Background Information and Rationale

UNGULATE WINTER RANGE
U-6-017
Mountain Goats, Lakes TSA Nadina Forest District

1.0 Introduction

The Ecosystems Section, Resource Management, Skeena Region of the Ministry of Forests, Lands and Natural Resource Operations is tasked with identifying *Ungulate Winter Range* (UWR) areas and objectives to ensure winter survival for ungulate species. The term "ungulate winter range" means an area that is identified as being critical for the winter survival of an ungulate species; mountain goat in this case.

UWR objectives need to consider key life requisites including refugia habitat from predators and human intrusion, forage supply, thermal cover and security cover.

The overall intent of the Lakes Mountain Goat UWR proposal is to:

(1) protect the areas that are critical for the winter and year-round survival of the low elevation population;

(2) ensure that these areas are distributed in the most effective way for maintaining this population across it's natural range; and

The Ecosystems Section, Resource Management, Skeena Region of the Ministry of Forests, Lands and Natural Resource Operations recommends that mapped areas of mountain goat winter range in the Lakes TSA be designated as Ungulate Winter Range.

2.0 Background

Ecology

Mountain goats are a moderate sized ungulate found in rocky, mountainous, escarpment or canyon terrain at mid to high elevations over much of British Columbia. Mountain goats have also been found to use canyons extensively (Foster and Rahs 1985, Harrison 1999, Turney *et al.* 2001, Turney *et al.* 2003) and there is growing information on the use of forested rocky areas below the subalpine parkland (Foster 1982, Smith and Raedeke 1982, Turney *et al.* 1999, 2000 and 2001, Turney and Roberts 2004). Rocky cliffs, rock outcrops and talus slopes are an important habitat requirement for mountain goats as they provide escape terrain for security from predators (Russell 1974, Hebert and Turnbull 1977, Shoen and Kirchoff 1982, Foster 1982, McCallum 1983, Fox *et al.* 1989). These security habitats are so important to mountain goats that they are seldom found more than 300 to 500m from these habitat types at any time of the year (Shoen and Kirchoff 1982, Foster 1982, Smith 1986a, Fox *et al.* 1989). Areas with abundant food supply and little escape terrain are generally not utilized by mountain goats (Hebert 1967, Chadwick 1973, Russell 1974, Smith 1977, Fox 1978, Shoen and Kirchoff 1982).

The most critical factor of goat winter range is the availability of escape terrain with sufficient forage quality and abundance. Subalpine forests are used for forage during the winter, but it has not been determined if subalpine forests are selected for, or if they are utilized primarily because of their sole availability in higher elevations. Windswept slopes surrounding escape terrain will

widely increase goat winter range by allowing movement away from the escape terrain. Steep, forested slopes are also ranked as potential winter areas for goats. Cover will not be avoided by goats, and will be used if it meets security requirements that are otherwise provided by steep cliffs and bluffs. In the Belcourt area, goats make use of steep, forested slopes similar to those used in Nadina FD for winter habitat (Goddard 2003).

Human disturbances, unlike the passing of a predator, are often more frequent, persistent and intense. Goats have dispersed in search of greater seclusion when faced by steady disturbance from road construction and traffic, logging or mineral exploration adjacent to their ranges. Even if goats are not totally displaced by such activities, they may be more closely confined to escape terrain and unable to efficiently use the less secure parts of their range (for other necessary activities). Human disturbance and harassment of goats in Alberta is a potentially significant limiting factor (to maintaining populations) warranting increased attention in the future (see Glasgow et al 2003). Geist (1978) notes that harassment has a number of consequences, including: 1) elevates metabolism at the cost of energy resources and reserves needed for normal growth and reproductive potential; 2) can cause death, illness or reduced reproduction due to secondary effects from physical exertion and temporary confusion, and displacement into unfamiliar habitat; 3) can lead to avoidance or abandonment of areas and to reduction in a population's range and, ultimately, to reduction of the population due to loss of access to resources, increased predation or increased energy cost for existence. Further, if prolonged, harassment can be expected to result in organ damage, reduced viability and early death. The most critical times of disturbance tend to be during cold weather, late pregnancy, and whenever animals are in a state of negative energy balance. In response to human disturbance, mountain goats have not been found to habituate and tend to remain flighty and far less approachable than bighorn sheep. Keim (2004) states that winter mountain goat habitat relationships are identifiable and should be incorporated into the planning and management of winter recreational activities, resource development, and flight paths for low flying aircraft. In this study, goats were relatively inactive during winter, moving only small distances within limited winter home range areas, were found to re-use winter habitats to some degree, and were found to utilize specific and definable core winter habitat areas. Keim recommends that the development of management guidelines for winter range should be required before resource use is considered.

Foster and Rahs (1983) reported that mountain goats in the Stikine Canyon exhibited disruptive behavioural patterns to aircraft and ground disturbance during 83% of events (n = 667). They recorded a "severe flight response" during 33% of observations. Fifty-five percent of severe flight responses were observed when disturbance distance was <100 m. In 22.5% of encounters, disruptive, including both moderate and severe flight, stress-response occurred in distances from 401-1600 m. They did not observe any habituation to noise stimuli, and noted that goats actually became more sensitized to milder forms of disturbance, suggesting additive negative effects. They also detected temporary range abandonment as a result of disturbance. To completely avoid harassment, they recommend a 2 km buffer from helicopters. Côté (1996) found that mountain goats, as measured by overt responses, were disturbed by 58% of the flights and were more adversely affected when helicopters flew within 500 m. Distance between animals and helicopters was the most important factor affecting goat response; overt disturbance responses were observed 85% of the time when helicopters approached to <500 m.

Disturbance also caused the disintegration of social groups on at least 5 occasions and resulted in 1 case of severe injury to an adult female. He observed panic behaviour, with goats staying alert for several hours without attempting to forage while helicopters were placing seismic lines nearby. Côté suggests the cumulative effect of this response could impact body condition and reproductive success (severe consequences especially for kids and nursing females). In this study there was no evidence that wild ungulates habituate to repeated helicopter overflights.

Côté recommends a 2000 m horizontal buffer between helicopter activity and goat range. In cases where helicopters must infringe on goat habitats, aircraft should stay at least 300 m above ground level and not land on treeless ridges. Frid (1997) reviewed human disturbance to mountain goats and recommends helicopters should maintain a setback horizontal distance of 2 km from areas known to be used by goats and helicopter and fixed wing routes that minimize disturbance to goats should be designed. Gordon & Wilson (2004)studied the effects of helicopter logging activity on mountain goat behaviour and found that helicopter yarding activity had significant effects on mountain goat behaviour at distances of 1.5 km.

Goats responded to initiation of helicopter yarding activities in both study years (compared to a control), including displacement/avoidance behavior and changes in feeding and bedding activity. The study cautioned against relying strictly on overt disturbance responses because the physiological effects of disturbance may not be apparent. For example, increased vigilance may reduce the physiological fitness of affected animals either through stress, increased locomotion costs, or through reduced time spent in necessary behaviour such as foraging or ruminating (Frid 2002 *in* Gordon & Wilson 2004).

Management recommendations arising from this study include limiting helicopter disturbance within 1.5 km of occupied goat habitats during the period of October 1 through May 15 to avoid disturbance to over-wintering mountain goats (with refinement of dates based on local conditions). They also recommended additional timing restrictions (May 15 through June 15 & within 1.5 km) be applied for helicopter activity adjacent to nursery herds of adult females and kids. Management of other disturbance stimuli should be based on the distance between the stimuli and goats, the type and duration of stimuli, and the presence of topographic features to ameliorate the auditory and visual effects of disturbance. Toweill et al. (2004) found that increased use of aircraft near occupied mountain goat habitat is highlighted as a particular concern. Human related disturbance to ungulates is postulated to have a variety of effects, including: habitat abandonment, changes in seasonal habitat use, alarm responses, lowered foraging and resting rates, increased rates of movement and reduced productivity.

Non-lethal disturbance stimuli (such as helicopter activity) can impact fitness-enhancing activities such as feeding, parental care and mating and can significantly affect survival and reproduction. Physiological responses to disturbance may not be reflected by overt behaviour but are nonetheless costly to individual animals and ultimately to populations. Winter is a period of particular concern for the management of disturbance stimuli, because periods of deep snow can reduce food availability and increase locomotion costs. Helicopters are generally more disruptive compared to fixed wing aircraft. Goldstein et al (2005) recorded behavioural responses (maintenance, alert, vigilance, fleeing) of 122 groups of mountain goats from 347 over flights at distances ranging from 143m to 1911m. The probability of any mountain goat in a group becoming disturbed at 500m distance to the helicopter was 62%, 52%, 38% and 25% among the

four study areas. At 1000m distance, probability of disturbance was 45%, 25%, 18% and 10% among the four study areas. The probability of a group of mountain goats remaining in the maintenance category (not being disturbed) was >90% if distance to the group was >1730m, >1481m, >1318m, and >991m at the four study areas. Topography may provide some explanation for the different magnitudes of responses (as compared to Côté & Foster and Rahs), due to terrain, noise levels and proximity to escape terrain.

Northern Wild Sheep & Goat Council (2004) state:

- helicopter activity should not occur within 1.5 km of occupied/suspected nursery groups or crucial winter range habitats during critical periods. Helicopter exclusion zones should be identified prior to tenures being issued.
- Helicopter activity should not occur on or near occupied winter ranges between November 15 to April 30. Helicopter activity should not occur on or near occupied or suspected nursery group habitats between May 1 to June 15 each year.
- Vertical and horizontal approach vectors should be considered when developing mitigation strategies. Strategies should also consider local conditions (e.g. topography, escape terrain, cover).
- It is inappropriate to assume that habituation of mountain goats to helicopter disturbance will occur over time. Reluctance to flee should not be perceived as habituation; numerous physiological responses occur, even in the absence of overt behavioural responses. All helicopter flights over or near crucial mountain goat habitat should be considered harmful to mountain goat populations, based on current knowledge.
- Long-term monitoring is essential…monitoring should include both compliance with, and evaluation of the effectiveness of, mitigation strategies and exclusion zones.

Chadwick (1983) noted that kids, yearlings and adult females carrying an unborn fetus, are likely to be the most susceptible to stress-related mortality. Disturbance to goats in winter induces stress which increases the goats' metabolic rate which in turn burns important fat reserves and may reduce recruitment.

Effects of ground disturbance vary, but appear to consistently impact mountain goats. Sopuck (1985) indicated that coal mining operations in northeastern British Columbia appeared to have displaced mountain goats from areas within 1.5 km of the mine. Kuck (1985) stated that the main key to goat habitat management is to encourage public land management agencies to avoid or limit use or access into, or adjacent to, goat habitat. Joslin (1986) suggested that seismic activities coincided with a decline in adult female numbers, kid numbers and productivity in one population (the population decline appeared coincident with the peak in seismic activity). The added impact of seismic activity, over and above other human activities in this population, appeared to be the primary cause of changing population characteristics. Joslin further postulated that the stress induced by seismic activity was cumulative over the years, resulting in reduced productivity. Blasting activities associated with road construction, mineral exploration or other industrial activities can also directly affect the suitability of mountain goat habitat by precluding use of critical escape terrain. Blasting might also disturb goats during critical periods (such as kidding) or increase the risk of avalanches on winter ranges (Toweill et al. 2004).

Penner (1988): Conducted experimental habituation for an atypical mountain goat population at Pinto Creek, Alberta (7 to 14 animals in study). Penner studied if goats could habituate to noise

stimuli representative of petroleum exploration activities. A gas powered generator and pre-recorded noise of an operating drill rig, and periodic pipe clanging and shotgun blasts were used as stimuli. The closest experimental noise stimuli occurred at distances between 400 to 600 m across the valley from goats (the actual seismic program passed about 600 m from traditional winter range). At 400 to 600 m distance, mountain goats appeared to develop a tolerance of indirect and persistent noise stimuli (i.e. pre-recorded drill noise), but continued to exhibit elevated behavioural response levels to initial, novel or sudden noise and visual stimuli (i.e. they did not habituate to periodic or inconsistent noise). Other observations made were that nannies were sensitive to stimuli of all kinds during the kidding and post-kidding seasons. The sounds of an approaching helicopter frequently elicited a concerned or alarmed response from goats. Noise stimuli was the documented source of 48% (spring) to 78% (winter) of elevated goat responses (ranging from 'curious' to 'very alarmed'). Festa-Bianchet and Côté. (2008) state that goats are more sensitive to disturbance by helicopters than other ungulates. They recommend that helicopters should not fly within 2 km of mountain goat habitat.

Joslin (1980) *in* Haynes (1992) states that regardless of the mechanism of interaction, the ultimate result of close association between humans and mountain goats seems to be the eventual reduction or elimination of goats (i.e. the effects of increased, human-caused stress may lead to a rise in mortality in the short term and reduced productivity of a herd over the long term). Haynes (1992) provides management recommendations for major land uses like timber, mineral development and recreation. The "timber recommendations" section states there should be a buffer zone of 0.25-0.50 miles (400-800 m) adjacent to goat habitat where no logging activity or road building takes place (i.e. a no disturbance zone). Further, the complete closure of all logging roads within 1 mile (1600 m) of crucial range (i.e. including winter range) is recommended. Lastly, no activity within 1 mile (1600 m) of goat habitat during birthing (May 1 to Jun 30) and breeding (Nov 1 to Dec 31) is recommended.

Reproduction

The life span of the mountain goat is variable but estimated at approximately 12 years. Full maturity is reached at 4 years of age, while female sexual maturity first occurs at 2.5 years of age (Blood 2000; Coté and Festa-Bianchet 2001). Males are capable of procreating at that age, but are generally out-dominated by older males.

Mountain goats breed in the fall from November to December and have a gestation period of approximately 6 months. Kids are born in mid May to early June on protected cliff areas, usually the steepest, most rugged areas available. Generally one kid is born, although twins are common, and they will stay with their mothers in nursery groups for up to two years (MacGregor 1977).

Habitat Use and Home Range

Many mountain goat herds will remain in the same general home range year-round, while others herds have been known to move to different home ranges at different times of the year. When seasonal home ranges are used, elevational shifts are often present.

During the winter, interior populations will use lower elevation timbered habitats but tend to prefer wind-swept alpine areas and steep cliffs where snow is shed by the steep terrain (Hebert 1967, Smith 1977). Mountain goat populations in the Telkwa Mountains and Nadina Mountain

near Houston showed that forest use in winter was on forest edges adjacent to escape terrain (Turney *et al* 1999, 2000 and 2001).

As snow levels recede, mountain goats will move to low elevation alpine and sub-alpine areas where emergent plants are available. As the season progresses, mountain goats will tend to follow the receding snow line upslope, taking advantage of the opportunity to forage on the new green plants that emerge (Casebeer *et. al.* 1950, Hebert 1967, Russell 1974, Foster 1982, Fox *et al.* 1989). Foraging takes place in a variety of habitat types ranging from alpine tundra, alpine grass-herb communities, sub-alpine meadows and sub-alpine shrub and early seral stage forests (Chadwick 1973, Russell 1974, Fox 1978, Foster 1982, Fox *et al.* 1989).

Mountain goats tend to forage and bed in the same general area, moving slowly from site to site within the area and seldom moving more than a few hundred meters in a day. Once an area has been used for a short period, mountain goats will move to another area, generally using a direct path and repeat the process (Chadwick 1973).

In west central B.C., the home range size for mountain goats in subalpine habitats were smallest in the winter and largest during the summer (Blume *et al.* 2003), which is a trend similar to that observed by other studies (e.g. Chadwick 1973, Adams *et al.* 1982, Stevens 1983). This change in seasonal range size is likely related to snow accumulation in winter and melt in the spring, which affects the ability of animals to travel (Casebeer *et al.* 1950, Hebert 1967, Russell 1974, Stevens 1983) and possibly energy conservation in the harsher winter weather (Adam *et al.* 1982). Studies have also observed that adult male ranges tend to be much larger than those of adult females, especially during the fall rut (Chadwick 1973, Thompson 1980, Schoen and Kirchoff 1982, Smith and Raedeke 1982).

Key Habitat Requirements – Life Requisites

Feeding Habitat (FD)

Mountain goats consume a variety of plant species and can be found eating almost any available vegetation. Their diets change seasonally, taking advantage of newly emergent plants during the spring and summer seasons, and shrubs, trees and lichens during the winter. Table 1 (Plant species used by mountain goats) displays a summary of plant species used by mountain goats in a variety of study areas including British Columbia, Alaska and Montana (Hjeljord 1973, Thompson 1980, Smith 1982, Foster and Rahs 1985, Fox and Smith 1988).

Table 1. Plant species used by mountain goats

Food Type	Species	
Trees	subalpine fir (*Abies lasiocarpa*) western hemlock (*Tsuga heterophylla*) lodgepole pine (*Pinus contorta*)	yellow cedar (*Chamaecyparis nootkatensis*) mountain hemlock (*Tsuga mertensia*)
Shrubs	*Vaccinium* spp. *Ribes* spp. *Salix* spp. Utah honeysuckle (*Lonicera*	*Rubus* spp. white mountain-heather (*Cassiope mertensiana*) kinnickinnick (*Arctostphylos uva-*

Food Type	Species	
	utahensis) high-bush cranberry (*Viburnum edule*) *Rosa* spp.	*ursi*) soopolallie (*Shepherdia Canadensis*)
Graminoids	sedges (*Carex* spp.)	grass (not specified)
Forbs	partridgefoot (*Leutkea pectinata*) arnica (*Arnica* spp.) grounsel/butterweed (*Senecio* spp.) lousewort (*Pedicularis* spp.) bedstraw (*Galium* spp.) mountain sagewort (*Artemesia norvegica*)	fireweed (*Epilobium* spp.) daisy/fleabane (*Erigeron* spp.) buttercup (*Ranunculus* spp.) vetch (*Hedysarum* spp.) Arctic lupin (*Lupininus arcticus*) Jacob's ladder (*Polemonium* spp.)
Ferns	deer fern (*Blechnum spicant*)	lady fern (*Athyrium felix-femina*)
Lichens	*Lobaria* spp. *Alectoria* spp.	*Usnea* spp.
Mosses	step moss (*Hylocomium* spp.)	*Rhytidiadelphus* spp.
Other	bunchberry (*Cornus canadensis*)	roseroot (*Sedum integrifolium*)

Mineral licks are an important habitat feature for mountain goats and they will travel further from their normal habitats than any other ungulate to obtain minerals (Hebert 1967). Mountain goats will use mineral licks that are in unfavourable habitats and will travel through forests to obtain minerals (Hebert 1967, Turney *et al.* 1999, 2000 and 2001). Mineral licks are used once they become snow-free in the spring until snowfall in late fall, early winter (Hebert 1967, Thompson 1980, Turney *et al.* 1999, 2000 and 2001). Mineral licks are used by both sexes, with males using them more often in the spring, while females or females with kids use these features in the spring and throughout the summer (Thompson 1980, Turney *et al.* 1999, 2000 and 2001).

Winter

During winter, feeding occurs on steep, south-facing rocky areas and in some cases forested or scrub forest areas nearby (Chadwick 1973, Smith 1977, Schoen and Kirchoff 1982). Winter forage is dependent on availability but is primarily grasses and sedges, shrubs, lichens, and conifers (Chadwick 1973, Thompson 1980, Stevens 1983). Use of forested habitats in winter is dependent on the availability of nearby escape terrain, snow condition and snow depth. In the interior, when snow levels are high, mountain goats will tend to stay on steep, snow-shedding terrain or in areas where the wind keeps the snow from accumulating (Hebert 1967, Smith 1977). In coastal areas, mountain goats will use south-facing timbered habitats below and adjacent to escape terrain, foraging on plant species such as *Vaccinium spp*, bunchberry, sedges, tree lichens and mosses (Foster 1982, Smith 1986a, Fox and Smith 1988, Fox *et al.* 1989). This difference in use of forested terrain in winter appears to be related to the difficulty in moving in the deep, wet snow found in coastal areas as opposed to the drier snow found in interior areas.

Spring
Mountain goats move to south-facing lower elevations in the spring to take advantage of newly emergent plants as the snow melts (Chadwick 1973, Smith 1977, Schoen and Kirchoff 1982). In early spring, grasses and sedges make up the majority of the diet, with forbs becoming more important later in the spring (Chadwick 1973, Thompson 1980). Use of alpine meadows, sub-alpine meadows, avalanche tracks and parklands adjacent to escape terrain is common (Smith 1977, Thompson 1980). Mineral licks are important sites that are used during the early spring by males (Hebert 1967).

Summer
The habitats used by mountain goats for summer feeding are more variable than at other times of the year, and include krummholz-parkland, avalanche tracks, alpine and sub-alpine meadows, cliffs, rocky outcrops, snowfields, sub-alpine parkland and sub-alpine forests (Thompson 1980, Foster 1982, Schoen and Kirchoff 1982, Stevens 1983). Travel to find feeding areas is greatest during the summer when movements of a couple of kilometres are common (Chadwick 1973). Plants commonly used during the summer include shrubs (e.g. willows and soopolallie), grasses, sedges and herbaceous plants (Chadwick 1973, Thompson 1980). Mineral licks are an important habitat feature used in summer by females and females with kids (Hebert 1967).

Fall
Grasses were a main fall food for goats studied in Montana, with shrubs and forbs a minor component. Habitats selected tended to be found at lower elevations than summer habitats (Thompson 1980, Schoen and Kirchoff 1982). Cliff and rocky habitats are used often in the fall, although some use of shrubby habitats, sub-alpine and alpine meadows is found (Chadwick 1973, Smith 1977).

Thermal Habitat
Thermoregulation is an important factor in determining summer mountain goat habitats. During the summer, mountain goats will use higher elevations, north aspects and bed in snowbanks to help keep cool (Smith 1977, Fox 1978, Schoen and Kirchoff 1982, Stevens 1983). During the winter, the selection of south-facing habitats is common for both coastal and interior mountain goats (Smith 1977, Fox 1978, Schoen and Kirchoff 1982).

Security/Reproducing Habitat
Security habitats for mountain goats are steep cliffs, rocky outcrops and talus slopes where they can climb away from predators (Hebert 1967, Chadwick 1973, Foster 1982, Schoen and Kirchoff 1982, Stevens 1983). For reproduction, female goats choose the steepest, most inaccessible rocky areas to have their kids (MacGregor 1977).

2.1 Habitat use
Mountain Goats in the Nadina Forest District occur in a variety of habitats. It is important to recognize the distinction between two predominant goat winter range types: the coastal ranges where goat habitat is primarily associated with high elevation mountainous terrain, and the interior where most habitat is associated with clustered or isolated rocky bluffs, canyons, and steep valley side walls adjacent to plateaus, throughout the district, at various elevations.

Within the Nadina Forest District, mountain goat habitats have been studied intensively since 2001, with the goal of identifying where important habitats are located in alpine and forested sub-alpine areas. These studies have identified an extensive population of mountain goats as well as use patterns within forested habitats that may be affected by forest development and increased access by humans. The mountain goat habitat found in the Morice and Lakes Timber Supply Areas has a significant portion adjacent to existing and proposed harvest areas (Turney et al.2001 and 2002). Assessments of mountain goat sign and population surveys indicate that some of these forested cliff and canyon features are no longer used (Turney *et al.* 2000) although the reason for their abandonment is unclear. There are concerns from resource managers that the loss of mountain goats from these features may be permanent, which may affect overall mountain goat population dynamics.

Although the ruggedness of goat terrain has prevented forest harvesting within or near many winter ranges in the past, AAC related pressures, improved logging methods, and changing log markets increase the risk that localized goat winter ranges will be impacted by forest harvesting in the future. Most issues concerning goats are related to access (e.g. roads, aerial recreation) and protection of winter/natal habitats.

Schedule A has updated the mountain goat winter range from what was known at the time of the Lakes LRMP. Even though the Lakes TSA does not have a lot of mountain goat habitat, what exists is important and this Order contains approximately twice the amount of habitat identified in the LRMP (has been confirmed by Ardea Consultants (Laurence Turney) since the LRMP was signed off).

The Ministry of Environment, Skeena Region, Ecosystems Section contracted the services of Ardea Biological Consulting (Turney, 2004) to summarize existing knowledge and data for the purposes of producing a map of mountain goat winter range in the Nadina Forest District (FD). L. Turney has conducted or participated in most of the mountain goat research and inventory in the Nadina FD to date, and has produced the mountain goat winter range map within the Nadina FD. To delineate the mountain goat UWR areas, a combination of geographic information system (GIS) queries and inventory information were combined to create a habitat capability model.

A model algorithm was developed using a Habitat Suitability Index (HSI) approach and ArcView 3.2a GIS (Turney, 2004). Habitat attributes such as ***slope, distance from steep slopes, elevation, aspect, forest crown closure, and presence of glaciers*** were used in the algorithm. Each habitat attribute had various categories, each of which was given a value from 0 to1, with values of 0 being not suitable and 1 being very suitable. Habitat Value ratings were based on the information from the various studies that are ongoing or just recently completed on mountain goats in north-western British Columbia (see Turney 2003, Reid et al. 2002, Turney et al. 2003, Blume et al. 2003 and Mahon et al. 2003). The habitat attributes were then combined in an equation to determine capable primary and secondary habitats. Weightings for the various habitat attributes within the equations were derived from assumptions on the relative importance of the habitat attributes to mountain goats for habitat selection. The presence of glaciers was applied as a filter to the equation to remove unsuitable or un-used habitats.
Two habitat capability ratings classes were defined for the mapping: Primary and Secondary. Primary habitats are those that contain steep slopes, or are very close to steep slopes, are

generally south-facing and are in lower alpine or sub-alpine elevation, but are not glaciers. Secondary habitats are similar to primary habitats, but would likely be less steep slopes, aspects that may be more easterly or westerly, or are higher or lower elevation than the primary habitats.

Secondary habitats were those with HSI values ranging from 0.55 to 0.75, and primary habitats were those with HSI values from 0.76 to 1.0. The breakpoints for the HIS ratings were determined through visual comparison of the model results to known high value use areas within the Nadina Forest District. The importance of any single attribute (i.e slope, distance from steep slope, etc) is dependent on the combined values of all other attributes in the model and the given weighting. Therefore polygons include both primary and secondary habitat. The spatial extent of a given polygon is dependent on all attributes in the model. For example the amount of area captured adjacent to steep terrain depends on the slope of the adjacent terrain, steepness of escape terrain, aspect, and elevation.

To produce the final map all polygons less than 1 ha and all "unknown" mountain goat habitat polygons were then removed, as well as areas of private land, protected and proposed protected areas.

2.2 Habitat Capability Mapping

Habitat capability maps were created from the habitat model algorithms using the Map Calculator function of the Spatial Analyst Extension in ArcView 3.2a GIS. Each habitat attribute was created as a 25m resolution GRID layer from existing Digital Elevation Model (DEM), and Terrain Resources Inventory Map (TRIM) information obtained from the Integrated Land Management Bureau. The calculated GRID map was converted to a polygon map file and filtered to remove secondary habitat polygons less than 0.5 ha. As an attempt to refine the capability mapping to address areas of use, an overlay of the known areas of mountain goat use based on sightings, sign, or telemetry was used to modify the primary and secondary habitat classes. Any polygon complex that was within 5 kilometres of a known use areas was labelled as "known", while all others were labelled as "unknown". Area statistics and summaries were then prepared from this final map.

3.0 Rationale for General Wildlife Measures

GWM	Rational
1 & 2	Objectives 1.1, 1.2, 1.4. 2.1, 2.2, 4.1, and 4.2 of SRMZ 4 within the Lakes LRMP. Consistency with mountain goat habitat management within the remainder of the Nadina Forest District (i.e. Morice TSA). Polygons are predominantly comprised of cliffs, canyons, and rocky bluffs that are generally not conducive to timber harvest. This measure protects the most critical mountain goat habitat; escape terrain and forest directly adjacent to escape terrain. The model used by Turney above incorporates habitat extending *up to* 400 meters from escape terrain. Turney (in prep). Significant use of forested habitat by mountain goats in the Nadina up to 400 m from escape terrain. Mountain goats normally remain <400 m from adequate escape terrain (Fox *et*

	al. 1989). Chadwick (1973) reported that population estimates of goats were 2 to 3 times higher prior to the development of access roads for logging, with mountain goats abandoning preferred cliff habitats if roads or clear-cutting approached within 400 meters. Taylor and Brunt (2003) found that the mean distances between winter telemetry locations and rock outcrop polygons was 100 m and were never more than 571 m. Current forest management practices for mountain goat habitats suggest the application of no-harvest buffers or wildlife habitat areas to protect important habitat features (Turney 2003). Old forests with high-diameter trees and multi-layered, closed canopies are most efficient at reducing the depth of snow on the ground (Kirchhoff and Schoen 1987). Older forests are generally associated with more abundant arboreal lichens and litter fall (Rochetta 2002).
3	Provision for felling of single trees for danger, guy line anchors, or tail hold trees when required to address worker safety. Consistency with mountain goat habitat management within the remainder of the Nadina Forest District (i.e. Morice TSA).
4	Joslin (1980) *in* Haynes (1992) states that regardless of the mechanism of interaction, the ultimate result of close association between humans and mountain goats seems to be the eventual reduction or elimination of goats (i.e. the effects of increased, human-caused stress may lead to a rise in mortality in the short term and reduced productivity of a herd over the long term). Haynes (1992) provides management recommendations for major land uses like timber, mineral development and recreation. The "timber recommendations" section states there should be a buffer zone of 0.25-0.50 miles (400-800 m) adjacent to goat habitat where no logging activity or road building takes place (i.e. a no disturbance zone). Further, the complete closure of all logging roads within 1 mile (1600 m) of crucial range (i.e. including winter range) is recommended. Lastly, no activity within 1 mile (1600 m) of goat habitat during birthing (May 1 to Jun 30) and breeding (Nov 1 to Dec 31) is recommended. Objectives 4.1, and 4.2 of SRMZ 4 within the Lakes LRMP. Consistency with mountain goat habitat management within the remainder of the Nadina Forest District (i.e. Morice TSA). Reduces the risk of habitat displacement directly adjacent to escape terrain due to noise during the most critical periods: winter, and kidding season. Habitat avoidance has been documented in goat populations disturbed by development activities. Joslin (1986) in particular, as well as Foster and Rahs (1983), indicate that the

	effects of disturbance on goats are additive if the levels of disturbance are high (such as those associated with helicopters). Penner (1988) examined the effects of noise stimuli representative of petroleum exploration activities on forest-dwelling goats in Alberta. Goats habituated to predictable, continuous stimuli, but were disturbed by unpredictable, sudden stimuli. Nannies were more sensitive to stimuli of all kinds during the kidding and post-kidding seasons.
5	Joslin (1980) *in* Haynes (1992) states that regardless of the mechanism of interaction, the ultimate result of close association between humans and mountain goats seems to be the eventual reduction or elimination of goats (i.e. the effects of increased, human-caused stress may lead to a rise in mortality in the short term and reduced productivity of a herd over the long term). Haynes (1992) provides management recommendations for major land uses like timber, mineral development and recreation. The "timber recommendations" section states there should be a buffer zone of 0.25-0.50 miles (400-800 m) adjacent to goat habitat where no logging activity or road building takes place (i.e. a no disturbance zone). Further, the complete closure of all logging roads within 1 mile (1600 m) of crucial range (i.e. including winter range) is recommended. Lastly, no activity within 1 mile (1600 m) of goat habitat during birthing (May 1 to Jun 30) and breeding (Nov 1 to Dec 31) is recommended. Objectives 1.1, 4.1, and 4.3 of SRMZ 4 within the Lakes LRMP. Consistency with mountain goat habitat management within the remainder of the Nadina Forest District (i.e. Morice TSA). To prevent public access on secondary roads following forestry operations. Reduces direct mortality due to road kills, hunters, poachers, and reduces habitat displacement due to industrial activity and motorized recreational use. In British Columbia, increased access resulted in many mountain goat populations being overhunted prior to the 1980's, and increased access was singled out as the cause of overhunting in many mountain goat populations (Macgregor 1977). Mahon *et al* (2003). Minimize road development that will provide access to goat habitat areas. Where possible avoid permanent roads within 1 km of goat habitat areas, deactivate/un-build all spur and in-block road within 500 meters of habitat areas so that they do not provide vehicle or ATV access, and avoid developing any roads within 200 m of habitat areas. Chadwick (1973) reported that population estimates of goats were 2 to 3 times higher prior to the development of access roads for logging, with mountain goats abandoning preferred cliff habitats if roads or clear-cutting approached within 400 meters. The relatively gentle terrain of the interior plateau, and the juxtapositions of escape terrain (canyons and rock outcrops) within the plateau setting creates higher risks to goats because it is very easy to build roads right to the edge of

	habitat polygons (as opposed to more mountainous terrain). As well, these goat populations are known to travel large distances between habitat polygons which increases the risk of interception with humans or habitat displacement. The primary rationale for the 1 km access buffer comes from the Morice LRMP which states (1)"100% of land within 3 km of occupied mountain goat habitats will have no roads or have Best Management Practices by 2005", and (2)"Minimize the length of time that roads are drivable within 1 km of occupied goat habitat. Deactivated roads should not be driveable by 4 wheel vehicles (includes ATV's)". We felt that 3 km was not flexible enough to incorporate as a GWM. The 1 km/1 year GWM is in keeping with the Morice LRMP and the associated risks in these landscapes (as described above). Once a pattern of public use is established on a road, access control is generally ineffective. 1 year deactivation period reduces the risk of new access within mountain goat UWR.
6	Foster and Rahs (1983) reported that mountain goats in the Stikine Canyon exhibited disruptive behavioural patterns to aircraft and ground disturbance during 83% of events (n = 667). They recorded a "severe flight response" during 33% of observations. Fifty-five percent of severe flight responses were observed when disturbance distance was <100 m. In 22.5% of encounters, disruptive, including both moderate and severe flight, stress-response occurred in distances from 401-1600 m. They did not observe any habituation to noise stimuli, and noted that goats actually became more sensitized to milder forms of disturbance, suggesting additive negative effects. They also detected temporary range abandonment as a result of disturbance. To completely avoid harassment, they recommend a 2 km buffer from helicopters. Côté (1996) found that mountain goats, as measured by overt responses, were disturbed by 58% of the flights and were more adversely affected when helicopters flew within 500 m. Distance between animals and helicopters was the most important factor affecting goat response; overt disturbance responses were observed 85% of the time when helicopters approached to <500 m. Disturbance also caused the disintegration of social groups on at least 5 occasions and resulted in 1 case of severe injury to an adult female. He observed panic behaviour, with goats staying alert for several hours without attempting to forage while helicopters were placing seismic lines nearby. Côté suggests the cumulative effect of this response could impact body condition and reproductive success (severe consequences especially for kids and nursing females). In this study there was no evidence that wild ungulates habituate to repeated helicopter overflights. Côté recommends a 2000 m horizontal buffer between helicopter activity and goat range. In cases where helicopters must infringe on goat habitats, aircraft should stay at least 300 m above ground level and not land on treeless ridges. Gordon & Wilson (2004)studied the effects of helicopter logging activity on mountain goat behaviour and found that helicopter yarding activity had significant effects on mountain goat behaviour at distances of 1.5 km. Goats responded to initiation of helicopter yarding

	activities in both study years (compared to a control), including displacement/avoidance behavior and changes in feeding and bedding activity. The study cautioned against relying strictly on overt disturbance responses because the physiological effects of disturbance may not be apparent. For example, increased vigilance may reduce the physiological fitness of affected animals either through stress, increased locomotion costs, or through reduced time spent in necessary behaviour such as foraging or ruminating (Frid 2002 *in* Gordon & Wilson 2004). Management recommendations arising from this study include limiting helicopter disturbance within 1.5 km of occupied goat habitats during the period of October 1 through May 15 to avoid disturbance to over-wintering mountain goats (with refinement of dates based on local conditions). They also recommended additional timing restrictions (May 15 through June 15 & within 1.5 km) be applied for helicopter activity adjacent to nursery herds of adult females and kids. Management of other disturbance stimuli should be based on the distance between the stimuli and goats, the type and duration of stimuli, and the presence of topographic features to ameliorate the auditory and visual effects of disturbance. Goldstein et al (2005) recorded behavioural responses (maintenance, alert, vigilance, fleeing) of 122 groups of mountain goats from 347 over flights at distances ranging from 143m to 1911m. The probability of any mountain goat in a group becoming disturbed at 500m distance to the helicopter was 62%, 52%, 38% and 25% among the four study areas. At 1000m distance, probability of disturbance was 45%, 25%, 18% and 10% among the four study areas. The probability of a group of mountain goats remaining in the maintenance category (not being disturbed) was >90% if distance to the group was >1730m, >1481m, >1318m, and >991m at the four study areas. Topography may provide some explanation for the different magnitudes of responses (as compared to Côté & Foster and Rahs), due to terrain, noise levels and proximity to escape terrain. Festa-Bianchet and Côté. (2008) state that goats are more sensitive to disturbance by helicopters than other ungulates. They recommend that helicopters should not fly within 2 km of mountain goat habitat. Côté (1996) recommended a 2,000 m buffer between mountain goats and helicopter activities to minimize adverse impacts. Foster and Rahs (1983) analyzed mountain goat response to hydroelectric exploration in British Columbia and recommended a 2000 m buffer to prevent an overt disturbance response to human activity. To mitigate disturbance risk and displacement effect associated with heavy traffic on primary roads. Consistency with mountain goat habitat management within the remainder of the Nadina Forest District (i.e. Morice TSA).

4.0 Strategic Land Use Plan Recommendations

The Lakes TSA LRMP provided direction to manage for mountain goat habitat within Special Resource Management Zone 4 (SRMZ 4 - Ungulate Winter range). Figure 10 of the LRMP identifies the known distribution of mountain goat winter range at the time of LRMP development. Recent work on the mountain goats in the Nadina Forest District (Turney et al. 2002), however, indicates that forested habitat use by mountain goats is more extensive and intensive than previously identified (Turney et al. 2003). Consistent with objective 1.4 of SRMZ 4 the map has been improved based on more current modelling and field assessment by Ardea Consulting.

By establishing this recommended Ungulate Winter Range, Government will:

- Endorse existing forest management policy as it relates to establishment of Ungulate Winter Range,
- Follow LRMP recommendations, which have the agreement of the stakeholders in the Nadina Forest District,
- Assist in preventing the extirpation or decline in mountain goat populations.

5.0 Land Designation

All mountain goat management zones are in unoccupied crown provincial forest lands. There are no known land title conflicts within the area covered by this proposed mountain goat Ungulate Winter Range.

6.0 Forestry Resource Impacts

LAKES TSA

This proposal is consistent with (although improved) the goat winter range indicated on Figure 10 of the Lakes LRMP, as well as objectives 1,2, and 4 of Special Resource Management Zone 4.

THLB Impact Analysis Results (as calculated by the Integrated Land Management Bureau for Lakes TSA).-min polygon size = 1 ha

TSA	Polygon count	Total THLB (ha)	Total GWR*	GWR overlap with THLB	Percent in THLB
Lakes	96	571000	5097.4	1753.4	0.31

* private land, parks/protected areas, & polygons < 1.0 hectare removed.

The total area identified in the proposed Lakes Mountain Goat Ungulate Winter Range portion in the Lakes TSA is 5,097 ha (gross). The THLB overlap is 1,753 ha. Combined overlap with THLB and OGMA occurs within the proposed Takla Caribou UWR order.

No Section 7 budget is allotted for mountain goats within the Lakes TSA.

Unproductive area net-downs s in GWR THLB

In some cases, areas of THLB within GWR contain portions of non-forested habitat (e.g. escape terrain, patches of shrub, etc.). Due to the resolution used to determine THLB, and given the

nature and small sizes of GWR relative to the district, if non forest features were considered, the actual THLB impact might be lower than assumed.

GWR, low forest productivity

Owing to its location, THLB within GWR polygons typically occupies low productivity sites. Consequently, GWR has a lower impact on Timber Supply than reflected in a straight 1:1 THLB/Timber Supply conversion. Therefore, regarding THLB calculations within GWR, the impact would likely be lower than expected.

In the Mt. Sidney Williams area goat winter range has some overlap with caribou range. This has the effect of reducing timber supply impacts.

Note: The map included with this package reflects the removal of goat habitat polygons within parks and protected areas, private land, and polygons <1.0 ha.

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