future Use. Limited to none. The same constraints as those outlined for ground-based net gun use are applicable.

Drive Net

Description. Linear nets supported by poles are stretched across goat travel and escape routes. A helicopter is used to drive animals into the net. The net collapses, entangling the animal. Ground personnel hidden nearby finish capture using physical restraint.

Uses at Olympic. Used experimentally to capture animals for sterilization and contraception trials. As the technique is the most expensive and least efficient of any of the active capture techniques, it was abandoned.

Potential for Future Use. None. The technique is less efficient than other available techniques, and can only be used on populations in moderate terrain. The extensive precapture scouting and logistical requirements make this technique unwieldy.

Combined Tactics

Chemical Immobilization with Net Gun

Description. During capture attempts using chemical immobilization, occasionally the percussion dart will not discharge. At other times, the immobilizing drug does not take effect, even after multiple dosages. In these instances, the net gun can be used to finish capture of the animal.

Uses at Olympic. Used only on a contingency basis to complete darting captures which have developed problems. It prevents loss of an animal which would otherwise not be captured and allows recovery of contaminated dart components.

Potential for Future Use. None, except as a contingency technique.

Other

Manual

Description. During prolonged aerial pursuit of individual animals during darting or netting capture attempts, animals can sometimes be maneuvered toward moderate terrain. As the animals become exhausted, they are captured "manually" by using heli-jumping. The aircraft flies parallel to the animal's path until a crewmember can jump from an aircraft skid onto the animal. Capture is completed using physical restraint.

Uses At Olympic. Used on a contingency basis only.

Potential for Future Use. A last-resort, contingency technique only. Obviously, this is a very hazardous technique for personnel. Office of Aircraft Services prohibitions on certain landing techniques (one-skid, toe-in, heli-jumping) render this technique obsolete unless a waiver of these prohibitions can be obtained.

Lethal Tactics

Shooting (Ground)

Description. Animals are shot from the ground using high-powered rifles.

Uses at Olympic. Has been used on a limited basis to collect individual animals as biological specimens for research. Feasible only in areas where goat densities and moderate terrain make ground stalking feasible. Inefficient in collecting multiple specimens, as noise disturbance rapidly disperses other animals.

Potential for Future Use. Limited. Could be used to remove individual animals habituated to presence of people in heavily-used backcountry sites.

Shooting (Aerial)

Description. This technique has been widely used worldwide to manage animal populations. A variety of weapon types can be used. The technique is very efficient when used by personnel experienced in animal control work and knowledgeable of the behavior of the target species.

Uses at Olympic. Has been used at Olympic to collect a few biological specimens only. Shooting has not been used as a goat management tool at Olympic. Some simulations with aircraft flight patterns, pilot-gunner communication, and weaponry have been conducted.

Potential for Future Use. An efficient, humane, and cost-effective population reduction or elimination technique (McCullough 1994; Warren et al. 1992). Much safer for personnel than any available active capture technique. With skilled pilots and marksmen, potential efficiency (capture per unit of effort) is many times greater than the potential efficiency of any other technique.

Table 6. Comparison of Mountain Goat Capture Techniques Used in Olympic National Park During Experimental/Operational Management Programs, 1981-1989¹

Method	Precapture Requirements	Population Requirements	Selectivity	Multiple Capture	Safety of Personnel	Relative Safety of Goats	Relative Efficiency	Relative Cost per Animal ²
<u>Passive Techniques</u>								
Rope snare	Minimal	All densities	Good	No	Good	Good	Poor	Moderate
Other traps/snares	Minimal	High density	Poor	No	Good	Fair	Poor	Moderate
Drop net	Extensive	High density	Good	Yes	Good	Good	Fair	Moderate-High
<u>Active techniques</u>								
Net gun - ground	Minimal	All densities	Excellent	No	Fair	Poor	Poor	Moderate-High
Net gun - aerial	Minimal	All densities	Excellent	Yes	Poor	Poor	Good	Very High
Chemical immobilization Ground	Minimal	All densities	Excellent	No	Good	Fair	Poor	Moderate-High
Aerial	Minimal	All densities	Excellent	No	Fair	Fair	Good	Very High
Drive net	Extensive	Medium-high density	Poor	Yes	Fair	Poor	Poor	Very High
<u>Combined Tactics</u>								
Aerial chemical immobilization w/net gun	Minimal	All densities	Excellent	No	Fair	Fair	Poor	Very High
<u>Other</u>								
Manual (Heli-jumping following pursuit)	Minimal	All densities	Excellent	No	Poor	Poor	Poor	Very High
<u>Lethal Tactics</u>								
Shooting - ground ³	Minimal	All densities	Excellent	N/A	Good	N/A	Fair-Good	Very Low
Shooting - aerial ³	Minimal	All densities	Excellent	N/A	Good	N/A	Very Good	Very Low

¹ Modified from NPS 1987 by R.W. Olson 1993.

² Includes transportation from capture site to a frontcountry staging area, but excludes other expenses which would be associated with a goat management program, such as ground transportation to release site, vegetation monitoring, goat censusing, and equipment replacement.

³ Data based on biological collections on Klahhane Ridge, Mt. Dana, Mt. Appleton, Mt. Carrie; simulated aerial shooting trials on Mt. Dana; euthanasia during capture attempts; and review of other ungulate removal programs.

Description of evaluation criteria used in technique comparison table on page 215:

Precapture Requirements

Gives an estimate of the level of effort or planning required prior to using the technique. This includes reconnaissance, site preparation, equipment preparation, baiting, etc. Two techniques, drop net and linear drive net, require considerable logistical support using helicopters to position heavy, bulky capture equipment. Both also entail the use and transport of large numbers of personnel.

Population Requirements

Passive techniques, in particular, are most successful when used on high density subpopulations which have become habituated to humans.

Selectivity

Selectivity gives an idea of how effectively a specific animal (i.e., specific sex or size/age class) can be captured. When conducting capture/translocation programs, the receiving agency usually specifies a preference. Selectivity may also be an important factor when considering reproductive control techniques.

Multiple Capture

Evaluates the potential to capture more than one animal at a time with each technique. Also considered is the feasibility of capturing intact social groups, such as a female with kids.

Safety to Personnel

In this column the techniques are rated on how hazardous they are for personnel. NOTE: this assumes the use of experienced, trained persons familiar with mountain goat capture and restraint techniques, and experienced in helicopter operations in mountainous terrain.

Safety to Goats

The techniques are rated on how hazardous they are to the health of the animal being captured.

Relative Efficiency

This element reflects the expected number of mountain goats which can be captured or controlled per unit of effort (person/hours, person/days, etc.).

APPENDIX E. INFORMATION ON ESTIMATED COSTS OF THE ALTERNATIVES

Some assumptions were necessary to estimate the comparative costs of the alternatives as accurately as possible. The assumptions are based on past research at Olympic and on the experimental and operational management programs of the 1980s. A detailed action plan and risk assessment will be completed to implement the selected alternative. The plan will include factors such as the availability of funding. The actual program and associated costs may differ from those outlined here.

Costs were estimated for the first 10 years of implementation for each alternative. All costs are estimated in 1995 dollars. No adjustments were made for inflation during the ten year implementation period.

For all the alternatives, it was assumed that the initial goat population would contain up to 500 animals. The 1990 census estimated the population between 181-597 goats (with 95% confidence). The 1994 census estimated 225-351 goats (with 95% confidence). Statistically, there is no significant difference between these two census estimates.

For the action alternatives, it was assumed that priorities for subpopulation area action would be based on resource impacts, including rare plants and proposed wilderness management classes (as defined in the ONP Wilderness Management Plan), and on densities, fecundity, and population dynamics of each goat subpopulation.

If the Olympic Mt. milkvetch, a candidate species under the federal Endangered Species Act, is listed as threatened or endangered, actions and timetables for reduction/elimination of goats and for plant monitoring could be identified by the U.S. Fish and Wildlife Service in a species recovery plan. Actions specified in the recovery plan would then be taken. Costs would vary accordingly.

National Park Service Special Directive 94-5 promulgated operational guidelines for aerial capture, eradication, and tagging activities (NPS 1994). ACETA requires preparation of an action plan, including a risk assessment for implementation of action. Cost estimates for employee training and certification for alternatives 1 and 3 are based on requirements as specified in this directive. These training and certification costs assume little or no turn-over of personnel during the 10 year period of the estimates, although, in reality, it is likely that personnel would experience some turn-over. The estimates also assume that all employees involved in the programs would need to obtain all required training at the start of the goat management program, however, in reality, some employees would already possess some of the training requirements. For example, a helibase manager may have already attended training for wildland fire which would satisfy some of the ACETA requirements.

Personnel costs include base salaries and hazard pay, when appropriate. No costs for benefits, such as health insurance, were included. All personnel costs are based on 1995 salary figures. No adjustments were made for cost-of-living increases during the 10 year implementation period.

Helicopter costs were estimated at \$550 per hour plus fuel truck mileage.

Energy requirements were based on an estimated consumption of 20 gallons Jet A fuel per hour of helicopter operation. It was estimated that the fuel truck associated with helicopter operations might drive 10 miles on a gallon of diesel fuel. Fuel for ground transportation was estimated at 10 miles per gallon of unleaded gasoline.

Alternative 1. Eliminate Goats by Shooting Only

Operational Costs

Costs were estimated for an intensive 3-year program. It is possible that some level of action would be required for another year or two, but any such costs are not included in these estimates.

The aerial portion of the elimination program would typically be conducted with one contracted helicopter (and pilot) and three GS-9 NPS employees: one observer and two marksmen. A helispot or staging area manager would also be necessary. Operations would be conducted on three days per week. Approximately 5.5 hours of flight time would be anticipated each day. This type of work is too fatiguing to continue for 8 hours in a day. All salary costs would be regular time (not overtime) with hazard pay required for helicopter operations. The cost was estimated for an early summer (mid-May through mid-July) and fall (September) operation, totally 30 days each year for three years. Equipment costs (excluding the helicopter) were estimated at \$6,000 for the three-year program. Additionally, one vehicle would be needed for ground transportation of personnel to and from the helispot.

Employee training and certification during the elimination program would cost approximately \$10,000.

Ground-based shooting would be used in very limited circumstances incidental to other duties, so no costs were included for this portion of the program.

The initial elimination program would cost approximately \$337,000 over the three-year period.

The maintenance program was estimated to be a helicopter survey to eliminate any goats observed within the park. This program would likely be conducted every five years, but could be more frequent if necessary. On a five-year maintenance interval beginning at completion of the elimination program, the maintenance program would be conducted only once during the first 10 years of implementation (in year 8). Required employee training would cost approximately \$6,000. Costs for this program would be approximately \$27,000 during the 10 year period.

Monitoring Costs

Previously established milkvetch permanent plots would be monitored every year. New milkvetch permanent plots would be established in the Mt. Angeles area and monitored yearly. Community-level permanent vegetation plots would likely be monitored every year at Lake Constance, Klahhane Ridge and Mt. Dana during the first ten year period, and at 2-5 year intervals later.

Vegetation monitoring for alternative 1 was estimated at \$455,000 for the first 10 years of implementation.

No goat censusing would be conducted under this alternative.

Total Costs

Alternative 1 would be the most cost effective alternative to achieve goals for ecosystem protection and restoration. The relative cost per animal would be very low for a shooting program.

Cost of this alternative over the first 10 year period would be approximately \$364,000 for operations, including the initial elimination program and the first cycle of the maintenance program; and approximately \$455,000 for monitoring.

Future costs (beyond the initial 10 year period) would be minimal: approximately \$27,000 every five years for the maintenance program.

Energy Requirements

For the shooting program: helicopter was estimated to use about 9,900 gallons of Jet A fuel; fuel truck usage was estimated at 1,350 gallons of diesel fuel; and the ground transportation vehicle for personnel would use about 180 gallons of unleaded gasoline.

For the maintenance program: helicopter would use approximately 630 gallons of Jet A fuel; fuel truck would use about 90 gallons of diesel; and ground transportation for personnel would use approximately 30 gallons of unleaded gasoline.

For vegetation monitoring: helicopter support would use about 2,000 gallons of Jet A fuel over the first 10 years; the fuel truck would use about 300 gallons of diesel fuel over the first 10 years; and ground transportation for personnel would use 30 gallons of unleaded gasoline.

Alternative 2. No Action

Operational Costs

There would be no operational costs under alternative 2.

Monitoring Costs

Regardless of goat management programs, the National Park Service has a responsibility to protect park resources. Vegetation monitoring would be extensive with this alternative because of increased risks to communities and rare plants caused by increasing goat numbers.

The minimum estimate for a vegetation monitoring program could potentially include monitoring of:

- *Previously established permanent community-level vegetation plots on Klahhane Ridge only.
- *Existing milkvetch permanent plots.
- *New permanent milkvetch plots that would be established in the Mt. Angeles area.

*Permanent plots that would be established in populations of those rare species that are known from 5 or fewer locations in ONP.

The maximum estimate for a monitoring program would likely include yearly monitoring of:

*Previously established permanent community-level vegetation plots on Klahhane Ridge, Mt. Dana, and Mt. Constance.

*New community-level permanent plots that would be established in other areas, such as Appleton Pass and Royal Basin.

*Existing milkvetch permanent plots.

*New permanent milkvetch plots that would be established in the Mt. Angeles area.

*Permanent plots that would be established in populations of those rare species that are known from 5 or fewer locations in ONP.

Vegetation monitoring during the first 10 year implementation period would cost approximately \$522,000-\$965,000.

Goat population dynamics would still be an important factor in plant protection. A population census would likely be conducted every five years, using the same helicopter census design that was used in the 1990 census (Houston et al. 1991a). This census requires approximately 4.5 hours of helicopter counting time each day for seven days. During the first 10 year implementation period, three censuses would be conducted at a cost of approximately \$21,000 for each census (a total of \$63,000).

Total Costs

Estimated total cost of this alternative over the first 10 year period would be approximately \$585,000-\$1,028,000, including vegetation and goat monitoring. These costs would continue indefinitely.

Energy Requirements

Maximum energy requirements for this alternative would be:

Helicopter use for the three goat censuses during the first 10 year period would use approximately 1,890 gallons of Jet A fuel. Fuel truck use during the censuses would be about 315 gallons of diesel fuel. Ground transportation for personnel during the censuses would use approximately 126 gallons of unleaded gasoline.

Vegetation monitoring during the first 10 years of implementation would utilize the following amounts of energy: 1) the helicopter would use 2,000 gallons of Jet A fuel; 2) fuel trucks would use about 300 gallons of diesel; and 3) personnel ground transportation would use about 60 gallons of unleaded gasoline.

Alternative 3. Eliminate Goats by a Combination of Shooting and Live-capture

For cost analysis, it is assumed that a live-capture program would be conducted for one field season before the elimination program would begin. If a live-capture partner does not come forward within the specified time period, then NPS would begin a shooting program in the first field season and costs would be similar to those for alternative 1.

Operational Costs

The live-capture program would typically be conducted with one contracted helicopter (and pilot). Personnel involved are: a team leader, a technical animal handling specialist, four animal handling/medical protocol personnel, a helispot/staging area manager, a law enforcement/security person, two traffic control people, and a liaison to coordinate with WDFW. Operations would be conducted on three days per week. Approximately 8 hours of flight time would be anticipated each day. An eight-hour work period is possible because there is more physical and mental variety than during a shooting program. Personnel spend some time in the helicopter and some time on the ground while restraining and preparing the animal for transport. All salary costs would be regular time (not overtime) with hazard pay required for helicopter operations. The cost was estimated for an early summer (mid-May through mid-July) and fall (September) operation, totally 30 days. Equipment (excluding the helicopter) and expendable supplies were estimated at \$20,000. Additionally, three vehicles would be needed for ground transportation of personnel to and from the staging area.

Employee training and certification for the live-capture program would cost approximately \$17,000.

Total cost of the one-season live-capture program was estimated at \$215,000.

Costs to implement the shooting and maintenance programs would be very similar to alternative 1 costs and were included as follows:

Costs were estimated for an intensive 3-year program. It is possible that some level of action would be required for another year or two, but any such costs are not included in these estimates.

The aerial portion of the elimination program would typically be conducted with one contracted helicopter (and pilot) and three GS-9 NPS employees: one observer and two marksmen. A helispot or staging area manager would also be necessary. Operations would be conducted on three days per week. Approximately 5.5 hours of flight time would be anticipated each day. This type of work is too fatiguing to continue for 8 hours in a day. All salary costs would be regular time (not overtime) with hazard pay required for helicopter operations. The cost was estimated for an early summer (mid-May through mid-July) and fall (September) operation, totally 30 days each year for three years. Equipment costs (excluding the helicopter) were estimated at \$6,000 for the three-year program. Additionally, one vehicle would be needed for ground transportation of personnel to and from the helispot.

Employee training and certification during the elimination program would cost approximately \$10,000.

Ground-based shooting would be used in very limited circumstances incidental to other duties, so no costs were included for this portion of the program.

The initial elimination program would cost approximately \$337,000 over the three-year period.

The maintenance program was estimated to be a helicopter survey to eliminate any goats observed within the park. This program would likely be conducted every five years, but could be more frequent if necessary. On a five-year maintenance interval beginning at completion of the elimination program, the maintenance program would be conducted only once during the first 10 years of implementation (in year 9). Required employee training would cost approximately \$6,000. Costs for this program would be approximately \$27,000 during the 10 year period.

Monitoring Costs

Previously established milkvetch permanent plots would be monitored every year. New milkvetch permanent plots would be established in the Mt. Angeles area and monitored yearly. Community-level permanent vegetation plots would likely be monitored every year at Lake Constance, Klahhane Ridge and Mt. Dana during the first ten years, and at 2-5 year intervals later. Vegetation monitoring for alternative 3 was estimated at \$455,000 for the first 10 years of implementation.

No goat censusing would be conducted under this alternative.

Total Costs

Alternative 3 would be the most expensive of the three alternatives, although the substantial costs of the live-capture program may be borne by an agency or organization other than NPS. The relative cost per animal is very low for the shooting program, but high for the live-capture program.

Total cost of this alternative over the first ten year period would be approximately \$579,000 for operations, including the live-capture and shooting programs and the first cycle of the maintenance program; and approximately \$455,000 for vegetation monitoring. Substantial operational costs for implementation of the live-capture program (approximately \$215,000) may or may not be funded by NPS.

Future costs (beyond the initial ten year period) would be minimal: approximately \$27,000 every five years for the maintenance program.

Energy Requirements

Energy requirements for the live-capture program would likely be as follows: 1) aircraft would use approximately 4,800 gallons of Jet A fuel; 2) the fuel truck would use about 450 gallons of diesel fuel; and 3) ground transportation for personnel would use about 540 gallons of unleaded gasoline.

Energy requirements for the three-year shooting program would be similar to those in alternative 1. The helicopter would likely use 9,900 gallons of Jet A fuel, while the fuel truck would require 1,350 gallons of diesel fuel and ground transportation for staff would require 180 gallons of unleaded gasoline.

Energy requirements for the first cycle of the maintenance program would also be similar to those for alternative 1. The helicopter would be expected to use about 630 gallons of Jet A fuel, while the fuel

truck would use about 90 gallons of diesel and personnel ground transportation would use about 30 gallons of unleaded.

Likewise, energy required for vegetation monitoring under alternatives 1 and 3 would be quite similar: helicopter support would use about 2,000 gallons of Jet A fuel over the first 10 years; the fuel truck would use about 300 gallons of diesel fuel over the first 10 years; and ground transportation for personnel would use 30 gallons of unleaded gasoline.

Table 7. Comparison of Costs for Each Alternative

Program Component	Alternative 1: Eliminate All by Shooting (Preferred Alternative)	Alternative 2: No Action	Alternative 3: Eliminate All by Combination
Live-capture	N/A	N/A	\$215,000
Shooting	\$337,000	N/A	\$337,000
Maintenance (one cycle)	\$27,000	N/A	\$27,000
Vegetation Monitoring	\$455,000	\$522,000-\$965,000	\$455,000
Goat Population Monitoring	N/A	\$63,000	N/A

APPENDIX F. EVALUATION OF INFORMATION RELATIVE TO THE PRESENCE OF GOATS ON THE OLYMPIC PENINSULA PRIOR TO THE 1925 INTRODUCTION (Excerpts from Exotic/Native Review Materials)

During the scoping process for this document, some members of the public raised questions about the presence of goats on the Olympic Peninsula prior to their introduction in the 1920s (i.e., whether goats are an exotic species in the park). This was partly in response to a 1988 article by Dr. R. Lee Lyman. The National Park Service thoroughly re-examined all relevant evidence on this question and three reports were produced. All three documents, plus Dr. Lyman's 1988 report, were reviewed by nine independent experts selected by professional societies (The American Society of Mammalogists, the Forest History Society, and the History of Science Society) and the Department of Interior Consulting Archeologist. A summary of the peer reviews follows the four document summaries. The full text of all 13 documents are available from Olympic National Park.

Further discussion of this issue can be found in several published references, such as Scheffer 1993a; Anunsen 1993; Scheffer 1993b; and Lyman 1994.

TITLE: A Review of the Ethnographic and Archaeological Evidence Relating to Mountain Goats in the Olympic Mountains

PRIMARY INVESTIGATOR: Dr. Randall F. Schalk, INFOTEC Research, Inc.

DESCRIPTION: "The objective of the present study is to review and summarize the anthropological evidence pertaining to the existence of mountain goats on the Olympic Peninsula. Two kinds of anthropological data are available and of direct relevance to development of reliable knowledge about the former existence of the mountain goat in this region. The first is ethnography - the written records documenting the cultures of the native people of the Olympic Peninsula The second is the archaeological record.... The purpose of this effort is not only to carefully examine the evidence but also to consider the adequacy of these data sources.... This review relied not only on published reports and unpublished written records, but also on consultation with numerous anthropologists who have conducted research in this region" (Schalk 1993).

Dr. Schalk consulted 35 anthropologists or archeologists and approximately 124 references in this report.

RESULTS:

Ethnographic Evidence. "A review of ethnographic documents for the Olympic Peninsula indicates that this region's mammalian fauna did not include mountain goats in the nineteenth century. Multiple and independent ethnographic sources unequivocally support this conclusion, which goes well beyond negative evidence or simple failure to mention mountain goats.... In addition to these substantial and direct ethnographic data...this conclusion is supported indirectly as well. There are three types of indirect ethnographic evidence. First, the ethnographies document the keeping of wool dogs by the Quinault, Quileute, Makah, Klallam, and Twana.... The second kind of indirect evidence comes from the ethnographic sources for surrounding regions.... These sources corroborate that interregional trade systems existed in which mountain goat wool was exchanged for other resources and that the sources for goat wool were the Cascades of Washington and the Coast Range of British

Columbia. A third line of indirect evidence for the absence of mountain goats in the region is the apparent lack of reference to this animal in folklore, mythology, and decorative art" (Schalk 1993).

Archeological Evidence. "A review of the available archaeofaunal data from the Olympic Peninsula indicates that mountain goat bones have not been identified in any site in this region... Mountain goat bones have not been reported from a single archaeological site. Mountain goat horns, however, were reputedly recovered in one instance - at La Push. Considering the extent of the trade in mountain goat wool and horn along the Northwest Coast, even well documented occurrences of these materials would not constitute evidence for the presence of mountain goats in the Olympic Mountains... Because of limitations of sample size, distribution, and temporal range, the present archaeofaunal data do not allow conclusive statements regarding the presence of mountain goats in the Olympics during the Holocene or Late Pleistocene..." (Schalk 1993).

TITLE: A Review of the Historical Evidence Relating to Mountain Goats in the Olympic Mountains

PRIMARY INVESTIGATOR: Dr. Susan Schultz, Olympic National Park

DESCRIPTION: "The present report reviews early accounts of explorations of the Olympic Peninsula, paying special attention to wildlife observations and statements concerning the presence or absence of mountain goats prior to their 1925 introduction. Historic references to the use of mountain goat wool in the Puget Sound area are also considered. A variety of sources was consulted, including published expedition narratives; early newspaper accounts; U.S. Geological and Biological Survey published reports and unpublished field records; catalogues of mammals; territorial governors' reports; U.S. Forest Service files; selected nineteenth and early twentieth-century literature on natural history, recreation, and game hunting; as well as unpublished field notes, journals, and correspondence. The research involved visits to the Smithsonian Institution, the Library of Congress, the Bancroft Library of the University of California at Berkeley, and other reference libraries" (Schultz 1993).

Dr. Schultz researched approximately 140 historic references in preparation of this report.

RESULTS: "This review of historical records of wildlife observations on the Olympic Peninsula includes conflicting reports concerning the presence of mountain goats. Spanish explorers, S.C. Gilman, and a newspaper summary of the Press Expedition mentioned that goats were present. In addition, several nineteenth-century ethnographic writers, as well as the Spanish explorers and Captain Vancouver, mentioned the use of mountain goat wool by Native Americans in the Puget Sound region. On the other hand, at least three other pre-1925 discussions of Olympic Peninsula wildlife state positively that goats were not present. Early naturalists describing the known range of mountain goats in North America do not include the Olympic Mountains. Several biologists writing about Washington mammals, after the 1920s, state that mountain goats were not native to the Olympic Mountains. The remainder of the reports by recreationists and wildlife biologists which list Olympic mammals do not include goats" (Schultz 1993).

"Because goats were not mentioned in the majority of cases, however, it does not logically follow that they were not observed or were not present. To assert this would be to succumb to the 'fallacy of negative proof' --claiming that because these observers provided no evidence of goats, they prove that goats weren't there. Nevertheless, the considerable amount of negative evidence (failures to mention goats among mammals observed in the Olympics) does not lack significance. By examining the thoroughness and quality of, and the reasons for, the observations of those who do not mention goats, a reasonably accurate assessment can be made of whether or not such observers would have

mentioned goats if they had noticed them, and how likely they would have been to have seen them if, in fact, goats had been present" (Schultz 1993).

"The Fund for Animals has cited three sources to support a contention that mountain goats are native to the Olympic Mountains: the 1896 National Geographic article, the 1890 Seattle Press article, and John Dunn's 1844 comment that the Indians at Cape Flattery wove blankets of goat wool. Randall Schalk (1993) has demonstrated that the historic use of goat wool does not prove the presence of mountain goats on the Olympic Peninsula. The other two references to goats being present on the peninsula are unsupported by any observational detail. Neither account provides any information on the circumstances, location, or date of a specific goat sighting, nor a description of the animal. When weighed against the numerous, detailed observations provided by skilled wildlife observers who did not find evidence of goats during this same period, such reports are clearly of questionable credibility. Establishing the composition of the historic fauna of the Olympic Mountains has required the consideration of many accounts from various sources and a careful evaluation of their reliability. No compelling evidence has been found in the present review to suggest that mountain goats actually occurred on the Olympic Peninsula prior to their introduction in 1925" (Schultz 1993).

TITLE: Extract from Draft Monograph Regarding Mountain Goats in Olympic National Park

PRIMARY INVESTIGATORS: Dr. Douglas B. Houston and Dr. Edward G. Schreiner, National Biological Service - stationed at Olympic National Park

DESCRIPTION:

"Of particular interest is the evolution of endemic forms, the reduced mammalian species diversity compared to more 'mainland' continental regions, and the presence of plant taxa with intriguing, often disjunct, distributions. Here we examine the biogeographic character of the Olympic biota, with emphasis on mammals and vascular plants. Findings are interpreted in relation to concepts of geographical ecology within the context of western North America" (Houston and Schreiner 1993).

RESULTS:

"Features of the geographic setting and landscape level events that have strongly influenced evolution of the Olympic biota include: (1) The mountainous peninsular landform, sculpted repeatedly by glaciers of different origins and coverages; (2) The temporally varying isolation of the area as a peninsula and associated changes in land mass as sea level and ice cover fluctuated ...; (3) The strategic location of the peninsula at the southwest corner of the massive Cordilleran Ice Sheet during the Fraser Glaciation; (4) The isolation for at least 10 millennia of subalpine and alpine areas as 'habitat islands' in the mountain range, surrounded by forest and water (Barnosky 1984); (5) The sharp precipitation and elevation gradients that have yielded a broad array of habitats within a comparatively small area; (6) The moderating influence of the Pacific Ocean on climate.... The terrestrial mammal fauna (48 species, excluding bats and marine mammals) of the Olympic Peninsula is impoverished compared to the nearby Cascade mountains. Based upon surveys and collected specimens, early naturalists and mammalogists reported 12 species absent from the Olympic Peninsula, although suitable habitat seemed to be present" (Houston and Schreiner 1993).

"Mammals 'missing' from the landbridge island faunas encompass species that were absent historically from the Olympics as well, including the mountain goat. As with the Olympics, this means either: (1)

the species failed to colonize because of environmental barriers, or (2) earlier populations met extinction. That unoccupied habitat exists for additional species is suggested by the success of deliberate introductions" (Houston and Schreiner 1993).

"Overall, the species diversity and endemism characteristic of the terrestrial mammal fauna on the Olympic Peninsula seem broadly comparable to landbridge islands along the glaciated west coast of North America. It is the *particular assemblage* of extant and endemic forms that stamps the Olympic fauna unique. Species absent historically from the Olympics were also absent from landbridge archipelagos" (Houston and Schreiner 1993).

TITLE: Significance for Wildlife Management of the Late Quaternary Biogeography of Mountain Goats (*Oreamnos americanus*) in the Pacific Northwest, U.S.A.

PRIMARY INVESTIGATOR: Dr. R. Lee Lyman, Department of Anthropology, University of Missouri - Columbia

DESCRIPTION: "The conclusion that mountain goats are not native to the Olympic Peninsula is based on negative evidence. It is tenuous to argue a species was not present in an area even when fossil localities and archaeological sites in that area have been examined (Grayson, 1981). To argue a species was not present without having truly looked for it is even more tenuous.... The most reasonable position is to hypothesize mountain goats were present in the Olympic Mountains during the late Quaternary. This hypothesis requires that the route and timing of dispersal be modeled. The model should also account for the apparent early twentieth-century absence of mountain goats from the Olympic Mountains" (Lyman 1988). Lyman then attempts to create such a model.

RESULTS: "I conjecture that prior to 18,000 BP, *O. americanus* occupied the Washington Cascades.... Between 17,500 and 13,500 BP,...mountain goat populations in Washington's southern Cascades were overcrowded, and as a response dispersed southward across the Columbia River (when it was frozen over?) to the Oregon Cascades.... Some also dispersed westward from Washington's southern Cascades across the Puget lowland and then northward to the Olympic Mountains" (Lyman 1988).

"The model I have proposed must be subjected to testing with data from the prehistoric record. If my model is correct, *Oreamnos* remains 15,000± 2,500 yr old should be found in the Puget lowland and Columbia River gorge.... Remains of this taxon dating throughout the last 18,000 yr should also be found in the Olympic Mountains, Oregon Cascades, northern California, and eastern Oregon.... Discovery of any such remains would lend strong support to the hypothetical dispersal model outlined here" (Lyman 1988).

"I suspect that at the beginning of the Holocene some 10,000 yr ago, mountain goat populations disjunct from the southern Cascades...may have been isolated on or near...the Olympic Mountains...(this population) may have...represented a biogeographic 'island' on which random extinction events took place.... It is not difficult, then, to suggest the hypothetical prehistoric mountain goat population of the Olympic Peninsula had become extinct prior to the early 20th century, or was so small as to have escaped detection by early biologists" (Lyman 1988).

PEER REVIEWS OF ABOVE DOCUMENTS:

REVIEWER: Dr. Thomas R. Cox, San Diego State University (selected by the Forest History Society)

Schalk document. "Dr. Schalk provides a comprehensive survey of the available ethnographic and archaeological data bearing either directly or indirectly on the question of the prehistoric presence or absence of mountain goats on the Olympic Peninsula.... Dr. Schalk weighs the...data carefully and reaches judicious conclusions. This reviewer is persuaded both that Dr. Schalk's work is thorough and that his conclusions are the logical ones to reach through study of the data presented" (Cox 1993).

Schultz document. "Her analysis of the sources is even-handed and judicious..." Cox makes several suggestions for improvement of the document, but concludes "Dr. Schultz's general conclusions hold up in spite of the minor caveats expressed above. A central challenge for historians is assessing the reliability and relative credibility of conflicting sources. Dr. Schultz does this well. She notes that those sources suggesting that mountain goats might have been present in the Olympics are all suspect in one way or another, while the major ones suggesting that mountain goats were absent were quite credible...evidence too strong to allow a responsible historian to come to any other conclusions than that mountain goats were not present in the Olympics in the historical period until introduced by man in the 1920s" (Cox 1993).

Houston/Schreiner document. Dr. Cox makes a few suggestions for improvement of the document. He then concludes "Drs. Houston and Schreiner have provided a sound, carefully focused survey. Their research is impressive" (Cox 1993).

Lyman document. "Dr. Lyman says that the discovery of mountain goat remains in the Olympic Peninsula would provide strong support for the dispersal model he outlines. Of course. But the fact remains, no such finds have been unearthed in spite of numerous archaeological excavations on the peninsula; indeed, the list of digs is both longer and in locations more relevant to the question at hand than Dr. Lyman makes it appear.... It is possible that the hypothesis presented by Dr. Lyman is valid, but there is little evidence to support it. Moreover, much of the evidence presented by Dr. Lyman is flawed and the logic used to connect it to the question at hand is open to serious question. At various points the arguments used border on the downright specious" (Cox 1993).

General comments. "In the end only one conclusion is possible: there were never mountain goats in the Olympics prior to the 1920s. Chances that mountain goats were present seem so remote as to be of negligible importance" (Cox 1993).

REVIEWER: Dr. Paul Lawrence Farber, Oregon State University (selected by the History of Science Society)

Schalk document. "The ethnographic and archaeological reviews by Dr. Schalk strongly support the conclusions of the historical review" (Farber 1993).

Schultz document. "Dr. Schultz's review presents a convincing case that the historical record does not provide evidence that mountain goats were found in the Olympic Mountains prior to 1925. Although a few early reports mention goats, the credibility of the references are low" (Farber 1993).

Houston/Schreiner document. "Drs. Houston and Schreiner... argue that the mountain goat is but one of many species found on the adjacent mainland, but not found in the Olympic Peninsula.... (They) relate this ecological situation to the geological and geographical history of the region" (Farber 1993).

Lyman document. Dr. Lyman "...hypothesizes that mountain goats were among the species that possibly crossed the Puget Trough and colonized a habitat that was suited ecologically to them. This is, of course, a possibility. But without any historical, ethnographic, archaeological, or paleontological evidence to back the claim, and in light of the impoverished fauna of the Olympic Peninsula, which suggests many possible species didn't colonize the peninsula, it is at present a weak and unsupported speculation" (Farber 1993).

General comments. "The historical and ethnographic evidence convincingly suggest the lack of mountain goats in the Olympic Mountains from the late eighteenth century until their introduction in the 1920s. Such evidence does not preclude their existence earlier during the late Quaternary" (Farber 1993).

REVIEWER: Dr. Gay Frederick, Royal Provincial Museum, Victoria, British Columbia (selected by the DOI Consulting Archaeologist)

Schalk document. "Schalk has competently summarized the existing ethnographic record...these points are strong support for the lack of direct access to mountain goats by peninsula tribes. While this cannot be taken as direct evidence of the absence of mountain goats from the Olympic Range, it is certainly indirect evidence of such. One must characterize the ethnographic record not as a poor indicator of the presence or absence of mountain goats in the Olympic Mountains, but as one that indirectly supports the absence of mountain goats in the Olympic Range during the 1700s and 1800s" (Frederick 1993).

The "archaeological evidence is in agreement with the ... summarized ethnographic and historic evidence" (Frederick 1993).

Schultz document. "Schultz's review of the historical record is considerably more extensive (than Lyman's).... The written historical evidence, then, tends to support the view that there were no mountain goats on the Olympic Peninsula during the 1750s to the 1850s and more strongly supports the contention of their absence for the period 1850s to early 1900s. Contrary to Lyman's contention, at least some of the 1890s explorations did pass through prime goat habitat, finding no evidence of goats" (Frederick 1993).

Houston/Schreiner document. Dr. Frederick reviewed this document, but did not specifically address it in her report.

Lyman document. "It is apparent that the historical records consulted by Lyman...were not exhaustive of the available documentation" (Frederick 1993).

General comments. "Taken in conjunction, the historical, ethnographic, archaeological and biological data available at this time support the contention that mountain goats were not present on the Olympic Peninsula prior to their deliberate introduction in the 1920s. Much of this data is negative rather than positive, but the agreement between the four types of data lends greater support to the theory of absence than that of hypothetical presence. The possibility still exists that mountain goats were present early in the Holocene and became locally extinct prior to the 1750s and the beginning of

written historical record, but it seems more likely that they have not formed part of the indigenous fauna of the Olympic Peninsula in the Holocene. Paleontological evidence for the post glacial time period from the alpine/sub-alpine regions of the peninsula is required to better evaluate the strength of this statement. Until such evidence is available, this question remains open, but present evidence supports the position that mountain goats were absent from the post glacial fauna of the Olympic Peninsula until their deliberate introduction in the 1920s" (Frederick 1993).

REVIEWER: Dr. Mott T. Greene, The University of Puget Sound (selected by the History of Science Society)

Schalk document. "This is a complete, scientifically accurate, carefully worded and conservative study of all the available material on Olympic archaeology and ethnography. It is a model of thoroughness. It shows convincingly that in the whole record there is but a single archaeological claim of goat bones, that by Reagan (1917), who footnoted his own claim to remark that he was speaking of horn spoons.... In the whole ethnographic record there is no account of hunting mountain goat or seeing mountain goat by any of the peninsula peoples and bands, though there are very many attestations of obtaining mountain goat wool by trade.... This evidence points very strongly toward the conclusion that native peoples subsisting on the peninsula had no access to goats, except through trade for goat wool with mainland peoples" (Greene 1993).

Schultz document. "This document is the most complete historical survey of natural-historical explorations and historical accounts of exploration of the Olympic Peninsula produced to date. It employs the full range of documentation.... The weight of the evidence in the historical record as presented here (and I believe this record to be accurate and complete) indicates that throughout the historical period there is not a single reliable or documented sighting of a mountain goat, or of the spoor, scat, physical remains or habitation traces of mountain goats on the Olympic Peninsula prior to introduction of same in the 1920s, in spite of repeated and extensive expeditions...looking for these highly visible, gregarious animals in a very restricted geographical area" (Greene 1993).

Houston/Schreiner document. "The biogeographical evidence, set in a context of geological rather than human history, argues very strongly that mountain goats failed to colonize any of the landbridge or habitat islands from Alaska to the Olympics.... The authors have done an excellent job in collecting data on plant endemism, vascular plant distribution and diversity of terrestrial mammals in making their cautious but instructive comparison to the islands and archipelagoes further North" (Greene 1993).

Lyman document. "...his argument is entirely conjectural, offering no evidence on behalf of (the) hypothesis he supports and refuting none of the evidence offered in favor of the hypothesis he opposes.... The argument by general induction from phenomena has been made (no native goat population or sign or remnant of one) and Lyman has attempted to evade the argument from induction by a hypothesis (there might have been native goat population even though there is no evidence). The whole history of modern science is unanimous in not according arguments of the latter class scientific standing - 'until such time as other phenomena occur' - that is, until they produce evidence. Since Lyman produced no evidence of any sort -- but merely imagines how things might be different, his argument has no scientific standing whatever" (Greene 1993).

General comments. The Schultz, Schalk, Houston/Schreiner documents "...point very strongly toward the conclusion that the mountain goat (*Oreamnos americanus*) was, prior to its introduction to the peninsula in the 1920s, absent from the Olympic Peninsula in historic, prehistoric, and late Quaternary

time.... Lyman's approach to the available evidence is both unduly restrictive and at variance with commonly accepted canons of scientific procedure" (Greene 1993).

REVIEWER: Dr. Barbara Lane, Victoria, British Columbia (selected by DOI Consulting Archaeologist)

Schalk document. Dr. Lane notes that her comments are limited to the ethnographic data. She describes some additional ethnographic data that was published after Dr. Schalk wrote his report and also discusses some linguistic evidence. She states, "...the newly published data...are consistent with and provide added support for Dr. Schalk's conclusions based on a review of the earlier ethnographic record" (Lane 1993).

Schultz document. "Dr. Schultz provides a comprehensive analysis of all known accounts by visitors to the region which contain mention of mountain goat, or which might have been expected to mention mountain goat.... Dr. Schultz presents a clear discussion of the kinds of criteria she applies in weighing the historical accounts. She concludes that the record indicates that mountain goats were not present in the Olympic Mountains in the historic period. Her conclusion is clearly warranted by the evidence" (Lane 1993).

Houston/Schreiner document. Although this document was sent to Dr. Lane, she does not mention it in her review.

Lyman document. "Dr. Lyman's discussion of the evidentiary record is unsatisfactory because it simply asserts that the lack of evidence regarding mountain goat is a function of the record. No discussion of data or context is provided to assess the weight to [be] placed on the absence of evidence. Evidence in the record which is counter to his hypothesis is simply not discussed.... Dr. Lyman's discussion of the evidence is superficial and not persuasive" (Lane 1993).

General comments. "I agree with the conclusions reached by Dr. Schultz and by Dr. Schalk that the evidentiary record provides no support for the hypothesis that mountain goat may have been native to the Olympic Mountains. On the basis of the evidence adduced and analyzed by Dr. Schultz and by Dr. Schalk, I find that the absence of evidence provides strong indication that mountain goats were not present in the Olympics in historic times. Further, the ethnographic record contains specific denials that this species was present on the Olympic Peninsula.... Dr. Lyman's speculations and hypotheses are interesting and appropriate as an academic exercise, but conjectures as to what might have been in the Pleistocene or Holocene cannot be bases for practical decisions concerning mountain goat management in the present" (Lane 1993).

REVIEWER: Dr. R. Lee Lyman, University of Missouri - Columbia

Schalk document. "This is a truly excellent, and largely even-handed and mostly complete account of the available evidence.... At present there is simply no archaeological evidence that leads me to believe mountain goats were native to the Olympic Peninsula.... I am presently developing one way to build a conclusive argument for the absence of prehistoric mountain goats from the Olympics..." (Lyman 1993a).

Schultz document. "Schultz has produced a very good draft report. However, my reading of it leads me to suspect she did not want to find historic evidence of goats and in fact wanted to conclude that goats were not present in the Olympics prior to 1925..." (Lyman 1993a).

Lyman document. "That I can build such a model or scenario (as I did in my 1988 article), of course, does not mean that goats were present in the Olympics prior to 1925" (Lyman 1993a).

General comments. Dr. Lyman made several recommendations for improvement of the Schalk and Schultz documents.

REVIEWER: Dr. Brian A. Maurer, Brigham Young University (selected by American Society of Mammalogists)

Schalk and Schultz documents. "The evidence presented by these authors seems to me to indicate that it is highly unlikely that the mountain goat was present in the Olympic Mountains during the last several hundred years covered by the historical record" (Maurer 1993).

Houston/Schreiner document. "Houston and Schreiner's analysis of the present day biogeography of the park suggest that dispersal to the Olympic Peninsula during the last glacial period was selective and therefore, it is just as tenable to take the view that the goats never colonized the Olympics as to hypothesize that they did" (Maurer 1993).

Lyman document. "...on the point of the paleontological record, Lyman apparently draws a faulty conclusion regarding the negative paleontological record. He states that we cannot conclude that the mountain goat was absent when the fossil data are so few. He also states, however, that it is faulty to conclude...that the goat must have been present. Yet he draws the contradictory conclusion: 'The most reasonable position is to hypothesize mountain goats were present in the Olympic Mountains during the late Quaternary' (Lyman 1988). It seems that the most reasonable approach is to suspend judgement regarding the presence of the goat [during the Quaternary] until more data have accumulated" (Maurer 1993).

General comments. "At this juncture, I am inclined to conclude, tentatively, that even if Lyman's hypothesis is correct, it may be irrelevant to the current debate regarding mountain goats in Olympic National Park. It seems that if goats were ever present in the Olympics, they were never able to establish large enough populations to allow them to persist prehistorically. Therefore, the current population, which is with little doubt the consequence of human introductions, should be considered to be exotic" (Maurer 1993).

REVIEWER: Dr. Madonna L. Moss, University of Oregon (selected by the DOI Consulting Archaeologist)

Schalk document. "Schalk does a masterful job of integrating a variety of types of ethnographic and archaeological data. His review supports Schultz's finding that goats were not present historically" (Moss 1993).

Schultz document. "The Schultz paper is a thorough and detailed review of the historical evidence.... I think she makes a strong case that mountain goats were not present historically on the Olympic Peninsula" (Moss 1993).

Lyman document. Dr. Moss reviewed Lyman's work, but did not specifically comment on it in her report.

General comments. Dr. Moss made several suggestions for further work to clarify whether mountain goats were present on the peninsula during the Holocene period.

REVIEWER: Dr. H. Duane Smith, Brigham Young University (selected by American Society of Mammalogists)

Schalk and Schultz documents. "...the reviews of Schalk and Schultz are very thorough. They fairly present the recorded evidence both supporting and refuting the presence of mountain goats in the Olympic Mountains. They both take the position that mountain goats were not historically present and adequately defend their position by presenting conflicting reports and discussing alternative explanations of the limited supportive statements" (Smith 1993).

Houston/Schreiner document. "The Houston and Schreiner manuscript is well written and supports the position of the Park Service" (Smith 1993).

Lyman document. "Lyman's reasoning throughout his paper is mainly supposition and conjectural and can be used against his hypothesis as well as for it..." (Smith 1993).

General comments. "In conclusion, my review of these documents and previous experience with goats and other mammals leads me to support the position that mountain goats did not prehistorically nor historically occupy the Olympic Mountains prior to their introduction. Therefore, they should be treated as an exotic rather than a native species and be managed to protect and maintain the ecosystem..." (Smith 1993).

REVIEWER: Dr. Harold K. Steen, Duke University (selected by the Forest History Society)

Schalk document "I am most influenced by Randall Schalk's... work.... If goats had existed on the peninsula during the time period studied, a resource that valuable would have left abundant evidence" (Steen 1993).

Schultz document. "Ms. Schultz's historical work was most competent and readable.... I found it to be properly balanced.... I believe she is correct in interpreting the absence of goat references in the large majority of the sources as reasonable proof that goats did not exist" (Steen 1993).

Houston/Schreiner document. This document "...provided the necessary background to evaluate the Lyman piece.... Based upon these two documents, I find no evidence that goats existed in the park area during the late Quaternary" (Steen 1993).

Lyman document. "To be blunt, I found it to be a poorly written, poorly edited, and poorly published bit of speculation of what might possibly be found if there were enough grants to support enough [archeological] digs" (Steen 1993).

General comments. "In sum, the four documents offer adequate evidence to answer the basic question on the presence of goats" (Steen 1993).

Table 8. Summary of Exotic/Native Reviews

Reviewer	Review of Schalk Document	Review of Schultz Document
Dr. Thomas R. Cox	"This reviewer is persuaded both that Dr. Schalk's work is thorough and that his conclusions are the logical ones to reach through study of the data presented" (Cox 1993).	"... those sources suggesting that mountain goats might have been present in the Olympics are all suspect in one way or another, while the major ones suggesting that mountain goats were absent were quite credible... evidence too strong to allow a responsible historian to come to any other conclusions than that mountain goats were not present in the Olympics in the historical period until introduced" (Cox 1993).
Dr. Paul L. Farber	"The ethnographic and archaeological reviews by Dr. Schalk strongly support the conclusions of the historical review" (Farber 1993).	"Dr. Schultz's review presents a convincing case that the historical record does not provide evidence that mountain goats were found in the Olympic Mountains prior to 1925. Although a few early reports mention goats, the credibility of the references are low" (Farber 1993).
Dr. Gay Frederick	"One must characterize the ethnographic record not as a poor indicator of the presence or absence of mountain goats in the Olympic Mountains, but as one that indirectly supports the absence of mountain goats in the Olympic Range during the 1700s and 1800s" (Frederick 1993)	"The written historical evidence, then, tends to support the view that there were no mountain goats on the Olympic Peninsula during the 1750s to the 1850s and more strongly supports the contention of their absence for the period 1850s to early 1900s (Frederick 1993).
Dr. Mott T. Greene	"This evidence points very strongly toward the conclusion that native peoples subsisting on the peninsula had no access to goats, except through trade for goat wool with mainland peoples" (Greene 1993).	"The weight of the evidence in the historical record as presented here (and I believe this record to be accurate and complete) indicates that throughout the historical period there is not a single reliable or documented sighting of a mountain goat, or of...traces of mountain goats on the Olympic Peninsula prior to introduction...in spite of repeated and extensive expeditions" (Greene 1993).
Dr. Barbara Lane	Agrees with Dr. Schalk's findings.	Schultz "concludes that the record indicates that mountain goats were not present in the Olympic Mountains in the historic period. Her conclusion is clearly warranted by the evidence" (Lane 1993).
Dr. Brian A. Maurer	"The evidence presented by these authors seems to me to indicate that it is highly unlikely that the mountain goat was present in the Olympic Mountains during the last several hundred years covered by the historical record" (Maurer 1993).	
Dr. Madonna L. Moss	"Schalk does a masterful job of integrating a variety of types of ethnographic and archaeological data. His review supports Schultz's finding that goats were not present historically" (Moss 1993).	"The Schultz paper is a thorough and detailed review of the historical evidence.... I think she makes a strong case that mountain goats were not present historically on the Olympic Peninsula" (Moss 1993).

Table 8. Summary of Exotic/Native Reviews (continued)

Reviewer	Review of Schalk Document	Review of Schultz Document
Dr. H. Duane Smith	These two reports "are very thorough. They fairly present the recorded evidence both supporting and refuting the presence of mountain goats in the Olympic Mountains. They both take the position that mountain goats were not historically present and adequately defend their position by presenting conflicting reports and discussing alternative explanations of the limited supportive statements" (Smith 1993).	
Dr. Harold K. Steen	"If goats had existed on the peninsula during the time period studied, a resource that valuable would have left abundant evidence" (Steen 1993).	"I believe she is correct in interpreting the absence of goat references in the large majority of the sources as reasonable proof that goats did not exist" (Steen 1993).

Table 8. Summary of Exotic/Native Reviews (continued)

Reviewer	Review of Houston/Schreiner Document	Review of Lyman Document
Dr. Thomas R. Cox	"Drs. Houston and Schreiner have provided a sound, carefully focused survey. Their research is impressive" (Cox 1993).	"It is possible that the hypothesis presented by Dr. Lyman is valid, but there is little evidence to support it. Moreover, much of the evidence presented by Dr. Lyman is flawed and the logic used to connect it to the question at hand is open to serious question" (Cox 1993).
Dr. Paul L. Farber	No specific comments	Dr. Lyman's hypothesis "is, of course, a possibility. But without any historical, ethnographic, archaeological, or paleontological evidence to back the claim... it is at present a weak and unsupported speculation" (Farber 1993)
Dr. Gay Frederick	No specific comments	"It is apparent that the historical records consulted by Lyman... were not exhaustive of the available documentation" (Frederick 1993).
Dr. Mott T. Greene	"The biogeographical evidence, set in a context of geological rather than human history, argues very strongly that mountain goats failed to colonize any of the landbridge or habitat islands from Alaska to the Olympics" (Greene 1993)	"Since Lyman produced no evidence of any sort -- but merely imagines how things might be different, his argument has no scientific standing whatever" (Greene 1993).
Dr. Barbara Lane	No specific comments	"Dr. Lyman's discussion of the evidence is superficial and not persuasive" (Lane 1993).
Dr. Brian A. Maurer	"Houston and Schreiner's analysis of the present day biogeography of the park suggest that dispersal to the Olympic Peninsula during the last glacial period was selective and therefore, it is just as tenable to take the view that the goats never colonized the Olympics as to hypothesize that they did" (Maurer 1993).	"... on the point of the paleontological record, Lyman apparently draws a faulty conclusion regarding the negative paleontological record" (Maurer 1993).
Dr. Madonna L. Moss	No specific comments	No specific comments
Dr. H. Duane Smith	"The Houston and Schreiner manuscript is well written and supports the position of the Park Service" (Smith 1993).	"Lyman's reasoning throughout his paper is mainly supposition and conjectural and can be used against his hypothesis as well as for it..." (Smith 1993).
Dr. Harold K. Steen	"...provided the necessary background to evaluate the Lyman piece.... Based upon these two documents, I find no evidence that goats existed in the park area during the late Quaternary" (Steen 1993).	"To be blunt, I found it to be a poorly written, poorly edited, and poorly published bit of speculation of what might possibly be found if there were enough grants to support enough [archeological] digs" (Steen 1993).

Table 8. Summary of Exotic/Native Reviews (continued)

Reviewer	General Comments
Dr. Thomas R. Cox	"In the end only one conclusion is possible: there were never mountain goats in the Olympics prior to the 1920s. Chances that mountain goats were present seem so remote as to be of negligible importance" (Cox 1993).
Dr. Paul L. Farber	"The historical and ethnographic evidence convincingly suggest the lack of mountain goats in the Olympic Mountains from the late eighteenth century until their introduction in the 1920s. Such evidence does not preclude their existence earlier during the late Quaternary" (Farber 1993).
Dr. Gay Frederick	"...the historical, ethnographic, archaeological and biological data available at this time support the contention that mountain goats were not present on the Olympic Peninsula prior to their deliberate introduction in the 1920s....The possibility still exists that mountain goats were present early in the Holocene and became locally extinct prior to the 1750s...but it seems more likely that they have not formed part of the indigenous fauna of the Olympic Peninsula in the Holocene" (Frederick 1993).
Dr. Mott T. Greene	These documents "...point very strongly toward the conclusion that the mountain goat (<i>Oreamnos americanus</i>) was, prior to its introduction to the peninsula in the 1920s, absent from the Olympic Peninsula in historic, prehistoric, and late Quaternary time" (Greene 1993).
Dr. Barbara Lane	"I agree with the conclusions reached by Dr. Schultz and by Dr. Schalk that the evidentiary record provides no support for the hypothesis that mountain goat may have been native to the Olympic Mountains" (Lane 1993).
Dr. Brian A. Maurer	"It seems that if goats were ever present in the Olympics, they were never able to establish large enough populations to allow them to persist prehistorically. Therefore, the current population, which is with little doubt the consequence of human introductions, should be considered to be exotic" (Maurer 1993).
Dr. Madonna L. Moss	No specific comments
Dr. H. Duane Smith	"In conclusion, my review of these documents and previous experience with goats and other mammals leads me to support the position that mountain goats did not prehistorically nor historically occupy the Olympic Mountains prior to their introduction. Therefore, they should be treated as an exotic rather than a native species and be managed to protect and maintain the ecosystem..." (Smith 1993).
Dr. Harold K. Steen	"In sum, the four documents offer adequate evidence to answer the basic question on the presence of goats" (Steen 1993).

APPENDIX G. U.S. FOREST SERVICE AND WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AUTHORITY, MANDATES, AND DEFINITIONS

NEPA and SEPA allow for tiering of subsequent related environmental assessments or environmental impact statements off of an initial EIS. Because of possible future goat management decisions by WDFW or ONF, information on pertinent authorities and mandates is included in this EIS to support tiering to meet their NEPA or SEPA requirements.

Authority and Mandates: U.S. Forest Service

The Organic Administration Act of 1897 established the National Forest System "for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of the citizens of the United States."

The Multiple-Use Sustained Yield Act in 1960 (16 USC 528) added management for outdoor recreation, wildlife, fish, and range as purposes of national forests. Although the administration of wildlife and fish was included in the purpose of forests, the act states, "Nothing herein shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish on the national forests."

Under the Forest and Rangeland Renewable Resources Planning Act of 1974 (16 USC 1601), a plan setting national policy and direction for forest management is prepared every five years. Under this act, the Forest Service also provides an assessment of the forest and range situation on a national level every ten years.

The 1974 act was amended in 1976 by the National Forest Management Act (36 CFR 219). This act requires development of Regional Guides for every region and Land and Resource Management Plans (Forest Plans) for every national forest. The regulations (36 CFR 219) state that forest plans "... shall provide for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long-term net public benefits in an environmentally sound manner."

Forest Service regulations promulgated under the Forest and Rangeland Renewable Resources Planning Act of 1974 (36 CFR 219.1 (3)) include: "Regional and forest planning will be based on the following principles:...Recognition that the National Forests are ecosystems and their management for goods and services requires an awareness and consideration of the interrelationships among plants, animals, soil, water, air and other environmental factors within such ecosystems." The regulations further state, "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area" (36 CFR 219.19). Wilderness planning regulations "provide for limiting and distributing visitor use...(to) allow natural processes to operate freely...."

The Endangered Species Act (PL 93-205, 87 Stat 884, 16 USC § 1531 et seq., as amended) is relevant to the Forest Service, as well as to the National Park Service. Forest Service regulations state, "All management prescriptions shall...include measures for preventing the destruction or adverse modification of critical habitat for threatened and endangered species" (36 CFR 219.27 (a)(8)). The ONP 1990 Forest Plan states that "Forest Service Policy requires that (State-listed sensitive plants) be managed to prevent the need for placing them on the Federal List."

The Wilderness Act (PL 88-577, 78 Stat 890, 16 USC 1131 et seq.) applies to designated wilderness areas within Olympic National Forest. The Washington State Wilderness Act of 1984 created five wilderness areas within the national forest. A subsequent boundary adjustment altered boundaries on three of the five areas. Current acreage of designated wilderness is: Buckhorn Wilderness, 44,258 acres (179 km²); Colonel Bob Wilderness, 11,961 acres (48 km²); Mt. Skokomish Wilderness, 13,015 acres (53 km²); The Brothers Wilderness, 16,682 acres (68 km²); and Wonder Mountain Wilderness, 2,349 acres (10 km²) (Olympic National Forest 1990).

Forest Service wilderness regulations contained in 36 CFR Part 293 state, "...National Forest Wilderness resources shall be managed to promote, perpetuate, and, where necessary, restore the wilderness character of the land and its specific values of solitude, physical and mental challenge, scientific study, inspiration, and primitive recreation. To that end: (a) Natural ecological succession will be allowed to operate freely to the extent feasible."

Forest Service Region 6 policy stresses, "Wilderness is to be managed to prevent degradation.... Additionally, we must seek to improve conditions in situations where natural processes are not operating freely," (R-6 Supplement 2300-90-11, 12/18/90).

The Forest Service Manual (2323.31) states an objective of wilderness management to "Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist." FSM 2323.32 states wilderness policy of "Wildlife...management programs shall be consistent with wilderness values." However, it is also policy to "Discourage measures for direct control (other than normal harvest) of wildlife...." FSM 2322.03 define standards and guidelines for wilderness opportunity classes. Pristine areas are to be "...free from evidence of past human activities...." They are to be managed "to sustain or enhance the natural ecosystems." All opportunity classes are to be managed to "... maintain healthy, native vegetation...maintain fish and wildlife indigenous to the wilderness.... There should be no long-term modification of natural plant succession as a result of human activities."

The Regional Guide for the Pacific Northwest Region (1984) established regional standards and guidelines that facilitate land and resource management planning for the 19 national forests within the region. The final EIS published with the Regional Guide states, "Priority management is provided for threatened and endangered species, sensitive species, and their habitats. Management actions include habitat protection, recovery programs, habitat perpetuation, and cooperative management with federal and state agencies, groups, and individuals." The Regional Guide and FEIS also addressed wilderness management by stating, "As part of the forest planning process, the forests will...allow the natural processes to operate as freely as possible" within wilderness areas.

The 1990 Land and Resource Management Plan for Olympic National Forest identifies numerous management goals, including "Manage wildlife habitat to maintain (at a minimum) viable populations of all existing native vertebrates.... Provide for and maintain diversity of plant and animal communities to meet overall multiple use objectives.... Protect communities of native plant species." The forest plan also states, "The protection of species and communities of native plants has emerged as a key issue on the forest. Impacts to these plants from management activities and from introduced plant and animal species is of primary concern." A need for research on the impacts of mountain goats on native plants and soils is identified.

The forest plan states, "Wildlife...should be managed to prevent damage to habitat that affects Wilderness values. Unacceptable changes shall be determined through the LAC process." Opportunity classes II, III, and IV are "characterized by an unmodified natural environment."

Limits of acceptable change (LAC) indicators, factors, and standards are being developed for the forest. Wilderness implementation schedules (i.e., action plans) are being written for each of the wilderness areas. These schedules are expected to address goat management.

Authority and Mandates: Washington State

Department of Fish and Wildlife

RCW 77.12.010 states that the Department of Fish and Wildlife "shall preserve, protect, and perpetuate wildlife. Game animals...may be taken only at times or places, or in manners or quantities as in the judgement of the commission maximizes public recreational opportunities without impairing the supply of wildlife."

The 1989 Washington Wildlife Commission Goals, Policies, and Objectives publication lists the mission statement as "The Department of Wildlife shall preserve, protect, and perpetuate Washington's diverse wildlife, and wildlife habitats and shall maximize the recreational and aesthetic benefits of wildlife for all citizens." Wildlife management goals include, "Maintain diversity, distribution and a reasonable abundance of all native wildlife and their habitats.... Maintain abundant populations of naturally reproducing game species for consumptive use." The commission's wildlife management policies state that "Department programs shall emphasize native species and natural production.... Impacts on ecosystems should be considered when making wildlife management decisions, and undue impacts should be avoided. Importation of exotic wildlife species shall be carefully assessed and limited to avoid introduction of diseases and control displacement of, or conflict with, existing or native species on limited habitat."

The Washington Wildlife Commission Goals, Policies, and Objectives are being revised in early 1995, but a copy of the newest document was not available as this DEIS was going to print. The newer information will be incorporated into the final EIS.

Department of Natural Resources

The Washington state legislature passed the Natural Areas Preserves Act (RCW 79.70) in 1972. This act states, "Natural lands, together with the plants and animals living thereon in natural ecological systems, are valuable for the purposes of scientific research, teaching, as habitats of rare and vanishing species, as places of natural historic and natural interest and scenic beauty, and as living museums of the original heritage of the state."

The 1981 amendment to the act established the natural heritage program within the Department of Natural Resources. The program goals include identification and preservation of Washington's natural diversity. Elements of natural diversity are established as part of a systematic evaluation system. An element may be a rare plant or animal species, or it may be an ecological community.

Definitions: U.S. Forest Service

Forest Service Manual 2605 lists the following definitions:

"Exotic. Species not originally occurring in the United States and introduced from a foreign country. Exotic species that have become naturalized such as ring-necked pheasant are considered the same as native species. Consult the Fish and Wildlife Service where there is a question. A native species is considered native to the United States. An indigenous species is considered indigenous to a National Forest."

"Indigenous species. A species which originally inhabited a particular National Forest or National Grassland."

"Native species. All animal and plant species originally occurring in the United States."

Under Forest Service definitions, mountain goats are a native species in the United States, however they are not an indigenous species within Olympic National Forest.

Definitions: Washington State

Department of Fish and Wildlife

The Washington Department of Fish and Wildlife has no written definition of the terms 'exotic' and 'native' relative to management of species previously introduced within the state.

The Revised Washington Code (RCW 77.08.010) lists the following definitions:

"Wildlife means all species of the animal kingdom whose members exist in Washington in a wild state."

"Deleterious exotic wildlife means species of the animal kingdom not native to Washington and designated as dangerous to the environment or wildlife of the state."

For management of wildlife species currently occurring within Washington, an animal is considered native throughout Washington by the WDFW if the species occurred anywhere within the state when European explorers arrived (personal communication R.L.Johnson 7/23/92 and T. Juelson 7/7/93). Under this definition, WDFW considers mountain goats on the Olympic Peninsula to be native. Mountain goats are not classified as deleterious exotic wildlife. The mountain goat is also classified as a big game species by the Washington Department of Fish and Wildlife (RCW 77.08.030).

The Washington Department of Fish and Wildlife 1988 Policy on Release of Exotic Wildlife into the Wild (POL-4001) "applies whenever any animal species, subspecies, or hybrid is being considered for release for the first time into wild natural habitat in Washington outside of the original native range of that animal species or hybrid." The policy includes the following definitions:

Native Wildlife: "Wildlife which occupied habitat within Washington at the time of European exploration"

Exotic Wildlife: "Wildlife which either occupies, or could occupy through human introduction, habitat within Washington outside the natural historic range for that animal species, subspecies, or hybrid."

Under this policy, mountain goats on the peninsula could be classified as exotic. This definition, however, does not apply to the goat situation on the peninsula since they were introduced previous to establishment of the policy.

Department of Natural Resources

The Natural Heritage Plan (1991) includes the following definitions:

"Native - indigenous to, or originating naturally in, Washington; remaining or growing in an unaltered natural condition."

"Natural -... indicates something existing or found in nature without human intervention."

APPENDIX H. DISCUSSION OF ETHICAL CONCERNS

A wide range of ethical concerns has been raised by management and the public during the scoping process. These concerns generally fall under three main categories:

Environmental Ethics or Biocentrism

Central Tenets

This view takes a holistic approach to ecosystem management. Humans have a moral responsibility to protect the integrity of natural ecosystems. Human-caused animal suffering should be minimized, but the integrity of the natural ecosystem is of primary importance.

Leopold (1970) expressed the "land ethic" this way: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

Callicott (1992) characterized it this way: "In every case the effect upon ecological systems is the decisive factor in the determination of the ethical quality of actions."

Implications for the Mountain Goat Issue

Under this viewpoint, if exotic mountain goats are damaging native ecosystems, they should be removed. Restoration and perpetuation of the native ecosystem would be the goal.

Animal Welfare or Utilitarianism

Central Tenets

This view holds that human beings may use or manage non-human animal resources, as long as we are sensitive and compassionate to the animals' condition. In some cases, it is necessary to kill individual animals. Consideration for the individual's pain and suffering is of primary importance.

The welfare viewpoint is expressed by Passmore (1974): "... It is one thing to say that it is wrong to treat animals cruelly, quite another to say that animals have rights."

Jeremy Bentham, an 18th and early 19th century philosopher, also wrote of animal welfare: Animals "... have none of those long-protracted anticipations of future misery which we have. The death they suffer in our hands commonly is, and always may be, a speedier, and by that means a less painful one, than that which would await them in the inevitable course of nature. If the being killed were all, there is very good reason why we should be suffered to kill such as molest us; we should be the worse for their living, and they are never the worse for their being dead. But is there any reason why we should be suffered to torment them? Not any that I can see" (Burns and Hart 1970).

Implications for the Mountain Goat Issue

Under this view, consideration should be given to individual mountain goats. However, if exotic goats are damaging natural ecosystems, individual goats might need to be killed. Any management action should minimize pain and suffering for individual goats, but protect the native ecosystem.

Animal Rights or Moral Extensionism

Central Tenets

This view holds that each individual animal has absolute and inalienable moral rights. An animal's rights may not be identical to a human being's rights in a particular situation, but the basis for rights is similar for both humans and non-human animals. The individual animal is of primary importance.

Regan (1983) explains this viewpoint: "...animals have certain basic moral rights, including in particular the fundamental right to be treated with the respect that, as possessors of inherent value, they are due as a matter of strict justice. Like us, therefore... any harm that is done to them must be consistent with the recognition of their equal inherent value and their equal *prima facie* right not to be harmed." Regan goes on to say, "...an untimely death is a deprivation of a quite fundamental and irreversible kind. It is irreversible because, once dead, always dead. It is fundamental because death forecloses all possibilities of finding satisfaction. Once dead, the individual who had preferences, who could find satisfaction in this or that, who could exercise preference autonomy, can do this no more."

Warren (1992) also describes this viewpoint: This tradition "is individualist in its moral focus, in that it treats the needs and interests of individual sentient beings as the ultimate basis for conclusions about right and wrong."

Implications for the Mountain Goat Issue

Under this view, each individual mountain goat has an absolute and inalienable right to life regardless of any damage it may cause to natural ecosystem components and processes.

Proponents of this view would object to removal of goats by shooting. They would also oppose recreational hunting of mountain goats. Although contraception or sterilization may under certain circumstances be acceptable under this viewpoint, the ideal would be no human interference with goats whatsoever.

Appendix I. Olympic Peninsula WNHP-listed vascular plant taxa with an average elevation within mountain goat summer range. WNHP (1990) categories: (2) Threatened, (3) Sensitive, (4) Monitor, and (4a) Monitor for listing. **Total** = Number of Areas where the plant is known to occur on the Olympic Peninsula; **Average** = Average elevation (m); **P** = Number of known Olympic National Park locations; **B** = Number of known locations on the border with ONP, i.e., may or may not be in the park; **O** = Number of known locations outside ONP; **U** = Precise location unknown (e.g., "Clallam County"). (Modified from Houston et al. 1994b)

Species	[Species Code]	(WNHP Status)	Total	Average Elevation	P	B	O	U
Species known from 5 or fewer locations in Olympic National Park								
<i>Botrychium lunaria</i>	[BOLU]	(3)	1	1768	1	0	0	0
<i>Douglasia nivalis</i> var. <i>dentata</i>	[DONIDE]	(4)	1	1829	1	0	0	0
<i>Salix brachycarpa</i> ssp. <i>brachycarpa</i> var. <i>brach</i>	[SABRBR]	(4)	1	1905	1	0	0	0
<i>Dryas drummondii</i>	[DRDRDR]	(3)	1	2057	1	0	0	0
<i>Pellaea breweri</i>	[PEBR]	(3)	2	1631	1	0	1	0
<i>Poa rupicola</i>	[PORU]	(4)	2	1846	1	0	1	0
<i>Botrychium pinnatum</i>	[BOPI]	(3)	3	1591	1	0	2	0
<i>Carex obtusata</i>	[CAOBT]	(3)	5	1800	1	0	4	0
<i>Zigadenus elegans</i> ssp. <i>elegans</i>	[ZIELEL]	(4a)	6	1795	1	0	5	0
<i>Poa suksdorfii</i>	[POSU]	(4)	3	1788	2	0	1	0
<i>Saxifraga debilis</i>	[SADE]	(3)	3	1798	2	0	1	0
<i>Erigeron flettii</i>	[ERFL]	(4) ¹	19	1580	2	3	14	0
<i>Phlox hendersonii</i>	[PHHE]	(4)	10	1908	4	0	6	0
<i>Lloydia serotina</i> ssp. <i>serotina</i>	[LLSESE]	(4)	11	1676	4	0	7	0
<i>Astragalus australis</i> var. <i>olympicus</i>	[ASAUOL]	(2) ¹	5	1554	4	0	1	0
<i>Asplenium viride</i>	[ASVI]	(4)	8	1696	5	1	2	0
<i>Saxifraga tischii</i>	[SATI]	(4a) ²	8	1856	5	1	2	0

Species known from 6 or more locations in Olympic National Park

<i>Oxytropis viscida</i> var. <i>viscida</i>	[OXVIVI]	(3)	6	1734	6	0	0	0
<i>Poa arctica</i> ssp. <i>grayana</i>	[POARGR]	(3)	8	1539	6	0	2	0
<i>Arnica nevadensis</i>	[ARNE]	(4)	10	1759	8	1	1	0
<i>Salix arctica</i>	[SAARC]	(4)	10	1789	8	0	2	0
<i>Poa paucispicula</i>	[POPAU]	(4)	10	1687	9	0	1	0
<i>Carex raynoldsii</i>	[CARAY]	(4)	11	1667	6	0	5	0
<i>Synthyris pinnatifida</i> var. <i>lanuginosa</i>	[SYPILA]	(3) ¹	14	1867	8	1	5	0
<i>Arnica rydbergii</i>	[ARRY]	(4)	16	1676	10	0	6	0
<i>Geum triflorum</i> var. <i>campanulatum</i>	[GETRCA]	(4)	18	1654	11	0	7	0
<i>Erigeron compositus</i> var. <i>discoideus</i>	[ERCODI]	(4)	18	1784	13	0	0	5
<i>Senecio neowebsteri</i>	[SENE]	(4) ¹	23	1824	16	1	6	0
<i>Orthocarpus imbricatus</i>	[ORIM]	(4)	24	1683	16	1	6	1
<i>Viola flettii</i>	[VIFL]	(4) ¹	36	1751	19	3	13	1
<i>Petrophytum hendersonii</i>	[PEHE]	(4) ^{1,3}	46	1500	24	2	17	3
<i>Campanula piperi</i>	[CAPI]	(4) ¹	47	1698	27	4	16	0
<i>Aster paucicapitatus</i>	[ASPA]	(4) ²	47	1574	34	1	11	1
<i>Pedicularis bracteosa</i> var. <i>atrosanguinea</i>	[PEBRAT]	(4) ^{2,4}	4	1547	4	0	0	0

Species that may occur in Olympic National Park

<i>Senecio lugens</i>	[SELU]	(4)	8	1769	0	1	7	0
<i>Draba longipes</i>	[DRLO]	(3)	1	1890	0	1	0	0

Species not known to occur in Olympic National Park

<i>Draba cana</i>	[DRCA]	(3)	1	1829	0	0	1	0
<i>Astragalus microcystis</i>	[ASMI]	(3)	2	1813	0	0	2	0

¹ Olympic Peninsula endemic.

² Olympic Peninsula-Vancouver Island endemic.

³ We list this species as a goat summer range plant because it occurs mainly on rocky outcrops.

⁴ Incomplete data

APPENDIX J. PLANT LIST

This appendix contains the scientific names for all plants encountered in research plots within mountain goat summer range, Olympic National Park (Schreiner 1993)

GENUS	SPECIES	VARIETY OR SSP
Abies	amabilis	
Abies	lasiocarpa	
Achillea	millefolium	
Agoseris	aurantiaca	
Agoseris	glauca	
Agoseris	spp.	
Agropyron	caninum	subsp. majus
Agrostis	exarata	
Agrostis	scabrella	
Agrostis	thurberiana	
Agrostis	variabilis	
Allium	crenulatum	
Allium	cernuum	
Amelanchier	alnifolia	
Anaphalis	margaritacea	
Anemone	drummondii	drummondii
Anemone	drummondii	
Anemone	lyalii	
Anemone	multifida	
Anemone	occidenalis	
Antennaria	alpina	media
Antennaria	lanata	
Antennaria	microphylla	
Antennaria	racemosa	
Antennaria	umbrinella	
Aquilegia	formosa	
Arabis	hirsuta	
Arabis	unknown	
Arctostaphylos	uva-ursi	
Arenaria	capillaris	
Arenaria	macrophylla	
Arenaria	obtusiloba	
Arenaria	rossii	
Arenaria	rubella	
Arnica	diversifolia	
Arnica	latifolia	
Arnica	parryi	parryi
Arnica	rydbergii	
Artemisia	ludoviciana	
Artemisia	norvegica	
Aster	alpigenus	alpigenus
Astragalus	australis	olympicus
Aster	foliaceus	foliaceus
Aster	paucicapitatus	
Athyrium	distentifolium	americanum
Athyrium	filix-femina	
Blechnum	spicant	
Botrychium	lanceolatum	
Botrychium	multifidum	
Bromus	carinatus	
Bromus	sitchensis	
Caltha	biflora	biflora
Calamagrostis	inexpansa	barbulata

GENUS	SPECIES	VARIETY OR SSP
Calamagrostis	purpurascens	
Calamagrostis	sesquiflora	
Campanula	piperi	
Campanula	rotundifolia	
Carex	albonigra	
Carex	aurea	
Carex	californica	
Carex	hoodii	
Carex	illota	
Carex	nigricans	
Carex	obtusata	
Carex	oederi	viridula
Cardamine	oligosperma	kamschatica
Carex	phaeocephala	
Carex	pluriflora	
Carex	pyrenaica	
Carex	raynoldsii	
Carex	rossii	
Carex	spectabilis	
Carex	spp.	
Carex	mertensia	
Castilleja	hispida	
Cassiope	mertensiana	
Castilleja	miniata	
Castilleja	parviflora	
Cerastium	arvense	
Chamaecyparis	nootkatensis	
Cheilanthes	gracillima	
Cirsium	edule	
Claytonia	lanceolata	
Collomia	debilis	larsenii
Collinsia	parviflora	
Crepis	nana	subsp. nana
Crepis	occidentalis	
Cryptogamma	crispa	acrostichoides
Cryptantha	intermedia	
Cystopteris	fragilis	
Danthonia	intermedia	
Delphinium	glareosum	
Delphinium	menziesii	
Delphinium	nuttallii	
Deschampsia	atropurpurea	
Deschampsia	caespitosa	
Dodecatheon	jeffreyi	
Douglasia	laevigata	
Draba	incerta	
Draba	loncharpa	
Draba	paysonis	
Draba	spp.	
Drosera	rotundifolia	
Elmera	racemosa	
Elymus	glaucus	?
Elymus	hirsutus	
Empetrum	nigrum	
Epilobium	alpinum	
Epilobium	angustifolium	

GENUS	SPECIES	VARIETY OR SSP
Epilobium	glaberrimum	
Epilobium	glandulosum or glaberr	
Epilobium	latifolium	
Epilobium	luteum	
Epilobium	minutum	
Epilobium	mirabile	
Epilobium	paniculatum	paniculatum
Epilobium	spp.	
Eriophorum	chamissonis	
Erigeron	compositus	
Erigeron	flettii	
Eriophyllum	lanatum	
Eriogonum	ovalifolium	
Erigeron	peregrinus	
Erigeron	spp.	
Erigeron	subtrinervis	conspicuous
Erysimum	arenicola	torulosum
Erythronium	grandiflorum	grandiflorum
Erythronium	montanum	
Festuca	idahoensis	
Festuca	ovina	
Festuca	subulata	
Fragaria	vesca	
Fragaria	virginiana	
Galium	bifolium	
Galium	unknown species #1	
Galium	Trifidum or triflorum	
Galium	trifidum or triflorum	
Gaultheria	ovatifolia	
Gentiana	amarella	
Gentiana	calycosa	
Gentiana	douglasiana	
Gentiana	sceptrum	
Geum	triflorum	campanulatum
Habenaria	unalascensis	
Haplopappus	lyallii	
Hedysarum	occidentale	
Heuchera	glabra	
Heuchera	micrantha	diversifolia
Hieracium	albiflorum	
Hieracium	gracile	
Hydrophyllum	fendleri	albifrons
Hypericum	anagalloides	
Juncus	balticus	balticus
Juniperus	communis	montana
Juncus	covillei	covillei
Juncus	drummondii	subtriflorus
Juncus	mertensianus	
Juncus	parryi	
Juncus	sp.	
Kalmia	occidentalis	
Koeleria	cristata	
Lathyrus	nevadensis	ssp lanceolatus var pilos
Ledum	groenlandicum	
Leptarrhena	pyrolifolia	
Lewisia	columbiana	rupicola
Lillium	colmbianum	

GENUS	SPECIES	VARIETY OR SSP
Linnaea	borealis	
Lithophragma	bulbifera	
Lomatium	martindalei	flavum
Lomatium	nudicaule	
Lomatium	utriculatum	
Luetkia	pectinata	
Luina	hypoleuca	
Lupinus	latifolius	
Lupinus	lepidus	lobbii
Luzula	piperi	
Luzula	campestris	
Luzula	hitchcockii	
Luzula	parviflora	
Luzula	spicata	
Luzula	spp.	
Lycopodium	inundatum	
Lycopodium	sitchense	
Lycopus	uniflorus	
Lysichitum	americanum	
Melica	subulata	subulata
Mertensia	paniculata	borealis
Microsteris	gracilis	
Mimulus	guttatus	
Mimulus	lewisii	
Mimulus	tilingii	
Mitella	breweri	
Mitella	pentandra	
Mitella	trifida	
Montia	cordifolia	
Montia	parvifolia	
Myrica	gale	
Nothechelone	nemorosa	
Orobanche	fasciculata	
Orobanche	uniflora	purpurea
Orthocarpus	imbricatus	
Osmorrhiza	spp	
Oxyria	digyna	
Oxytropus	campestris	gracilis
Oxytropus	viscida	
Pachistima	myrsinites	
Parnassia	fimbriata	fimbriata
Pedicularis	bracteosa	atrosanguinea
Pedicularis	racemosa	racemosa
Penstemon	davidsonii	
Penstemon	procerus	tolmiei
Penstemon	serrulatus	
Petasites	frigidus	nivalis
Petrophytum	hendersonii	
Phacelia	heterophylla	
Phacelia	sericea	sericea
Phleum	alpinum	
Phlox	diffusa	longistyla
Phlox	hendersonii	
Phyllodoce	empetriformis	
Phyllodoce	glanduliflora	
Phyllodoce	x intermedia	

GENUS	SPECIES	VARIETY OR SSP
Pinus	albicaulus	
Pinus	monticola	
Plantago	macrocarpa	
Poa	cusickii	
Poa	leptocoma	
Poa	pratensis	
Poa	secunda	
Poa	sp.	
Polygonum	bistortoides	
Polygonum	douglasii	
Polypodium	hesperium	
Polystichum	lonchitus	
Polygonum	minimum	
Polystichum	munitum	
Polygonum	newberri	glaucum
Polemonium	pulcherrimum	
Potentilla	diversifolia	diversifolia
Potentilla	drummondii	
Potentilla	flabellifolia	
Potentilla	fruticosa	
Potentilla	glandulosa	glandulosa
Potentilla	villosa	
Prenanthes	alata	
Prunus	emarginata	
Pseudotsuga	menziesii	
Pteridium	aquilinum	
Pyrola	secunda	
Ranunculus	eschsoltzii	
Ranunculus	verecundus	
Rhododendron	albiflorum	
Ribes	howellii	
Ribes	lacustre	
Rorripa	curvisiliqua	
Rosa	gymnocarpa	
Rosa	nutkana	nutkana
Rubus	lasiococcus	
Rubus	parviflorus	
Rubus	pedatus	
Sagina	saginoides	
Sanicula	graveolens	
Sanguisorba	officinalis	
Sauseria	americana	
Saxifraga	arguta	
Saxifraga	bronchialis	
Saxifraga	caespitosa	emmarginat
Saxifraga	ferruginea	macounii (?)
Saxifraga	occidentalis	rufidula
Saxifraga	punctata	cascadensis
Saxifraga	tolmiei	tolmiei
Sedum	divergens	
Sedum	lanceolatum	
Sedum	unknown	
Sedum	stenopetalum	
Selaginella	densa	scopulorum
Selaginella	wallacei	
Senecio	fletti	
Senecio	neowebsteri	

GENUS	SPECIES	VARIETY OR SSP
Senecio	triangularis	?
Sibbaldia	procumbens	
Silene	acaulis	exscapa
Silene	douglasii	douglasii
Silene	parryi	
Sisyrinchium	angustifolium	
Sisyrinchium	douglasii	
Sitanion	hystrix	hystrix
Smelowskia	calycina	americana
Smilacina	stellata	
Solidaga	multiradiata	scopulorum
Sorbus	sitchensis	
Spiraea	densiflora	
Spiranthes	romanzoffiana	romanzoffiana
Stellaria	calycantha	?
Stipa	occidentalis	minor
Symphoricarpos	albus	
Synthyris	pinnatifida	lanuginosa
Taraxacum	officinale	
Taxus	brevifolia	
Thalictrum	occidentale	
Thlaspi	fendleri	glaucum
Thuja	plicata	
Tofieldia	glutinose	brevistyla
Trautvetteria	caroliniensis	occidentalis
Trisetum	spicatum	
Tsuga	mertensiana	
Vaccinium	caespitosum	
Vaccinium	deliciosum	
Vaccinium	membranaceum	
Vaccinium	oxycoccos	
Valeriana	scouleri	
Valeriana	sitchensis	
Veronica	cusickii	
Veronica	sp.	
Veratrum	viride	
Veronica	wormskjoldii	
Vicia	americana	truncata
Viola	adunca	?
Viola	flettii	
Viola	glabella	
Woodsia	scopulina	
Xerophyllum	tenax	

**APPENDIX K.
ENDANGERED, THREATENED AND CANDIDATE SPECIES
WITHIN OLYMPIC NATIONAL PARK AND ADJACENT AREAS
(As Listed by the U.S. Fish and Wildlife Service)**

Endangered

Brown pelican (*Pelecanus occidentalis*)
Gray wolf (*Canis lupus*; extirpated)
Leatherback sea turtle (*Dermochelys coriacea*)
Peregrine falcon (*Falco peregrinus*)

Threatened

Aleutian Canada goose (*Branta canadensis leucopareia*)
Bald eagle (*Haliaeetus leucocephalus*)
Green sea turtle (*Chelonia mydas*)
Loggerhead sea turtle (*Caretta caretta*)
Marbled murrelet (*Brachyramphus marmoratus marmoratus*)
Northern spotted owl (*Strix occidentalis caurina*)
Olive ridley sea turtle (*Lepidochelys olivacea*)

Proposed

Golden paintbrush (*Castilleja levisecta*)

Candidate Animals

Bull trout (*Salvelinus confluentus*)
Cascades frog (*Rana cascadae*)
California wolverine (*Gulo gulo luteus*)
Destruction Island shrew (*Sorex trowbridgii destructioni*)
Harlequin duck (*Histrionicus histrionicus*)
Little willow flycatcher (*Empidonax traillii brewsteri*)
Long-eared myotis (bat) (*Myotis evotis*)
Long-legged myotis (bat) (*Myotis volans*)
Mountain quail (*Oreortyx pictus*)
Northern goshawk (*Accipiter gentilis*)
Northern red-legged frog (*Rana aurora aurora*)
Olive-sided flycatcher (*Contopus borealis*)
Olympic mudminnow (*Novumbra hubbsi*)
Pacific fisher (*Martes pennanti pacifica*)
Pacific lamprey (*Lampetra tridentata*)
Pacific western big-eared bat (*Plecotus townsendii townsendii*)
River lamprey (*Lampetra ayresi*)
Tailed frog (*Ascaphus truei*)
Yuma myotis (bat) (*Myotis yumanensis*)

Candidate Plants

Pink (or rose-purple) sand verbenia (*Abronia umbellata* spp. *acutalata*)
Olympic Mountain (or Cotton's) milk vetch (*Astragalus australis* var. *olympicus*)
Thurber's reedgrass (*Calamagrostis crassiglumis*)

APPENDIX L. ACRONYMS USED IN THIS DOCUMENT

ACETA - Aerial Capture, Eradication, and Tagging of Animals
 BP - Before Present
 C1 - Category 1 Species under the Endangered Species Act
 CEQ - Council on Environmental Quality
 CFR - Code of Federal Regulations
 DEIS - Draft Environmental Impact Statement
 DOI - Department of the Interior
 DVM - Doctor of Veterinary Medicine
 EA - Environmental Assessment
 EIS - Environmental Impact Statement
 FEIS - Final Environmental Impact Statement
 FS - Forest Service
 FSM - Forest Service Manual
 GnRH - Gonadatropin Releasing Hormone
 HA - Hectare
 IGMT - Interagency Goat Management Team
 IUCN - International Union for Conservation of Nature and Natural Resources
 IUD - Intrauterine Device
 LAC - Limits of Acceptable Change
 MGA - Melengestrol Acetate or Megestrol Acetate
 NBS - National Biological Service
 NEPA - National Environmental Policy Act
 NPS - National Park Service
 OAS - Office of Aircraft Safety (Department of the Interior)
 ONF - Olympic National Forest
 ONP - Olympic National Park
 PL - Public Law
 PSPB - Pregnancy Specific Protein B
 PZP - Porcine Zona Pellucida (see also ZP)
 RCW - Revised Code of Washington State
 SE - Standard Error
 SEPA - State Environmental Policy Act
 T&E - Threatened and Endangered
 UNESCO - United Nations Education, Scientific and Cultural Organization
 USC - United States Code
 USFS - United States Forest Service
 USFWS - United States Fish and Wildlife Service
 WDFW - Washington Department of Fish and Wildlife
 (agency name changed to WDFW in spring, 1994)
 WDW - Washington Department of Wildlife
 (agency name changed from WDW in spring, 1994)
 WNHP - Washington Natural Heritage Program
 ZP - Zona Pellucida (see also PZP)

References

Index



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NOTE: Copies of any unpublished references listed here are available from Olympic National Park.

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