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**Distribution and Abundance of Mountain Goats
within the Ross Lake Watershed,
North Cascades National Park Service Complex**

Final Report
to
Skagit Environmental Endowment Commission

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31.

December 1997

1997

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Introduction

Mountain goats (*Oreamnus americanus*) are native to northwestern North America and can be found throughout the North Cascades National Park Service Complex (NOCA). Their habitat requirements are quite specific and suitable habitat is patchily distributed across the landscape. During all seasons, mountain goat habitat is characterized by steep, rocky terrain. Summer habitat is generally above 1525 m (5000 ft) elevation, and features rock outcrops in or near subalpine meadows and forest (Welch, 1991; Holmes, 1993; Schoen and Kirchoff, 1981; NCASI, 1989; Chadwick, 1983; Benzon and Rice, 1988).

Many mountain goat populations in Washington have declined during the last 20 years. Although specific causes have not been identified, several factors may have contributed to the regional decline. These include logging, road-building, and other habitat alterations; increased hunting pressure; nutritional deficiencies; adverse weather conditions; parasitism and disease; and human disturbance (Welch and Raedeke, 1990; Welch, 1991; Johnson, 1983; P. Reed, US Forest Service, pers. comm., 1991). It is unclear whether NOCA's mountain goat populations have also declined. In NOCA's Resources Management Plan (1994), "a parkwide survey to determine population status and distribution of mountain goats", is listed as part of a recommended action (NOCA-N-23.02) - to inventory and monitor mountain goat populations.

This study sought to identify "hot spots" of goat activity - areas where mountain goat densities are high - as well as provide overall distribution within the study area. These objectives were particularly important given the lack of specific information we have on mountain goats within NOCA.

Award of a grant from the Skagit Environmental Endowment Commission enabled surveys of mountain goat summer habitat within the upper Skagit watershed in 1996 and 1997. Goals of the grant included identifying summer distribution of mountain goats, establishing a minimum population estimate, estimating productivity of the population, refining the accuracy of an existing GIS-based habitat model, and developing a monitoring strategy.

Study Area

The study area is in the upper Skagit River watershed of western Washington, within the boundaries of North Cascades National Park and Ross Lake National Recreation Area (Figure 1). This area is a transition zone between moist coastal forests west of the Cascade crest and dry interior forests (Franklin and Dyrness, 1993). The topography of the area consists of rugged mountainous terrain with deep-seated valleys of great relief. Elevations range from 489 m along the shores of Ross Lake to 2,737 m at the summit of Mt. Spickard. Areas exceeding 1,980 m are heavily glaciated and commonly consist of permanent snowfields. Annual precipitation grades from 100 cm at Hozomeen to over 250 cm in the Picket Range. A reservoir, Ross Lake, lies near

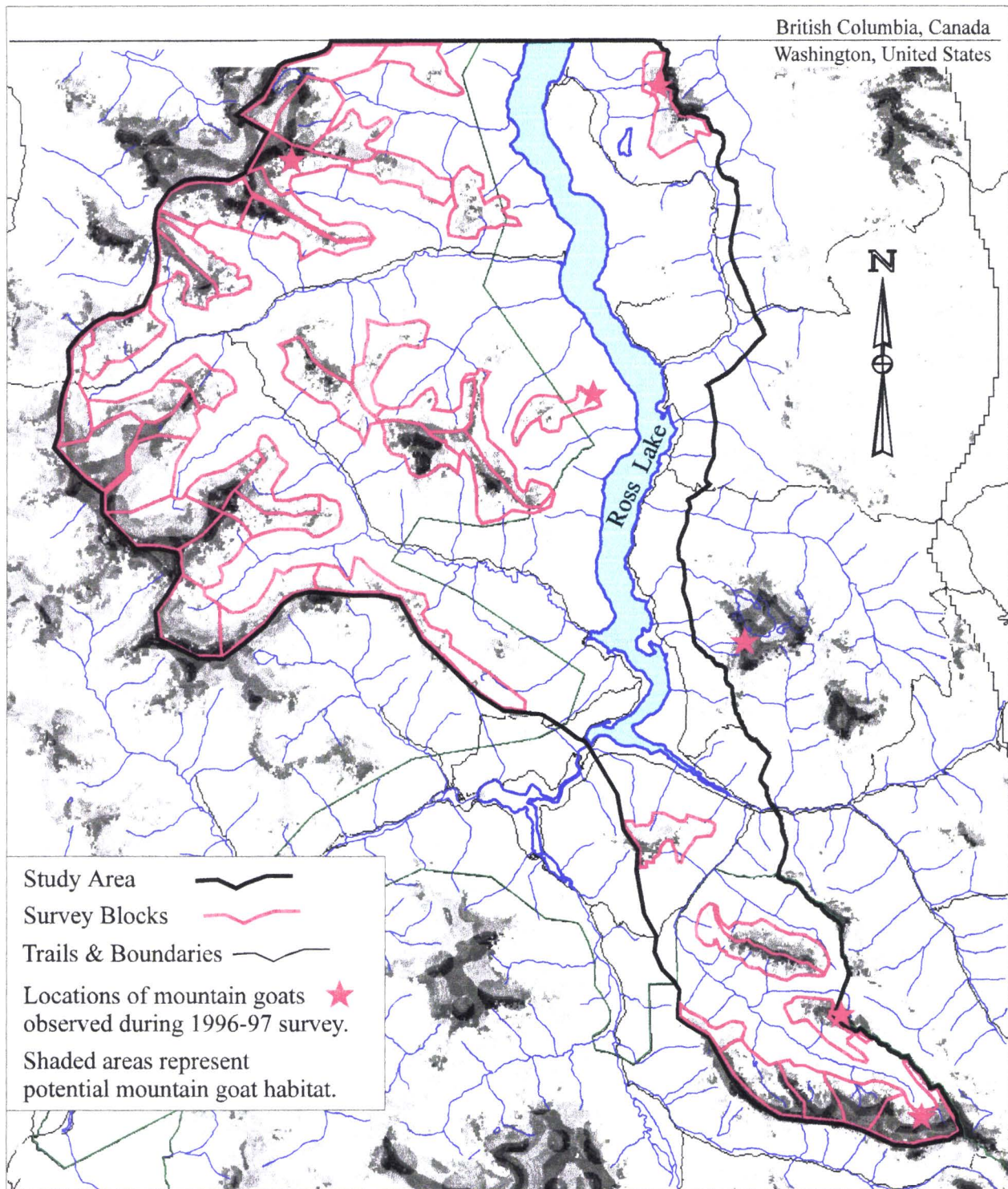


Figure 1. Mountain goat study area in Ross Lake watershed, North Cascades National Park Service Complex, Washington (1996-1997).

the eastern boundary, across which mountain goats are believed not to travel. Our survey covered areas of subalpine and alpine habitat between 1,220 m and 2,200 m.

The main vegetation cover types (Agee and Kertis 1986) in the potential mountain goat habitat survey blocks were lush herbaceous (subalpine herb), heather meadow, open-canopy Pacific silver fir, and open canopy mountain hemlock. Other cover types found in the survey blocks include barren rock, snowfields, and glaciers.

Methods

Holmes (1993) constructed a GIS-based habitat model to determine mountain goat summer habitat in NOCA. This model extracts values for five variables (elevation, slope, aspect, vegetation, and distance to escape terrain) and assigns a suitability index to habitat pixels (cell size - 50m x 50m). The model was tested with reported observations of mountain goats during the summers of 1969 through 1992. For this study, mountain goat summer habitat was surveyed using a block count sampling method (Houston et al. 1986 and 1991). Forty-four survey blocks, approximately 500 ha in size (Figure 1), were delineated on topographic maps in areas identified as suitable in NOCA's GIS-based habitat model (Holmes, 1993).

Population estimates, productivity and recruitment rates, and distribution of mountain goats have all been established through aerial surveys (Michalovic, 1988; Benzon and Rice, 1988; Smith, 1988; Houston et al, 1986 and 1991; among others). Researchers have employed both fixed-wing aircraft and helicopters to conduct surveys. Survey results are often best in early morning or early evening, when goats are feeding and most visible (Welch, 1991; Michalovic, 1988; Chadwick, 1974), and when skies are high overcast, with calm air and some cloud cover. These conditions contribute to goats being out in the open (rather than seeking cover in shady areas) and assist viewers by minimizing glare off snowfields and the contrast between sunny and shaded areas (Michalovic, 1988). Mountain goats exhibit strong fidelity to their summer range, and will often return to the same area every year (Nichols, 1985); population trends can thus be extrapolated to the larger population by monitoring specific groups at the same time each year.

Houston et al. (1986 and 1991) conducted surveys in late July because most mountain goats at Olympic National Park occupy open summer ranges above timberline and are conspicuous against the low, green vegetation. As identified in NOCA's Wilderness Management Plan (1989), park managers are implementing guidelines to reduce fixed-wing aircraft and helicopter flights in NOCA's backcountry, particularly during the peak human visitation period in July and August. Park management has requested park staff to conduct flights outside this period; hence this study utilized June and September flights.

Productivity (number of young born each year) is commonly calculated for wildlife populations; high rates of productivity generally correspond to a healthy, growing population. Productivity in mountain goat populations is often expressed as number of kids per 100 adult goats. Although a more precise measure would be number of kids per 100 adult females, the similarity between male and female mountain goats precludes accurate identification of females from the air. Researchers in Washington have found productivity rates ranging from 25 to 58 kids per 100 adults (Michalovic, 1988; Johnson, 1983; Anderson, 1940). Because productivity varies

tremendously from year to year, conclusions about population status require several consecutive years of data (Michalovic, 1988).

Each block was contoured to terrain and designed to include a variety of slopes and aspects. Mountain goat sightings and demographic information were mapped on the topographic maps identifying the sampling blocks and pertinent information recorded on data sheets. We originally estimated 15-20 minutes to survey each block and identified a random subset of blocks to survey.

Mountain goats were censused using a Hughes 500D helicopter, flown by HiLine Helicopters of Darrington, WA. Surveys, consisting of flights approximately three hours in length, were flown in late June (20-31) and early September (1-16), 1996 and 1997. Every attempt was made to survey on consecutive days, weather permitting. Survey flights were planned for early morning or early evening.

Results

Surveys were flown on June 26 and 30, and September 11, 12, and 16, 1996. In 1997, early-season surveys were cancelled due to an unusually heavy snowpack. Late-season flights occurred on September 4, 8, and 10, 1997. Flights began between 6am and 8am, except for one evening flight on 9/4/97, and generally took three hours (including travel and refueling time). Time spent surveying individual blocks averaged 5.7 minutes. Because of this unexpected efficiency, we were able to adequately cover every block each year, surveying a total of 22,228 ha. (54,925 acres) each season. Total survey time was 8.9 hours in 1996 (June and September surveys) and 4.0 hours in 1997 (September survey only); these times do not include travel to or between blocks or refueling stations. Surveys were conducted with clear skies or high overcast clouds at temperatures of 5-10°C at 1800 m.

Three adult mountain goats were observed during the June, 1996 surveys, and two more adults were observed during the September, 1996 flights. No mountain goats were observed in 1997, although we did see tracks in one area (Table 1). In all cases, goats were seen in rocky terrain, although there was some variation in other habitat measures (Table 2). All goats were observed alone and we did not see any kids.

TABLE 1: Mountain goat observations

Date	Number	Location	Elevation	Aspect
6/26/96	1	Ridge between No Name and Skymo Creeks	1525 m	NE
6/30/96	1	Hozomeen Mountain	2010 m	W
6/30/96	1	Southeast of Mount Spickard	1875 m	SW
9/16/96	1	Headwaters of Gabriel Creek	1890 m	N
9/16/96	1	Headwaters of Panther Creek	1525 m	N
9/8/97	tracks	Southeast of Whatcom Peak (in snow)	2100 m	S

Numerous black bears were observed during the course of our fall surveys (28 in 1996 and 30 in 1997). They were most often seen in subalpine meadows.

TABLE 2: Habitat characteristics where mountain goats were observed

Date	Cover Type	Habitat Feature	Slope
6/26/96	Rock, heather meadow, shrub	Bench	Moderate
6/30/96	Rock	Cliff	Steep
6/30/96	Rock	Small bench on cliff face	Steep
9/16/96	Rock, deciduous forest, grass/heather meadow, shrub	Bench in talus	Flat
9/16/96	Rock, mixed coniferous and deciduous forest, grass/heather meadow, shrub	Talus	Moderate

Discussion

The number of mountain goats observed during our two-year study was much lower than expected and precludes most inferences about the status of NOCA's mountain goat population. Furthermore, the lack of data means we are unable to estimate productivity of the mountain goat population or refine the accuracy of the GIS habitat model. The effort was worthwhile, however, as a benchmark for future surveys.

Only one observation of mountain goats was documented on wildlife observation cards during the study period: climbing rangers spotted two adult goats near Ragged Ridge. Upon hearing the rangers, the goats ran up, over the ridge, and out of our study area. During our helicopter survey the next day, we did not see them in the study area.

It may be worthwhile to speculate briefly on possible reasons why we did not observe more mountain goats in the study area. It could be as simple as there not being very many mountain goats here. This agrees with the impression of the helicopter pilot, who has been flying over NOCA for close to 15 years (A. Reece, HiLine Helicopters, pers. comm., 1997). Perhaps some aspect of our survey method was faulty - too little time in each block? Wrong time of day or year? Looking in the wrong places? However, our method and pilot are the same that the Washington Department of Fish and Wildlife uses for their surveys of neighboring lands, where they observe many mountain goats. Furthermore, during each survey season, we checked our observers' spotting skills by flying over Jack Mountain, just east of the study area. In every instance, we quickly observed ten or more mountain goats.

Another reason may be that our study area does not contain prime mountain goat habitat. While Holmes (1993) used five habitat variables to determine habitat suitability, no consideration of patch size or connectivity was incorporated into his model. The study area includes some of the most rugged topography in the North Cascades mountain range, including the Pickets, Mt. Spickard, and Hozomeen Mountain. Although a few single goats were found in these locations, the habitat may not be able to support larger groups of mountain goats. One important characteristic of prime mountain goat habitat that seems to be missing from the study area is large patches of open subalpine meadows, the preferred foraging habitat, situated near escape terrain. A broader, landscape view of the North Cascades ecosystem reveals that areas to the

west (Mount Baker-Snoqualmie National Forest) and to the east (Pasayten Wilderness, Okanogan National Forest) have more gentle topography. These areas are known to have greater numbers of mountain goats (M. Davison, WDFW, pers. comm., 1996; S. Fitkin, WDFW, pers. comm., 1996). In contrast, our study area is dissected by many deep, steep-walled valleys which go from forested slopes immediately into rugged rocky outcrops and barren, snow-covered summits. A second important habitat characteristic that seems to be missing in the study area is the occurrence of natural salt licks. On Forest Service lands adjacent to NOCA where natural salt licks have been documented, mountain goat population density seems to be higher (W. Wright 1977). Lastly, if in fact goats are not using these areas, it may be because some other resource is limiting, perhaps the availability of satisfactory winter habitat nearby.

Recommendations

1. Conduct a systematic survey of mountain goat summer habitat in NOCA within 10 years. This survey should include at least the SEEC study area and appropriate connected areas outside the Skagit drainage. Ideally it would be coordinated with neighboring land-management agencies for an ecosystem-wide survey.
2. Conduct a study of mountain goat winter habitat in NOCA to determine if that is a limiting resource. The first step would be to map potential habitat using typical characteristics identified in the literature and applied to NOCA using GIS. An aerial survey could follow. Note that because of the usual winter weather patterns, flying may be difficult.
3. Conduct a detailed study of forage types and availability, which may dictate the distribution of mountain goats in this region. This endeavor should include an evaluation of patch size and connectivity and their influence on goat use of the resources.
4. Establish and maintain strong working relationships with other agencies interested in mountain goats in the North Cascades and participate in a region-wide dialog about population trends.

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