



PROJECT SUMMARY

Ecosystem
Management

Forest Productivity

Public Involvement

Adaptive
Management

The ecosystem management component of the Morice & Lakes IFPA has embarked on several projects that assess biodiversity, ecological attributes, and fish and wildlife habitat. These projects will provide important ecological data that will be used in learning scenario development for the IFPA's Sustainable Forest Management Plan.

Inventory of Mountain Goats in Non-Alpine Habitats in the Morice and Lakes Forest Districts



Fraser Lake Sawmills

Introduction

Mountain goats (*Oreamnos americanus*, hereafter goats) are generally associated with mountainous areas and most frequently inhabit alpine and subalpine habitats (Banfield 1974, Haynes 1994). Use of forested areas adjacent to mountain cliffs is common and goats will also often travel through forest to reach mineral licks, during travel between seasonal ranges, and during

dispersal (Hebert and Cowan 1971, Chadwick 1973). Forests are also used frequently as winter range in coastal regions, where they provide snow interception, snow pack stabilization and forage (Hebert and Turnbull 1977, Smith 1986). There are few occurrences, however, where goats occupy predominantly forested landscapes away from mountainous areas. Two circumstances where this has been reported are for clusters of small, discreet cliffs and rock outcrops



surrounded by forest (Smith and Raedeke 1982, Turney *et al.* 2001, 2002) and in canyons (Foster and Raes 1985, Harrison 1999, Mahon and Turney 2002). A combination of these two types of features occur in the southern Morice and Lakes Districts over an area of approximately 13,000 km², which is used by a population of at least 100 goats. Limited escape terrain with a fragmented distribution, low population density, isolated population structure, long distance to core populations in more typical mountainous habitats, and extensive human activity throughout the area may make this goat population especially sensitive to natural and human related disturbance.

The purpose of this project is to investigate the use of potential non-alpine habitat areas by mountain goats (*Oreamnos americanus*, hereafter goats) in the Lakes and Morice Forest Districts and to correlate observed use with habitat attributes and subjective suitability ratings.

Project Objectives

The specific objectives of the project were to:

1. Systematically identify potential mountain goat habitat in non-alpine areas across the Morice and Lakes Forest Districts;
2. Assess actual use of a subsample of potential habitat areas by mountain goats; and
3. Develop a model to predict the probability of mountain goat occurrence by examining relationships between goat use and habitat attributes at potential habitat areas.

Study Area

Systematic inventory of potential non-alpine mountain goat habitat areas was conducted across all portions of the Morice and Lakes Forest Districts below the Alpine biogeoclimatic zone. Ground surveys were conducted within a core study area of approximately 13,000 km² in the central and southern Lakes and Morice Forest Districts. The core study area is bounded in the west by the Morice River and the Coast Range Mountains, in the south by Whitesail Reach and Ootsa Lake, and in the east by the Lakes Forest District boundary. The area also extends to just north of Babine Lake in the Lakes Forest District and just north of Highway 16 and Houston in the Morice Forest District.

Methodology

Systematic Inventory of Potential Mountain Goat Habitat Areas

The initial inventory of potential mountain goat habitat areas was conducted in the Morice in 2000 and in the Lakes in 2001 (Turney *et al.* 2001, 2002). Potential habitat areas were identified using a Geographic Information System (GIS) query of slope attributes and forest cover information. Each distinct area of steep terrain or rock outcrop was then evaluated using stereo pairs of air photos, or digital orthophotographs, for the presence and extent of steep rock or cliff (escape terrain). The approximate boundary of each potential mountain goat habitat area (polygon) was mapped in the GIS and a preliminary habitat suitability rating of nil, low, moderate or high was assigned based primarily on the amount of escape terrain. A summary of the criteria used for preliminary rating of potential mountain goat habitat is provided in Table 1. Aerial assessments were then conducted for almost all potential goat areas rated low, medium and high, and approximately 20% of those sites rated as nil, to confirm or revise the preliminary rating.

Ground Assessment of Potential Mountain Goat Habitat Areas

We assessed use of potential habitat areas by mountain goats by conducting ground surveys at a subsample of habitat areas to locate goat sign. Sample sites were selected using a stratified random selection procedure, with habitat suitability ratings being used for stratification. Sample sites were accessed using a Bell 206 Jet-Ranger helicopter. Prior to landing at each site a fly-over was conducted to assess whether goats were currently present in the area. Ground assessments of each site consisted of a detailed sign survey transect and a reconnaissance-level investigation covering much of the polygon area. The detailed sign survey consisted of a 100 m-long, 2 m-wide belt transect located along the top of the most significant escape terrain in the area (where goat use and sign is typically highest). Along each transect observers counted the number of pellet groups, hair tufts, tracks, trails and beds, and noted any feeding sign. An estimate of the age of the sign was also recorded (fresh = <1 week old, young = <1 year old, and old = >1 year old). In addition to the detailed transect, crews searched representative habitats and ensured broad geographic coverage of each potential habitat polygon, to ensure detection of goat sign if that area was indeed used by goats. Four categories, very high (VH), moderate to high (MH), low (L), and not detected (N) were used to describe the amount of use.

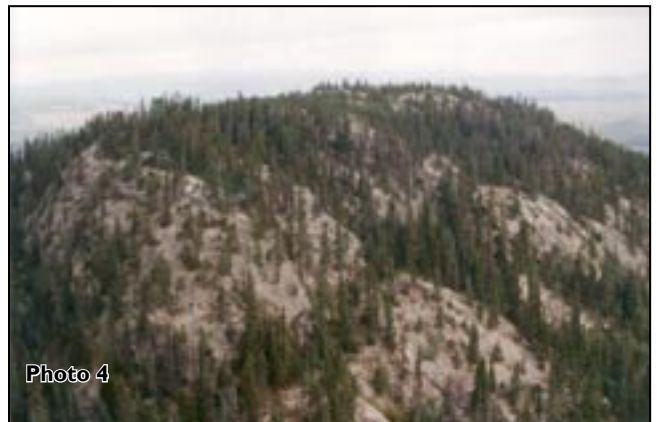
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Table 1. Summary of the criteria used for rating potential mountain goat habitat features.



Nil Value (Likely No Value)

Potential sites considered to have nil value for mountain goats include gently to moderately sloped hill features, mostly covered by forest. These features may have limited areas of talus (Photo 1), but do not offer security habitat such as cliff or rock outcrops, or seepage/earthen type mineral licks. In these features, feeding habitat is also non-existent, or if present to any extent, is with the absence of security habitat (Photo 2).



Low Value (Habitat Useable)

Potential sites considered to be of low value are those that offer some limited security habitat within extensive feeding habitat (Photo 3), or extensive security habitat, but little feeding habitat (Photo 4). Small areas of discontinuous cliff and rock outcrop are present. Limited feeding habitat is found adjacent to these small areas of escape terrain. Low value habitat features do not contain a mineral lick.

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Table 1 (continued). Summary of the criteria used for rating potential mountain goat habitat features.



Moderate Value (Habitat Useable)

Potential sites that are considered to be of moderate value are those that offer both security and feeding habitat, but are generally physically smaller features (Photo 5 and Photo 6). These features can support a small number of goats for limited periods. Seepage/earthen type mineral licks with little or no adjacent security habitat are also considered to be of moderate value.



High Value (Habitat Useable)

High value features are those sites that contain extensive regions of security habitat, including cliff and rock outcrops, with feeding habitat in close proximity (Photo 7). These features may contain a mosaic of rock and cliff, small herbaceous meadows, scrub forest and steep talus lower slopes. Summer thermal cover is available through nearby forest and cliff shading. Winter thermal cover is provided by nearby forest, or the site may have a southerly aspect. Such sites that also fulfill an important habitat function, such as a mineral lick or a kidding area, are of high value. Photo 8 shows a known mineral lick that also offers excellent security habitat, as well as feeding habitat along the forested crest and lower talus slopes.

Developing the Predictive Goat Use Model

We analyzed use of potential goat habitat areas by mountain goats, and developed a predictive model of use, using resource selection function methods (Manly *et al.* 2002). We used logistic regression procedures to develop the model. Logistic regression allows us to evaluate probability of use of resource units based on observations of areas being used/not used, and is the most common method used in resource selection functions (Manly *et al.* 2002). We identified several potential independent habitat variables that can affect use of areas by goats, including: size of habitat area, amount of escape terrain, type of feature (cliff or canyon), elevation, aspect, and area of nearby habitat areas (pers. obs., Harrison 1999, Haynes 1994, Gross *et al.* 2002). For each potential habitat area we derived measures of each attribute using a GIS. Multiple logistic regression analysis was run using all independent variables and utilized a stepwise variable entry method with an entry probability of 0.05 and removal probability of 0.10.



Results

A total of 1291 potential non-alpine mountain goat habitat areas have been identified in the Morice and Lakes Forest Districts (927 in the Morice and 364 in the Lakes). Approximately half of the potential areas identified through the GIS exercise were rated nil (no goat potential) based on air photo, aerial, and ground assessments of the areas. This results in a total of 593 habitat areas that offer potentially suitable habitat for mountain goats (442 Morice, 151 Lakes).

Ground sign surveys were conducted at 103 potential habitat areas (approximately 17% sample intensity) and mountain goat sign was detected at 56 of these sites. The proportion of areas used by goats differed between the two districts, with much lower frequency of use in the Lakes (31%) than in the Morice (65%). The pattern of use in the Lakes appears to be demarcated by a distinct east-west range boundary running north and south of Burns Lake.

Several areas were identified as having very high use by mountain goats. Based on high levels of multi-aged sign, direct observations of numerous goats over the past five years, and historic sighting reports from the Ministry of Water, Land and Air Protection (MWLAP) forest licensees, and the public, these areas appear to be core population centres that likely function as population sources for the surrounding areas. Maintenance of these core areas may be critical to the persistence of mountain goat use over the larger area.

There was strong correlation between the habitat suitability ratings and observed goat use, with an increasing proportion of areas used with higher suitability ratings. No goat sign was detected at any potential habitat areas with a final habitat suitability of nil.

The results from the logistic regression analysis indicate that only the amount of escape terrain was significant in predicting goat use. Further, the resulting model equation indicates that if any escape terrain is present, there is a reasonable probability the area will be used by goats. Since the presence of escape terrain has been directly assessed from multiple sources (air photos, forest cover information, TRIM slope models, aerial assessment, and ground assessment for a subsample of areas) as part of the habitat suitability ratings, it is recommended that those ratings be considered as the primary inventory source for management purposes.

Discussion

As mentioned in the introduction, there are few reported occurrences where mountain goats inhabit predominantly forested landscapes with numerous but widely spaced bluffs and canyons offering escape terrain. We are aware of only one other study that has documented a situation similar to the extensive use of non-alpine habitats by mountain goats that occurs in the central and southern Morice and Lakes Forest Districts. That area occurs on the Cleveland Peninsula in Alaska and contained a population of 50-70 animals within 800 km² (Smith and Raedeke 1982). Sub populations and groups occupied small patches of habitat consisting of slides, rock outcrops or forested areas exceeding 40 degrees, on discreet ridge complexes separated by forested valleys ranging from 0.8 to 2.4 km wide. Smith and Raedeke (1982) suggested that small population size and patchy distribution has potential for inbreeding and periodic local extinction. Genetic exchange and mating occurred only because of male movements. Timber development was just beginning in the area and Smith and Raedeke (1982) predicted that habitat alteration, human activity and illegal hunting would reduce inter-ridge movement and increase mortality leading to reproductive isolation and instability of individual groups, and that those combined effects could lead to extirpation of the goats.

The situation in the central and southern Morice and Lakes Forest Districts may represent the largest area of non-mountainous range inhabited by mountain goats. In smaller areas of forested goat range local goat populations have declined following timber development (Chadwick 1973), as Smith and Raedeke (1982) forecast for the Cleveland Peninsula. In contrast, the mountain goat populations inhabiting the non-alpine areas in the Morice and Lakes have persisted for at least 30 years since major forest development activity began in the area. Currently, at least five major mainline haul roads bisect the area with an extensive network of secondary and block roads throughout the area. The negative impacts of forest development locally are largely unknown. Illegal hunting and native harvest are known to occur in the area (Schultze, *pers comm.*), and have resulted in the short-term extirpation of small groups of goats from individual bluffs, but the overall population impacts are not known. Of the eight core population areas identified, only one area appears to have fewer goats present now than historic reports and old sign suggest. Maintenance of these core areas may be critical to the persistence of mountain goat use over the larger area.

The results of the resource selection function model, which found escape terrain was the only significant variable in predicting use of areas by goats, is similar to results of a recent study of alpine habitats in Colorado (Gross et al. 2002). In that study the authors examined the locations of mountain goats, determined using telemetry, with respect to elevation, slope (degrees), aspect and distance to escape terrain. Using similar logistic regression analysis, Gross et al. (2002) found that a model based only on distance to escape terrain provided the best correlation to observed locations of goats.

Management Guidelines

Results from this work have produced a comprehensive inventory of potential non-alpine mountain goat habitat areas in the Lakes and Morice Forest Districts. Based on observations of areas that are used and not used by goats, all habitat areas with a habitat suitability rating of low, moderate, or high, and that are within the observed mountain goat range boundary, should be considered as potential goat habitat for management purposes. A digital coverage of the potential goat habitat areas has been distributed to the Ministry of Forests and major licensees in each respective district. This component of the overall study did not focus on developing management recommendations to address habitat and movement requirements of the mountain goats using this area. Other past and ongoing aspects of the larger goat study are specifically examining those requirements (Mahon and Turney 2002, Turney *et al.* 2003). For more discussion of management implications, including our interim recommendations, please refer to the final report for this project.

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For More
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