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THE USE OF VIDEO FOR MOUNTAIN GOAT WINTER RANGE HABITAT INVENTORY AND ASSESSMENT OF OVERT HELICOPTER DISTURBANCE

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Abstract: During the winters of 1997-2000 we conducted 39 helicopter surveys throughout the Sunshine Coast area of British Columbia to identify coastal mountain goat (*Oreamnos americanus*) winter range habitat. We also conducted 4 ground surveys to support the aerial survey program. We confirmed that coastal mountain goats used mature coniferous forest for snow interception cover, bedding, and foraging habitat. A total of 716 mountain goat sightings were classified; 58% of the total animals sighted were captured on video. Each video clip was analyzed as a separate "sighting event" to remove the influence of group size. The video data was used to document overt mountain goat helicopter disturbance response, winter association with forested stands, and to assess the effectiveness of video as a wildlife inventory tool. We noted a high degree of mountain goat association with forested cover during our winter flights; 72% of all sighting events were associated with non-productive or productive forest stands. Mountain goats showed a moderate-to-extreme overt response to the helicopter in 73% of the sighting events captured on video. We found video to be a very useful tool for determining mountain goat helicopter disturbance response, use of habitat components and for ongoing habitat classification.

Key words: forest association, snow interception, *Oreamnos americanus*, overt disturbance, sighting event, Sunshine Coast, ungulate, video, winter range habitat.

In British Columbia, ungulate winter range habitats have been recognized as a resource feature requiring special management under the Forest Practices Code of B.C. Act. Coastal mountain goats are thought to be particularly dependent upon stands of snow interception forest for their winter survival due to the heavy, persistent snowpack typical of coastal ecosystems (Hebert and Turnbull 1977). Southerly aspect, closed canopy forested stands associated with suitable escape terrain are required to provide both snow-free refugia and foraging opportunities during heavy snowfall events. Focusing on mountain goat winter range habitats in the Sunshine Coast, we undertook 4 years of intensive winter helicopter surveys to identify winter range habitats, assess mountain goat use of habitat components, and to document the overt disturbance responses of mountain goats sighted during the inventory program.

Funding was provided through Forest Renewal British Columbia and the Common Land Information Base for the Sechelt and Homalco First Nations traditional territories.

STUDY AREA

Located on the southwest mainland coast of British Columbia, the Sunshine Coast is an area of complex topography within the Coast and Mountains Ecoprovince, and includes portions of the northern and southern Pacific Ranges, Outer Fiordlands, and Georgia Depressions ecosections (Demarchi 1995). The complex, mountainous topography and associated high rainfall result in a very diverse climate and ecology, which is expressed in a variety of ecosystems from nutrient rich, moist valley bottoms and productive river estuaries to high elevation alpine meadows. The majority of the area experiences a significant snowpack during most winters with wet coastal snow often persisting through the winter months from as early as October through to April in many areas. Mountain goats are widely distributed throughout the Sunshine Coast and are closely associated with habitat complexes that include both escape terrain and forested stands.

METHODS

Survey methodology was consistent with the Resource Inventory Committee (1996) population presence/absence aerial ungulate survey methodology. Individual mountain goats were classified using binoculars and video magnification to identify physical characteristics outlined by Chadwick (1983) and Smith (1988). Surveys were conducted from January through March when mountain goats are typically concentrated on their winter range habitats. Video footage was captured for all survey transects for post-flight review.

The location and elevation of animal and track sightings were recorded using helicopter Global Positioning System (GPS) according to longitude and latitude or UTM co-ordinates. Elevations were recorded in feet above sea level using the helicopter gauges during flights and converted to meters above sea level when transferred to Terrain Resource Inventory Maps (TRIM) upon completion of flights. Continuous video footage was captured for all survey transects using hand-held video cameras. We used helicopters fitted with photo doors whenever possible to aid video capture. Audio commentary was recorded using a variable rheostat resistor to filter helicopter turbine noise. The elevation, GPS position, age/sex class of all animals observed and their responses to the helicopter were recorded both on video audio commentary and flight data forms. A video summary tape was prepared by collating all survey tapes chronologically and re-recording all visible mountain goat sightings in VHS format. Each video clip was assessed as a separate sighting event to remove the influence of group size.

RESULTS

Age/sex classification

A total of 716 individual mountain goats were classified (Table 1). " Adults" included unsexed goats confirmed as adults due to their size only. When adults could be visually sexed, they were separated into male and female classes. Adult "males" were generally classified with confidence due to their physical size and solitary nature. "Females" usually occurred in nursery groups with "kids" (animals less than 1 year old) and "yearlings" (animals between 1 and 2 years of age) which were distinguishable by their relative size and horn development. Solitary animals were classified as females only if horn shape was clearly visible in flight or on the video footage. Adults in nursery groups were classified as females with a high degree of confidence based on existing knowledge of goat habitat use and behaviour (Foster

1982, Chadwick 1983, Stevens 1983, Shackleton 1999).

Table 1: Age/sex classification of mountain goat observations (n = 716).

Survey Year	Male	Female	Yearling	Kid	Unclass-ified	Adult
1997 (n = 173)	9	42	17	28	57	20
1998 (n = 344)	16	62	47	43	77	99
1999 (n = 83)	11	20	5	10	14	23
2000 (n = 116)	14	21	17	4	31	29

Habitat use

Past surveys in the Sunshine Coast found preferred mountain goat winter range habitats ranged from 300 to 1000 m in elevation on predominantly southerly aspect cliff/bluff/gully complexes (Morgan and Forbes 1982). We found goats occupying habitats between 200 and 1500 m above sea level in elevation in our study area (Fig. 1). The majority of goat sightings occurred between 751 and 1250 m in elevation. We found limited use of habitats below 500 m, though use of low elevation areas was documented adjacent to lakeshore and marine foreshore habitats. Low elevation habitats were typically occupied by nursery groups. Adult male mountain goats appeared to use higher elevation, northerly aspect habitats to a greater degree than females and nursery groups. The elevation of goat sightings in our study area is generally lower compared to sightings recorded in interior ecosystems in adjacent Districts. Ongoing analysis of habitat polygons identified through our survey program according to slope, aspect and elevation classes is occurring.

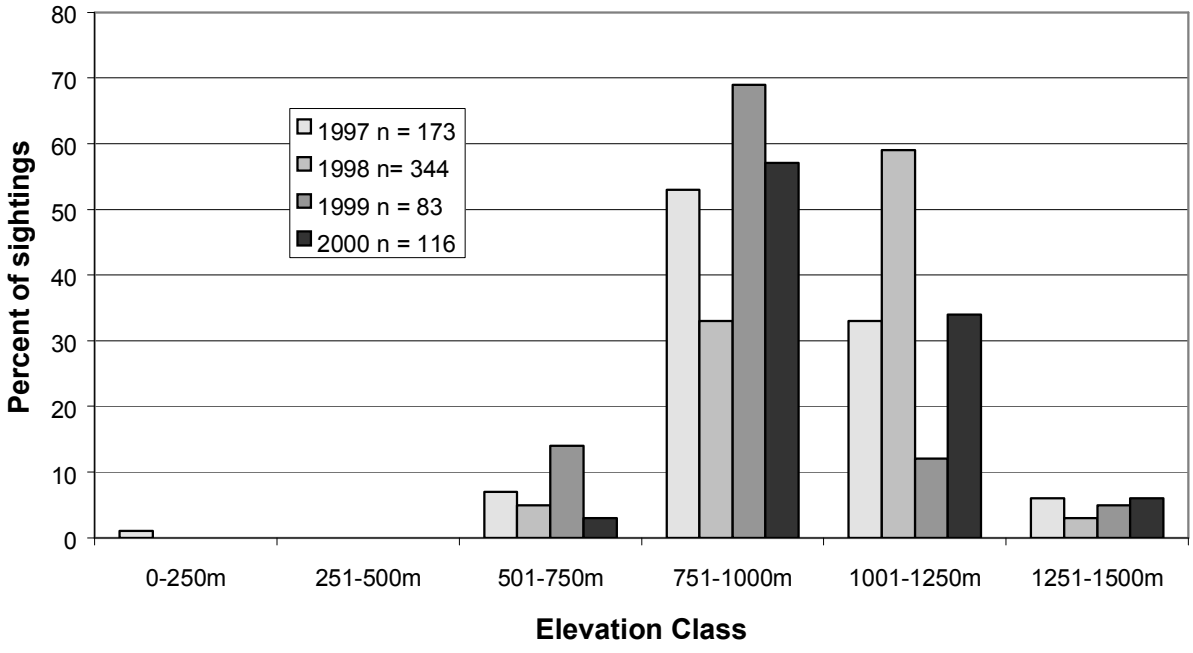

Fig. 1. Elevation classes of goat sightings 1997 – 2000 (n= 716).

Video analysis

We attempted to capture all sightings on video during our survey flights. One hundred and seventy-five video clips with visible mountain goats were captured; each clip includes a single sighting event with variable numbers of individual animals visible. The video data set was used to assess goat disturbance response to helicopters and to assess their use of forested areas in winter. Success capturing goats on video varied from year to year (Table 2).

Table 2. Video success by survey year. The number of sighting events captured on video compared to total number of sighting events has not been calculated.

Year	1997	1998	1999	2000	Total
No. Animals sighted	173	344	83	116	716
Total Video Capture (No. animals)	73	258	26	58	415
Video Success	42%	75%	31%	50%	58%

Forest Association

Mountain goat use of forested stands was documented throughout the study area by review of the 175 sighting events captured on video (Table 3). Our aerial surveys confirmed mountain goat use of structures such as individual large diameter old-growth coniferous trees, hollow snags and mature forested stands in winter. Our ground surveys also confirmed mountain goat use of these habitat components. We classified video clips according to 4 categories: productive forest (areas containing stands of large coniferous trees), non-productive forest (short trees, scattered distribution, low volume stands), non-productive scrub (areas with no large coniferous trees, woody vegetation limited to small shrubs or deciduous stems), and non-forested areas. Sighting events were associated with forested stands if such habitat occurred within estimated 50 horizontal meters of a given mountain goat sighting.

A total of 72% of the video clips (sighting events) were associated with productive or non-productive forested stands.

Table 3. Mountain goat forest association (n= 175).

Forest Category	No. of video clips	Percent of video clips
Non- forested	7	4%
Non-productive scrub	42	24%
Non-productive forest	68	39%
Productive forest	58	33%

Helicopter Disturbance

The set of 175 video clips was also used to assess the level of mountain goat disturbance according to visible criteria. Five classes of overt response to helicopter disturbance were used for analysis:

EXTREME - Panic: animals scattered and ran for duration of sighting.

HIGH – Animals ran, sought shelter, obvious disturbance.

MODERATE – Visible fright response (tail raised). Animals walked to shelter, hid.

LOW - Interrupted foraging/ruminating, increased vigilance. Animals observed the helicopter and stopped foraging or bedding (did not walk or run).

NIL - No visible overt response (animals remained bedded, continued foraging)

Physiological stress was not assessed but is expected to be significant in all overt reaction classes (Joslin 1986*a*, Frid 1997).

Only 5% of all sighting events showed a "nil" overt disturbance response and 22% of sighting events showed a "low" overt response. Thirty-three percent of the video clips showed a moderate disturbance

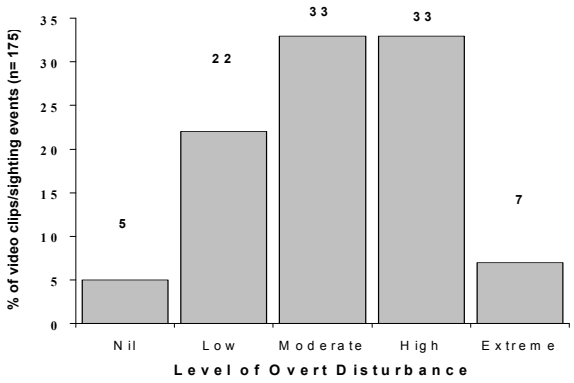

Fig. 2: Level of Overt Disturbance vs. % of sighting events .

response, 33% a high disturbance response and 7% an extreme response. Combining the moderate to extreme disturbance classes results in 73% of clips indicating a marked overt disturbance response to helicopter activity. We conducted surveys as close to the hillside as practical to maximize track visibility within forested stands; the distance from the helicopter to the hillside thus varied during surveys due to topographic constraints and our efforts to minimize goat disturbance and duration of exposure. Based on our aerial observations there does not appear to be a consistent relationship between goat overt disturbance response and the distance to the helicopter.

Goats exhibited a greater overt disturbance reaction to helicopter presence if overhead shelters such as caves, ledges, or large conifer trees with low-lying boughs were not available; goats used such features to hide from the helicopter whenever available and accessible. Higher overt disturbance levels were noted when the helicopter was above or level with the relative position of mountain goats on the hillside. Lower overt disturbance responses were noted when the helicopter was below the relative position of goats sighted. Females with kids (nursery groups) showed the highest levels of overt reaction to helicopter presence while adult males (billies and lone adult goats) appeared to be disturbed to a lesser degree. We assessed the percent of encounters of each class of goats vs. overt disturbance rather than the number of animals, to remove the influence of sample size (Fig. 3).

Four ground surveys were conducted to support the aerial survey program. During ground surveys, we noted noise levels were much higher when the helicopter was above our position on the ground. Noise levels were notably reduced when the helicopter was below or level with our position. The extreme terrain occupied by goats and limited access restricted our ground surveys to relatively subdued winter range habitats. Egress points were limited to areas with large ledges and meadows.

DISCUSSION

Video Analysis

Track sightings in snow often indicated mountain goat movement between forested and non-forested habitat components and were recorded on the audio commentary. Tracks were often not visible on the video clips. We intend to further review the audio commentary to include mountain goats' use of forested stands not visible on the video clips in the forest association analysis. We found video very useful for assessing mountain goat overt disturbance reaction to helicopter activity, for quantifying mountain goat use of forested stands in winter, and for cataloguing winter range habitats for future management applications. The use of video enabled us to maximize information obtained during each survey by facilitating ongoing review of 175 sighting events. For example, we may be able to further refine our categories of forested stands to include such variables as the amount of arboreal

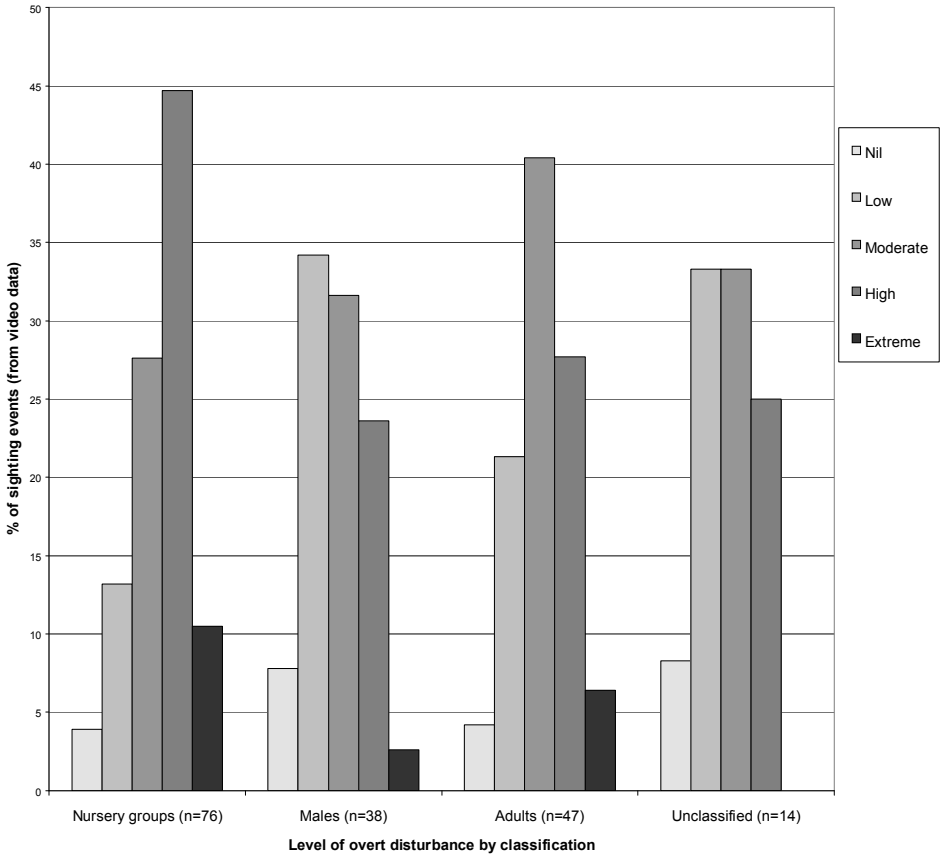

Fig. 3: Level of overt disturbance vs. grouped age/sex class of mountain goats (n= 175)

lichen (*Alectoria* spp.) and presence of large-diameter old growth trees.

While we expected video success to increase as the survey program proceeded, we noted poor results in 1999 relative to other years of the survey program. This may be due to inclement weather and deep snow conditions that occurred during the winter of 1998/1999.

Use of digital video allowed capture of footage up to 120 times magnification but the utility of the higher magnifications was often limited by helicopter vibration. Video footage provided useable images of physical characteristics such as horn shape, leggings, relative size, and face shape (Chadwick 1983, Shackleton 1999) for confirming age/sex classification in many cases. Ongoing review of the video footage may enable us to quantify the degree of error in flight classification of individual animals or define classification uncertainty.

Video capture has also allowed us to develop a comprehensive visual record of habitat complexes throughout the study area. Still images will be extracted from the video in order to catalogue winter range habitats identified during our surveys programs, facilitating detailed descriptions of each area for management applications.

Helicopter disturbance

Helicopter disturbance can result in significant effects on mountain goats, including interrupted foraging, physiological stress and reduced vitality due to increased

energy expenditure, increased metabolic rate, and reduced time foraging (Chadwick 1983, Joslin 1986*b*, Côté 1996, Shackleton 1999). Chadwick (1983) noted slowed chewing rates and interrupted rumination associated with logging and road building in Montana. Joslin (1986*b*) found peaks in seismic exploration activity coincided with declining adult female numbers, kid numbers and reduced reproductive success in a radio telemetry study in Montana. In the high to extreme disturbance classes (40% of the total sighting events on video) significant energy expenditure was evident through flight responses with goats running or obviously stressed due to helicopter presence. Given the extreme terrain typical of mountain goat winter range habitats, we consider goats at increased risk of falling or injury in the moderate to extreme overt disturbance classes; 73% of the 175 sighting events were classed as moderate to extreme overt responses. The level of physiological disturbance was not determined. Actual physiological stress levels in the nil to low overt response classes may be significant and result in detrimental effects on goats (Joslin 1986*b*, Côté 1996, Frid 1997). Though increased vigilance of mountain goats was classified as a low overt disturbance in our study, it may be indicative of increased physiological stress. We consider our overt disturbance classes to be conservative estimates of helicopter disturbance levels; total stress is likely under-estimated.

Habitat abandonment by mountain goats has been previously documented; Foster and Rahs (1985) noted temporary abandonment of summer ranges in northwestern B.C. due to hydroelectric exploration activities. The potential for abandonment of home ranges by mountain goats due to chronic disturbance is supported by our observations of goat habitat occupation in the Jervis Inlet portion of our study area. The results of aerial inventories, operational flights and anecdotal observations indicate decreased goat use of previously occupied habitats subsequent to sustained helicopter logging in close proximity. This may be due to habitat alienation from timber harvesting, habitat abandonment in response to sustained helicopter disturbance, or a combination of factors. It is unclear whether increased mortality or habitat abandonment has resulted from industrial helicopter logging disturbance, however, re-occupation of previously occupied habitats has not been confirmed. No increase in goat density was noted in adjacent winter range habitats, which would have indicated movement of animals from disturbed areas to alternate habitats. Alienation of goats from historically occupied habitats is also suspected based on flight results in the nearby Squamish area (S. Rochetta, B.C. Ministry of Environment, Lands and Parks, personal communication). The causal factors for reduced goat sightings in areas with recent high intensity helicopter activity have not been determined. Historic mortality due to hunting, increased road access and disturbance by industrial activity may be factors contributing to the reduced levels of mountain goat occupation noted.

Since mountain goats, like other ungulates, are in poor physical condition during the winter and at highest risk of mortality due to falling, starvation or other factors, care must be taken to reduce stress on animals during surveys and any activities adjacent to occupied winter range habitats (Frid 1997). As surveys must be conducted close to the hillside to obtain track sightings, we attempted to minimize total exposure time and to distance the helicopter from the animals immediately after a confirmed sighting to reduce disturbance.

We attempted to estimate the distance of goats from the helicopter during surveys and via review of the video footage. Distance was difficult to estimate as the relative position of the helicopter to the ground constantly changed. In most cases, the level of disturbance observed increased as the distance to the helicopter decreased, though this does not appear to be a consistent relationship. In some cases, a low level of overt response was evident when the helicopter was in close proximity to individual goats. Conversely, high overt disturbance reactions were noted in several cases when the helicopter was a kilometer or more from the goats. The results of our video analysis indicate a higher degree of overt disturbance by nursery groups compared to solitary adult animals or bachelor groups of adult male goats (Fig. 3). This contrasts with the results outlined in Côté (1996) which indicated no apparent difference in the level of reaction to helicopters between bachelor or nursery group types. We found a generally higher overt response to helicopters by nursery groups throughout the study, though we were only able to assess the responses captured on the video data set (n=175 clips/ 415 animals). Frid (1997) hypothesized that animal-related variables such as group size, composition and pre-disturbance activity may interact to affect the strength of a disturbance reaction; our results appear to support this hypothesis. The relative elevation of the helicopter also appears to be a factor affecting overt disturbance response. Foster and Rahs (1985) noted accentuated stress responses to helicopters when the disturbance was above or level with a particular animal; our observations are consistent with this finding. We found goats consistently responded more dramatically to helicopter presence when the helicopter was above their position. Our ground surveys confirmed noise levels were lower and mountain goat overt disturbance less visible when the helicopter was below the position of the goats during ground surveys.

The availability of overhead shelters appeared to affect the degree of overt disturbance response exhibited by mountain goats. We noted a lower level of overt disturbance reaction when overhead shelters such as rock ledges, caves, or low-hanging coniferous boughs were immediately available and accessible to goats. Goats responded to the helicopter most strongly when overhead cover was not available and they were caught in the open.

We did not find lower stress reactions in mountain goat herds subjected to regular aircraft flights. In fact, we observed dramatic disturbance reactions while surveying herds with regular air traffic in the vicinity of their winter ranges. The degree to which goats can become habituated to human/aerial disturbance has not been well studied. However, our inventory flights suggest that habituation to helicopter disturbance has not occurred in our study area. As physiological stress cannot be measured during a brief helicopter survey, assumptions regarding habituation must be made with caution. The sample size of herds in close proximity to heavily used flight paths is limited; further work is required to assess the degree to which habituation may occur based on overt responses. Other factors such as distance, relative elevation, availability of security shelters, and weather conditions must be considered (Frid 1997). Distances of up to 2 km have been suggested as the distance at which behavioural changes are evident in response to helicopters (Côté 1996). The threshold distance at which goats exhibit overt disturbance behaviour has not been determined by this study. We hope to

conduct further analysis of the video data to assess this factor.

MANAGEMENT IMPLICATIONS

The implications of mountain goat sensitivity to helicopter disturbance for timber harvesting operations are significant. The disturbance levels presented in Figures 2 and 3 are based on mountain goat overt disturbance responses to a Bell 206-B helicopter and a total exposure time of less than 1 minute. The large heavy-lift helicopters used for commercial timber harvesting and the sustained noise of cedar shake salvaging are far more disruptive than a brief survey with a Bell 206. There is a valid concern than sustained industrial helicopter activity can negatively affect mountain goats if repeated flight paths occur over or adjacent to occupied habitats. The use of industrial helicopters in close proximity to winter range habitats for forest harvesting is expected to have chronic detrimental affects on mountain goat populations. The increased use of helicopters for winter recreation is also of concern where flight paths cross winter range habitats. For these reasons, the Lower Mainland Region of the Ministry of Environment has implemented a timing policy restricting industrial operations adjacent to mountain goat winter range habitat (Appendix 1). Our findings support the implementation of measures to reduce helicopter activity near occupied mountain goat habitat during the winter months. Timing restrictions and mitigation measures for industrial activities adjacent to ungulate winter ranges must be implemented to ensure disturbance levels are minimized and alienation of mountain goats from otherwise viable habitats does not occur (Appendix 1).

We intend to further compare group size, use of aspect, elevation and slope classes using sighting data and composition of identified winter range habitat polygons between the 3 Lower Mainland Districts of the British Columbia Ministry of Environment, Lands and Parks. We also intend to review sighting data according to ecosystem type to compare winter habitat use between coastal and interior mountain goat ecotypes. To date, the degree of coastal goat association with forest cover has been assessed through review of the video data subset only. Ongoing review of all sightings via air photo and forest cover mapping will assess the degree of forest cover association for the entire data set of 716 mountain goat sightings. We also hope to review the degree of mountain goat use of forested stands in winter through compilation and analysis of all track sightings. Further work is required to assess the level of reaction to helicopter presence compared to group composition (nursery vs. bachelor groups). More restrictive management of helicopter/industrial activities may be required adjacent to areas occupied by nursery groups to reduce potential long-term impacts of disturbance on mountain goat populations and habitat use.

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Appendix 1.

July 15, 1997

BC Environment Region 2 Mountain Goat Winter Range Timing Restriction Policy

Background:

Mountain Goats (*Oreamnos americanus*) are a species of management concern in the Lower Mainland Region and have been shown to be extremely sensitive to human-induced disturbance. Due to their sensitivity to disturbance, special measures are necessary to ensure mountain goats are not adversely affected by proposed industrial operations. Of particular concern is activities proposed in close proximity to areas utilised by mountain goat populations as winter range habitat. Such areas often provide critical escape terrain, security and thermal cover, and foraging opportunities for goats during the winter months. Disturbance during critical periods may discourage mountain goats from travelling to suitable winter range habitats, forcing them to occupy sub-optimal habitats thereby reducing their chances of survival, or displace them completely. To ensure protection of over wintering mountain goats, BC Environment requires that all activities within 500 metres of winter range habitat be restricted to the period of May 1 to October 31 in a given year. BC Environment, Fish and Wildlife Management has developed the following policy regarding all proposed industrial activities adjacent to winter range habitats outside this timing window:

1. All industrial operations within 500 metres of known mountain goat winter range habitat must be undertaken between May 1 to October 31 in a given year. Deviations or extensions to this timing window will not normally be granted except as outlined below. Note: 500 metres is considered a minimum distance based on the results of reviews of existing literature and field observations of mountain goat behaviour by Fish and Wildlife Management staff. There may be occasions where operations greater than 500 metres from winter range habitats may require application of a timing restriction due to site specific factors such as elevation, aspect, topography, heavy snowfall, etc. An additional timing restriction may be applied after May 1 where critical natal habitats are identified by Fish and Wildlife Management.
2. Extension requests will not be considered after November 15 or before April 15. Any extensions granted will be on a day to day basis, dependent upon weather conditions and presence of goats. Works areas are to be kept small so operations can be stopped on short notice.
3. Extensions will not be granted for activities involving significant or sustained disturbance such as helicopter yarding, road construction with heavy equipment, drilling, or blasting.
4. Each extension request will be evaluated on its own merit according to the historical intensity of mountain goat use of an area, type of work proposed, current weather conditions and short and long term weather forecasts. Note that any relaxation of operational constraints is contingent upon goats not using the area and continuation of

favourable weather conditions.

5. The absence of mountain goats must be determined prior to operations outside the constrained work period. It is the proponent's responsibility to conduct a brief aerial survey (to the satisfaction of Fish and Wildlife Management staff) to confirm that goats are not present. If any sign of mountain goat activity is noted within 500 metres of the proposed operational area, all work must cease and no extension will be granted. Note that helicopter flights in themselves can cause excessive disturbance to wintering goats. If goats or tracks are sighted during overflights, the flight should be terminated immediately and the location and type of sign forwarded to F&W staff. **Repeated overflights of occupied habitats are not to occur.**

6. Fish and Wildlife Management staff must be informed in writing of the results of assessments prior to work occurring. Reports will then be assessed by this agency to determine if relaxation of the work window is appropriate. Works outside the timing window are not permitted until confirmed by Fish and Wildlife Management staff.

7. When an extension has been granted, work may be allowed to continue when minor snowfalls (i.e. less than 8 hours duration and less than 0.3 metres in depth) occur. However, when snowfalls exceed 0.3 metres in depth or continue for longer than 8 hours, all work is to cease and the timing restriction will be enforced.

8. Fish and Wildlife Management may revise this protocol subsequent to receipt of additional information.

9. Where the locations of known mountain goat winter ranges have been provided to the licensee, it must be shown on operational Plans (i.e. Forest Development Plans) to reflect "best known information" as per Section 11 of the Operational Planning Regulations.

10. Fish and Wildlife Management reserves the right to recommend non-approval of extension requests where proposed works present an unacceptable risk to over-wintering mountain goat populations.

Please be advised that BC Environment will be updating winter range maps once the results of the 1997/98 FRBC mountain goat winter range inventory have been collated.

Please contact the appropriate BC Environment, Fish and Wildlife Management District staff (Forest Ecosystem Specialists or Habitat Protection Officers) in your area if you have any questions or require further information.

Brian Clark
Regional Manager
Fish and Wildlife Management
BC Environment
Lower Mainland Region