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Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia

Year 2 (1999) Inventory Results

Prepared for

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EXECUTIVE SUMMARY

This report summarizes the 1999 results of an inventory of the ecological factors affecting northern caribou in the Mackenzie Timber Supply Area. Generally, concerns for caribou populations are based on the knowledge that widespread habitat alteration, past over-hunting, and increased predation contributed to the disappearance of mountain caribou from 43% of their historic range in southern British Columbia. This population decline of mountain caribou has resulted in expensive conservation efforts such as habitat rehabilitation and animal translocation programs. The intent of this inventory is to investigate the ecological factors affecting the more northern ecotype of woodland caribou, referred to as northern caribou populations, so future forest management decisions will minimize adverse effects on these populations and their habitats.

The general objectives of this project are to: determine habitat values for caribou; develop methods to verify these values; develop, implement and monitor the Mackenzie Land and Resource Management Plan Caribou Management Strategy; and develop acceptable adaptive management directions. These objectives will be addressed by investigating: the movements and distribution of caribou, moose, and wolves: adult caribou survival rates and causes of mortality; seasonal habitat use patterns; causes of mortality and subsequent recruitment of caribou calves and their fidelity to maternal patterns; and the general population status of caribou and moose.

In 1999 we captured 122 caribou, moose, and wolves to attach or replace radio-transmitters, to collect physical measurements, and to collect genetic samples from each animal. We monitored these animals, and an additional 34 animals collared in previous studies, using VHF telemetry methods from fixed- and rotary-wing aircraft. Capture of these animals, and the subsequent telemetry surveys, provided information about adult mortalities and the movement and distribution of caribou in relation to their major conspecific, moose, to their primary predator, wolves, and to the spatial arrangement of their habitat. We also captured and radio-tagged 19 calves of collared cows to facilitate an investigation of calf survivorship, cause-specific mortality, and fidelity to maternal habitat use patterns. Mortality sites were investigated to provide information on causes, timing, and location of mortalities. Habitat sites were investigated to provide information on habitat use patterns, to refine habitat descriptions, and to assist in verifying Terrestrial Ecosystem Mapping conducted in the area.

A total of 3289 animal locations were recorded over 129 flights, of which 2657 were for caribou, 407 for moose, and 225 for wolves. A total of 5153 locations were collected and downloaded from 1 wolf and 13 caribou collared with Global Positioning System automated data recorders. An additional 10,000 locations are estimated to be available from GPS collars in 1999 that have yet to be retrieved. During the calving season in June we observed 26 of the 35 radio-

collared cows to have a calf with them (74%). By mid-September there were 13 calves surviving 34 cows (38%), and a follow-up survey in December showed there were 9 calves surviving 31 cows (29%). Forty-nine mortalities were investigated and we visited 270 specific habitat sites.

The data summarized in this 1999 inventory report will provide the basis for improving caribou habitat mapping and modeling to assist with directing forest management practices in the Mackenzie Timber Supply Area. However, because data collection has only begun, the analytical interpretations that would allow for confidence in management models have not been presented here. Annual variation in weather patterns and multi-year cycles in population response, among other factors, contribute to the usual requirement, of wildlife inventories, for more than one full year of data collection before interpretations can be made of the data. Nevertheless, the data will contribute directly to construction of a caribou management model planned to begin early in 2000. Also, even in the absence of analytical rigor, 5 general (but inconclusive) observations can be made of the data collected in 1999: 1. the Chase/Sustut herd appeared to have unusually low recruitment of calves; 2. radio-collared caribou in all 3 herds appeared to make greater use of low elevation winter habitats than we would have thought based on available literature; 3. there appeared to be greater use of arboreal lichens in winter than we expected based on available literature; 4. the spatial separation between caribou and moose in our radio-collared sample was consistent with available literature and was impressive, especially during the calving and summer seasons; and 5. the number of wolf packs in the 3 study areas and the size of individual packs were also impressive.

This Resource Inventory Project, largely funded through Forest Renewal B.C. and initiated in November of 1998, generated 10.18 person-years of employment during 1999 at an average cost of $76,289 per person-year (assuming 200 days per person-year). Thirty-four different employees were directly employed in 25 different employment positions or roles. The inventory was conducted over 3 million hectares of land and involved a total of 148 animals fitted with radio transmitters. New information derived from this inventory project is partially described by 18,442 site-specific animal locations ($42/location), 270 site investigations, and 7 surveys of calf survival.

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This project was designed and developed by Scott McNay (Slocan Forest Products, Ltd., Wolverine and Akie study areas) and by Wayne Lewis (Donohue Forest Products, Inc., Chase study area). Pacific Slope Consulting implemented the project. Line Giguere, Shirley Gilmour, Wayne Lewis, Jeffrey Joy, Scott McNay, Leslie Yaremko, and Kathi Zimmerman provided project planning, leadership, and administration. Ministry of Environment staff members Doug Heard, Glen Watts, and Doug Wilson have regularly supported this project, and their field assistance was greatly appreciated. Robin McKinley and Rob McCann assisted with spatial data capture and analytical support.

Animal captures were conducted by Bighorn Helicopters Clay Wilson, Barry Scott, Barry Minor, Shirley MacDonald, and Rick Eramus. In addition to the field biologists and assistants mentioned previously, assistance with data collection was provided by Charlie Boya, Craig Cassity, Shayla Chappe, Helen Davis, Mathew Izona, Cameron Nelin, and Tommy Poole. Chris Johnson provided GPS collar locations for the caribou that we assumed capture and monitoring responsibilities. Flying was provided by pilots Greg Altoft, Keith Conner, Doug Dyck, Ben Giesbrecht, Mark Holenstein, Erwin Karrer, Lyn Robinson, Dean Scarrow, Leif Scott, Dave Wiebe, Armin Wilke, and Blake Mitchell. Funding for an Environment Youth Team position was provided by the Youth Options BC program, administered by the Ministry of Environment, Lands and Parks.

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INTRODUCTION

General Background

Woodland caribou (*Rangifer tarandus caribou*) in British Columbia (BC) are classified into mountain, northern, and boreal ecotypes based on behavioral and ecological characteristics (Heard and Vagt 1996). In BC, mountain caribou are considered to be a sensitive species due to past declines in distribution and abundance. This ecotype currently has an estimated 2300-2500 animals, distributed across 13 spatially distinct sub-populations (Heard and Vagt 1996, Hatter 1999). According to Hatter (1999), widespread habitat alteration, past over-hunting, and increased predation have contributed to the disappearance of mountain caribou from 43% of their historic range in BC. The degree to which each of these factors is independently responsible for the decline of mountain caribou, and the degree and extent of the decline itself, is still the subject of debate, largely due to a lack of conclusive data on historic populations. Declines of caribou in the 1970's were usually attributed to over-hunting (Seip and Cichowski 1996) while more recent declines are considered to be due to a combination of factors. However, most biologists agree that increased predation by wolves (*Canis lupus*) is a key factor in the recent declines (Seip and Cichowski 1994, Heard and Vagt 1996). Apparently increased moose (*Alces alces*) populations, which are believed to be correlated with increased forest development or harvesting, have supported increased wolf numbers, resulting in greater predation on caribou (Seip 1992). The ensuing debate on these issues and the apparently high risk of eliminating some sub-populations of mountain caribou has led to a draft conservation strategy for this ecotype with the goal to "*maintain caribou and their habitat in perpetuity throughout British Columbia's mountain caribou range*" (Hatter 1999). Intensive efforts towards the management of individual populations, and strong support in higher-level plans for these management efforts (e.g., Caribou-Chilcotin Land Use Plan Caribou Strategy Committee 1998) attest to the importance of caribou to British Columbians.

Resource managers in other parts of Canada have also recognized that specific measures are required to conserve woodland caribou populations and habitats. In Saskatchewan, objectives to manage woodland caribou include minimizing the impacts of resource development and providing and managing extensive contiguous tracts of forested habitat for woodland caribou (Rock 1992). In Ontario, Racey and Armstrong (1998) suggested that the success of caribou conservation and management programs require the consideration of both population and habitat management strategies and the recognition that they interact. In Alberta, several programs are underway to determine the affects of the petroleum, forest, and peatland industries on woodland caribou populations, which are classified as threatened (Bradshaw et al. 1997, Stuart-Smith et al. 1997, Hervieux et al. 1996). In the Yukon, various research programs have been conducted to collect data on caribou herd distribution, movements, demography,

and habitat use (Farnell et al., 1991, Farnell and McDonald 1990, Farnell and McDonald, 1989).

By comparison with the mountain caribou ecotype, northern caribou are relatively abundant in BC (approximately 16,000 animals), and tend to occur in the mountainous western and northern parts of the province, wintering in mature low elevation lodgepole pine or black spruce forests or high wind-swept slopes, and feeding primarily on terrestrial lichens (Heard and Vagt 1996). Much of the Mackenzie Timber Supply Area (TSA) is comprised of high to medium value caribou habitat. Concerns exist that northern caribou populations here could become exposed to similar conditions that caused the decline in mountain caribou. Heard and Vagt (1996) recognised 28 distinct herds of northern caribou, 10 of which at least partially reside in the Mackenzie TSA. BC Ministry of Environment, Lands, and Parks (MELP) recently reassessed the composition and boundaries for these herds (see the most recent depictions on the MELP web site under "Caribou" at: http://www.elp.gov.bc.ca/nor/mackenzie/ or at: ftp://ftpprg.env.gov.bc.ca/pub/outgoing/mackenzie/caribou/coverage/).

Currently, MELP considers that a total of 7 herds of northern caribou and 1 herd composed of both northern and mountain caribou reside in the Mackenzie TSA. Population data for these herds are listed in Table 1.

Table 1. Estimated population sizes and population status for caribou herds in north-central British Columbia.

Herd	Population Size	Population Status	Authority
Frog/Gataga	400-1200	unknown	Heard & Vagt 1996
Upper Finlay	500-1000	unknown	
Akie/Ospika	200-500	unknown	
Chase/Sustut	600-800	stable / slowly declining	Wood 1996
Graham	800	unknown	Heard & Vagt 1996
Wolverine	300-400	stable / slowly declining	Wood 1998
Scott/Blackwater	50-200	unknown	
Misinchinka	100-250	unknown	

Summary of Previous Studies

Most information about caribou in BC has been recently summarized by Stevenson (1991), Seip and Cichowski (1996), Heard and Vagt (1996), and Hatter (1999). Page (1988) and Stevenson and Hatler (1985) provided a summary of research projects on caribou in BC. Wood and Terry (1999b) described a local study on caribou, which was conducted on the west side of the Williston Reservoir. This study, referred to as the "Omineca Mountains Caribou Project", focused on the seasonal movement patterns, habitat use, and general ecology of the caribou in the Wolverine Range herd. Johnson and Parker (1996) investigated Woodland caribou from the Takla Range herd (west of the Klawli area in the Mackenzie TSA) and from the Wolverine Range herd to enhance the understanding of the ecology of northern caribou. Poole et al. (2000) investigated the distribution, movements, and habitat selection of 2 sub-herds surrounding Takla Lake. Several caribou from the Chase Mountain Range, west of the Finlay Reach of the Williston Reservoir ,were radio-collared as part of an investigation conducted by MELP, Skeena Region. There has also been a preliminary investigation of habitat use and seasonal movements of radio-collared caribou in the Peace sub-region on the east side of the Reservoir (Murray 1992), and in the Graham River drainage (Backmeyer 1991).

Other smaller, short-term inventories have been completed in the area from time to time. These *ad hoc* studies were restricted in area and to objectives mostly relating to herd composition and distribution. Hatler (1990) completed one of the first comprehensive investigations of ungulates in north-central BC: however, his study was restricted to the northern area of the Williston reservoir only, and focused on an inventory of moose rather than caribou. Hatler's observations occurred primarily in the area we have called the Akie/Ospika study area (Appendix 1). More recent surveys of the same type in that area include Wood (1994) and Terry and Handler (1998). Wood and Terry (1999a,b) conducted similar surveys in the area we call the Wolverine, and in the Chase/Sustut study area.

Inventory Rationale and Objectives

Despite the studies on caribou referred to above, many questions about the management of caribou and their habitats in the Mackenzie TSA remain unanswered. Numbers of caribou in individual herds, and herd productivity, were often poorly estimated (Table 1), because most inventories were not directly comparable in either a temporal or a spatial sense, and some inventories lacked appropriate methods to estimate these parameters. Wood and Terry (1999b) have provided significant understanding about the Wolverine herd; specifically, seasonal movement characteristics and habitat use patterns. Nevertheless, the relative importance of ecological factors in determining caribou population status, and hence the appropriate management tactics, remain unclear because no mechanistic tests of habitat requirements were conducted as part of these past investigations. Generally though, based on these local studies and from studies elsewhere, some ecological factors affecting caribou do seem clear. Caribou range widely to accommodate their life requirements, depend heavily on lichens in whatever form they are most

abundant (terrestrial or arboreal), have low rates of reproduction, and can be seriously affected through predation by wolves and other predators. A major conclusion about their behavior over the past few decades has been that they use space (i.e. to exist at low density spatially) to avoid predators and possibly to avoid impacting the sustainability of their slow growing forage supply. Based on these generally accepted facts, a "large patch" habitat management strategy is often recommended (Racey et al. 1991, Seip 1998). This strategy attempts to minimize interactions between caribou, moose, and wolves by recommending large cutblocks, ranging from <40 - 5000ha, as well as retaining large patches of unharvested areas where caribou are less susceptible to predation. This strategy is thought to mimic the natural disturbance patterns found on this landscape, typically large stand-replacing fires, and to minimize fragmentation. The Mackenzie Land and Resource Management Planning Table (LRMP) has promoted this principle of management through the Caribou Management Strategy. However, this management strategy has not been thoroughly assessed, and the significance of the overlap between caribou and moose remains unclear.

As a commitment to strategic forest renewal in BC, Slocan Forest Products, Ltd. (Slocan) and Donohue Forest Products, Inc. (Donohue) aim to further improve the effectiveness of caribou management with an inventory program to assess the ecological factors affecting northern caribou. This inventory will be conducted under an adaptive management system that is founded on the large patch recommendation. This inventory program on northern caribou is largely an exercise to:

- ensure management activities will provide sustainable populations of northern caribou in light of pressures such as forest development, predation, and hunting.

- commit to the concept of preventative management as a more efficient and effective strategy compared to corrective conservation (i.e., compare the Mackenzie LRMP's Caribou Management Strategy with the provincial Mountain Caribou Conservation Strategy).

We hope to provide a foundation upon which to base management decisions about the future of northern caribou and their habitats in the Mackenzie TSA by introducing an adaptive approach toward the implementation of the Mackenzie LRMP's Caribou Management Strategy. A Caribou Management Model is being developed concurrent to the inventory (Ellis 1999) to aid proper use of inventory data collected here and to help refine direction of adaptive management.

This inventory program (McNay 1999) is currently being conducted in the Mackenzie Forest District and has the following goals:

- to provide basic inventory information concerning abundance, seasonal movements, mortality causes, and habitat needs of caribou, moose and

wolves, where such basic information could then lead to better assessments of habitat values for these species;

- to provide standard expressions of, or procedures for verifying, Wildlife Habitat Assessments, where increased confidence in these assessments could then lead to better strategic planning for integrated management of forests and the ecological system involving caribou, moose, and wolves;

- to develop, implement, and monitor a strategic management plan for caribou (i.e., the Mackenzie LRMP's Caribou Management Strategy'); and

- to aid subsequent development of, and discussion about, adaptive management initiatives with industry, government, First Nations, and local communities within the Mackenzie Forest District.

To accomplish these goals, we will focus the inventory program on the following project components:

- caribou population structure (general distribution, relative abundance, gender/age structure),
- caribou habitat use patterns (including seasonal movements),
- predation rates by wolves (population characteristics, movement patterns, and kill frequencies), and
- potential for distribution overlap with moose (*Alces alces*) populations (general distribution, relative abundance, gender/age structure, and habitat use patterns).

This inventory program has been established in 3 study areas, roughly consistent with the Wolverine, Chase/Sustut, and Akie/Ospika herd areas (Appendix 1).

Objectives Specific to 1999 Inventory

In order to address the goals and objectives outlined above we implemented 3 different data collection methods (telemetry, site investigations, and caribou census) to investigate the movements and distribution of caribou, moose, and wolves, adult caribou survival/mortality rates and seasonal habitat use patterns, mortality causes, recruitment/survival of caribou calves, and population status of caribou and moose. For each study area we captured and radio-collared animals, which we located regularly using aerial and ground telemetry, investigated all mortalities found, and characterized habitat use within plots centered on a telemetry location, mortality site, or area with evidence of habitat use. Throughout the spring and summer we assessed the caribou calf survival rate by capturing, radio-tagging, and monitoring calves of collared cows. The objectives of the 1999 Inventory year were to implement these methods correctly, efficiently, and effectively.

STUDY AREAS

Our study occurs within the Mackenzie TSA, in North Central British Columbia. This TSA is located within the Omineca sub-region and includes all of the Mackenzie Forest District. The 3 study areas, Akie/Ospika, Chase/Sustut, and Wolverine are generally bounded by caribou herd areas, and cover approximately 25,000km^2. Study area boundaries are displayed in Appendix 1, and map sheet numbers for each study area are provided in Appendix 2. These study areas consist of a matrix of managed and natural stands that are part of 8 biogeoclimatic units (Table 2) within the Skeena and Omineca Mountains Ecoregions.

Table 2. Physical features of the Akie/Ospika, Chase/Sustut, and Wolverine study areas in north-central British Columbia.

Study Area	North Latitudinal Range	West Longitudinal Range	Area (km^2)	Elevational Range (m a.s.l.)	Biogeoclimatic Units[a]	Landscape Units[b]
Akie/Ospika	57°47'09''- 56°11'31"	123°46'43"- 125°36'10"	10,252	750 - 2850	SBS mk 2 SBS wk 2 BWBS dk 1 SWB mk ESSF mv 4 AT p	Collins Lower Ospika Upper Ospika Davis Chowika Pesika Lower Akie Paul Kwadacha
Chase/Sustut	56°57'49"- 55°48'45"	126°34'00"- 124°30'22"	9,628	750 - 2250	SBS wk 2 SBS mk 2 SWB mk BWBS dk 1 ESSF mv 3 ESSF mv 4 AT p	Upper Osilinka Lower Osilinka Tenakihi Mesilinka Factor Ross Carina Tomias Swannell Aiken Upper Ingenika Lower Ingenika Thutade
Wolverine	56°06'34" - 55°11'12"	123°32'36"- 125°17'53"	5,623	750 - 1950	BWBS dk 1 SBS mk 1 SBS mk 2 SBS wk 2 ESSF mv 2 ESSF mv 3 AT p	Manson Klawli Germansen Wolverine Upper Omineca Lower Omineca Discovery Strandburg

a - see Appendix 3g for biogeoclimatic unit code definitions
b - see unpublished Landscape Unit maps at the Ministry of Environment website:
http://www.elp.gov.bc.ca/nor/mackenzie/index.html

The Akie/Ospika, Chase/Sustut, and Wolverine study areas are characterized by mountainous terrain with extensive alpine habitat, large river valleys, and dense coniferous forests. Much of the Engelmann Spruce-Subalpine Fir and Spruce-Willow-Birch biogeoclimatic zones of these study areas are characterized as ecosystems with infrequent stand-initiating events, such as wildfires, with a mean disturbance return interval of 200 years (BC Ministries 1995). The Boreal White and Black Spruce and Sub-boreal Spruce zones are characterized as ecosystems with frequent stand-initiating events, with wildfires reaching sizes of tens of thousands of hectares. With a mean return interval of approximately 125 years, the resulting landscape is a mosaic of even-aged stands of different ages (BC Ministries 1995).

The Akie/Ospika study area is bounded in the north by the Kwadacha River, in the west by the Finlay River and the Finlay Reach of the Williston Reservoir, in the south by the Ospika River and Ospika Arm of the Williston Reservoir. The central and eastern part of the Akie/Ospika is dominated by the Northern Rocky Mountains; consequently it is characterized by steep terrain, and has a greater elevational range than the other 2 study areas. It contains several large drainages including the Kwadacha, Akie, and Ospika Rivers. The Akie/Ospika study area has comparatively less management activities than the other 2 study areas due, in part, to its northerly position within the Mackenzie TSA. At low to mid-elevations, the Akie/Ospika study area is dominated by the Boreal White and Black Spruce dry cool Stikine variant (BWBSdk1), while at mid- to high-elevations the Engelmann Spruce-Subalpine Fir moist very cool Graham biogeoclimatic variant (ESSFmv4) and Spruce-Willow-Birch moist cool (SWBmk) predominate. The Alpine Tundra parkland (ATp) prevails above the tree line.

The Chase/Sustut study area is situated in steep mountainous terrain and contains multiple watersheds and mountain ranges. The study area is centered around Chase Mountain and is bounded in the north by Barriere Peak and the Russel Range, in the west by Johanson, Dartatelle, and Carruthers Creeks, in the south by Duckling, Haha, and Wasi Creeks, and in the east by the Finlay Reach of the Williston Reservoir. The Chase/Sustut study area also includes the Ingenika, Swannell, Mesilinka, and Osilinka Rivers. This area has comparatively moderate management activities relative to the other 2 study areas, yet significant portions of the area remain unmanaged. At low to mid-elevations, the area is dominated by the BWBSdk1 and the Sub-boreal Spruce moist cool Williston variant (SBSmk2), at mid to high-elevations the ESSF Omineca variant (ESSFmv3) predominates. The ATp prevails above tree line.

The Wolverine study area is situated in rolling high elevation foothills and encompasses the Wolverine Mountain range. It is roughly bounded in the north by the headwaters of Discovery, Goat, Nina, and Big Creeks, in the west by Ground Hog and Valleau Creeks, in the south by Klawdetelle Creek, Sylvester Creek, and the Nation River. The eastern slopes of the Wolverine Mountain Range demarcate the eastern boundary of the Wolverine study area. Of the 3

study areas, the Wolverine is the least mountainous and ranges the least in elevation. It encompasses several major watersheds including the Omineca, Manson, Klawli, and Germansen Rivers. Portions of this area have been extensively managed for timber, particularly in the Manson and Strandberg Landscape Units. The Klawli and Germansen Landscape Units by contrast remain relatively unmanaged. At low to mid-elevations, the area is dominated by the BWBSdk1, the SBS Mossvale and Williston variants (SBSmk1 and SBSmk2), and at mid to high-elevations ESSFmv3 predominates. The ATp prevails above tree line.

METHODS

Data were collected during 13, 2-week work sessions spaced throughout the year except during a 6-week break between July 31 and September 12. The calendar year was stratified into 5 seasons based on environmental attributes and on caribou behaviour during those seasons: 1. Late winter (February, March, April); 2. Spring/calving season (May, June); 3. Summer (July, August); 4. Autumn/staging (September, October); and 5. Early winter (November, December, January). Throughout most of the winter months (Jan-Mar and Nov-Dec) 3 crews conducted "intensive" field investigations, with 1 crew in each of the 3 study areas, completing a full sample in a 2-week period (Appendices 3a-g). During the remainder of the year, 1 crew circulated between the 3 study areas, completing a full sample in a 6-week period. Data were recorded on standard data sheets based on Resource Inventory Committee (RIC) standards (Appendix 4).

Capture/Handling

Animals were captured and handled according to standardized techniques (Resource Inventory Committee 1998f). For each animal caught we recorded: location; species; age class; gender; physical measurements; tooth wear; and, for adult females: reproductive condition; presence of young; vulva condition; and evidence of nursing. We collected samples of blood, hair, and skin (skin samples were only collected during the June and July capture sessions). We tested blood samples taken from females that were captured prior to calving for progesterone levels (Prairie Diagnostic Services, Saskatoon, Saskatchewan) to assess pregnancy status. Adult caribou, moose, and wolves were equipped with either a Very High Frequency (VHF) radio-collar (Lotek Engineering, New Market, Ontario, Canada), or a Global Positioning System (GPS) collar equipped with a VHF beacon (Televilt International, Lindesberg, Sweden, or Advanced Telemetry Systems, Isanti, Minnesota, USA). Caribou calves where outfitted with eartag-transmitters (Telonics, Mesa Arizona, USA), which were judged too heavy to be attached to the ear, and thus were attached through the soft fleshy area between the breast and the neck (brisket) instead. We set targets for capturing and fitting radio-transmitters to a minimum of 38 animals per study area (Table 3). The ratio of GPS to VHF collars was selected to: 1. extract the efficiency of GPS collars (large sample sizes for an

individual animal) while retaining reasonable statistical power at the level of the individual (VHF collars are much less expensive and therefore allow larger sample sizes of collared animals); and 2. provide a scalar approach to our investigation of habitat selection patterns (large number of animals followed weekly for seasonal comparisons and a selection of animals followed daily for habitat use). VHF locations offered a means to assess bias known to be encountered with GPS collars, and GPS collars offered a means to collect frequent locations during night. We targeted both males and females, broadly distributed across the study areas, for capture/collaring to ensure we obtained a representative sample of the population, with slightly higher numbers of females to facilitate the investigation of recruitment and calf survival, calving grounds, and fidelity to these grounds. For further details and categorical codes of variables recorded during a capture see Appendix 4a.

Table 3. Target number of animals to be captured and fitted with radio-transmitters, summarized by species, gender, and collar type, for each study area in north-central British Columbia, 1999.

Species	GPS Radio-Collar		VHF Radio-Collar		Ear-Transmitter
	Males	Females	Males	Females	Calves
Caribou	2	5	6	9	*
Moose	1	1	6	6	N/A
Wolf	2	*	*	*	N/A

* as many as time, money, and circumstances will allow

Telemetry

Telemetry surveys were conducted from a Cessna 185 or Cessna 206 fixed-wing aircraft or Bell 206 B Jet Ranger helicopter. We used methods consistent with the Resources Inventory Committee (1998b,c,d,e) aerial-based inventory techniques. During the intensive winter surveys, on average there were two 4-hour telemetry flights in each study area per session (2 week period), with the 2 flights separated by several days. This temporal distribution of samples was intended to allow us to locate mortality sites shortly after they occurred. In the summer we also conducted 2 telemetry flights, with 4 hours of telemetry per day, in each study area per session, however the sessions were over a 6-week period).

For each flight we recorded the temperature (°Celsius), precipitation (7 categories), cloud cover (4 categories), wind (7 categories), snow depth (8 categories), snow cover (6 categories), and days since last snow (5 categories). For details and categorical codes see Appendix 4b.

For each animal observed we recorded species, radio-collar frequency, total number of animals observed within a group (where a group is defined as 2 or more animals within 300m of each other), age class, gender, activity (e.g.

bedding, feeding, traveling), lat/long coordinates (degrees decimal minutes), general location description, habitat type (e.g. wetland, alpine ridge, lodgepole pine forest), estimated snow depth (8 categories), and sinking depth of the animal (estimated to the nearest 10cm). The level of accuracy of these locations varied depending on whether or not the animal was sighted. For sighted animals the location accuracy of the undifferentiated GPS location is within approximately 100m. For most animals that were not sighted a 'fix' on the transmission signal was obtained with an accuracy of within 100-250m in addition to the GPS location variance of up to 100m. 'General' locations were recorded when the signal could not be pinpointed but was within a 4km radius. Occasionally locations were recorded for signals that were simply 'heard' within a broad area ($\leq$30km radius). These locations only provided information about the status (live or dead) of the animal.

GPS collars were programmed to take four locations per 24-hour period spaced at regular intervals (05:00, 11:00, 17:00, and 23:00 Greenwich Mean Time). GPS collar programs were uploaded to the collars prior to placement in the field. Data were retrieved in a similar fashion once collars were retrieved from the animal, either by recapture of the animal or picking up the collar after a mortality occurred.

Calf Census

We conducted 7 surveys from a Bell 206B Jet Ranger helicopter to estimate calf survivorship in the Wolverine and Chase/Sustut study areas. Three surveys were conducted in June, 2 in July, and 1 in September, each separated by 2-3 weeks, and a follow-up survey in December. Each survey consisted of approximately 6-8 hours of survey time per study area. We attempted to locate as many of the 35 radio-collared caribou cows within the area as possible to record presence or absence of a calf, habitat type, group size, and where possible, age class and gender. The same information was collected for unmarked cows and calves whenever they were encountered. Between June 24 and June 26 we captured 19 calves of marked cows and 1 calf of an unmarked cow. We recorded information on the telemetry data forms (Appendix 4b). We assessed calf survival as the percentage of known marked cows with calves only. Cows must have been observed at least twice without their calf to conclude that her calf had died, and all calves were assumed to be born by the end of June.

Habitat

We conducted site investigations at select animal locations, mortality sites, and areas with evidence of habitat use. For sessions 1-10 we recorded site and vegetative characteristics within 10x10m plots. Site characteristics included slope, aspect, and elevation. Vegetation characteristics included percent cover of shrubs, herbs, lichens, and mosses, the species, height, diameter, and age of all trees included within a prism sweep (BAF 6 or 9), and a visual estimate of arboreal lichen cover on 5 trees. For sessions 10-13 we used 20x20m plots in order to be consistent in

design with 2 collaborative projects (1 focused on fisher and 1 on wolverine) within the Mackenzie TSA. In addition, these plots were then consistent with standard Terrestrial Ecosystem Mapping (TEM) ground inspection forms. Due to snow cover during these sessions we were unable to record full soil and vegetation information, but plots were permanently marked with tree-marking paint and site locations were recorded with sufficient detail to allow a re-visit in the summer of 2000 to complete the remainder of the data collection. Site variables measured in the 20x20m plots included elevation, slope, aspect, meso- and macro-slope position. We recorded biogeoclimatic zone, subzone, and variant information where possible, and tree species, height, diameter, and age of all trees falling within a prism sweep (BAF 6 or 9). We categorized vegetative browse species into 3 ages (this season, last season, and old) based on visual appearance, and recorded percent cover. Any signs of wildlife were also recorded. Total snow depth was measured beginning in one corner of the plot at 8 points spaced 10m apart around the perimeter, and one snow depth was also recorded at plot center. For further details on each of the measured variables see Appendix 4c.

Starting in session 10, site investigations were more strategically located within a sample design to allow for comparisons of seasonal habitat use among caribou cows. We chose sampling sites based on observed use by radio-collared animals and, to the extent possible, those locations used by a selection of residents with and without calves, as well as migrants with and without calves. Sampling sites were restricted to locations observed in early winter, late winter, and spring/calving seasons. Because the sample selection preceded analysis of individual behaviour patterns, we considered a caribou to be resident when its annual movements occurred within a relatively small area (5-35km^2) and migratory when it moved considerable distances (100-200km^2). Our objective was to complete inter-seasonal comparisons for 4 selected caribou cows in each study area. For each sample, the most recent location was used to represent the current season and locations from previous telemetry surveys in the past 2 seasons were used for locating comparative sites. This sampling strategy was applied in all 3 study areas, however variations between study areas occurred based on the number of animals within each category available (e.g. in the Chase/Sustut there were no known residents to monitor), and individual animals were held constant in so far as that was possible.

Mortality

For each site investigation of a mortality, we recorded the date the carcass was first sighted, weather details, species, collar frequency if applicable, gender and age class, estimated date of death, and probable cause of death. Where possible samples of bone, teeth, and hair from ungulates, and scat from bears and wolves were collected. Internal organs, if still present, were inspected for parasites. Extensive photo documentation and descriptive notes were also taken. See Appendix 4d for further details of the variables recorded at mortality site investigations.

Snow Sampling Methods

In November, snow-sampling stations were established in each study area based on the following criteria for site selection: 1) sites were located across a range of elevations, 2) we attempted to maximize the spatial distribution of snow sampling stations within the study area, 3) sites were chosen based on their ground and air accessibility, 4) macrosites were selected in areas where snow depths would not be influenced by topographic features (e.g. we avoided areas within close proximity to Williston Reservoir where associated warmer temperatures could influence snow depth), and 5) stations were established on relatively flat microsites in the open. In the Akie/Ospika study area there were 7 snow stations established, in the Chase/Sustut study area there were 6 stations, and in the Wolverine we established 7 stations in addition to 7 existing stations from a previous UNBC/MELP project (Johnson and Parker 1996). A total of 27 stations were available for sampling.

At most sampling sites we erected a snow stake pre-painted in 20 cm intervals such that the snow depth could be quickly estimated to the nearest 20cm from the helicopter without having to land. For the stations that did not have snow stakes we measured snow depth to the nearest 1cm with a ruler. Other variables recorded include the date, general location, and snow hardness (Appendix 4e).

RESULTS AND DISCUSSION

The distribution of animal captures, radio-collared animal locations, site investigations (mortality and habitat), and snow stations, in each study area are presented in Appendix 5. All raw data are included in electronic format in the following 5 files: 1999_ Capture.xls, 1999_Telemetry.xls, 1999_Calf_Census.xls, 1999_Habitat.xls, and 1999_Mortality.xls. One wolverine (*Gulo gulo*) was observed during the 1999 inventory year, for which a RIC Wildlife Sighting Form was completed (Appendix 6).

Capture/Handling

Between November 24, 1998 and November 5, 1999 we captured 122 animals in order to fit individuals with radio-transmitters or replace old transmitters (Table 4 and Appendix 7). Of these, 34 animals were fitted with GPS collars, 68 were fitted with VHF collars, and 20 caribou calves were fitted with VHF ear-transmitters. We also monitored an additional 34 animals that were radio-collared in previous studies. In total, there were 148 animals fitted with radio-transmitters within the 1999 survey year (see numbers in brackets in Table 4).

Table 4. Number of moose, caribou, and wolves captured and fitted with radio-transmitters, and (in brackets) total number of animals with radio-transmitters, summarized by age class and gender within each study area in north-central British Columbia, 1999.

Study Area	Age Class	Gender	Species			TOTAL
			Moose	Caribou	Wolves	
Wolverine	Adult	Male	6 (6)	4 (5)	0 (0)	**10 (11)**
		Female	10 (10)	19 (32)	1 (1)	**30 (43)**
		Unknown	0 (0)	0 (0)	0 (3*)	**0 (3)**
	Calf	Male	0 (0)	3 (3)	N/A	**3 (3)**
		Female	0 (0)	9 (9)	N/A	**9 (9)**
		Unknown	0 (0)	1 (1)	N/A	**1 (1)**
		Subtotal	**16 (16)**	**36 (50)**	**1 (4)**	**53 (70)**
Chase/Sustut	Adult	Male	6 (6)	4 (5)	2 (2)	**12 (13)**
		Female	7 (7)	7 (11)	1(1)	**15 (19)**
		Unknown	0 (0)	0 (3*)	0 (1*)	**0 (4)**
	Calf	Male	0 (0)	4 (4)	N/A	**4 (4)**
		Female	0 (0)	3 (3)	N/A	**3 (3)**
		Subtotal	**13 (13)**	**18 (26)**	**3 (4)**	**34 (43)**
Akie/Ospika	Adult	Male	6 (6)	6 (6)	4 (4)	**16 (16)**
		Female	8 (8)	9 (9)	2 (2)	**19 (19)**
	Calf	Male	0 (0)	0 (0)	N/A	**0 (0)**
		Female	0 (0)	0 (0)	N/A	**0 (0)**
		Subtotal	**14 (14)**	**15 (15)**	**6 (6)**	**35 (35)**
		TOTAL	**43 (43)**	**69 (91)**	**10 (14)**	**122 (148)**

*The genders of several animals that were collared in previous studies were unknown.

Telemetry

A total of 3289 animal locations were recorded over 129 flights, of which 2657 were for caribou, 407 for moose, and 225 for wolves. Of the caribou, moose, and wolf locations combined, 363 were in the Akie/Ospika study area, 1257 in the Chase/Sustut study area, and 1669 in the Wolverine study area (Table 5). For most locations, a visual on the animal was achieved, or a strong 'fix'; however, approximately 5-10% of these locations were simply 'heard' within a broad area. There were 5153 locations recorded and retrieved in 1999 from GPS radio-collars on 13 adult caribou and 1 wolf (Table 6). Eight of these caribou were initially captured and collared during a collaborative project between the Ministry of Environment, Lands, and Parks (MELP) and the University of Northern British Columbia (UNBC) (Johnson and Parker 1996). Slocan/Donohue assumed the monitoring and collar retrieval for these animals in early March 1999 and radio-locations from March forward were available to both projects. Of the 33 GPS collars outfitted on animals by Slocan/Donohue, only 1 wolf collar and 5 caribou collars were retrieved and downloaded in 1999. These GPS locations are not included on the maps of

Appendix 5 as they have yet to be completely processed. Stored locations from the remaining collars will be downloaded and analysed in 2000, once the collars have been retrieved (estimated for February, 2000).

Table 5. Number of caribou, moose, and wolf locations summarized by study area and observation type (radio-collared or uncollared but sighted) in north-central British Columbia, 1999.

STUDY AREA	CARIBOU		MOOSE		WOLVES		TOTAL
	Collared	Uncollared	Collared	Uncollared	Collared	Uncollared	
Akie/Ospika	89	91	104	18	33	28	363
Chase/Sustut	348	687	128	13	36	45	1257
Wolverine	570	872	138	6	37	46	1669
TOTAL	1007	1650	370	37	106	119	**3289**

Table 6. Number of animal locations retrieved from GPS collars fitted on animals, summarized by study area, project origin, species, and gender, in north-central British Columbia, 1999.

Study Area	Animal ID	Project	Species	Gender	Data Collection Period:		# of Locations
					Start Date	End Date	
Wolverine	1D3C	MELP/UNBC/ Slocan/Donohue	Caribou	Female	07/04/99	25/06/99	453
Wolverine	833C	MELP/UNBC/ Slocan/Donohue	Caribou	Female	21/03/99	12/05/99	47
Wolverine	843C	MELP/UNBC/ Slocan/Donohue	Caribou	Female	01/03/99	06/04/99	281
Wolverine	853C	MELP/UNBC/ Slocan/Donohue	Caribou	Female	11/03/99	25/06/99	725
Wolverine	861A	MELP/UNBC/ Slocan/Donohue	Caribou	Female	01/03/99	25/04/99	291
Wolverine	882B	MELP/UNBC/ Slocan/Donohue	Caribou	Female	01/03/99	30/06/99	452
Wolverine	B94D	MELP/UNBC/ Slocan/Donohue	Caribou	Female	01/03/99	05/04/99	52
Wolverine	BA5E	MELP/UNBC/ Slocan/Donohue	Caribou	Female	01/03/99	25/05/99	392
Chase/Sustut	C057A	Slocan/Donohue	Caribou	Female	06/03/99	30/05/99	160
Wolverine	C029W	Slocan/Donohue	Caribou	Female	25/06/99	23/12/99	573
Chase/Sustut	C056C	Slocan/Donohue	Caribou	Male	08/03/99	18/12/99	813
Chase/Sustut	C066C	Slocan/Donohue	Caribou	Male	09/03/99	24/01/00	578
Wolverine	C068W	Slocan/Donohue	Caribou	Male	04/03/99	03/05/99	154
Chase/Sustut	W016C	Slocan/Donohue	Wolf	Male	10/03/99	18/11/99	182
						TOTAL	**5153**

Calf Census

Approximately 74 hours of calf surveys were conducted over 6 samples in the spring and summer, with a total of 338 caribou cows and 211 calves observed. Twenty-six of 35 radio-collared caribou cows were known to have calves over the length of the survey for a hypothetical calf:cow ratio of 74:100 (Table 7). The total number of calves was high in session 5 because the focus during this session was on locating cows with calves in order to capture and mark the calves. There were 13 calves surviving 34 cows at the end of the 6th survey, indicating that 38% of collared cows had surviving calves (Table 8). This did not include the marked calf of an uncollared cow as its status was unknown in the last 2 sessions. This differs substantially from survival rates estimated using total cows and calves observed (61%). By monitoring the radio-collared cows, we felt that we obtained a much more precise estimate of calf survival rates. We conducted a follow-up survey in December to determine the fate of the 14 calves known or assumed to be alive in session 6 and confirmed 9 were still alive, 3 dead and 2 of unknown status. Our data showed that 16 of the remaining 20 cows that were not relocated did not have calves, and 2 of the cows had died; therefore, there were at least 9 calves surviving 31 cows, for a survival rate of 29% in December.

Habitat

A total of 270 site investigations were conducted within the 3 study areas during the 1999 inventory (Table 8). Plots were established at recorded locations of mortality sites, or at sites based on anecdotal observations of habitat use by caribou, moose, or wolves. Of these 270 site investigations, 51 plots were centered on observed locations of adult, radio-collared female caribou for seasonal habitat comparisons (Table 9). The majority of focal animals have not yet been categorized as a resident or migrant, with or without a calf, because further data collection is required to provide more conclusive evidence of their classification. We met our objective of completing seasonal habitat comparison site investigations for 4 animals in the Chase/Sustut study area, but only completed investigations for 3 animals in the Akie/Ospika and Wolverine study area for 2 reasons: 1) for sites that were accessed by helicopter, telemetry and mortality site investigations were a higher priority, therefore habitat sites were visited only if there was enough helicopter time available; and 2) weather conditions did not permit access.

Table 7. Survival of caribou calves of radio-collared cows over 7 surveys in north-central British Columbia, 1999.

#	Study Area	Collar Type	Collared Cow[a]	Tagged Calf	Calf Presence (0 or 1) by Session[b]						
					1	2	3	4	5	6	7
1	Chase/Sustut	VHF	148.231	148.820	1	1	1	1	-	0	-
2	Chase/Sustut	GPS	148.570	-	NF[c]	NF	NF	1	1	0	NF
3	Chase/Sustut	GPS	148.700	-	1	1	0	NF	NF	NF	NF
4	Chase/Sustut	GPS	148.710	-	NF	0	NF	0	NF	NF	NF
5	Chase/Sustut	VHF	148.882	148.850	1	1	1	1	NF	1	MO[d]
6	Chase/Sustut	VHF	148.910	148.831	1	1	1	1	NF	1	1
7	Chase/Sustut	VHF	148.932	148.810	1	1	1	1	NF	NF	1
8	Chase/Sustut	VHF	148.941	-	0	0	NF	NF	NF	NF	NF
9	Chase/Sustut	VHF	148.961	148.790	1	1	1	0	NF	NF	NF
10	Chase/Sustut	VHF	148.991	-	0	0	0	0	0	NF	NF
11	Chase/Sustut	VHF	149.012	148.860	0	1	1	0	NF	NF	NF
12	Chase/Sustut	GPS	149.410	148.870	1	1	1	1	NF	1	NF
13	Chase/Sustut	GPS	149.420	-	0	0	NF	0	NF	NF	NF
14	Wolverine	VHF	149.610	149.720	1	1	1	1	NF	1	1
15	Wolverine	VHF	149.691	-	0	0	0	0	NF	NF	NF
16	Wolverine	VHF	149.781	148.140	1	1	1	1	NF	1	1
17	Wolverine	VHF	149.960	149.490	NF	NF	1	1	NF	1	1
18	Wolverine	VHF	149.990	149.531	NF	NF	NF	NF	1	1	1
19	Wolverine	VHF	150.121	149.770	1	1	1	1	NF	1	NF
20	Wolverine	GPS	150.250 / 148.222	149.710	NF	1	1	1	NF	1	1
21	Wolverine	VHF	150.272	-	0	0	0	1	1	0	0
22	Wolverine	VHF	150.282	148.150	1	1	1	1	1	1	0
23	Wolverine	VHF	150.292	-	1	1	1	1	1	1	1
24	Wolverine	VHF	150.361	-	1	0	0	0	NF	NF	NF
25	Wolverine	VHF	150.464 / 149.470	149.550	NF	1	1	1	NF	1	MO[c]
26	Wolverine	VHF	150.490	149.510	NF	0	1	1	NF	0	NF
27	Wolverine	VHF	150.524 / 149.951	-	0	NF	NF	NF	0	0	0
28	Wolverine	VHF	150.551	-	NF	1	1	1	NF	0	0
29	Wolverine	VHF	150.781	-	0	0	0	0	NF	NF	0
30	Wolverine	GPS	150.940 / 149.930	149.530	NF	1	1	1	1	0	NF
31	Wolverine	GPS	150.960 / 149.981	-	NF	NF	NF	0	0	0	NF
32	Wolverine	GPS	150.980 / 149.941	148.170	1	NF	1	0	NF	NF	NF
33	Wolverine	GPS	151.910 / 149.450	-	0	NF	0	0	NF	NF	0
34	Wolverine	GPS	151.920 / 149.440	-	1	1	0	0	NF	NF	NF
35	Wolverine	GPS	151.930 / 148.050	148.130	1	1	1	1	NF	1	1
TOTAL CALVES VS. COWS:					16/ 25	19/ 28	20/ 30	19/ 33		13/ 34	9/ 31

a: cows with 2 collar frequencies were captured and re-collared during the calving season
b: for session dates see Appendix 3f
c: NF = Not found during that session
d: Cow is dead, therefore status of calf is unknown.

Table 8. Number of habitat site investigations conducted by study area and species in north-central British Columbia, 1999.

Study Area	Habitat Plots Centered on:				Total
	Caribou	Moose	Wolves	Other	
Akie/Ospika	39	39	1	0	**79**
Chase/Sustut	60	28	5	3	**96**
Wolverine	83	11	1	0	**95**
TOTAL	**182**	**78**	**7**	**3**	**270**

Table 9. Number of seasonal habitat site investigations conducted at observed locations of radio-collared caribou cows in early winter summarized by season for each study area in north-central British Columbia, 1999.

Study Area	Season	Number of Plots	Number of Caribou Cows	Seasonal Comparison Samples
Akie/Ospika	Late Winter	6	3	4
	Spring	4	3	4
	Early Winter	6	3	4
Chase/Sustut	Late Winter	7	4	5
	Spring	6	4	5
	Early Winter	8	4	5
Wolverine	Late Winter	5	3	4
	Spring	4	3	4
	Early Winter	5	4	4
	TOTAL	**51**	**11**	**13**

Note: samples for this season are incomplete since early winter didn't end until January 2000. Also, other seasonal samples (e.g. late winter and calving) had yet to be conducted.

Mortality

In total, 49 mortalities were investigated during 1999 (Table 10). While the cause of death was difficult to determine for many of these mortalities, we found that all 5 of the caribou calf mortalities investigated were caused by predation, with 1 confirmed bear kill, 3 confirmed wolf kills, and 1 unknown predator kill. Of the adult mortalities, 2 wolves and 2 moose were shot, 1 moose was killed in an avalanche, 13 moose and 5 caribou were killed by wolves, and 2 caribou were killed by grizzly bears (*Ursus arctos*). Eighteen of the 49 mortalities were radio-collared animals, 9 in the Wolverine study area, 6 in the Chase, and 3 in the Akie.

Table 10. Number of mortality site investigations, summarized by species and study area in north-central British Columbia, 1999.

Study Area	Moose	Caribou		Wolves	TOTAL
		Adults	Calves		
Wolverine	10	6	1	4	**21**
Chase/Sustut	7	4	4	0	**15**
Akie/Ospika	11	2	0	0	**13**
TOTAL	**28**	**12**	**5**	**4**	**49**

Of the radio-collared caribou cows monitored during the calf census, 24 of 35 calves did not survive: 5 died of predation (3 by wolves, 1 by a bear, and 1 by an unknown predator); 1 was stillborn; 8 died during or shortly after birth (< 1 week), or were aborted and therefore, were never observed; and 10 died of unknown causes (Table 11). The status of 2 calves was unknown, and 9 calves were alive at the end of December.

Table 11. Mortality causes of caribou calves in the Wolverine and Chase/Sustut study areas in north-central British Columbia, 1999.

Study Area	Wolves	Bear	Unknown Predator	Stillborn	Unknown	Other*	Alive
Wolverine	0	1	1	1	6	5	7
Chase	3	0	0	0	4	3	2
TOTAL	**3**	**1**	**1**	**1**	**10**	**8**	**9**

* Includes calves that were aborted or died during or shortly after birth (<1 week) and therefore were never observed

Snow Sampling

As snow stations were established in November, only 58 measurements were collected in 1999 (Appendix 8). There were not enough measurements available to conduct analyses on these data. Not all snow stations were visited each session for 2 reasons: 1) for stations that were accessed by helicopter only, habitat and mortality site investigations were a higher priority, therefore stations were sampled only if there was enough helicopter time available; 2) weather conditions did not permit access. For each study area a sub-sample of 3 snow stations (at different elevation ranges) had to be sampled every session. Where time was available we sampled additional snow stations.

CRITIQUE OF PROTOCOLS AND MANAGEMENT RECOMMENDATIONS

We found the different inventory protocols used in the 1999 inventory addressed our sampling goals and accomplished our specific objectives. However, the addition of both a caribou census and a moose census to the plan for 2000, would be beneficial in determining the composition of caribou and moose populations (scheduled for February/March, 2000). Our 3 inventory protocols (telemetry, site investigations, and census) were found to be effective, with some notable exceptions that we plan to revise in 2000.

Our VHF telemetry protocols were efficient, as 1 observer was able to record reasonably accurate data on each radio-collared animal location including position, group size, group composition, animal behaviour, and broad habitat characteristics. GPS collars appeared to have functioned well in almost all cases; however, the rate of data collection was found to limit battery length to less than 12 months. This will be amended in 2000 to target a battery life of a full year. Telemetry protocols also worked very well for calving surveys, where we split data recording into 2 separate categories, with 1 observer recording group size, group composition, and location, and the second observer recording habitat characteristics.

Our caribou calf telemetry was hampered by transmitter loss, which was a function of both the size of the transmitter and its' location in the brisket. For the 2000 inventory year we plan to use smaller VHF ear-tags secured to the ears of caribou calves, as well as several trials of elasticized collars that can expand as the calf grows, in an attempt to ensure that calves maintain their transmitters. This will assist us in determining calf survival rates and mortality causes in future years.

Our mortality site investigation protocols provided satisfactory data when we were able to identify and investigate a mortality quickly following death. However, we often identified mortalities too late, such that the effects of scavengers, weather, or both, masked the cause and circumstances of death. In the future we plan to use scanning receivers to scan and log pulse rates of our radio-collar sample. This additional sampling will hopefully provide opportunities to more effectively identify mortalities.

Initial habitat site investigations were modified to incorporate variables more relevant to the inventory objectives, and to include variables recorded by the wildlife biologists conducting inventories of fisher and wolverines within our study area. This data collaboration will facilitate data transfer between the 3 projects, as well as contribute towards refinement and verification of Terrestrial Ecosystem Mapping projects in the area. Our initial methods for sampling terrestrial and

arboreal lichen were inadequate for the life forms (e.g. terrestrial lichen display a rather clumped distribution not conducive to a percent cover measurement; arboreal lichen is also somewhat inconsistently distributed, and the trees closest to the plot centre aren't necessarily representative of arboreal lichens in the plot as a whole). In late summer we modified our sampling protocol to address these problems, and will utilize the same methods for our detailed habitat sampling scheduled to take place in the summer of 2000. We also amended our selection of plots for habitat investigations within a design to allow a comparison of habitats used among seasons by female caribou.

The design of our snow sampling stakes was not sturdy enough and they regularly suffered damage from high winds. We plan to establish these stations properly during the summer of 2000.

This report summarizes the first full year of preliminary data collection on the Ecological Factors Affecting Northern Caribou project, and the initiation of the first year of intensive data collection (beginning in early winter 1999). On the basis of the first preliminary year, protocols have been assessed and revisions to data forms have been made where necessary to improve data collection efficiency in 2000. The data summarized in this 1999 inventory report will contribute to improved caribou habitat description, and to refining caribou habitat mapping and habitat modeling in the Mackenzie TSA. However, because data collection has only begun, the analytical interpretations that would allow for confidence in management models have not been presented here. Annual variation in weather patterns and multi-year cycles in population response, among other factors, contribute to the usual requirement of wildlife inventories for more than one full year of data collection before interpretations can be made of the data. Nevertheless, the data will contribute directly to construction of a caribou management model planned to begin early in 2000 (Ellis 1999). Also, even in the absence of analytical rigor, 5 general (but inconclusive) observations can be made of the data collected in 1999: 1. the Chase/Sustut herd appeared to have unusually low recruitment of calves; 2. radio-collared caribou in all 3 herds appeared to make greater use of low elevation winter habitats than we would have thought based on available literature; 3. there appeared to be greater use of arboreal lichens in winter than we expected based on available literature; 4. the spatial separation between caribou and moose in our radio-collared sample was consistent with available literature and was impressive, especially during the calving and summer seasons; and 5. the number of wolf packs in the 3 study areas and the size of individual packs were also impressive.

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APPENDIX 1. GEOGRAPHIC COVERAGE OF THE PROJECT AREA - MAP A

Note that in-block roads and status of mainline roads are to be interpreted as approximations only

APPENDIX 2. WILDLIFE PROJECT DESCRIPTION FORM

Project Name: *An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia*

Project Agency: *Slocan Forest Products Ltd. and Donohue Forest Products, Inc.*

Project Coordinator: *Scott McNay (Slocan) Wayne Lewis (Donohue)*

Start Date: *1998 / Sept / 01* **End Date:** *2002/ Dec / 23*

Funding Agencies

Funding Agency Name	Funding Agency Project ID
FRBC	*99840023 , 99840012 (Multi-year Agreement Number)*
FRBC	*10251, 10288 (Activity Number)*

Mapsheet(s) # 93N.094-93N.100, 93N.084-93N.090, 93N.074-93N.080, 93N.064-93N.070, 93N.055-93N.060, 93N.046-93N.050, 93N.036-93N.040, 93N.027-93N.030, 93O.081, 93O.071, 93O.061-93O.063, 93O.051-93O.053, 93O.041-93O.043, 93O.031-93O.033, 93O.021-93O.023, 94C.001-94C.008, 94C.011-94C.018, 94C.021-94C.090, 94D.030, 94D.040, 94D.050, 94D.060, 94D.068-94D.070, 94D.078-94D.080, 94D.088-94D.090, 94B.021, 94B.031, 94B.041, 94B.051, 94B.061, 94B.062, 94B.071, 94B.072, 94B.081, 94B.091, 94G.001, 94C.095-94C.100, 94F.004-94F.010, 94F.013-94F.020, 94F.023-94F.030, 94F.032-94F.040, 94F.042-94F.050, 94F.052-94F.059, 94F.062-94F.068, 94F.073-94F.077, 94F.084-94F.087

Location Name: *Mackenzie TSA*

Location Description:

1. ***Wolverine*** *(Landscape Units); Manson, Klawli, Germansen, Wolverine, Upper Omineca, Lower Omineca, Discovery.*
2. ***Chase/Sustut*** *(L.U.) Upper Osilinka, Lower Osilinka, Tenakihi, Mesilinka, Factor Ross, Carina Tomias, Swannell, Aiken, Upper Ingenika, Lower Ingenika, Thutade.*
3. ***Akie/Ospika*** *(L.U.) Collins, lower Ospika, Upper Ospika, Davis, Chowika, Pesika, Lower Akie, Upper Akie, Paul, Kwadacha.*

MELP Region: *Prince George Region*
Forest District(s): *Mackenzie District*
Ecoregion(s): *Skeena and Omineca Mountains Ecoregion*

Special Objectives: *To address inventory concerns relating to:*

1. a lack of basic inventory information concerning abundance, seasonal movements, and habitat needs of large ungulates where such basic information could then lead to better assessments of habitat values for these species;
2. a lack of standard expressions of, or procedures for verifying, Wildlife Habitat Assessments where increased confidence in these assessments could then lead to better strategic planning for integrated management of forests and wildlife;
3. development, implementation, and monitoring of a strategic management plan for Caribou (i.e., the Mackenzie LRMP's ''Caribou Management Strategy''); and
4. use this activity to aid subsequent development of, and discussion about, adaptive management initiatives with industry, government, 1st Nations, and local communities within the Mackenzie Forest District.

APPENDIX 3A. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART A (TELEMETRY)

Project Name *An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia*

Survey Name: *Telemetry*

Survey Period: Start Date *1998 / Nov / 15* End Date *1998 / Dec / 23*

Survey Type: *Aerial and Ground Telemetry Surveys*

Survey Intensity PN ∝ : RA ∝ : AA ☐

Target Taxa	Class Level
M – ALAL	*3*
M - RATA	*3*
M - CALU	*3*

Transport *Pacific Western Bell 206 Helicopters* Avg Spd *80 Km/hr*

Survey Coordinator

First Given Name	Second Given	Surname
Line		*Giguere*

Surveyors

First Given Name	Second Given	Surname
Line		*Giguere*
Landon		*Wilson*
Helen		*Davis*
Jackie		*Caldwell*
Shannon		*Walshe*
Jeff		*Joy*
Ruth		*Van den Driessche*
Larry		*Frey*
Dan		*Tomlinson*
Glen		*Keddie*

Survey Objectives (continue on back side if needed)

1. Seasonal movements, migration routes, and site-specific habitat selection, for individual caribou, moose, and wolves
2. Survival rates of caribou, moose, and wolves
3. Identification of mortality (timing, sites and causes) of known, individual caribou, moose, and wolves

APPENDIX 3B. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART A (SITE INVESTIGATIONS)

Project Name *An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia*

Survey Name: *Site Investigations (Habitat and Mortality)*

Survey Period: Start Date *1998 / Nov / 15* End Date *1998 / Dec / 23*

Survey Type: *Site Investigations (Habitat and Mortality)*

Survey Intensity PN ∝ : RA ∝ : AA ☐

Target Taxa	Class Level
M – ALAL	*3*
M - RATA	*3*
M - CALU	*3*

Transport *Pacific Western Bell 206 Helicopters* Avg Spd *80 Km/hr*

Survey Coordinator

First Given Name	Second Given	Surname
Line		*Giguere*

Surveyors

First Given Name	Second Given	Surname
Line		*Giguere*
Landon		*Wilson*
Charlie		*Boya*
Jacques		*Perreault*
Helen		*Davis*
Jackie		*Caldwell*
Cameron		*Nelin*
Craig		*Cassity*
Kathi		*Zimmerman*
Jeff		*Joy*
Caroline		*Yakel*
Rich		*Weir*
Greg		*Altoff*
Glen		*Watts*
Doug		*Heard*
Ruth		*Van den Driessche*
Scott		*McNay*
Wayne		*Cook*
Dan		*Tomlinson*
Glen		*Keddie*

Survey Objectives (continue on back side if needed)

1. Verification of habitat types selected by radio-collared caribou, moose, and wolves
2. Identification of specific habitat attributes not available from mapped databases
3. Verification of ecosystem classification from established Terrestrial Ecosystem Maps

APPENDIX 3C. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART A (CALF CENSUS)

Project Name *An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia*

Survey Name: *Calf Census*

Survey Period: Start Date *1998 / Nov / 15* End Date *1998 / Dec / 23*

Survey Type: *Aerial Census*

Survey Intensity PN ∝ : RA ∝ : AA ☐

Target Taxa	Class Level
M - RATA	*3*

Transport *Pacific Western Bell 206 Helicopters* Avg Spd *80 Km/hr*

Survey Coordinator

First Given Name	Second Given	Surname
Line		*Giguere*

Surveyors

First Given Name	Second Given	Surname
Line		*Giguere*
Jacques		*Perreault*
Kathi		*Zimmerman*
Shannon		*Walshe*
Jeff		*Joy*
Scott		*McNay*

Survey Objectives (continue on back side if needed)

1. Caribou calf recruitment (annual estimate)
2. Mortality causes and survival rates for caribou calves
3. Productivity of known caribou cows
4. Estimate of fidelity to maternal habitat selection patterns

APPENDIX 3D. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART B (CAPTURE SESSION LABELS)

Project Name: An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia

Capture Session Label	Start Date	End Date	Duration
WOL98NOV	1998/11/24	1998/11/25	2 DAYS
WOL99MARCH	1999/03/03	1999/03/11	4 DAYS
CHA99MARCH	1999/03/08	1999/03/10	3 DAYS
AKI99MARCH	1999/03/05	1999/04/06	6 DAYS
WOL99JUNE	1999/06/25	1999/06/26	2 DAYS
CHA99JUNE	1999/06/24	1999/06/24	1 DAY
AKI99JUNE	1999/06/22	1999/06/23	2 DAYS
WOL99JULY	199/07/22	199/07/23	2 DAYS

APPENDIX 3E. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART B (TELEMETRY AND SITE INVESTIGATION SESSION LABELS)

Project Name: An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia

Telemetry and Site Investigation Session Labels	Start Date	End Date	Duration
1. Late Winter (High Intensity)	1999/01/18	1999/03/27	50 DAYS
2. Spring and Summer (Low Intensity)	1999/03/29	1999/07/31	90 DAYS
3. Fall (Low Intensity)	1999/09/13	1999/10/23	30 DAYS
4. Early Winter (High Intensity)	1999/10/25	1999/12/18	40 DAY

APPENDIX 3F. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART B (CALF CENSUS SESSION LABELS)

Project Name: An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia

Calf Census Session Label	Start Date	End Date	Duration
Calf Census Session 1	1999/06/09	1999/06/10	2 DAYS
Calf Census Session 2	1999/06/17	1999/06/18	2 DAYS
Calf Census Session 3	1999/06/24	1999/06/26	3 DAYS
Calf Census Session 4	1999/07/01	1999/07/02	2 DAYS
Calf Census Session 5	1999/07/22	1999/07/23	2 DAYS
Calf Census Session 6	1999/09/16	1999/09/17	2 DAYS
Calf Census Session 7	1999/12/18	1999/12/29	3 DAYS

APPENDIX 3G. WILDLIFE INVENTORY SURVEY DESCRIPTION FORM - GENERAL: PART C

Project Name: *An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia.*

Inventory Study Areas:

Study Area	Biogeoclimatic Units*		Landscape Units
Akie/ Ospika	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	Collins Pesika
	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	Lower Ospika Upper Ospika
	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	Davis Chowika
	SWBmk:	Spruce - Willow - Birch, moist cool	Lower Akie Paul
	ESSFmv4:	Engelmann Spruce - Subalpine Fir, moist very cold, Graham variant	Kwadacha
	ATp:	Alpine Tundra, parkland	
Chase/ Sustut	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	Upper Osilinka Lower Osilinka
	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	Tenakihi Mesilinka Factor Ross
	SWBmk:	Spruce - Willow - Birch, moist cool	Carina Tomias
	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	Swannell Aiken
	ESSFmv3:	Engelmann Spruce - Subalpine Fir, moist very cold, Omineca variant	Upper Ingenika 10. ower Ingenika
	ESSFmv4:	Engelmann Spruce - Subalpine Fir, moist very cold, Graham variant	I. Thutade
	ATp:	Alpine Tundra, parkland	
Wolverine	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	Manson Klawli
	SBSmk1:	Sub-boreal Spruce, moist cool, Mossvale variant	Germansen Wolverine
	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	Upper Omineca Lower Omineca
	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	Discovery Strandburg
	ESSFmv2:	Engelmann Spruce - Subalpine Fir, moist very cold, Bullmoose variant	
	ESSFmv3:	Engelmann Spruce - Subalpine Fir, moist very cold, Omineca variant	
	ATp:	Alpine Tundra, parkland	

*From Meidinger and Pojar (1991).

APPENDIX 4. DATA COLLECTION FORMS

a) CAPTURE/HANDLING

b) TELEMETRY (ALSO USED AS CALF CENSUS SURVEY FORM)

c) HABITAT

d) MORTALITY

e) SNOW SAMPLING

APPENDIX 5. POSITION OF SURVEY SAMPLE UNITS AND LOCATIONS WHERE SPECIES WERE OBSERVED – MAP B

Distribution of Capture Locations, Aerial Telemetry Locations, Snow Station Locations, Habitat Plots, and Mortality Site Locations in Each of the Following Study Areas:

1. AKIE/OSPIKA
2. CHASE/SUSTUT
3. WOLVERINE

Note that in-block roads and status of mainline roads are to be interpreted as approximations only.

APPENDIX 6. WILDLIFE SIGHTING FORM

APPENDIX 7. MARKED ANIMAL IDENTIFICATION FORM

Project: Omineca Northern Caribou **Survey:** Capture **Study Area:** Akie/Ospika

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-RATA	RT	Lotek VHF Collar	Meadow/Swamp, Isola Creek	55 Red Eartag		148.231	
M-RATA	RT	Lotek VHF Collar	Akie River			148.262	
M-RATA	RT	Lotek VHF Collar	Akie River	20 Red Eartag		148.301	
M-RATA	RT	Televilt GPS Collar	Meadow/Swamp, Isola Creek	57 Red Eartag		149.410	
M-RATA	RT	Televilt GPS Collar	Meadow/Swamp, Akie River	45 Red Eartag		148.550	
M-RATA	RT	Lotek VHF Collar	Akie River			148.211	
M-RATA	RT	Lotek VHF Collar	Meadow/Swamp Akie River			148.270	
M-RATA	RT	Lotek VHF Collar	Isola Creek/ Ingenika Arm	56 Red Eartag		148.280	
M-RATA	RT	Lotek VHF Collar	Akie River Meadow/Swamp	27 Red Eartag		148.291	
M-ALAL	RT	Lotek VHF Collar	Meadow / Swamp Del Ck			148.312	
M-ALAL	RT	Lotek VHF Collar	Akie River	49 Red Eartag		148.322	
M-ALAL	RT	Lotek VHF Collar	Meadow / Swamp Del Ck			148.331	
M-ALAL	RT	Lotek VHF Collar	Akie River			148.410	
M-ALAL	RT	Lotek VHF Collar	Finlay R/Akie River	12 Red Eartag		148.362	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp Paul Ck			148.372	
M-ALAL	RT	Lotek VHF Collar	Akie River			148.391	
M-ALAL	RT	Televilt GPS Collar	Akie River			148.090	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp/River Bottom			148.342	
M-ALAL	RT	Lotek VHF Collar	Akie River			148.351	
M-ALAL	RT	Lotek GPS Collar	Finlay River			148.381	L01
M-ALAL	RT	Lotek VHF Collar	Paul River			148.401	
M-ALAL	RT	Lotek VHF Collar	Akie River	30 Red Eartag		148.421	
M-CALU	RT	Lotek VHF Collar	Top of Mtn, west of Akie River	9 Red Eartag		148.480	
M-CALU	RT	Lotek VHF Collar	Cut block Finlay R/Akie River			148.512	
M-CALU	RT	Lotek VHF Collar	Del Ck, No GPS, Found week later at 57 17.50, 125 12.30			148.490	

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-CALU	RT	Lotek VHF Collar	Truneate Ck/Akie River	3 Red Eartag		148.500	
M-CALU	RT	ATS - GPS Collar	Cut block Finlay R/Akie River			150.180	
M-CALU	RT	ATS - GPS Collar	Del Ck	40 Red Eartag		150.620	
M-RATA	RT	Lotek VHF Collar	6000 ft, Alpine, Akie river, Backend Southside	115 Red Eartag		148.242	
M-RATA	RT	Lotek VHF Collar	6200 ft, Alpine, Akie River, mid way, Southside	101 Red Eartag		148.250	
M-RATA	RT	Lotek VHF Collar	5500 ft, Alpine, Akie River, Midway, Southside	120 Red Eartag		148.280	retrieved from RATA with eartag 56
M-RATA	RT	Lotek VHF Collar	6000 ft, Alpine, Akie river, Backend Southside	118 Red Eartag		148.470	
M-RATA	RT	Televilt GPS Collar	6500 ft, Alpine, Akie river, Mid way South side	114 Red Eartag		148.030	
M-RATA	RT	Televilt GPS Collar	6000 ft, Alpine, Akie river, Back end, South side	126 Red Eartag		148.040	
M-ALAL	RT	Televilt GPS Collar	4200 ft, On River Bottom, Backend of Akie River	119 Red Eartag		148.720	
M-RATA	RT	Televilt GPS Collar	Lake			148.570	

Project: Omineca Northern Caribou **Survey:** Capture **Study Area:** Chase/Sustut

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-RATA	RT	Televilt GPS Collar	Lake	35 Red Eartag	GOITX-044-DM	148.700	
M-RATA	RT	Televilt GPS Collar	Lake	37 Red Eartag	GOITX-045-DM	148.710	
M-RATA	RT	Lotek VHF Collar	Lake	48 Red Eartag		148.882	
M-RATA	RT	Lotek VHF Collar	Lake	44 Red Eartag		148.932	
M-RATA	RT	Lotek VHF Collar	Lake	46 Red Eartag		149.012	
M-RATA	RT	Televilt GPS Collar	Lake	41 Red Eartag	GOITX-059-DM	149.420	
M-RATA	RT	Televilt GPS Collar	Lake	29 Red Eartag		148.520	
M-RATA	RT	Lotek VHF Collar	Meadow/Swamp	36 Red Eartag		148.892	
M-RATA	RT	Lotek VHF Collar	Lake	26 Red Eartag		149.001	
M-RATA	RT	Televilt GPS Collar	Meadow/Swamp	39 Red Eartag		149.390	
M-ALAL	RT	Lotek VHF Collar	Forest edge of power line	43 Red Eartag		149.021	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp	47 Red Eartag		149.071	
M-ALAL	RT	Lotek VHF Collar	River	52 Red Eartag		149.131	
M-ALAL	RT	Lotek VHF Collar	River	50 Red Eartag		149.141	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp			149.231	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp	28 Red Eartag		149.041	
M-ALAL	RT	Lotek VHF Collar	Forest	34 Red Eartag		149.061	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp	42 Red Eartag		149.081	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp	32 Red Eartag		149.092	
M-ALAL	RT	Lotek VHF Collar	Meadow/Swamp	38 Red Eartag		149.121	
M-ALAL	RT	Lotek VHF Collar	River	51 Red Eartag		149.201	
M-CALU	RT	ATS - GPS Collar	Forest	53 Red Eartag		150.141	
M-CALU	RT	ATS - GPS Collar	Lake	54 Red Eartag		150.630	
M-RATA	ES	Telonics VHF Ear Transmitter	Just South of Johanson Lake	102 Red Eartag		148.820	
M-RATA	ES	Telonics VHF Ear Transmitter	5800 ft, Alpine, Quenada Creek NE side	107 Red Eartag		148.831	
M-RATA	ES	Telonics VHF Ear Transmitter	Alpine, Back end of Rovenal Creek	106 Red Eartag		148.860	
M-RATA	ES	Telonics VHF Ear Transmitter	4800 ft - Johanson Lake (South)	125 Red Eartag		148.790	

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-RATA	ES	Telonics VHF Ear Transmitter	5700 ft - Alpine Tutizzi Lake North	123 Red Eartag		148.810	
M-RATA	ES	Telonics VHF Ear Transmitter	Alpine, Back end of Rovenal Creek	109 Red Eartag		148.850	
M-RATA	ES	Telonics VHF Ear Transmitter	Alpine, Ingenika River Back end/Conical Peak N.W.	103 Red Eartag		148.870	
M-ALAL	RT	Televilt GPS Collar	2000 ft., River bottom-Mesilinka River (E. Blackpine)	116 Red Eartag		148.750	
M-CALU	RT	ATS - GPS Collar	5800 ft, Alpine, back end of Wrede Eartage Creek (S.side)	113 Red Eartag		148.760	

Project: Omineca Northern Caribou **Survey:** Capture **Study Area:** Wolverine

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-ALAL	RT	Televilt GPS Collar (org.for grizzly)	Toe @ confluence of Donna & Manson Creek			151.390	Moose #1
M-ALAL	RT	Televilt GPS Collar (org.for grizzly)	Omineca River East Germansen			151.370	Moose #2
M-ALAL	RT	Televilt GPS Collar (org.for grizzly)	Omineca River East Germansen			151.380	Moose #3
M-ALAL	RT	Televilt GPS Collar (org.for grizzly)	Toe @ confluence of Donna & Manson Creek			151.360	Moose #4
M-RATA	RT	Lotek VHF Collar	Alpine-Top of Wolverine Range	13 Red Eartag		149.610	
M-RATA	RT	Lotek VHF Collar	Alpine-Top of Wolverine Range	2 Red Eartag		149.691	
M-RATA	RT	Lotek VHF Collar	Alpine-Top of Wolverine Range	5 Red Eartag		149.781	
M-RATA	RT	Lotek GPS Collar	Alpine 2 Km east of Wasi Lake			151.910	
M-RATA	RT	Lotek GPS Collar	Alpine-Top of Wolverine Range East of Blue Lake			150.930	
M-RATA	RT	Televilt GPS Collar	Wolverine Range	25 Red Eartag		149.370	
M-RATA	RT	Televilt GPS Collar	Alpine Range north of Germansen Lake	24 Red Eartag	G01TX-055-DM	149.380	
M-RATA	RT	Lotek VHF Collar	Alpine Range north of Germansen Lake	21 Red Eartag		149.632	
M-RATA	RT	Lotek VHF Collar	Blue Lake	17 Red Eartag		149.672	
M-ALAL	RT	Lotek VHF Collar	River bottom south of Germansen landing	8 Red Eartag		149.791	
M-ALAL	RT	Lotek VHF Collar	Manson Lake	1 Red Eartag		149.831	
M-ALAL	RT	Lotek VHF Collar	Creek bottom/Jackfish Creek	11 Red Eartag		149.861	
M-ALAL	RT	Lotek VHF Collar	East Germansen Landing	14 Red Eartag		149.891	
M-ALAL	RT	Lotek VHF Collar	Omineca River / Blue Lake Area	16 Red Eartag		149.851	
M-ALAL	RT	Lotek VHF Collar	Lower Manson Lake	22 Red Eartag		149.902	
M-ALAL	RT	Lotek VHF Collar	Swamp, Omineca R/Nina Creek	11 Red Eartag		149.802	
M-ALAL	RT	Lotek VHF Collar	Meadow- Blue Lake	18 Red Eartag		149.811	
M-ALAL	RT	Lotek VHF Collar		15 Red Eartag		149.822	
M-ALAL	RT	Lotek VHF Collar	Jackfish Creek	10 Red Eartag		149.841	
M-ALAL	RT	Lotek VHF Collar	Omineca R / Blue Lake Area	23 Red Eartag		146.871	
M-ALAL	RT	Lotek VHF Collar	Creek Bottom/ Meadow by Blue Lake	4 Red Eartag		149.881	

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-CALU	RT	Lotek VHF Collar	In Timber - Wolverine Lake	7 Red Eartag		149.910	
M-RATA	RT	Televilt Gps Collar	5600 ft, Alpine, Wolverine Rng N.W. of Mt. Porter	111 Red Eartag		148.050	
M-RATA	RT	Lotek VHF Collar	7400 ft., Alpine, Wolverine Rng, S end of Eklund Creek	121 Red Eartag		148.222	
M-RATA	RT	Televilt GPS Collar	Alpine, Nina Lake North/Flegel Creek back end	105 Red Eartag		149.440	
M-RATA	RT	Televilt GPS Collar	6100 ft, Alpine, Back end of Nina Creek	104 Red Eartag		149.450	
M-RATA	RT	Televilt GPS Collar	6000 ft, Alpine, Wolverine Range SE of Mt. Porter	108 Red Eartag		149.470	
M-RATA	RT	Lotek VHF Collar	5900 ft, Alpine, Wasi Lake SE	110 Red Eartag		149.931	Wolf Collar
M-RATA	RT	Lotek VHF Collar	5800 ft., Alpine, North end of Wolverine Range	136 Red Eartag		149.941	Wolf Collar
M-RATA	RT	Lotek VHF Collar	6400 ft., Alpine, Wolverine Range N of Mt. Porter	139 Red Eartag		149.960	Wolf Collar
M-RATA	ES	Telonics VHF Ear Transmitter	5650 ft., Alpine, Wolverine Range N.W. of Mt. Porter	112 Red Eartag		148.130	
M-RATA	ES	Telonics VHF Ear Transmitter	5800 ft, alpine, Wolverine Range, back end Eklund Creek	144 Red Eartag		148.140	
M-RATA	ES	Telonics VHF Ear Transmitter	5800 ft., Alpine, North end of Wolverine Range	142 Red Eartag		148.170	
M-RATA	ES	Telonics VHF Ear Transmitter	6400 ft., Alpine, Wolverine Range N of Mt. Porter	146 Red Eartag		149.490	
M-RATA	ES	Telonics VHF Ear Transmitter	6000 ft., Alpine, South East of Wasi Lake	138 Red Eartag		149.531	
M-RATA	ES	Telonics VHF Ear Transmitter	7400 ft., Alpine, Wolverine Range, S end Eklund Creek	117 Red Eartag		149.710	
M-RATA	ES	Telonics VHF Ear Transmitter	Alpine, In the Range S of Klawli Lake, Adade Mtn.	134 Red Eartag		149.721	
M-RATA	ES	Telonics VHF Ear Transmitter	5500 ft., Alpine, (Chamberland) S end Wolverine Range	131 Red Eartag		149.740	
M-RATA	ES	Telonics VHF Ear Transmitter	Ahdatay Lake West	147 Red Eartag		148.150	
M-RATA	ES	Telonics VHF Ear Transmitter	6000 ft., North of Mt. Tom (South of Tom Lake)	143 Red Eartag		149.510	
M-RATA	ES	Telonics VHF Ear Transmitter	L Hole South East of TSE Mtn. (Subalpine)	135 Red Eartag		149.770	
M-RATA	ES	Telonics VHF Ear Transmitter	6000 ft., Alpine, South East of Mt. Porter	124 Red Eartag		149.550	
M-RATA		Lotek GPS Collar	Top of Wolverine Range			150.970	removed collar, no new collar put on
M-RATA	RT	Lotek GPS Collar	Top of Wolverine Range			150.980	was 150.260 Lotek GPS
M-RATA	RT	Lotek GPS Collar	Top of Wolverine Range			150.250	new animal (refurbished collar)

Species	Mark Method	Model/Type	Location	Mark ID	Serial #	Radio Freq	Comments
M-RATA	RT	Lotek VHF (Wolf Collar)	S end of Wolverine Range	161		149.990	calf is 149.531
M-RATA	RT	Telonics Ear Transmitter	S end of Wolverine Range	148		149.531	retrieved from RATA with eartag 138
M-RATA	RT	Lotek VHF (Wolf Collar)	S end of Wolverine Range	159		149.981	was Lotek 150.960
M-RATA	RT	Lotek VHF (Wolf Collar)	Klawi	155		149.951	was Lotek 150.524

APPENDIX 8. SNOW SAMPLING STATION LOCATIONS

Study Area	Snow Stn ID #	Current Status	Location		Elev.	Access	Snow Measurements by Session # (cm)		
			Lat.	Long.	(m)		11	12	13
Akie/Ospika	Aki-01	Active	57 27.06	124 25.02	2089	Heli	3	5	Unk
Akie/Ospika	Aki-02	Active	57 23.78	125 19.02	900	Heli	10	13	35
Akie/Ospika	Aki-03	Active	57 15.92	125 25.91	831	Ground	0	21	25
Akie/Ospika	Aki-04	Active	56 57.35	125 08.84	750	Ground	1	15	20
Akie/Ospika	Aki-05	Active	56 54.77	124 58.27	630	Ground	0	9	5
Akie/Ospika	Aki-06	Active	56 49.63	125 13.64	1780	Heli	5	Unk	Unk
Akie/Ospika	Aki-07	Active	56 28.89	124 19.29	1229	Heli	8	Unk	Unk
Chase/Sustut	Cha-01	Active	56 10.30	125 10.10	910	Ground	5	36	45
Chase/Sustut	Cha-02	Inactive	56 30.20	125 07.87	1870	Heli	30	Unk	Unk
Chase/Sustut	Cha-03	Active	56 09.60	125 03.73	1530	Heli	20	30	60
Chase/Sustut	Cha-04	Inactive	56 19.62	125 33.93	1915	Heli	20	Unk	Unk
Chase/Sustut	Cha-05	Inactive	56 09.19	125 50.15	1510	Heli	50	Unk	Unk
Chase/Sustut	Cha-06	Active	56 14.50	125 17.00	1250	Ground	22	32	70
Chase/Sustut	Cha-07	Active	56 20.70	126 12.97	NA	Heli	Unk	Unk	125
Chase/Sustut	Cha-08	Active	56 33.33	126 09.71	NA	Heli	Unk	Unk	70
Chase/Sustut	Cha-09	Active	56 36.68	126 26.10	NA	Heli	Unk	80	82
Wolverine	Wol-01	Active	56 27.31	124 42.40	1598	Heli	12	Unk	Unk
Wolverine	Wol-02	Active	55 34.24	124 39.32	1858	Heli	12	Unk	46
Wolverine	Wol-03	Active	55 47.00	124 42.00	NA	Ground	6	22	Unk
Wolverine	Wol-04	Active	55 40.80	124 57.96	967	Ground	12	21	36
Wolverine	Wol-05	Active	55 41.93	125 09.26	2064	Heli	7	Unk	Unk
Wolverine	Wol-06	Active	55 15.50	124 46.50	NA	Heli	Unk	Unk	Unk
Wolverine	Wol-07	Active	55 39.60	124 23.26	918	Ground	7	14	26
Wolverine	Wol-08	Active	55 52.36	124 30.19	1967	Heli	8	17	Unk
Wolverine	Wol-09	Active	55 30.34	124 26.71	1612	Heli	21	48	Unk
Wolverine	Wol-10	Active	55 32.64	124 09.59	784	Ground	15	27	54
Wolverine	Wol-11	Active	55 48.75	124 51.00	NA	Ground	12	12	27
Wolverine	Wol-12	Active	55 31.61	124 02.73	834	Ground	10	15	37
Wolverine	Wol-13	Active	55 36.00	124 09.00	NA	Ground	16	Unk	Unk
Wolverine	Wol-14	Active	55 49.50	124 55.00	NA	Ground	Unk	Unk	Unk

APPENDIX 9. 1999 PROJECT PRODUCT LIST

1. Becker, D. 1998. Preliminary woodland caribou habitat evaluation model for Mackenzie Timber Supply Area, British Columbia.

2. McNay, R. S., and W. Lewis. 1998. Wildlife Habitat Assessment (#10251) / Wildlife Migration Monitoring (#10288) Project Collaboration Details. Unpub. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia 11 pp.

3. McNay, R. S., J. B. Joy, and L. Giguere. 1999. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 1 (1998) Inventory Results. Unpubl. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia. 37 pp.

4. McNay, R.S. 1999. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 2 (1999) Inventory Sampling Plan. Unpub. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia 15 pp.

5. Zimmerman, K. L., J. B. Joy, R. S. McNay, and L. Giguere. 2000. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 2 (1999) Inventory Results. Unpubl. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia 52 pp.

6. Ellis, R. 1999. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia - Working Plan for the Development of Models and the Design of Adaptive Management. Unpubl. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia 10 pp.

7. McNay, R.S. 2000. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 3 (2000) Inventory Sampling Plan. Unpubl. Rep., Forest Renewal BC, Prince George Region, Prince George, British Columbia 9 pp.

8. Progress Reports:
   a) Session 6 (Mar. 28 - May 8, 1999)
   b) Session 7 (May 9 - June 19, 1999)
   c) Session 8 (June 20 - July 3, 1999)
   d) Session 9 (Sept. 12 - Oct. 23, 1999)
   e) Session 10-13 (Oct. 24 - Dec. 18, 1999)

9. Web Site: http://otaku.unbc.ca/nfrep/caribou/main_frame.html
   Contents: Introduction
   Map of Study Sites
   Progress Reports
   Wildlife Society Conference Poster
   Product List and Extension Activities
   Related Papers and Links
   Slocan Forest Products Ltd. Website Link
   Donohue Forest Products Ltd. Website Link

9. Databases:
   a) Mortality Site Investigations
   b) Telemetry Locations – VHF
   c) Telemetry Locations – GPS
   d) Habitat Plots
   f) Animal Captures

EXTENSION ACTIVITIES AND WORKSHOPS:

1. Poster and equipment display presented by Kathi Zimmerman at the Northern Forest Products Association (NFPA) convention, April 8, 1999, Prince George, B.C.

2. Poster display presented by Leslie Yaremko at the Mackenzie Showcase '99 trade show, May 7 - 9, 1999, Mackenzie, B.C.

3. Slide presentation by Leslie Yaremko for the Mackenzie Chamber of Commerce, May 11th, Mackenzie, B.C.

4. Newspaper Article: "Slocan Timber Supply Area: Radio-collaring transmits data". The Omineca-Peace Renewal Reporter. Vol. 1(2), Spring 1999.

5. Poster presentation to The Wildlife Society's 6th Annual Conference, Austin, Texas. September 7-11, 1999.

6. Attended the Symposium on Predicting Plant and Animal Occurrences, October 19-22, 1999, Snowbird, Utah.

7. Specialist's Tutorial. Modelling Wildlife Habitats Using "Belief" Networks. Conducted by Bruce Marcot, Senior Wildlife Biologist, USDA For. Serv. PNW Research Lab, Portland OR. October 20, 1999.

8. Slide presentation by Kathi Zimmerman for Slocan Forest Products, Mackenzie Woodlands Division. November 5, 1999.

9. Slide presentation by Scott McNay for the Ministry of Forests, Mackenzie Region. November 19, 1999.

10. Slide presentation by Kathi Zimmerman for the Tsay Keh Dene first nations community. December 10, 1999.

11. Slide presentation by Kathi Zimmerman for the Fort Ware first nations community. December 10, 1999.

PROPOSALS AND FUNDING APPLICATIONS:

1. Environment Youth Team (EYT) application - approved. Hired Robyn Scott from November 15, 1999 - March 31, 2000

2. Peace/Williston Compensation Program - 3 proposals submitted November,1999:
   - Wolf Ecology
   - Adaptive Enhancement Of Early Winter Habitat For Northern Caribou,
   - Caribou Population Health

3. Habitat Conservation Trust Fund (HCTF) - submitted proposal November, 1999: Wolf Ecology And Predator-Prey Dynamics in the Omineca Region, British Columbia. Currently under review.

4. GREAT Award application. Wolf Ecology. Graduate applicant: Adrian Walton.

APPENDIX 10. Administration Statistics For The Omineca Northern Caribou Project

Start date:	November 1998
Initiated preliminary data:	April 1999
Initiated standard data:	June 1999
Expected data termination:	June 2002
Expected completion date:	March 2003

Table 2. Study statistics associated with the Omineca Northern Caribou Project located in north-central British Columbia, 1999.

Area inventoried:	2,550,000 ha.
Caribou herds monitored:	3
Caribou monitored:	94
Moose monitored:	43
Wolves monitored:	18
Animal locations recorded (VHF):	3,289
Animal locations recorded (GPS estimated):	15,153
Site Investigations conducted:	270
Population surveys conducted:	7
Reports (administrative):	3
Reports (informative brochures):	4
Reports (technical):	0
Extension activities:	12

Table 3. Financial statistics for the Omineca Northern Caribou Project located in north-central British Columbia, 1999.

Funding Source	Spent ($)	Employment (days)	Employee Positions	Employees
FRBC	690,119	1706	14	23
FRBC(OH)	33,000	180	3	3
EnvYT	3,000	30	1	1
MoELP	1000	5	2	2
Donohue	12,500	25	1	1
Slocan	37,000	90	4	4
	776,619	2036	25	34