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

Year 4 (2001) Inventory Results

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EXECUTIVE SUMMARY

This report summarizes the results of an inventory of the ecological factors affecting northern caribou (*Rangifer tarandus caribou*) in the Mackenzie Timber Supply Area during the year 2001. Concerns for caribou populations in general 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. The inventory is part of a comprehensive program that begins with conceptual modeling and policy direction from the Mackenzie Land and Resources Management Plan, implements recommended management through two scales of adaptive management, focuses inventory by way of model-motivated data collection, and ends with decision-based modeling techniques to re-evaluate policy direction.

The working hypothesis for this program is that the pattern of logging can alter the manner in which the predator-prey system involving moose (*Alces alces*) and wolves (*Canis lupus*) can affect adult caribou survival and juvenile recruitment and thus, the health of caribou populations. Many small cut-blocks presumably fragment caribou habitat and enhance the likelihood that predation rates on caribou will increase. Conversely, a large-patch strategy presumably concentrates moose and wolves in more localized areas, and provides opportunities for caribou to exist elsewhere with less risk of predation by wolves. The general inventory objectives of this project are to: monitor annual population characteristics of caribou, moose, and wolves; monitor movements and distribution of caribou, moose, and wolves; assess characteristics of habitats used by caribou; and determine predation rates on caribou and causes of mortality.

We observed 377 animals (361 caribou, 13 stone sheep (*Ovis dalli stonei*), 2 elk (Cervus elaphus), and 1 moose) over the three study areas during the March caribou survey. A total of 81 radio-collared caribou were located, 21 in the Akie, 28 in the Chase, and 32 in the Wolverine. All except one of the radio-collared animals were correctly classified into age/gender categories, and all except one of the collared animals were sighted. The observed ratio of caribou bulls (including juveniles) to cows was 15:27 in the Akie/Ospika, 59:76 in the Chase/Sustut, and 39:62 in the Wolverine study area. The observed ratio of calves to cows was 6:27 in the Akie/Ospika, 28:76 in the Chase/Sustut, and 19:62 in the Wolverine study area.

We observed 350 groups of caribou over seven replicate calving surveys conducted in each study area. Our observation of the greatest number of calves (n=48) occurred during the seventh survey (early July), 48 calves per 58 cows. Of 55 radio-collared cows, 47 were observed to have had calves and eight apparently never produced calves or their calves died shortly after birth and therefore were not observed. During these surveys we captured and radio-tagged 28 calves of radio-collared cows.

In 2001 we conducted 109 animal captures (83 caribou, 24 moose, and 2 wolves) to attach or replace radio-transmitters, collect physical measurements, and collect genetic samples from each animal. We monitored these animals, as well as other animals

collared in the previous year or during previous studies, for a total of 233 marked animals, 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. Of the 83 caribou captured, 28 were calves of collared cows that we fitted with ear-transmitters to facilitate an investigation of calf survivorship, cause-specific mortality, and fidelity to maternal habitat use patterns.

A total of 6,458 focal species locations were recorded over 119 aerial telemetry flight days during 2001. Of these, 4,844 observations were of caribou, 1,348 of moose, and 266 of wolves, where 58% were radio-marked animals. There were 624 groups of caribou visually observed, ranging in size from 1 to 39 animals per group. Most groups tended to be small in number, with a median group size of four and a mean group size of 5 ± 0.2. A total of 11,745 locations were collected and downloaded from seven moose and 16 caribou collared with Global Positioning System automated data recorders. A further 10,000 locations during 2001 are estimated to be available from GPS collars that have yet to be retrieved.

Habitat sites were investigated to provide an assessment of seasonal habitat preferences, to refine habitat descriptions, and to assist in verifying Terrestrial Ecosystem Mapping conducted in the area. There were 146 individual sites sampled, most of which were visited multiple times, for a total of 600 site investigations within the three study areas. Of the individual sites, 10 were based on mortality sites, 134 were seasonal habitat preference plots, of which 126 were sampled during the summer for complete vegetation and soil data, and two plots were initially intended for seasonal comparison, but for various reasons were only used to characterize habitat used by caribou.

Mortality sites (n = 53) were investigated to provide information on causes, timing, and location of mortalities. While the causes of death were difficult to determine, we concluded that of the 27 moose mortalities, four were killed by hunters, six by wolves, one by a bear, one by an unknown predator, one by an avalanche, two died of starvation or disease, and the causes of death for the remaining 12 moose were unknown. Out of 23 caribou mortalities investigated, we were able to determine that four were killed by wolves, one by a bear, three by unknown predators, two calves died of infection caused by *Pasturella multocida*, and we were unable to determine the cause of death for the remaining 13 caribou. One unmarked elk died of unknown causes, and a hunter shot one radio-collared wolf. In total, 36 out of the 54 mortalities (67%) were radio-collared animals.

Six Resources Inventory Committee Wildlife Sighting Forms (used for observations of threatened or endangered species) were completed during the 2001 inventory year for observations of two wolverines and four grizzly bears.

We make several recommendations regarding changes to methods for 2002 and have some general, anecdotal observations about how our data relate to the major working hypothesis for this inventory project.

This Resource Inventory Project, largely funded through Forest Renewal B.C. and initiated in November of 1998, generated 13.98 person-years of employment during

2001 at an average cost of $102,468 per person-year (assuming 200 days per person-year). Twenty-three different employees were directly employed (i.e., not counting collaborations) in 21 different employment positions or roles. The inventory was conducted over three million hectares of land and involved a total of 311 animals fitted with radio transmitters. New information derived from this inventory is partially described by 28,203 site-specific animal locations ($50/location), 653 site investigations, seven calf survival surveys, and surveys of caribou populations.

ACKNOWLEDGEMENTS

Forest Renewal B.C. provided the majority of the funding for this Resource Inventory Project. The project was designed and developed by Scott McNay (Slocan Forest Products, Ltd., Wolverine and Akie study areas) with collaborative support from Wayne Lewis (Abitibi Consolidated, 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 Water, Land and Air Protection staff members Doug Heard, Glen Watts, Jim Tuck, and Doug Wilson regularly supported this project through advice, funding, and in-kind contributions. Tanya Barrett assisted with spatial data capture. Line Giguere and Kathi Zimmerman provided day-to-day leadership and direction on logistics of data collection and data capture to all field crews including Pam Hengeveld, Glen Keddie, Karin Schmidt, Shannon Walshe, and Landon Wilson. The management model resulting from this program (reported elsewhere) was a collaborative effort among Slocan Forest Products, Abitibi Consolidated, Canadian Forest Products, the Ministry of Water, Land and Air Protection, and the Ministry of Sustainable Resource Management, and includes regular support from Bill Arthur, Tanya Barrett, Annette Constable, Rick Ellis, Evelyn Hamilton, Doug Heard, Lars Hulstein, David Johnston, Wayne Lewis, Rob McCann, Scott McNay, Bruce Marcot, Brian Nyberg, Dale Seip, Randy Sulyma, Jim Tuck, Adrian Walton, Glen Watts, Mari Wood, and Kathi Zimmerman.

Animal captures were conducted by Greg Altoft, Grant Lortie, Gord Carl (Altoft Helicopters Services), and Glen Watts (Ministry of Water, Land and Air Protection), with assistance from Landon Wilson, Glen Keddie, Line Giguere, Shannon Walshe, and Scott McNay. Flights were provided by pilots Greg Altoft, Grant Luck, Westley Luck, Keith Connors, Leif Scott, and Larry Frey. Several caribou were collared in the Valleau Creek area by both Industrial Forestry Service, Ltd. and the Omineca Northern Caribou Project, and data collection involving these animals was conducted by, and data were shared between, the two projects.

Our website (http://www.nfrep.org/content/default.asp?NavBarID=12&SideBarID=37) was maintained and edited by Herschel Boydston, Linda Kolisnek and Butch Arocena at the Northern Forest Research and Extension Partnership.

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INTRODUCTION

General Background

Woodland caribou (*Rangifer tarandus caribou*) in British Columbia (B.C.) are classified into mountain, northern, and boreal ecotypes based on behavioural and ecological characteristics (Heard and Vagt 1998). In B.C., mountain caribou are considered to be an endangered species (i.e., facing imminent extinction or extirpation) due to past declines in distribution and abundance, and are listed federally by COSEWIC (2000) as threatened (i.e., will become endangered if limiting factors are not reversed). This mountain ecotype currently has an estimated 2300-2500 animals, distributed across 13 spatially distinct sub-populations (Heard and Vagt 1998, 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 B.C. The extent to which each of these factors is independently responsible for the decline of mountain caribou, and the magnitude and spatial 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 (Bergerud and Elliot 1986, Seip 1989, Seip and Cichowski 1994). Apparently, increased moose (*Alces alces*) populations, which are believed to be correlated with forest development or harvesting, have supported increased wolf numbers, resulting in higher predation on caribou (Seip 1992). The ensuing debate on these issues and the apparent high risk of eliminating some sub-populations of mountain caribou has led to a 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 caribou populations are supported in B.C. Government's strategic and higher-level plans and by a draft recovery plan for mountain caribou populations (e.g., CCLUP 1998; MLRMP 2000; MCTAC. in prep.), which 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 peat land 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 Territory, research has 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 more abundant in B.C., currently estimated at approximately 16,000 animals (Heard and Vagt 1998). However, the federal listing of caribou as threatened (COSEWIC 2000) applies to the entire Southern Mountain population, including 13 herds of the northern caribou ecotype. Northern caribou occur in the mountainous western and northern parts of the province, wintering in mature low elevation lodgepole pine (*Pinus contorta*) or black spruce (*Picea mariana*) forests or high wind-swept slopes, and feeding primarily on terrestrial lichens (Heard and Vagt 1998). Much of the Mackenzie Timber Supply Area (TSA) is considered to be high- to medium-value caribou habitat (http://wlapwww.gov.bc.ca/nor/mackenzie/index.html). Concerns exist that northern caribou populations could become exposed to similar conditions that caused the decline of mountain caribou.

Heard and Vagt (1998) recognised 28 distinct herds of northern caribou, 10 of which at least partially reside in the Mackenzie TSA. Population data for these herds are listed in Table 1.

Table 1. Estimated population sizes and population status for northern caribou herds that reside at least partially in the Mackenzie Timber Supply Area in north-central British Columbia.

Herd	Population Size	Population Status	Authority
Frog	400	Unknown	Heard and Vagt 1998
Gataga	400	Unknown	Heard and Vagt 1998
Muskwa	Unknown	Unknown	
Finlay	Unknown	Unknown	
Pink Mountain	Unknown	Unknown	
Chase	700	Unknown	Cichowski In Prep., Wood 1996
Graham	300	Declining	Cichowski In Prep.
Wolverine	400	Unknown	Cichowski In Prep.
Moberly	190	Unknown	Cichowski In Prep.
Kennedy Siding	100	Unknown	Cichowski In Prep.

Summary of Previous Studies

Most information about caribou in B.C. has been summarized by Stevenson (1991), Seip and Cichowski (1996), Heard and Vagt (1998), Hatter (1999), and Gray (1999). Page (1988) and Stevenson and Hatler (1985) provided a summary of research projects on caribou in B.C. Terry and Wood (1999) and Wood and Terry (1999) 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 herd using the Wolverine and Chase Ranges. Johnson (2000) investigated Woodland caribou herds from the Takla Range (west of the Klawli area in the Mackenzie TSA), and from the Wolverine Range, to enhance the understanding of the movements of northern caribou. Poole *et al.* (2000) investigated the distribution, movements, and habitat selection of two 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 what is now the Ministry of Water, Land and Air Protection (MWLAP), 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 Williston Reservoir in the Graham River drainage (Murray 1992, Backmeyer 1994).

Wood and Terry (1999b) and Johnson (2000) have provided significant understanding about the seasonal movement characteristics and habitat use patterns of caribou in the Wolverine herd. As a result, we have a good understanding about the spatial distribution of this herd. Johnson (2000) has also contributed to the understanding of the attributes of feeding sites, the influence of correlated movements, cover type and predation risk on small-scale movements, and the influence of cover type, predation risk, energetic cost, and land configuration on large-scale movements.

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 composition and distribution of individual herds. Hatler (1989) conducted an aerial survey of caribou in the Wolverine Range. Hatler (1990) also completed one of the first comprehensive investigations of ungulates in north-central B.C.; 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). Terry and Wood (1999) and Wood and Terry (1999) conducted similar surveys in the area we call the Wolverine, and in the Chase/Sustut study area (Appendix 1). Caribou in the Valleau Creek drainage (southwest end of the Wolverine study area) are currently being monitored pre- and post-harvesting to assess the local caribou's response to disturbance (Lance 2000).

Generally, 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 behaviour over the past few decades has been that they occur at low density to avoid predators (Bergerud and Page 1987, Seip 1989, Brown 1994) and possibly to avoid impacting the sustainability of their slow growing forage supply (Bloomfield 1980). Based on these generally accepted facts, a "large patch" habitat management strategy is often recommended for caribou habitat (e.g., Racey *et al.* 1991, Seip 1998). This strategy attempts to minimize interactions between caribou, moose, and wolves by the creation of large habitat patches, (400 – 5000 ha cut blocks and equally large patches of leave areas), where caribou are less susceptible to predation. This strategy is thought to minimize human-caused habitat fragmentation by more closely mimicking natural disturbance patterns. In the Mackenzie TSA, large stand-replacing fires have historically shaped the ecological processes and habitat patterns including those basic to the sustainability of northern caribou. The Mackenzie LRMP has promoted this principle of large-patch management through the Caribou Management Strategy (http://www.luco.gov.bc.ca/lrmp/mackenzi/index.htm)

Inventory Rationale, Goals, and Working Hypotheses

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). Most inventories were not directly comparable in either a temporal or a spatial sense and some inventories lacked appropriate methods to estimate parameters. Also, the relative importance of ecological factors in determining caribou population status remains unclear because few mechanistic tests of habitat requirements were conducted as part of these past investigations (the exception being Johnson 2000). Although the large-patch management strategy adopted by the Mackenzie LRMP appears to be logical, it has not been thoroughly assessed, and the ecological significance of the overlap between caribou and moose for the caribou herds in this area remains unclear. Finally, other site-specific management strategies adopted by the Mackenzie LRMP (e.g., protection of calving areas and maintenance of pine-lichen winter ranges) remain without clear operational direction.

As a commitment to strategic forest renewal in B.C. and as an aid to implementation of the Mackenzie LRMP, Slocan Forest Products, Ltd. (Slocan) and Abitibi Consolidated, Inc. (Abitibi) constructed a project to further improve the effectiveness of caribou management under the working hypothesis that the pattern of logging (i.e., small versus large patches) can affect the overall sustainability of northern caribou. The Omineca Northern Caribou Project (ONCP) was initiated with the following goals:

- Implementation of an inventory program to gather basic information on the primary ecological factors affecting northern caribou, including those that characterize specific management actions associated with adaptive management activities

- Development of strategic policy (through participation in the Mackenzie LRMP) for the management of caribou habitat;

- Adaptive management of caribou habitat at two spatial scales: landscape-level management (i.e., large-patches) and forest stand-level management for retention of terrestrial lichens in pine-lichen winter ranges.

- Development of a Caribou Management Model to ensure management activities are set within the context of potentially cumulative effects associated with forest development, recreational snowmobiling, predation, and hunting.

The policy, adaptive management, and Caribou Management Model are related projects and the time-lines for activities on these general project components, as well as the inventory component, are provided in Table 2.

Table 2. Planned time-line, years 1998 to 2003, for activities on each general component (policy, adaptive management, inventory, and management model) of the Omineca Northern Caribou Project.

Year	Season[a]	Policy	Adaptive Management		Inventory		Manage-ment Model[f]
			FDP[b]	Lichens[c]	Mapping[d]	Animal	
1998 Year 1	LW						
	S/C						
	S						
	A/R						
	EW					Prep	
1999 Year 2	LW					Prep	
	S/C						
	S						
	A/R						
	EW	LRMP					
2000 Year 3	LW		2000-2005		TEM	Data 1	
	S/C						
	S						
	A/R						
	EW						
2001 Year 4	LW		2001-2006	AM Plan		Data 2	Klawli
	S/C				PEM		
	S						
	A/R						
	EW						Herd 1
2002 Year 5	LW		2002-2007	Trials 1-3		Data 3	Herd 2
	S/C						
	S						
	A/R	Policy Rev					Herd 3
	EW						
2003 Year 6	LW		2003-2008	Trial 4		Data Org	Model Tests
	S/C						
	S						
	A/R						
	EW						
	LW			Trial 5	VRI		Model Tests

a – where seasons are LW - late-winter (Feb – Apr), S/C - spring/calving (May – Jun), S - summer (Jul–Aug), A/R - autumn/rut (Sep – Oct), and EW - early-winter (Nov – Jan);
b – where FDP is Forest Development Plans;
c – where Lichens refers to an independent adaptive management project to retain terrestrial lichens in pine-lichen winter ranges;
d – where Mapping refers to a series of independent habitat mapping projects over the Mackenzie Timber Supply Area (TEM = Terrestrial Ecosystem Mapping; PEM = Predictive Ecosystem Mapping; and VRI = Vegetation Resources Inventory).
e – where Animals refers to this inventory project.
f - where Management Model refers to an independent project involving the development of decision-based modeling for the management of caribou populations in the Mackenzie Timber Supply Area.

The inventory program reported here had 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 Interpretations, 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 focused on the following ecological factors:

- Population structure of caribou and moose (general distribution, relative abundance, gender/age structure);
- Habitat use patterns of caribou and moose (including seasonal movements and potential for overlap between the two species); and
- Predation effects by wolves (population characteristics, movement patterns, and kill frequencies).

Specific Inventory Objectives

Annual Population Characteristics of Caribou, Moose, and Wolves

1) We conducted population censuses to:

   a) Estimate caribou population composition and abundance;

   b) Determine calf production by female caribou (primarily that of our collared population); and

   c) Estimate juvenile caribou recruitment.

Movements and Distribution of Caribou, Moose, and Wolves

2) We fitted radio-transmitters to caribou, moose, and wolves, and monitored their movements and distribution to:

   a) Identify migration routes used by caribou throughout the year;

   b) Test for fidelity of caribou to calving areas;

c) Characterize temporal and spatial patterns of habitat use (particularly fidelity to seasonal movement behaviours); and

d) Examine temporal and spatial population overlap between caribou, moose, and wolves.

Characteristics of Habitats Used by Caribou

3) We monitored radio-marked caribou and conducted habitat and mortality site investigations to:

    a) Obtain information on habitat characteristics that would otherwise not be available from map-based datasets;

    b) Test for differences among habitats used by select radio-collared caribou cows through three seasons of use - early-winter, late-winter, and spring/calving;

    c) Characterize mortality sites of caribou, moose, and wolves; and

    d) Provide field data to test veracity of Predictive Ecosystem Mapping procedures (Resources Inventory Committee 2000).

Predation Rates and Causes

4) We monitored radio-marked animals and conducted mortality site investigations to:

    a) Estimate survival rates; and

    b) Determine mortality causes.

5) We ear-tagged calves of radio-collared caribou cows to:

    a) Estimate post-natal survival; and

    b) Determine causes of post-natal mortality.

Weather Monitoring

6) We established weather monitoring stations at select locations throughout the three study areas to:

    a) Test for correlations between snow characteristics and habitat use patterns over time within and between years.

    b) Test for correlations between temperatures and habitat use patterns over time within and between years.

STUDY AREAS

Our inventory occurred 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 three study areas, Akie/Ospika, Chase/Sustut, and Wolverine are generally equivalent to caribou herd areas depicted by the MWLAP http://wlapwww.gov.bc.ca/nor/mackenzie/index.htmland cover approximately 25,503 km^2; these herds are more commonly known as the Pink Mountain, Finlay, Chase, and Wolverine herds (Table 1). Study area boundaries are displayed in Appendix 1 (Map A1), and map sheet numbers for the study areas are provided in Appendix 2. These study areas consist of a matrix of managed and natural stands that are part of eight biogeoclimatic units within the Skeena and Omineca Mountains Ecoregions (Table 3).

Generally, all three 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 (ESSF) and Spruce-Willow-Birch (SWB) 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 (B.C. Ministries 1995). By comparison, the Boreal White and Black Spruce (BWBS) and Sub-boreal Spruce zones (SBS) are characterized as ecosystems with frequent stand-initiating events, with wildfires reaching sizes of tens of thousands of hectares and a mean return interval of approximately 125 years. The resulting landscape is a mosaic of even-aged stands of different ages (B.C. Ministries 1995).

The Akie/Ospika Study Area

The Akie/Ospika study area encompasses an area of approximately 10,252 square kilometers, and 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 the Ospika Arm of the Williston Reservoir, and in the east by the Rocky Mountains. 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 broad elevation range. It contains several large drainages including the Kwadacha, Akie, and Ospika Rivers. The Akie/Ospika study area has comparatively fewer management activities than either the Chase/Sustut or the Wolverine study areas due, in part, to its more northerly position within the Mackenzie TSA and its distance from any primary forest processing facility such as those in the town of Mackenzie. At low- to mid-elevations, the Akie/Ospika study area is dominated by the BWBS dry cool Stikine variant (BWBSdk1), while at mid- to high-elevations the ESSF moist very cold Graham (ESSFmv4) and the SWB moist cool (SWBmk) variants predominate. The Williston Reservoir shoreline and the lower Ospika River valley bottom are dominated by the SBS moist cool Williston variant (SBSmk2). The Alpine Tundra parkland (ATp) prevails above the tree line.

Table 3. 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)	Elevation Range (m a.s.l.)	Biogeoclimatic Units[a]	Landscape Units[b]
Akie/Ospika	57°47'09'' to 56°11'31"	123°46'43" to 125°36'10"	10,252	750 to 2850	SBSmk2 SBSwk2 BWBSdk1 SWBmk ESSFmv4 ATp	Collins Lower Ospika Upper Ospika Davis Chowika Pesika Lower Akie Paul Kwadacha
Chase/Sustut	56°57'49" to 55°48'45"	126°34'00" to 124°30'22"	9,628	750 to 2250	SBSwk2 SBSmk2 SWBmk BWBSdk1 ESSFmv3 ESSFmv4 ATp	Upper Osilinka Lower Osilinka Tenakihi Mesilinka Factor Ross Carina Tomias Swannell Aiken Upper Ingenika Lower Ingenika Thutade
Wolverine	56°06'34" to 55°11'12"	123°32'36" to 125°17'53"	5,623	750 to 1950	BWBSdk1 SBSmk1 SBSmk2 SBSwk2 ESSFmv2 ESSFmv3 ATp	Manson Klawli Germansen Wolverine Upper Omineca Lower Omineca Discovery Strandburg

a - see Appendix 5f for biogeoclimatic unit code definitions
b - see unpublished Landscape Unit maps at:
http://wlapwww.gov.bc.ca/nor/mackenzie/index.html

The Akie study area contains a caribou herd of approximately 200-500 animals (Table 1). These caribou have been known to migrate as far as 110 km between seasonal ranges. For example, caribou that were collared along the mid Akie River have traveled as far east as Chicken Creek, about 12 km west of the Alaska Highway (Hwy 97). In early- to mid-May, animals that migrate begin moving from late-winter habitats to summer areas around the upper Ospika to the mid Akie River area. In early-November these animals move from summer and rut ranges to early-winter ranges, which consist of the low-lying areas around Trimble Lake. In early-December to early-January they move from this early-winter range to late-winter range on the Rocky Mountain Foothills where they join herds of up to 100 caribou. These large herds are often referred to the Pink Herds as they reside in the Pink Mountain area. In late-winter the migratory animals proceed eastward to the general area east of Trimble Lake, up to 52 km outside of the study area, as we have defined it. This late-winter range has consistently lower snow depths, likely providing better forage opportunities. In early May the migration cycle continues when the caribou travel back to their calving and summer ranges.

Some caribou exhibit a more resident, rather than migratory, behaviour. These resident caribou generally have seasonal movements no further than 15 km. When this behaviour occurs, the caribou can be found in areas such as the mid-Kwadacha and lower Akie River, along with the mountains that make up the Deserters Range.

The Chase/Sustut Study Area

The Chase/Sustut study area encompasses an area of approximately 9,700 square kilometers including the Mesilinka, Osilinka, Swannell and Ingenika river drainages. The area is situated in steep, mountainous terrain and contains multiple watersheds and mountain ranges. The study area encompasses 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. This area has moderate management activities relative to the Akie/Ospika and Wolverine study areas, with a significant portion of the area unmanaged. At low- to mid-elevations, the area is dominated by the BWBSdk1 and the SBSmk2, at mid- to high-elevations the ESSF Omineca variant (ESSFmv3) predominates. The ATp prevails above tree line.

The Chase/Sustut caribou herd consists of approximately 700 animals (Table 1). Their range extends to the Butler Mountains in the east and as far as the upper Sustut River in the west . Some caribou migrate relatively long distances (20-90$^+$ km) between seasons. In early- to mid-May, the animals that migrate begin moving from their late-winter habitats on Chase Mountain and/or the Butler Range (and Carrina / Tomias lakes between these mountains) to their calving and summer ranges around Sustut Lake and Carruthers Creek (one collared animal travels as far west as Bear Lake). In early-November these animals move back to their early-winter ranges in the Upper Swannell River and Wrede Creek drainages. In early- to late-December, they move again from these early-winter ranges, east to their late-winter ranges. Some of these animals have been known to use habitats in late-winter as far north as Isola Creek.

Some caribou in this herd move very little throughout the year and have been described as residents (as opposed to migratory.) These resident caribou are found throughout the eastern half of the study area, specifically within the Butler, Chase, Lay, and Tenakihi mountain ranges. Within seasons, movements for both migratory and resident animals are generally less than 10km.

The Wolverine Study Area

The Wolverine study area encompasses an area of approximately 5,623 square kilometers surrounding the Wolverine Mountain range, situated in rolling high-elevation foothills. 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, and in the east by the eastern slopes of the Wolverine Mountain Range. Of the three study areas, the Wolverine is the least mountainous with the smallest elevation range. 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, SBSmk1 and SBSmk2 variants, and the ESSFmv3 dominates the mid- to high-elevations. The ATp prevails above tree line.

The Wolverine caribou herd consists of 400 animals (Table 1), whose range encompasses the Wolverine mountains alongside Williston Reservoir, west to the Valleau drainage and the Kwanika (Kwun Yotasi) Range. Some Wolverine caribou migrate relatively long distances (80 km) between seasons. These migratory animals move in early May to mid June from late-winter habitats in the Blue Lake, Jackfish Creek, Slate Creek, and Germansen Lake area to calving areas around Valleau Creek, Mt. Nation, and Ahdatay Lake. In early-November 2000 they moved from summer and rut habitats to early-winter ranges on the Squawfish Plateau, and in early-December to early-January they moved north to the Manson River/Slate Creek area. However, in 2001 they began their move to the Squawfish plateau in late-October, staying in the area for about three weeks. Half of these caribou then continued to travel north to their early-winter range in the Blue Lake/Jackfish Creek area and the other half migrated to the west Germansen Lake area. Late-winter is generally spent on the Germansen and/or Wolverine Range, as well as the Slate Creek, Blue Lake, and Jackfish Creek area. Within seasons, movements are generally shorter, usually 0.5-10 km. The Valleau area serves as a traditional calving area, as well as summer range and a rutting area.

Some of the Wolverine caribou can also exhibit a more resident behaviour at times. One group of caribou spent most of the year on the south end of the Wolverine Range in 1999. However, in 2000 this group traveled down to the Squawfish Lake area in early-winter, covering distances of 10 to 30 km. In 2001 this group again traveled south to the Squawfish Lake area, however they moved back north to the Jackfish Creek area in a relatively short period of time, covering 15-30 km. We have one caribou that spends the whole year in the middle of the Wolverine Range and travels no further than 5-10 km. Another group is resident in the mountains surrounding Flegel Creek and Nina Lake. These caribou tend to travel 10-30 km from Nina Lake to Wasi Lake, north of the Osilinka River, and to the north end of the Wolverine Range.

METHODS

To address the specific inventory goals and objectives, we implemented four general techniques for data collection (specific methods are discussed below):

- Population surveys of caribou and caribou calves (objectives 1a-c, 4a, 5a);
- Remote monitoring of sample animals including capture of caribou, moose, and wolves with subsequent relocations by either VHF (Very High Frequency) telemetry and/or GPS (Global Positioning System) telemetry (objectives 1b-c, 2a-d, 4a, 5a);
- Investigation of sites including: those used by sample animals, those at which mortalities occurred, and those necessary to test ecosystem mapping (objectives 3a-d, 4b, 5b); and
- Monitoring weather conditions (objective 6a-b).

Data were collected over the year in 25 work sessions or 2-week work periods. The calendar year was stratified into five seasons based on environmental attributes, on caribou behaviour, and with an attempt to obtain relatively equal sample sizes among seasons: late-winter (February, March, April); spring/calving (May, June); summer (July, August); fall/rut (September, October); and early-winter (November, December, January) (Appendix 3). This report includes all data collected between early-winter 2000 and early-winter 2001 (Nov. 5, 2000 – Nov. 3, 2001). Throughout the early- and late-winter seasons, three crews conducted "intensive" field investigations with one crew in each study area completing a full sample of data collection in each work session. Data collection during intensive field investigations included: radio-collared animal relocations by aerial telemetry; mortality and habitat site investigations; weather station monitoring; as well as a caribou population composition survey. During the spring/calving season, the same intensive field investigations were conducted with a reduced telemetry schedule. Mortality and habitat site investigations, and weather station monitoring during this time were coordinated with calving surveys. Over the summer season two crew members conducted vegetation sampling of sites used by caribou in the early-winter, late-winter and spring seasons, occasional mortality investigations and a few telemetry flights. During the fall/rut season, one crew circulated among the three study areas each work session to conduct aerial telemetry surveys and occasional mortality investigations.

All data were recorded on forms (Appendix 4) developed in accordance with Resources Inventory Committee (RIC) standards (RIC 1997b, c, 1998b,c,d,e). Data were entered into spreadsheets and digital data quality assurance was conducted by cross-referencing 100% of the data files against the original forms. A general description of each survey type completed as a part of this inventory project, including the target taxa, survey crews, and objectives, is provided in Appendices 5a-e.

Population Surveys

Caribou Survey

We conducted a caribou population composition survey in all three study areas using a Bell 206B Jet Ranger helicopter. The survey occurred over four days between Mar. 30 and Apr. 5. Although time spent conducting the survey wasn't a determinant factor, we used approximately 17 hours of flight time, including the distance between study areas and the distance between groups of animals surveyed. Flights were conducted only in appropriate weather (not less than 10 km visibility) to ensure optimal conditions for sighting and classifying animals. We classified individuals according to the level two RIC classification standards (RIC 1997b, 1998b, c, d). We were unable to use level three classifications because most mature bulls had likely lost their antlers by the time of the survey.

A census of northern caribou is typically conducted when the majority of the population has moved up to open, high-elevation, alpine or subalpine habitats, where they are more concentrated and visible. The timing of this movement is unpredictable, and, in most of the recent years, has only occurred for short periods, making census ineffective. Therefore we decided to modify the linear encounter transect method (RIC 1997b, 1998b, c, d) to a point count method focused on counting and classifying caribou observed with or near radio-collared individuals. This method was chosen because it would provide results regardless of whether caribou were located in open habitats or mature forested stands.

For each study area the area biologist located all radio-collared caribou using aerial telemetry from a Cessna 206 fixed-wing aircraft on the day prior to the survey to expedite the location of these animals with the helicopter on the following day, and thereby minimize search-time costs. The survey crew consisted of the navigator (the field biologist of the study area being surveyed), seated in front with the pilot and two observers in the rear seats. The pilot and the two observers were unaware of the number of animals radio-collared in each group, or their age and gender class, and were thereby tested for classification and count accuracy. During the survey, the navigator re-located the marked individuals, and the number of caribou within the group were classified and enumerated by the crew.

The navigator directed the pilot towards the general destination of each marked animal. The pilot flew at a cruise speed of approximately 80 knots and upon reaching the general destination reduced the speed to 20-30 knots. While the observers and pilot were able to hear the VHF signal received from the radio-collared individual over the intercom system, they were not familiar with the area used by these animals and did not know how many marked animals were present in the group.

The number of individuals within a group (where a group was considered to be any observation of one or more caribou) was estimated from approximately 150m above ground to avoid dispersing the group. Groups were considered separate if they were at least 150m apart, occurred in different habitats, or displayed different group characteristics or behaviours. The helicopter was then lowered to 15-20m above ground or treetops (if area is forested) in order to classify individuals into age (adult or calf) and gender categories. For each observation the navigator recorded the following information: study area; crew names and there position; session number, date and time;

general location; general weather conditions; spatial co-ordinates in the Universal Transverse Mercator (UTM) system obtained from the on-board GPS unit; marking descriptions (e.g., collar vs. ear transmitter, colour of the transmitter/belt, ear-tag colour); approximate sinking depth in snow; VHF frequency number for each marked animal; and the success of the classification and the count. One observer recorded the detailed count and classifications for each group of animals observed, including: species; total number of animals; gender and age class; and presence/absence of antlers. The second observer recorded slope, aspect (when possible), elevation, habitat type, and percent cover by forest type. Complete survey information was also recorded for groups encountered that did not have a radio-collared caribou in the group, or for other wildlife species observed. For details and categorical codes see Appendices 4a, b, and c.

Caribou Calf Survey

We conducted aerial calf surveys in the Wolverine, Chase/Sustut, and Akie/Ospika study areas using a Bell 206B Jet Ranger helicopter. The final survey in the Akie/Ospika study area was conducted from a fixed-wing aircraft. The seven replicate surveys in each study area occurred 6-9 days apart between May 22 and Jul. 6, for a total of approximately 125 hours of elapsed time over 20 survey days. Most effort was concentrated on those areas inhabited by radio-collared female caribou.

For each adult female (marked or unmarked) encountered, we recorded the following information: session number, date and time; weather conditions at the start and end of the flight; animal ID# and VHF frequency of radio-collared caribou; group number; total animals in the group; number of animals by gender and age class; activity class; visual location code; spatial UTM coordinates; habitat type; estimate of animal sinking depth in snow; estimate of snow depth; identification of other marked animals in the vicinity; a photo of the site; and identification of the general location by name. For all caribou cows we also recorded the presence/absence of a new calf or juvenile from last year, and whether she had antlers and/or an enlarged udder. For details and categorical codes see Appendix 4d. In addition, we recorded the weather conditions every hour during each survey flight (Appendix 4g). Several calves of radio-collared cows were captured during the surveys and radio-tagged using methods described in the following Capture/Handling section.

Remote Monitoring of Sample Animals

Capture/Handling

Caribou and moose were captured using standardized net-gun techniques (RIC 1997c). Wolves were also captured using a net-gun, then were immediately administered immobilization drugs for the safety of the capturing crew. Immobilization and handling were also performed according to standardized techniques. For each animal caught we recorded: session number, date and time; surveyors name's; spatial UTM coordinates of the capture and a description of the general location; species; age class; gender; physical measurements including chest girth, neck size, total length, shoulder height, hind foot length, body mass for calves, front pad length and width for wolves; tooth wear; pelage condition (scarring and colour for wolves); and, for adult females; reproductive condition; presence and age of young; vulva condition; and evidence of nursing. The group size, presence of other marked animals and presence of antlers were also recorded. We collected samples of blood, hair, and skin, and for caribou calves we recorded body mass (kg). For further details and categorical codes of variables recorded during a capture see Appendix 4e. Adult caribou and moose were equipped with either a VHF radio-collar (Lotek Engineering, New Market, Ontario, Canada or Telemetry Solutions, Concord, California, USA), or a GPS collar equipped with a VHF beacon (Televilt International, Lindesberg, Sweden). Wolves were only equipped with VHF radio-collars from Lotek, and caribou calves where fitted with ear-tag transmitters from Televilt. All animals captured were also fitted with a numbered yellow ear-tag.

The use of both GPS and VHF collars and the ratio of these two types of collars was designed to address the following objectives:

1) Utilize the effectiveness, efficiency and location precision of GPS collars (i.e., obtain samples at night, obtain large sample sizes for an individual animal, and obtain samples with higher precision);

2) Provide reasonable statistical power, important for both estimates of habitat use and survival at the level of the individual by using a large number of VHF collars;

3) Provide a scalar approach to our investigation of habitat selection patterns (i.e. a large number of VHF-collared animals were followed weekly while GPS-collared animals were located up to four times daily);

4) Assess the influence of bias known to occur with GPS collars by locating these animals using both GPS and VHF methods (e.g. locations may not be acquired when animals are under dense forest canopy);

5) Obtain position data from both males and females, broadly distributed across the study areas 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.

The number of animals required to be captured and radio-marked was determined by comparing the number of active collars at the beginning of the year against the target sample sizes set for each study area. The target number of radio-marked animals was adjusted from previous years to the following:

- For each study area we set a target of having seven caribou (two males and five females) outfitted with GPS collars, 15 caribou (six males and nine females) with VHF collars, and as many one-year-old juveniles (already marked with an ear-transmitter) with expandable VHF collars, and calves with ear-tag transmitters, as possible.

- For moose we set a target of having two individuals (one of each gender) outfitted with GPS collars, and 12 individuals (six of each gender) outfitted with VHF collars; and

- For wolves we set a target of having as many VHF collars as possible given time and resources available.

The total number of animals targeted for capture (or recapture) to meet the sample sizes intended for the three study areas in 2001 was determined to be 76 (Table 4).

VHF Telemetry

Most telemetry surveys were conducted from a Cessna 185 or Cessna 206 fixed-wing aircraft to determine locations of radio-collared animals, however, some animal locations were obtained during other surveys using a Bell 206 B Jet Ranger helicopter. We used methods consistent with those used for the caribou calf surveys, however, we did not record information about the antler or udder condition of female caribou (Appendix 4f and 4g). During the early winter, late winter, and the first session of the spring/calving seasons, on average there were two, 4-hour telemetry flights in each study area per work session with flights separated by several days. This temporal distribution of samples was intended to increase the probability of detecting and locating mortality sites shortly after they occurred. For the remainder of the spring/calving and the fall/rut seasons we conducted one, 7-hour telemetry flight in each study area per work session, and in the summer season we conducted two 7-hour telemetry flights.

Table 4. Number of animals required to be captured and fitted with radio transmitters to meet the target number of samples per study area (in brackets) for 2001, summarized by age class, gender, species, and radio transmitter type.

Study Area	Age Class	Gender	Species: Moose GPS Collar	Moose VHF Collar	Caribou GPS Collar	Caribou VHF Collar	Caribou VHF Expandable	Caribou VHF Eartag *	Wolf VHF Collar	Total
Wolverine	Adult	Male	0(1)	1(6)	0(2)	3(6)	-	-	*	**4(15)**
		Female	0(1)	2(6)	0(5)	0(9)	-	-	*	**2(21)**
	Calf	Male	-	-	-	-	3(3)	7(7)	-	**10(10)**
		Female	-	-	-	-	2(3)	7(7)	-	**9(10)**
Subtotal			**0(2)**	**3(12)**	**0(7)**	**3(15)**	**5(6)**	**14(14)**	*	**25(56)**
Chase/ Sustut	Adult	Male	0(1)	1(6)	0(2)	4(6)	-	-	*	**5(15)**
		Female	0(1)	0(6)	1(5)	0(9)	-	-	*	**1(21)**
	Calf	Male	-	-	-	-	3(3)	7(7)	-	**10(10)**
		Female	-	-	-	-	3(3)	7(7)	-	**10(10)**
Subtotal			**0(2)**	**1(12)**	**1(7)**	**4(15)**	**6(6)**	**14(14)**	*	**26(56)**
Akie/ Ospika	Adult	Male	0(1)	3(6)	1(2)	3(6)	-	-	*	**7(15)**
		Female	0(1)	0(6)	2(5)	2(9)	-	-	*	**4(21)**
	Calf	Male	-	-	-	-	-	7(7)	-	**7(7)**
		Female	-	-	-	-	-	7(7)	-	**7(7)**
Subtotal			**0(2)**	**3(12)**	**3(7)**	**5(15)**	**-**	**14(14)**	*	**25(50)**
TOTAL			**0(6)**	**7(36)**	**4(21)**	**12(45)**	**11(12)**	**42(42)**	*	**76(162)**

- = Not Applicable,
* = Opportunistic captures - as many as time and circumstances will allow

We collected a GPS location for each VHF telemetry position using the aviation GPS unit that the aircraft was equipped with. Even though the accuracy of the undifferentiated GPS locations (from an on-board GPS unit) has improved since selective availability (the artificial degradation of GPS satellite signal imposed by the United States' Department of Defense) was turned off in May 2000, this in addition to other sources of error leads us to estimate location accuracy as the following:

- Visual – 100-m radius;
- Fix – 200-m radius;
- General – 4-km radius; and
- Heard – 30-km radius.

GPS Telemetry

Collar Programming/Collar and Data Retrieval

GPS collars were programmed in 2000 to collect four locations per day (05:00, 11:00, 17:00, and 23:00 Pacific Standard Time) on Tuesdays, Thursdays, Saturdays, and Sundays, and twice per day on Mondays, Wednesdays and Fridays (11:00 and 23:00). The two different schedules were introduced to increase the life expectancy of the collar batteries by reducing the number of locations recorded per week. This increased life expectancy provided flexibility in the timing of animal recaptures, thereby allowing us to avoid captures during unfavorable conditions (e.g., deep snow and/or presence of antlers). In 2001, GPS collars were programmed according to two schedules, depending on battery pack size. Several collars with large battery packs (requiring three D-cell lithium batteries) were purchased in 2001 to allow four GPS locations each day (05:00, 11:00, 17:00, and 23:00 Pacific Standard Time) with a life expectancy of at least one year. The collars with the small battery packs (two D-cell lithium batteries) were programmed according to the same schedule used in 2000. Data were downloaded after collars were retrieved from recaptured animals or from carcasses following mortality. The resulting data files were stored for processing.

Location Data

For each location acquired and stored by a GPS collar, the information recorded included latitude, longitude, elevation, identity of each satellite used, and time. This dataset is referred to as a single point solution. Single point solutions were recorded for each location with a Position Dilution of Precision (PDOP) better than six. PDOP values are an indication of the quality of a location based on the number of satellites available to the GPS receiver and their positions in the sky relative to each other and the GPS receiver at the time a location is collected (Waypoint Consulting, Inc. 2000). This criterion of PDOP better than 6 (3-dimensional fixes) was programmed as the minimum quality to be stored to permanent memory. We processed the weekly files produced by a Televilt GPS base-station located at Slocan Forest Products' Mackenzie office (latitude 55° 17' 51.056", longitude 123° 09' 26.316", elevation 713.92m) to generate weekly raw binary GPS data (receiver computed latitude, longitude, elevation, time, and identity of each satellite used to compute the position for the base station) and ephemeris files containing weekly ephemeris data. Simply put, ephemeris data is satellite position data relative to a fixed co-ordinate or reference system, providing exact information about where any given satellite was in space and time. Base-station shutdowns or differences in the individual satellites providing data to the base-station versus the active collars, meant that we needed to download broadcast ephemeris data for a complete dataset. This was achieved using publicly accessible databases from the National Geodetic Survey network of continuously operating reference stations (CORS) website (http://www.ngs.noaa.gov/CORS/cors-data.html) and the Scripps Orbit and Permanent Array Center (SOPAC) website (http://sopac.ucsd.edu/). We then computed single point solutions by combining the raw binary GPS data from our collars with the matching, complete, ephemeris data using GrafNav 6.02 (Waypoint Consulting Inc. 2000).

Differentially Corrected Location Data

Differentially corrected solutions combine the information present in the single point solution with ephemeris data and data from a known point (base station) to gain a more accurate position. In order to evaluate the utility of correcting single point solutions in a post selective availability world for each collar, we calculated the combined difference in latitude, longitude, and elevation between 10 randomly selected single-point solutions and their corresponding corrected solution. We found a difference large enough to warrant correction. In order to obtain the highest accuracy possible, we differentially corrected as many single point solutions as possible by combining the raw binary GPS data from our GPS collars with the raw binary GPS data from our base-station and the ephemeris data using GrafNav 6.02 Lite.

Site Investigations

Assessment of Habitat Components and Testing Seasonal Habitat Preferences

To test for the significance of factors that may influence seasonal habitat preferences, we monitored sites used by adult radio-collared caribou cows during the following seasons: early-winter, late-winter, and spring/calving. Three cows were selected from each study area and monitored biweekly (e.g., if a select individual died, we resumed site monitoring of another study animal within the same geographical area and if possible, with the same behavioural type). During each session, a complete habitat comparison for each caribou included a site investigation of the most recently observed location and repeat site investigations from three locations previously used by the same animal. Each plot was, therefore, assessed every two weeks, over a total of six weeks.

Each target caribou cow was located using aerial telemetry, then the field biologist accessed the site by ground and established a 20 x 20m plot in the area containing signs of the caribou's activity. That site was then assigned a unique site reference number. For each site investigation, we recorded the site reference number and listed the data form identification numbers of any other investigations conducted at this site; the current and the initial (if applicable) session numbers and dates; surveyors names; the general location description, spatial UTM coordinates; site access description and location; target animal ID and collar frequency; and the survey during with the site was originally located. Slope and slope positions, aspect, elevation, evidence of wildlife use, canopy closure, snow depth, and vegetative browse within the plot were also recorded.

Plots were permanently marked with ribbon and site photographs were taken both on the ground and from the air to facilitate the return to these sites on subsequent visits and for vegetation sampling in the summer. The species of each tree within a prism sweep (Basal Area Factor 6 or 9) from plot centre was recorded, and trees were numbered sequentially with white spray paint so that measurements (e.g. diameter-at-breast-height, etc.) could be made during the summer assessment. Canopy closure (Bunnell 1985), snow depth and crusts, and sinking depth of the investigator were measured with a moosehorn and ruler respectively, at nine points in the plot: one at each corner; one at the midpoint of each side; and one at plot-centre. For each browsed vegetative species we estimated the percentage cover on the plot and the percentage of browse based on visual appearance, in each of three strata: 1) current - this season; 2) last season; and 3) >2 seasons ago. On the three subsequent visits to the same plot, we recorded current wildlife signs and current browse on the over- and understory vegetation; canopy closure, snow depths, crust depths, and sinking depths were re-measured at the nine established points. During the spring/calving season, plots that were snow-free were not revisited because current wildlife signs and browse were too difficult to determine in the absence of snow. If the plot had patchy snow, an estimate of percent cover of snow and estimated snow depth were recorded but the site was not revisited.

Plots were revisited between mid June to end of August to obtain information on habitat components, including vegetation composition and cover, soil and terrain descriptions, and coarse woody debris characteristics. At each plot, a complete inventory of vegetation was recorded, where all trees, shrubs, forbs, mosses, and terrestrial lichen encountered within the plot were identified to species (when possible) and percent cover of each species was recorded. The species, diameter-at-breast-height, vegetation strata (RIC 1998e), height, age class, and wildlife tree class (RIC 1998e) were recorded for all trees within the prism sweep. Canopy closure was re-measured at each of the nine established points along the plot boundary; however, where the flagging for those points was absent, canopy closure was not recorded unless it was undoubtedly zero. If patches of snow were still present, snow depth at the nine points was recorded. Current wildlife sign and browse were also measured during the summer site investigations.

Soil pits were excavated to determine the organic layer thickness, as well as the humus form represented. Where the organic layer was greater than 40 cm thick, a moisture subclass was determined. The depth and type of root restricting layer was recorded and the mineral soil texture and coarse fragment content was classified. Mineral soil drainage, moisture and nutrients were classified and used in combination with vegetation data to determine the Biogeoclimatic Zone, Subzone, Variant and Site Series (Meidinger and Pojar 1992) of the site. The structural stage and modifier of the site were also determined and any indications of natural disturbance (fire, root-rot, etc.) were recorded. Broad Ecosystem Units (BEU) for each plot and for the adjacent area within 100m were determined from a database query of the plot center location co-ordinates.

Terrain texture, surficial material, surface expression and geomorphological processes were determined for landform classification. Terrain texture refers to the size of unconsolidated material and fibre classes. Surficial material refers to the mode of formation of unconsolidated material, and surface expression refers to their form over the landscape. Geomorphological processes were recorded for sites still undergoing active processes such as avalanches or erosion.

Terrestrial lichen species within the plot were placed into three classes based on preference by caribou (Lance and Eastland 1999). The extent of lichen was classified as either greater than or less than 30 x 100m and the distribution was classified as scattered, clumped or carpet. These factors as well as the distance to adjacent wetlands or other lichen stands were used to determine overall lichen class (Lance and Eastland 1999). When the total percent cover of preferred lichen was less than 50% and the distribution was clumped, a step tally (Lance and Eastland 1999) was used to determine the lichen class. Arboreal lichen abundance was estimated using methods described by Armleder *et al.* (1992).

We recorded measurements for coarse woody debris larger than 7.5 cm diametre along two, 24 m linear transects that extended from the plot centre. One transect was established on a randomly selected bearing and the other was established 90 degrees from the first. For each piece of coarse woody debris (to a maximum of eight pieces) encountered along the transect, we identified the tree species if possible, decay class (RIC 1998e), diameter, tilt angle, and length. The height above ground of each piece, in combination with its diameter, was used to determine its potential for use as a resting spot or travel log by small mammals. Impediments to caribou movement (coarse woody debris often resulting from blow-down) were categorized as nil, minor or major and their extent within the plot was recorded as <10%, 10-25% or >25%.

For further details on each of the variables measured see Appendix 4h and 4i.

Testing Veracity of Ecosystem Mapping

Over the past 10 years there have been many efforts to characterize the Mackenzie TSA using terrestrial and predictive ecosystem mapping but with few tests of the products. The habitat site investigations conducted during this project contribute to field verification of ecosystem mapping and will be reported under separate cover.

Mortality

A mortality investigation was performed for every dead animal (marked or unmarked) located during any of the surveys conducted. Where possible, mortality sites were accessed by motorized vehicles, however most were only accessible using a Bell 206 B Jet Ranger helicopter. For each site investigated we recorded the unique site reference number, mortality data form ID number, list of data form ID numbers of any other investigations conducted at the site, surveyor's names, current date and session number, original location session number and date, general location, spatial UTM coordinates, and site access description and location, how the carcass was located, details about animals observed at site when first located, estimated snow depth and cover at the time of death; and the weather when located and when investigated. For each carcass we recorded the species, animal ID and VHF frequency for marked individuals, gender and age class, estimated date of death, probable cause of death, estimated number of predators if applicable, and other scavengers on the carcass. Extensive photo documentation and descriptive notes were taken to provide support for the date and cause of death. Where possible samples of bone, teeth, hair, muscle from ungulates, and scat from predators were collected. Internal organs, if still present, were inspected for parasites and if any were discovered then a sample was collected and sent for identification. We established and sampled habitat plots for several mortality sites investigated. See Appendix 4j for further details of the variables recorded at mortality site investigations.

Weather Monitoring

A two-tiered sampling approach was used to monitor snow conditions in the three study areas over the 2000/01 winter. The first priority was to record snow conditions over a range of elevations within a watershed representative of the study area. For each watershed, a sample station was located at the valley bottom, at the mid-slope elevation, and on the mountaintop. The second priority was to monitor snow conditions at a high- and a low-elevation station located in two areas frequently used by local caribou, for a total of four stations. Stations were established in areas with minimal influence from local topographic features (e.g. we avoided areas close to the Williston Reservoir, in steep valleys, on shaded northern slopes, etc.) and from forest cover (i.e. we selected open sites). The snow station locations are described in further detail in Appendix 6. At each station we recorded the current date and session number, the surveyor's names, snow station ID number, general location; snow descriptions, and general comments (Appendix 4k). Using a foldout ruler, we recorded the total snow depth, depth of each crust layer, and sinking depth of the data recorder at nine random locations. The shoe measurements and body mass of the data recorders were recorded separately for calculating relative sinking depth.

A temperature data logger (HoboTemp®) was installed at each of the three high-priority stations in November or December, and programmed to record the temperature every hour. Temperature sensors measured ambient air temperature over the operating range of -30°C to +50°C with an accuracy of 0.2°C at 21°C in high-resolution mode (0.4°C in standard-resolution mode). Temperatures at the extremes and outside the operating range were subject to lower accuracy (e.g. 0.6°C at -40°C). The temperature logger resolution was 0.02°C at +21°C in high-resolution mode (0.38°C in standard resolution mode). Data were downloaded every two weeks from early-winter to the beginning of the summer season.

In 2001, we recorded hourly weather conditions during each telemetry and calving survey, whereas in 2000 we only recorded weather conditions at the start and end of these surveys. Variables measured included cloud cover, wind, temperature, precipitation, snow depth, snow cover, and number of days since a minimum of 5 cm snow accumulation. Data were recorded using standardized RIC (1998c) codes. We also recorded the general geographic location and comments on topographic position (e.g. alpine, valley bottom, north aspect, etc.) (Appendix 4g).

RESULTS AND DISCUSSION

This report provides an account of inventory activities and a summary of the data collected during year four of the project. Detailed analysis and subsequent interpretation of all data has not occurred, but is planned to begin at the same time as model testing (Table 2), beginning next fiscal year. Discussion of results in this report is therefore qualified consistent with a basic presentation of the inventory, and interpretation of the data is intentionally limited.

Spatial representation of all survey sample units and locations where species were observed or captured is provided in Appendix 7. Digital data are provided in the following files as deliverables with this report:

2001_Captures.xls	2001_VHF_Telemetry.xls	2001_Hourly_Weather.xls
2001_Caribou_Survey.xls	2001_GPS_Telemetry.xls	2001_Temperatures.xls
2001_Calf_Survey.xls	2001_Winter_Habitat.xls	2001_Snow.xls
2001_Mortality.xls	2001_Summer_Habitat.xls	2001_Map_A1.rcl
2001_Map_B1a.rcl	2001_Map_B1b.rcl	2001_Map_B1c.rcl
2001_Map_B2a.rcl	2001_Map_B2b.rcl	2001_Map_B2c.rcl

Six RIC Wildlife Sighting Forms were completed during the 2001 inventory year for observations of species at risk of becoming endangered, which included two wolverines (*Gulo gulo*) and four grizzly bears (*Ursus arctos*) (Appendix 8).

Population Survey

Caribou Survey

In total, 377 animals (361 caribou, 13 stone sheep, 2 elk, and 1 moose) were observed in the three study areas combined (Table 5 and Appendix 7: Maps B2a-c). A total of 81 radio-collared caribou were located, 21 in the Akie, 28 in the Chase, and 32 in the Wolverine. The total number of groups observed was 61, the median group size was 4, and the mean group size was 6 $\pm$ 1 (Fig. 1). The two observers and pilot correctly classified all radio-collared animals except one, and sighted all except one collared animal. There were 53, 174, and 134 caribou observed in the Akie/Ospika, Chase/Sustut, and Wolverine study areas, respectively. The observed ratio of caribou bulls (including juveniles) to cows was 15:27 in the Akie/Ospika, 59:76 in the Chase/Sustut, and 39:62 in the Wolverine study area. The observed ratio of calves to cows was 6:27 in the Akie/Ospika, 28:76 in the Chase/Sustut, and 19:62 in the Wolverine study area.

Table 5. Number of animals observed, by study area, species, age class, and gender, during the caribou survey in north-central British Columbia, March 2001.

Study Area	Species*	Adult			Juvenile			Calf			Unclassified	Group Total
		Male	Female	Unknown	Male	Female	Unknown	Male	Female	Unknown		
Akie/ Ospika	Moose	0	0	0	0	0	0	0	0	0	1	**1**
	Elk	0	0	0	0	0	0	0	0	0	2	**2**
	Stone Sheep	0	0	0	0	0	0	0	0	0	13	**13**
	Caribou	15	27	5	0	0	0	3	1	2	0	**53**
	Subtotal	**15**	**27**	**5**	**0**	**0**	**0**	**3**	**1**	**2**	**16**	**69**
Chase/ Sustut	Moose	0	0	0	0	0	0	0	0	0	0	**0**
	Elk	0	0	0	0	0	0	0	0	0	0	**0**
	Stone Sheep	0	0	0	0	0	0	0	0	0	0	**0**
	Caribou	58	76	5	1	0	1	0	1	27	5	**174**
	Subtotal	**58**	**76**	**5**	**1**	**0**	**1**	**0**	**1**	**27**	**5**	**174**
Wolverine	Moose	0	0	0	0	0	0	0	0	0	0	**0**
	Elk	0	0	0	0	0	0	0	0	0	0	**0**
	Stone Sheep	0	0	0	0	0	0	0	0	0	0	**0**
	Caribou	39	62	11	0	0	0	3	0	16	3	**134**
	Subtotal	**39**	**62**	**11**	**0**	**0**	**0**	**3**	**0**	**16**	**3**	**134**
TOTAL	Moose	0	0	0	0	0	0	0	0	0	1	**1**
	Elk	0	0	0	0	0	0	0	0	0	2	**2**
	Stone Sheep	0	0	0	0	0	0	0	0	0	13	**13**
	Caribou	112	165	21	1	0	1	6	2	45	8	**361**
	Grand Total	**112**	**165**	**21**	**1**	**0**	**1**	**6**	**2**	**45**	**24**	**377**

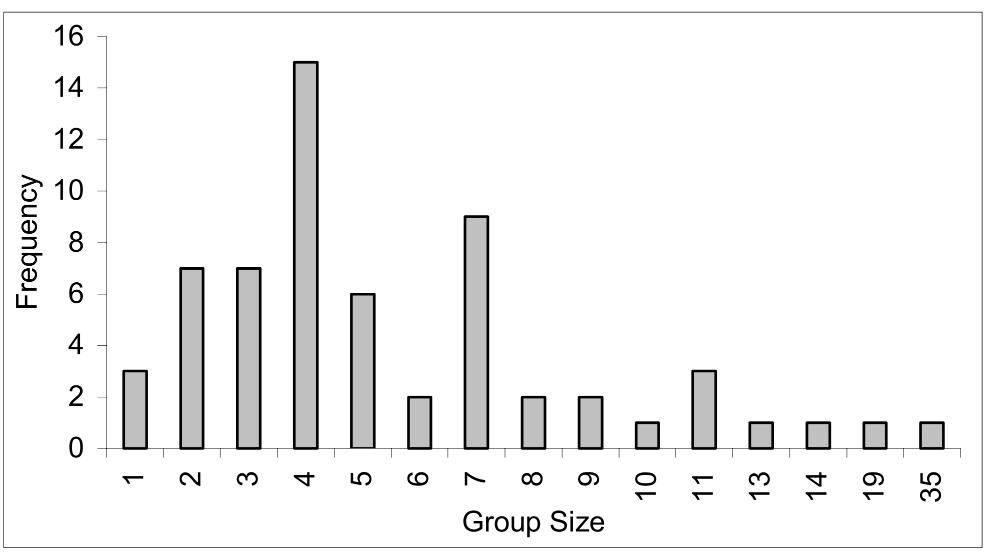

Figure 1. Frequency distribution of caribou group sizes observed during the caribou survey in north-central British Columbia, March 2001.

Caribou Calf Survey

We observed 350 groups of caribou over seven replicate surveys conducted in each study area (Table 6). Caribou appeared to be dispersed in small groups throughout calving areas, as the majority of our observations were either single (n = 76) or paired animals (n=179) (Table 7). The maximum group size observed in the Wolverine study area was 8 (n=1) while groups of 10 and 11 were each seen once in the Chase/Sustut study area. In the Akie/Ospika study area, three groups of 10 caribou and two groups of 13 animals were observed. We observed an average of 13 (SD=3.5, n=7), 14 (SD=1.5, n=7) and 23 (SD=2.6, n=7) individual groups of caribou during each survey within the Akie/Ospika, Chase/Sustut and Wolverine study areas, respectively. All but 19 observations included at least one adult cow (Table 8). One of these observations was a calf in the absence of an adult female in the Chase/Sustut study area. We observed single female caribou relatively frequently (n=235 of 350 total observations) and in total adult females were more often seen without calves (n=134), especially in the earlier calving surveys (Table 8). By the seventh survey, however, only 5 of 40 observations were cows seen without calves in the group. In these five cases it is likely that some calf mortality had already occurred, as is evident from the 17 mortalities of calves born to the 55 radio-collared cows monitored (Table 9). An additional four mortalities were discovered after the seventh calving survey.

We were able to capture and fit 28 calves with ear-tag, radio transmitters. Eleven of the remaining 19 untagged calves were no longer observed with the cow (one prior to the second survey, three prior to the third survey, five prior to the fourth survey, and two prior to the fifth survey), and were assumed to have died from unknown causes (Table 9). Two of the other untagged calves, known to be at least two weeks old, were found dead with no apparent external injuries. Necropsy results concluded that these calves died of septicemia as a result of a *Pasteurella multocida* infection, likely caused by a lynx (*Lynx canadensis*) bite wound. During the surveys, a wolf killed one of the ear-tagged calves and an unknown predator killed another. Since the surveys, another four calves have been found dead; one killed by an unknown predator; one killed by a wolf; and two died from unknown causes. A total of 19 ear-tagged calves are known to be alive, however the fate of the remaining seven unmarked calves is unknown.

Our observation of the greatest number of calves and the highest ratio of calves per cows occurred during the last survey, with 48 calves per 58 cows (Table 10). Of the 55 radio-collared adult female caribou monitored, 47 were observed to have had a calf and six apparently never produced a calf or had their calf die shortly after birth (i.e., before our surveys began or between surveys). The remaining two female caribou were each located only once early in the survey at which time they were without a calf; it is unknown whether they gave birth after the observations. The number of adult females observed during the surveys ranged from 53 in the second survey to a high of 93 recorded in the fifth survey (Table 10).

Table 6. Total number of caribou groups, by study area, survey (Survey #), date, start time, and end time recorded for each calving survey in north-central British Columbia, May - July 2001.

Study Area	**Survey #**	**Date**	**Start Time**	**End Time**																																	**Grand Total**
				9:49	**9:58**	**11:23**	**12:00**	**12:10**	**12:45**	**13:05**	**13:45**	**14:00**	**14:38**	**14:54**	**15:00**	**15:15**	**15:30**	**15:33**	**16:00**	**16:27**	**16:30**	**17:30**	**18:05**	**18:30**	**18:38**	**18:49**	**19:00**	**19:03**	**19:15**	**19:20**	**19:25**	**19:35**	**19:38**	**20:15**	**21:48**	**18:15**	
Akie/ Ospika	01	22/05/01	11:01																11																		**11**
		23/05/01	6:40	3																																	**3**
	02	31/05/01	7:15						12																												**12**
			13:06								1																										**1**
	03	06/06/01	7:03											14																							**14**
			14:54																																	5	**5**
	04	12/06/01	10:20																				10														**10**
		13/06/01	7:32		4																																**4**
	05	19/06/01	9:03																										13								**13**
	06	29/06/01	7:50				9																														**9**
			12:00															4																			**4**
	07	05/07/01	11:25							7																											**7**
	Subtotal			**3**	**4**		**9**		**12**	**7**	**1**			**14**				**4**	**11**				**10**						**13**							**5**	**93**
Chase/ Sustut	01	23/05/01	11:30																			14															**14**
	02	31/05/01	14:20																												9						**9**
		01/06/01	15:03																					2													**2**
	03	07/06/01	7:07										16																								**16**
	04	13/06/01	10:15																														13				**13**
	05	20/06/01	6:39														7																				**7**
			15:30																								7										**7**
	06	28/06/01	12:50																									10									**10**
			19:03																															3			**3**
	07	05/07/01	9:45			8																															**8**
			14:06												4																						**4**
		06/07/01	11:29													2																					**2**
	Subtotal					**8**							**16**		**4**	**2**	**7**					**14**		**2**			**7**	**10**			**9**		**13**	**3**			**95**
Wolverine	01	24/05/01	6:55																24																		**24**
	02	01/06/01	18:30																													5					**5**
		02/06/01	7:10									17																									**17**
	03	08/06/01	7:00				14																														**14**
			12:00																11																		**11**
	04	14/06/01	8:15												20																						**20**
			16:00																	1																	**1**
	05	21/06/01	7:23					18																													**18**
			12:10																		10																**10**
	06	27/06/01	9:20																						13												**13**
			18:38																											1							**1**
		29/06/01	16:00																							9											**9**
	07	05/07/01	17:30																																8		**8**
		06/07/01	7:10																		11																**11**
	Subtotal						**14**	**18**				**17**			**20**				**35**	**1**	**21**				**13**	**9**				**1**		**5**			**8**		**162**
Grand Total				**3**	**4**	**8**	**23**	**18**	**12**	**7**	**1**	**17**	**16**	**14**	**24**	**2**	**7**	**4**	**46**	**1**	**21**	**14**	**10**	**2**	**13**	**9**	**7**	**10**	**13**	**1**	**9**	**5**	**13**	**3**	**8**	**5**	**350**

Table 7. The frequency of observations of caribou groups, stratified by the number of animals in each group observed (Group Total), for each calving survey (Survey #) by study area in north-central British Columbia, May - July 2001.

Study Area	**Survey #**	**Group Total**											**Grand**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**	**13**	**Total**
Akie/Ospika	Calving 1	4	7	3									**14**
	Calving 2	4	8	1									**13**
	Calving 3	5	8	5		1							**19**
	Calving 4	3	5	3	1	1						1	**14**
	Calving 5	2	6	2		2				1			**13**
	Calving 6	1	4	2	2	1		1		2			**13**
	Calving 7		2	3					1			1	**7**
	Subtotal	19	40	19	3	5		1	1	3		2	**93**
Chase/Sustut	Calving 1	5	3	3	2	1							**14**
	Calving 2	2	6	2	1								**11**
	Calving 3	5	9	2									**16**
	Calving 4		10	1	1	1							**13**
	Calving 5	1	8	1	1	2	1						**14**
	Calving 6	3	5		2	1		1			1		**13**
	Calving 7	2	4	2	2	2		1		1			**14**
	Subtotal	**18**	**45**	**11**	**9**	**7**	**1**	**2**	**0**	**1**	**1**	**0**	**95**
Wolverine	Calving 1	8	8	3	1	2	2						**24**
	Calving 2	7	14	1			1						**23**
	Calving 3	5	19		1								**25**
	Calving 4	3	14	4									**21**
	Calving 5	7	12	1	2	1	2	2					**27**
	Calving 6	6	15		1		1						**23**
	Calving 7	3	12			1		2	1				**19**
	Subtotal	**39**	**94**	**9**	**5**	**4**	**6**	**4**	**1**	**0**	**0**	**0**	**162**
Grand Total		**76**	**179**	**39**	**17**	**16**	**7**	**7**	**2**	**4**	**1**	**2**	**350**

Table 8. Frequency of observations of caribou groups in which there were 0 - 4 calves seen (C0 - C4) where observations are stratified by number of adult females in the group (AF0 – AF10), calf survey number (Survey #), and study area in north-central British Columbia, May - July, 2001.

Study Area	Survey #	Total Adult Cows per Group over Total Calves per Group																					Grand Total
		AF0		AF1		AF2			AF3				AF4				AF5	AF6			AF9	AF10	
		C0	C1	C0	C1	C0	C1	C2	C0	C1	C2	C3	C0	C2	C3	C4	C0	C1	C2	C4	C3	C0	
Akie/ Ospika	1	1		8	3	1			1														**14**
	2			7	6																		**13**
	3	4		3	9	1	1						1										**19**
	4			4	5		2			1	1										1		**14**
	5			2	4	2	3			1												1	**13**
	6	1		1	2	1	2	1	1								2	1	1				**13**
	7				6							1											**7**
Subtotal		**6**		**25**	**35**	**5**	**8**	**1**	**2**	**2**	**1**	**1**	**1**				**2**	**1**	**1**		**1**	**1**	**93**
Chase/ Sustut	1	1		6		6			1														**14**
	2			4	4	1	1		1														**11**
	3	3		4	9																		**16**
	4				10		1			2													**13**
	5	1			8	1	1	1			1	1											**14**
	6		1	2	4	1		2			1	1								1			**13**
	7			3	4			5	1							1							**14**
Subtotal		**5**	**1**	**19**	**39**	**9**	**3**	**8**	**3**	**2**	**2**	**2**				**1**				**1**			**95**
Wolv-erine	1			9	3	6			4				2										**24**
	2	2		9	9	1	1		1														**23**
	3	2		8	15																		**25**
	4			4	11	3	3																**21**
	5			7	11	2	1	2	1		1		1					1					**27**
	6	1		5	13	2					1		1										**23**
	7	2		1	12			2						1	1								**19**
Subtotal		**7**		**43**	**74**	**14**	**5**	**4**	**6**		**2**		**4**	**1**	**1**			**1**					**162**
GRAND TOTAL		**18**	**1**	**87**	**148**	**28**	**16**	**13**	**11**	**4**	**5**	**3**	**5**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**350**

Table 9. Presence (1) or absence (0) of caribou calves born to radio-collared cows (Animal ID#), their cause of mortality, and the sum of visual locations (occurrences) observed over 7 surveys (Survey #) conducted in three study areas in north-central British Columbia, May - July, 2001.

Animal ID#	**Study Area**	**Survey #**														**Mortality Cause**[a]
		Calving 01		**Calving 02**		**Calving 03**		**Calving 04**		**Calving 05**		**Calving 06**		**Calving 07**		
		0	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	
C002C	Chase/Sustut	1		1			1	1		1						Unknown
C005C	Chase/Sustut	1		1		1			1		1	1				Unknown
C007C	Chase/Sustut	1		1			1		1		1		1	1		Wolf
C010C	Chase/Sustut	1														Alive
C012W	Wolverine	1			1		1		1		1		1		1	Alive
C013W	Wolverine	1			1		1	1		1		1		1		Unknown
C014W	Wolverine	1		1		1		1		1			1		1	Alive
C015W	Wolverine	1		1		1			1		1		1		1	Alive
C025W	Wolverine		1		1	1				1						Septicemia
C030W	Wolverine	1		1		1		1		1						No calf
C033W	Wolverine		1		1		1	1				1				Unknown
C036W	Wolverine	1		1			1		1		1	1	1		1	Alive
C037W	Wolverine	1					1		1		1		1		1	Alive
C041W	Wolverine	1		1			1		1		1		1		1	Alive
C042W	Wolverine	1			1	1		1		1						Unknown
C043W	Wolverine	1					1		1		1		1		1	Unknown[b]
C046W	Wolverine	1			1		1			1		1				Unknown
C047A	Chase/Sustut	1		1		1			1		1		1		1	Alive
C050A	Chase/Sustut	1					1		1		1		1		1	Alive
C058C	Chase/Sustut					1				1		1		1		No calf
C060C	Chase/Sustut	1			1		1		1		1		1		1	Alive
C063C	Chase/Sustut	1		1		1					1		1		1	Alive
C065C	Chase/Sustut	1		1			1		1	1		1				Septicemia
C067C	Chase/Sustut	1			1		1		1		1		1		1	Alive
C070W	Wolverine	1		1			1		1		1				1	Predation[b]
C085W[c]	Wolverine	1		1		1				1				1		No calf
C090W[c]	Wolverine									1		1				No calf
C096A	Akie/Ospika	1		1	1		1		1		1		1		1	Alive
C097A	Akie/Ospika	1			1		1		1		1		1		1	Alive
C098A	Akie/Ospika	1		1		1		1		1		1				No calf
C099W	Wolverine	1		1		1			1		1		1		1	Alive
C100W	Wolverine	1		1		1		1			1		1		1	Wolf[b]
C104C	Chase/Sustut	1			1		1		1		1					Alive
C105C	Chase/Sustut	1			1		1		1		1		1		1	Alive
C113A	Akie/Ospika	1		1			1		1		1		1		1	Alive
C114A	Akie/Ospika	1		1			1		1		1		1		1	Alive
C116A	Akie/Ospika	1		1		1		1		1						No calf
C117A	Akie/Ospika		1		1	1		1				1				Unknown
C119C	Chase/Sustut	1			1		1		1		1		1		1	Alive
C121W[c]	Wolverine	1							1	1						Unknown
C124W	Wolverine	1		1			1		1		1				1[d]	Alive
Animal	**Study Area**	**Survey**														**Mortality**

ID#		Calving 01		Calving 02		Calving 03		Calving 04		Calving 05		Calving 06		Calving 07		Cause[a]
		0	1	0	1	0	1	0	1	0	1	0	1	0	1	
C125W	Wolverine	1			1		1	1		1		1				Unknown
C140C	Chase/Sustut														1	Alive
C146W	Wolverine									1						Alive
C149A[c]	Akie/Ospika	1					1		1[d]		1		1		1	Alive
C150A	Akie/Ospika	1		1			1[d]				1		1		1	Unknown[b]
C155A	Akie/Ospika	1			1		1	1		1		1				Unknown
C157A	Akie/Ospika		1	1		1		1		1		1				Unknown
C158A	Akie/Ospika	1			1		1		1		1		1		1	Alive
C164W	Wolverine	1		1		1		1					1		1[d]	Alive
C165W	Wolverine	1			1		1		1		1		1			Predation
C166W	Wolverine	1					1		1	1		1				Unknown
C167W	Wolverine		1		1		1		1		1		1		1	Alive
C168A	Akie/Ospika		1		1	1		1		1						Unknown
C189C	Chase/Sustut										1		1		1	Alive
Sum of Occurrences		**44**	**6**	**24**	**20**	**18**	**32**	**15**	**31**	**20**	**30**	**14**	**28**	**4**	**31**	
Total Cows		**50**		**44**		**49**		**46**		**50**		**42**		**35**		

a - Mortality causes listed include: unknown, wolf predation, septicemia, and predation by an unknown species. Several collared cows were never observed with a calf (no calf), and many calves were still alive at the end of the final survey (alive). Shaded cells indicate calves that were marked with ear-tag transmitters.
b - Mortalities that occurred after the seventh survey
c - Two year old female
d - This cow was observed with her calf twice (same day or one day apart) during the survey

Table 10. Number of adult females and calves observed during the calf surveys (Survey #) within each study area of north-central British Columbia, May - July 2001.

Age/ Gender	Study Area	Survey #							Grand Total
		1	2	3	4	5	6	7	
Adult Females	Akie/Ospika	16	13	20	28	29	36	9	**151**
	Chase/Sustut	21	15	13	18	20	24	24	**135**
	Wolverine	44	25	23	27	44	29	25	**217**
	Subtotal	**81**	**53**	**56**	**73**	**93**	**89**	**58**	**503**
Calves	Akie/Ospika	3	6	10	13	8	9	9	**58**
	Chase/Sustut	0	5	9	13	16	18	18	**79**
	Wolverine	3	10	15	14	19	15	21	**97**
	Subtotal	**6**	**21**	**34**	**40**	**43**	**42**	**48**	**234**

Remote Monitoring of Sample Animals

Capture/Handling

We conducted 109 captures with no fatalities during 2001, over 35 days (full or partial) on four separate occasions: Jan. 21 - Feb. 7; Mar. 4 - 6; Mar. 29 through until Apr. 27; and Jun. 8 through until Jul. 6 (Appendix 7, Maps B1a-c, and Appendix 9). Of the 109 animal captures, 59 were conducted to fit transmitters on previously unmarked animals: 48 caribou, 9 moose, and 2 wolves; and 50 were conducted to recapture marked animals: 35 caribou and 15 moose (Table 11). Of the 50 recaptured animals, 25 were conducted to replace GPS collars and retrieve stored data, 9 were to recapture marked calves to replace ear-tag transmitters with a VHF expandable collar, and 16 were to replace the collar due to malfunction or for male moose to enlarge the collar size consistent with anticipated growth patterns. Three GPS collars and 56 VHF collars were fitted on previously unmarked animals. Of the 56 new VHF collared animals, four female caribou in the Valleau Creek drainage were captured in co-operation with Industrial Forestry Service. These captures were not identified in our target number of marked animals (Table 4).

Table 11. Animals captured or recaptured and fitted with a radio transmitter, by study area, age, gender, species, and transmitter type, in north-central British Columbia, 2001.

Study Area	Age Class	Gender	Moose			Caribou						Wolves	TOTAL
			GPS	VHF		Eartag	Expand[a]	GPS		VHF		VHF	
			Recap.	New	Recap.	New	Recap.	New	Recap.	New	Recap.	New	
Akie/ Ospika	Adult	F	1	0	1	0	0	2	4	3	1	0	**12**
		M	1	3	3	0	0	0	1	3	0	0	**11**
	Calf	F	0	0	0	4	0	0	0	0	0	0	**4**
		M	0	0	0	2	0	0	0	0	0	0	**2**
		Unk	0	0	0	1	0	0	0	0	0	0	**1**
Subtotal			**2**	**3**	**4**	**7**	**0**	**2**	**5**	**6**	**1**	**0**	**30**
Chase/ Sustut	Adult	F	1	0	0	0	0	1	5	1	1	1	**10**
		M	1	3	2	0	0	0	2	3	1	1	**13**
	Calf	F	0	0	0	5	3	0	0	0	0	0	**8**
		M	0	0	0	6	2	0	0	0	0	0	**8**
	Juv.	F	0	0	0	0	0	0	0	0	1	0	**1**
Subtotal			**2**	**3**	**2**	**11**	**5**	**1**	**7**	**4**	**3**	**2**	**40**
Wolverine	Adult	F	1	2	0	0	0	0	5	4	3	0	**15**
		M	1	1	3	0	0	0	2	3	0	0	**10**
	Calf	F	0	0	0	4	2	0	0	0	0	0	**6**
		M	0	0	0	6	2	0	0	0	0	0	**8**
Subtotal			**2**	**3**	**3**	**10**	**4**	**0**	**7**	**7**	**3**	**0**	**39**
TOTAL			**6**	**9**	**9**	**28**	**9**	**3**	**19**	**17**	**7**	**2**	**109**

a - Expand is an expandable VHF collar fitted on a juvenile caribou (< one year old).

In total, 24 moose, 83 caribou, and 2 wolves were captured or recaptured during 2001. The addition of the 59 newly marked animals captured this year resulted in a total of 233 marked animals (55 moose, 167 caribou, and 11 wolves) distributed across the three study areas during 2001.

VHF Telemetry

A total of 6,458 focal species were observed over 119 aerial telemetry flight days during 2001. We recorded 4,844 observations of caribou, 1,348 of moose, and 266 of wolves, where 58% of these observations were radio-marked animals (Table 12). For all species combined, 1,884 observations were in the Akie/Ospika study area, 2,498 in the Chase/Sustut study area, and 2,076 in the Wolverine study area (Appendix 7, Maps B1a-c). For the majority of the telemetry locations we achieved a visual location on the animal (58%) or a close 'fix' (23%). However, 2% of the locations were within the general area (within a 4 km radius), and 17% were simply heard transmissions with no specific location recorded. There were 624 groups of caribou visually observed, ranging in size from 1 to 39 animals per group. Most groups tended to be small in number, with a median group size of 4 and a mean group size of 5 $\pm$ 0.2 (Fig. 2).

Table 12. Caribou, moose, and wolf locations summarized by study area and observation type (radio-marked or unmarked but sighted) in north-central British Columbia, November 2000 – October 2001.

Study Area	Caribou		Moose		Wolves		TOTAL
	Marked	Unmarked	Marked	Unmarked	Marked	Unmarked	
Akie/Ospika	597	510	611	101	35	30	**1,884**
Chase/Sustut	764	1,292	257	20	110	55	**2,498**
Wolverine	1,015	666	353	6	27	9	**2,076**
TOTAL	**2,376**	**2,468**	**1,221**	**127**	**172**	**94**	**6,458**

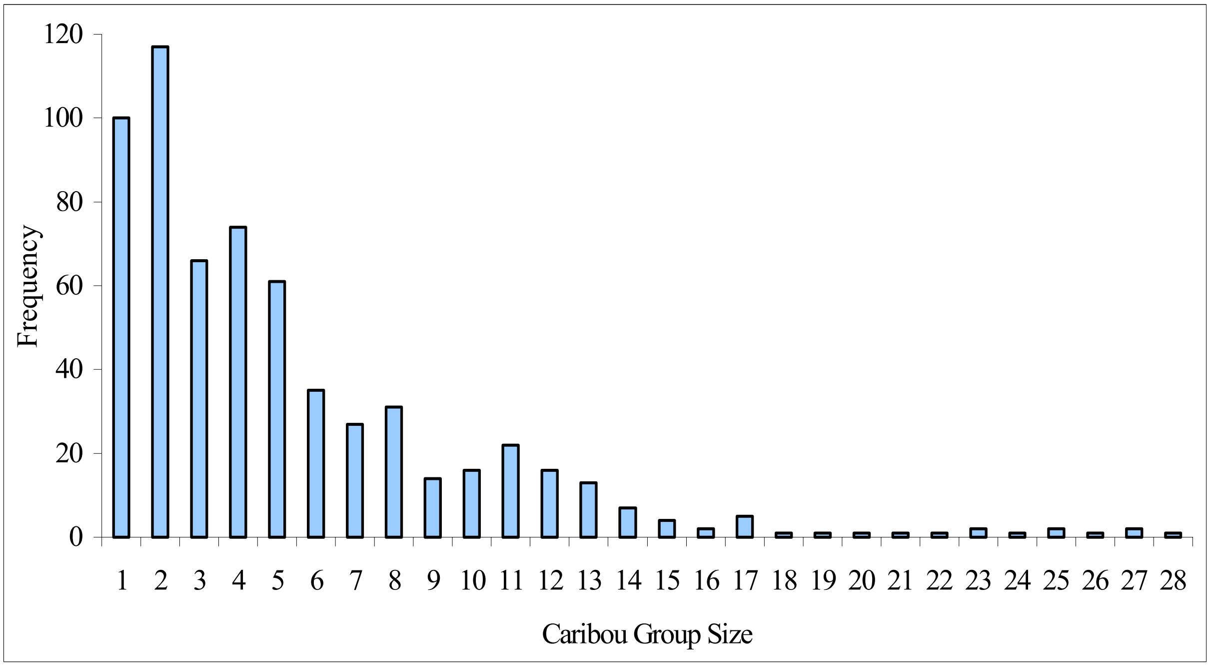

Figure 2. Frequency distribution of observed caribou group sizes in north-central British Columbia, November 2000 - October 2001.

GPS Telemetry

Data were downloaded and processed from 25 GPS collars, which were fitted on 16 caribou (11 females and 5 males), and 7 moose (4 females and 3 males). Collars were recovered from animals that were recaptured (two animals were recaptured twice, approximately one year apart), and one collar was recovered from an animal that died prior to the capture/handling sessions of 2001 (Table 13).

In total we had 23 GPS collars of data originating from the 2000-capture/handling sessions and two GPS collars of data originating from the 2001-capture/handling sessions. A total of 11,745 locations were obtained out of an attempted 24,811 for an average acquisition rate of 47% (Table 13). For both caribou and moose, there were 5,425 locations in the Akie/Ospika, 3,486 locations in the Chase/Sustut, and 2,834 locations in the Wolverine study area (Table 14).

Twenty-eight GPS collars were deployed in 2001 (Table 11) and, of those, the collars from one caribou and one moose have been recovered and downloaded. Therefore, we have yet to collect information from 26 active collars, which should provide an additional 10,000 locations for 2001.

Table 13. Summary of expected and actual locations obtained from each retrieved GPS collar, by study area, species, and gender during 2001 in north-central British Columbia. For each animal the identification number, collar VHF frequency, whether the collar was retrieved during recapture or from mortality of the animal, capture date, and number of days the animal was collared are provided.

Study Area	Species	Gender (F or M)	Animal ID#	Collar VHF Freq.	Recapture or Mortality	Capture Date	Days Collared	Single Point Solutions[a]		
								Expected[b]	Actual	% of Expected
Akie/ Ospika	Caribou	F	C047A	148.840	Recapture	Feb-00	348	1,094	679	62.1
		F	C047A	149.430	Recapture	Jan-01	146	489	484	99.0
		F	C113A	148.570	Recapture	Feb-00	329	1,034	389	37.6
		F	C114A	149.470	Recapture	Feb-00	360	1,131	742	65.6
		F	C117A	149.430	Recapture	Feb-00	334	1,050	582	55.4
		M	C118A	149.370	Recapture	Feb-00	344	1,081	520	48.1
	Moose	F	M042A	148.060	Recapture	Feb-00	356	1,119	673	60.2
		F	M054A	148.740	Mortality	Jan-01	111	349	253	26.3
		F	M054A	148.750	Recapture	Mar-00	306	962	614	63.8
		M	M046A	148.740	Recapture	Feb-00	337	1,059	489	46.2
Chase/ Sustut	Caribou	F	C058C	148.580	Recapture	Feb-00	220	691	54	7.6
		F	C060C	148.610	Recapture	Feb-00	350	1,100	525	47.7
		F	C067C	148.632	Recapture	Feb-00	338	1,062	548	51.6
		M	C102C	149.400	Recapture	Feb-00	353	1,109	662	59.7
		M	C106C	148.030	Recapture	Feb-00	310	974	642	65.9
	Moose	F	M043C	148.070	Recapture	Feb-00	304	955	360	37.7
		M	M048C	148.730	Recapture	Feb-00	342	1,075	695	64.7
Wolverine	Caribou	F	C013W	149.420	Recapture	Feb-00	344	1,081	479	44.3
		F	C041W	148.710	Recapture	Feb-00	346	1,087	438	40.3
		F	C042W	148.700	Recapture	Feb-00	348	1,094	258	23.6
		F	C043W	149.410	Recapture	Feb-00	346	1,087	186	17.1
		M	C069W	149.390	Recapture	Feb-00	347	1,091	353	32.4
		M	C123W	149.380	Recapture	Feb-00	276	867	146	16.8
	Moose	F	M051W	148.720	Recapture	Feb-00	345	1,084	393	36.2
		M	M050W	148.080	Recapture	Feb-00	345	1,084	581	53.6
						Totals	**7,885**	**24,811**	**11,745**	**47.3**

a. Number of single point solutions with a PDOP of six or less.
b. Based on four location attempts, four times per week and three location attempts, three times per week multiplied by number of days in the field.

Table 14. GPS collar single point solutions for animal locations summarized by study area, species, and gender of animals radio-collared in north-central British Columbia, January 2000 - June 2001.

Study Area	Caribou		Moose		Total
	Female	Male	Female	Male	
Akie/Ospika	2,876	520	1,540	489	**5,425**
Chase/Sustut	1,127	1,304	360	695	**3,486**
Wolverine	1,361	499	393	581	**2,834**
Total	**5,364**	**2,323**	**2,293**	**1,765**	**11,745**

Site Investigations

Assessment of Habitat Components and Testing Seasonal Habitat Preferences

There were 146 individual sites sampled, most of which were visited multiple times, for a total of 600 site investigations within the three study areas between November 2000 and October 2001 (Appendix 7, Maps B1a-c). Of the individual sites, 10 were mortality sites, 134 were seasonal habitat preference plots, of which 126 were sampled during the summer to inventory vegetation and soil characteristics, and two plots were initially intended for seasonal comparison, but for various reasons were only used to characterize habitat used by caribou (Table 15). We completed 95% (462 out of 486 site investigations) of the target number of early-winter, late-winter and spring/calving seasonal preference comparison samples across 15 work sessions (Appendix 10). Adverse weather conditions restricted helicopter access to two of the samples, and the remaining samples were missed due to target animal mortality.

Table 15. Number of habitat sites and total number of investigations (in brackets) by plot type, season of use, and species of mortalities, in each study area of north-central British Columbia, November 2000 - October 2001.

Study Area	Caribou Habitat Seasonal Preference Sites				Caribou Habitat	Mortalities			Total
	Early-winter	Late-winter	Spring	Summer		Caribou	Moose	Wolves	
Akie/Ospika	12(44)	19(68)	12(30)	1(41)	2	2	0	0	**48(187)**
Chase/Sustut	15(47)	18(84)	12(27)	(48)	0	0	3	0	**48(209)**
Wolverine	12(48)	21(84)	12(30)	(37)	0	2	3	0	**50(204)**
TOTAL	**39(139)**	**58(236)**	**36(87)**	**1(126)**	**2**	**4**	**6**	**0**	**146(600)**

Testing Veracity of Ecosystem Mapping

Testing veracity of ecosystem maps that have been produced as deliverables in related projects (Kesting and Teversham 1999, Kesting 2000, KTPW-Geo 2000) is a collaborative initiative with MWLAP and is not planned to conclude until March 2002. Results from that work will be presented under separate cover.

Mortality

We investigated 53 mortalities between November 2000 and October 2001, with 18 mortalities in the Akie/Ospika study area, 17 in the Chase/Sustut, and 18 in the Wolverine (Table 16 and Appendix 7, Maps B1a-c). While the causes of death were difficult to determine for many of these mortalities, we concluded that of the 27 moose, four were killed by hunters, six were killed by wolves, one was killed by a bear, one was killed by an unknown predator, one was killed in an avalanche, two died of starvation or disease, and the causes of death for the remaining 12 moose were unknown. Thirteen of these 27 moose were radio-collared. Out of 23 caribou mortalities investigated (13 calves and 10 adults, 19 of which had radio-transmitters), we were able to determine that four were killed by wolves, one by a bear, three by unknown predators, necropsy results showed that two calves died of infection caused by *Pasturella multocida*, and we were unable to determine the cause of death for the remaining 13 caribou. One unmarked elk died of unknown causes, one radio-collared wolf was shot by a hunter, and one unknown radio collar (from a different project) was located on mortality signal, however we did not find any evidence of a carcass near the collar. In total, 36 out of the 53 mortalities (68%) were radio-collared animals.

Table 16. Number of mortalities summarized by species and study area in north-central British Columbia, November 2000 – October 2001.

Study Area	Moose	Caribou		Wolves	Elk	Unknown	TOTAL
		Adults	Calves				
Akie/Ospika	13	3	1	0	1	0	**18**
Chase/Sustut	8	5	3	1	0	0	**17**
Wolverine	6	2	9	0	0	1	**18**
TOTAL	**27**	**10**	**13**	**1**	**1**	**1**	**53**

Weather Monitoring

Snow Conditions

Snow conditions were recorded for a total of 276 visits to the 9 high priority and 12 low priority snow stations, between Nov. 23, 2000 and Jun. 21, 2001. Mean biweekly snow depth measurements for the three high priority stations and the four low priority stations in each study area are displayed in Table 17 and Fig. 3.

Table 17. Mean biweekly snow depths for each snow station by study area in north-central British Columbia, November 2000 - June 2001.

Study Area	Snow Station	Priority	Elevation Position	Mean Snow Depth (cm) (n=9) by Approximate Date *(measured every 2 weeks)* [b]													
	ID #	*1 or 2* [a]	*Mtn-Top, Mid-slope, Valley-bottom*	**Nov. 25**	**Dec. 10**	**Jan. 20**	**Feb. 5**	**Feb. 15**	**Mar. 5**	**Mar. 15**	**Apr. 1**	**Apr. 15**	**May 1**	**May 15**	**May 25**	**Jun.10**	**Jun. 20**
Akie/ Ospika	A10	1	Top	17	11	39	36	53	40	12	24	21	62	77	55	37	0
	A11	1	Mid	37	49	87	104	104	99	97	116	104	93	78	64	7	0
	A12	1	Bottom	20	40	71	78	76	73	81	92	87	67	33	0	0	0
	A13	2	Top	7	6	7	10	16	20	4	7	6	3	16	8	0	0
	A14	2	Bottom	26	29	62	67	69	68	66	66	78	27	0	0	0	0
	A15	2	Bottom	12	23	29	32	32	-	-	44	-	26	2	0	0	0
	A16	2	Top	11	1	0	0	0	-	-	4	-	10	5	0	0	0
Chase/ Sustut	C01	1	Bottom	-	20	57	68	70	73	68	72	64	21	0	0	0	0
	C06	1	Mid	21	33	65	71	76	80	78	92	84	53	37	0	0	0
	C10	1	Top	11	16	53	12	16	29	32	30	30	23	29	41	0	0
	C11	2	Bottom	10	5	32	37	39	-	-	44	39	0	0	0	0	0
	C12	2	Top	14	12	20	16	17	-	-	7	26	-	11	27	0	0
	C13	2	Bottom	12	60	74	94	87	89	70	98	100	-	100	54	7	0
	C14	2	Top	53	12	7	8	4	6	9	6	11	-	19	0	0	0
Wolv-erine	W20	1	Mid	-	20	55	56	58	56	61	67	62	26	25	0	0	0
	W21	1	Top	46	46	-	145	93	55	51	70	92	54	36	40	30	0
	W22	2	Top	12	-	13	14	16	21	33	43	19	13	14	25	7	0
	W23	1	Bottom	-	4	44	50	57	58	51	62	54	0	0	0	0	0
	W24	2	Top	21	27	-	-	-	-	18	63	36	28	-	76	14	0
	W25	2	Bottom	11	16	-	-	-	-	54	26	48	24	-	0	0	0
	W26	2	Bottom	1	-	53	66	58	66	59	74	66	53	34	0	0	0

a - Priority 1 sites were visited each session and had temperature dataloggers recording hourly temperature; Priority 2 sites were visited each season, with no temperature dataloggers
b - see Appendix 3 for actual session dates

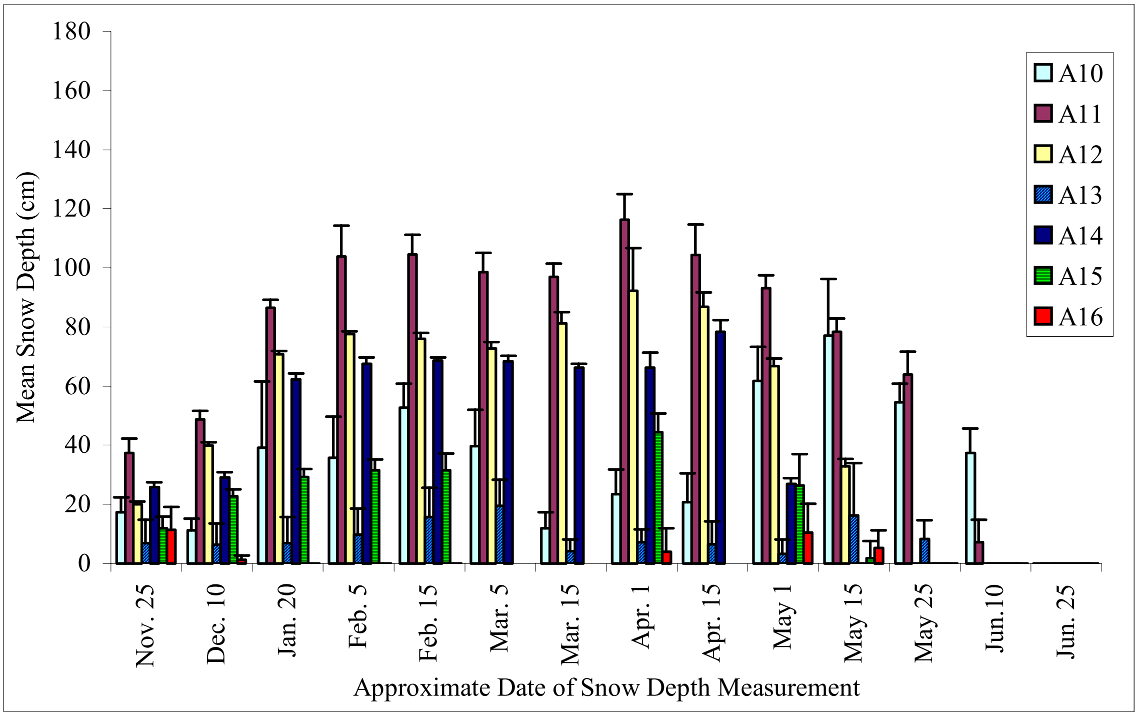

Figure 3a. Snow depth measurements in the Akie/Ospika study area over fourteen 2-week work sessions, November 2000 – June 2001.

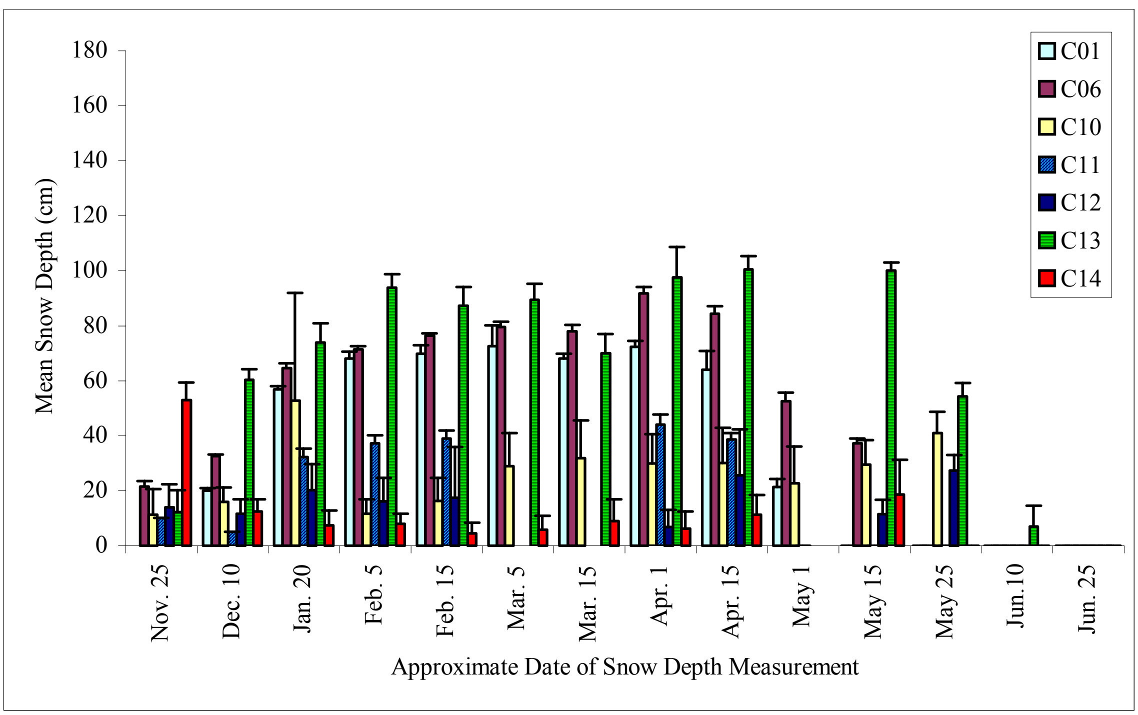

Figure 3b. Snow depth measurements in the Chase/Sustut study area over fourteen 2-week work sessions, November 2000 – June 2001.

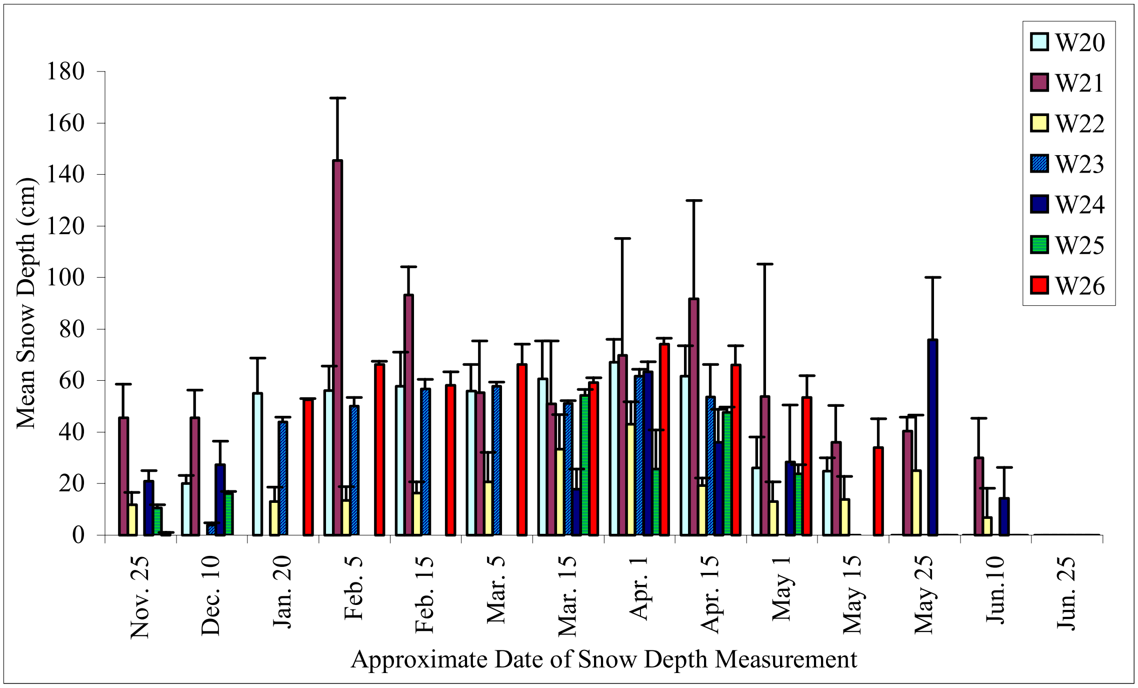

Figure 3c. Snow depth measurements in the Wolverine study area over fourteen 2-week work sessions, November 2000 – June 2001.

Temperature

For all nine temperature dataloggers, a total of 47,965 records of hourly temperature were obtained between Nov. 18, 2000 and Jun. 28, 2001. The mean daily temperatures during this time period ranged from -37°C to +14°C (Fig. 4).

Hourly Weather During Aerial Flights

Recording hourly weather conditions during all aerial flights allowed us to document different weather conditions among study areas, drainages, or different elevations both at the same point in time and over time. Results have yet to be summarized or analyzed, however, we anticipate that the information will help estimate climate effects on animal behaviors, movements, and patterns of habitat use at different times and scales. Also, the hourly weather information has helped to determine a more precise date of death for a number of mortality investigations in this past year.

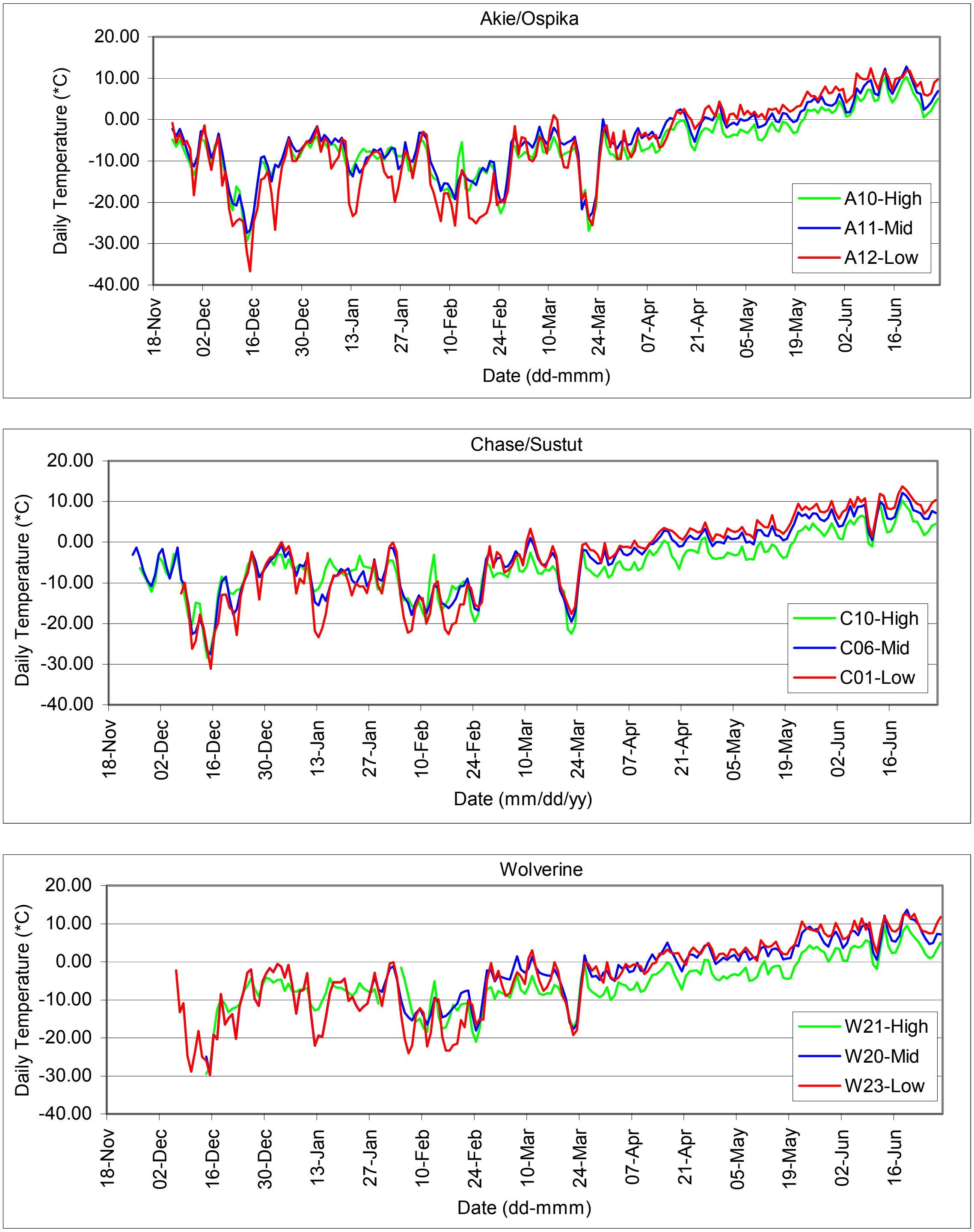

Figure 4. Mean daily temperatures (^{o}C) between Nov. 18, 2000 and Jun. 28, 2001 at the high-, mid- and low- elevation weather stations in each study area (Akie/Ospika, Chase/Sustut and Wolverine, respectively) of north-central British Columbia.

CRITIQUE OF PROTOCOLS

Our four inventory protocols (surveys, remote monitoring, site investigations, and weather monitoring) were found to be effective in addressing our specific inventory goals and objectives, with some notable exceptions that we plan to revise in 2002. Caribou densities and population size were not estimated from the surveys as they were not designed to be area-specific. Over the past three years, our project as well as other prior studies (Wood 1994, Wood 1998) conducted in parts of the Chase/Sustut and Akie/Ospika study areas, have shown caribou to congregate in open alpine habitats during late-winter. Population censuses for caribou are most effective at those times. However, we found that these congregations occurred over only short periods of time in 2000, and the timing of these congregations was inconsistent between study areas. Therefore, by the time we deployed a survey crew, most caribou had already moved back to forested habitats where surveys are less effective. We therefore focused on locating radio-collared caribou and classifying individuals in a group with the target animal to determine a minimum population estimate. We observed 80 out of 81 of the radio-collared animals. We also correctly classified age class and gender of 80 out of 81 collared animals, indicating that sightability and classification accuracy for this survey were very high. For the 2002 census we intend to conduct a random, stratified block, aerial caribou population census immediately after the first signs that movement to the alpine habitats has been completed, in order to determine the population size and density. The study areas will be stratified based on the High-Elevation Winter Range strata (preferred, equivocal and avoided habitats) assigned in the management model. We also intend to conduct a similar population census of moose based on the Winter Moose Relative Abundance values from the Caribou Management Model. The caribou calf survey achieved the desired results and will be implemented using the same methods next year.

The goals and objectives for the 2001-capture/handling sessions were achieved for the total number of collared animals by species, age, gender, collar type, and distribution throughout the three study areas. We fitted nine juvenile caribou (previously marked with ear-tag transmitters) with elasticized collars that can expand as the animal grows. Also, by coincidence, we were able to re-collar one of our 2-year-olds (previously marked as a calf and then as a juvenile) with a regular VHF radio transmitter after losing contact with it for more then 10 months. The expandable VHF collar that this animal was wearing had stopped functioning soon after deployment. In 2001, and for the first time since the start of the project, we lost contact with a GPS collar fitted on a caribou female. However, we believe that this animal was observed with other marked animals during a telemetry survey conducted in the summer. We assumed the VHF beacon of the collar has stopped functioning, and our challenge for the upcoming year is to relocate this animal so we can retrieve the collar to download the stored data. A total of three deaths (all caribou calves) occurred soon after the capture of the animal. However, it is not possible to prove that they were capture/handling related deaths. One calf died only one week following the capture, but was consumed by wolverines; another calf died three weeks after being captured, but few remains were found and cause of death was unconfirmed; and the ear-tag transmitter of the third calf was found intact, but without other evidence we could not confirm the death of this animal.

Our VHF telemetry protocols were efficient, providing reasonably accurate data on each radio-collared animal's visual location, including position, group size and composition, animal behaviour, and broad habitat characteristics. The level of accuracy obtained from aerial telemetry was suitable given our goals for the identification of broad seasonal movement patterns. This is especially so since habitat selection characteristics and finer-scale movements will be identified using GPS collar data. No change in these aerial telemetry techniques is recommended for 2002.

The collection of locations by GPS collars occurred at a rate roughly equivalent to 47% of the expected sample size. This compares favorably with that of last year (i.e., 52%), the first year of GPS collar deployment (Zimmerman et al. 2001). Although these rates appear to be lower than what might be expected, they are not inconsistent with other reported data (Dyer et al. 2001, Blake et al. 2001, Biggs et al. 2001). Another important consideration is that most other studies utilizing GPS collars reported values for a range of PDOP values (2-9) (Moen et al. 1996), whereas our collars only retain data of PDOP six or less (i.e., 3D or 3-dimensional fixes). For example, 52% of Johnson's (2000) fixes were 3D, resulting in a comparable acquisition rate during his study of 17% (52% of his overall 29% = 17%) for 3D fixes, making our 47% seem more acceptable. Nevertheless, not having access to locations of PDOP greater than six (our collars) is regrettable since these locations would help assess the known habitat bias associated with the data we do have. One useful method of quantifying the habitat and topographic biases associated with our GPS location datasets would be to place active GPS collars in known topographic and habitat types, and collect locations according to a similar time scale as active collars on animals. Evaluation of the resulting collar successes and failures relative to habitat and topographic variables may prove informative in determining bias in our GPS location datasets.

Our mortality site investigation protocols provided satisfactory data when we were able to identify and investigate a mortality quickly following death. However, due to our flying schedule, we often identified mortalities too late, such that the effects of scavengers, weather, or both, masked the cause and circumstances of death. By conducting telemetry flights spatially distributed seven days apart we have maximized our ability to locate mortalities within the financial confines of this project. More frequent flights would help improve the quality of these data.

Habitat site investigations were modified in 2000 to incorporate variables recorded by biologists conducting inventories of fisher (*Martes pennanti*) and wolverines within our study area. This data collaboration facilitated data transfer between the projects, thereby augmenting the data set to be used for verification of Terrestrial Ecosystem Mapping projects. In 2001 we modified our sample design to ensure that sampling was conducted during spring to provide a more complete representation of seasonal habitat selection tactics. We also modified the sample design to follow a continuous time series, where each site was only investigated on four consecutive visits, regardless of season. When a target animal died, a new animal was selected for monitoring for the remainder of the time series. We found this method addressed the objectives set out for habitat investigations, and therefore we will continue to sample in this manner during 2002.

We modified the sample design for weather monitoring such that weather stations were distributed across elevations (high, medium, and low) within a watershed, and were therefore influenced by similar environmental conditions. The comparisons of snow accumulations and characteristics are intended to reveal the effect of elevation and year, and are not intended to compare study area effects. We also installed temperature data-loggers at these stations in November, 2000 to record hourly temperature throughout the year. Sampling at these stations was the first priority, and the second priority was to sample at stations established in areas frequently utilized by caribou. As well, this was the first year that weather conditions were recorded on an hourly basis during all aerial flights related to the project, which has provided a more precise level of detail for future data analyses. This sample design has provided suitable data to meet the goals and objectives regarding weather monitoring, therefore the same methods will be employed during 2002.

As we begin to focus more effort on data analysis in 2002 it will be necessary to continually refine our map-based data from the accuracy required for purely graphical/visual purposes (i.e., our needs historically) to more precise and accurate mapping. Some key habitat attributes required for the expected analyses will be: forest cover (from Forest Inventory Planning maps); elevation contours, hydrology, slope, and aspect (from Terrestrial Resource Inventory Maps); biogeoclimatic units (from Terrestrial Ecosystem Maps and Predictive Ecosystem Maps); and roads. Not only will we be requiring the most up-to-date spatial data for the Mackenzie TSA, but we will also require those areas outside the TSA that are within our herd boundaries. We are assuming that the digital quality of Broad Ecosystem Unit maps, Terrestrial Ecosystem Maps, and Predictive Ecosystem Maps are already of sufficient quality. Taking this step to revise the Geographic Information System map-based data will allow for a more precise and accurate graphical representation of our data compared to our current ability.

Data quality assurance procedures have consistently revealed that data entry errors are easily made using spreadsheets. This, in combination with the increasing volume of data collected to date, and the need for linkages between datasets, has led to the development of a relational database. The database is intended to centralize the data, minimize errors through the use of option menus, minimize the amount of data entry duplication from nested forms (e.g. multiple entries of vegetation species on the habitat form), provide instant animal status updates for use in the field, and establish the relationships between datasets. The database will be available for data entry by the end of November 2001, and data from previous years will be imported by the end of December 2001.

The above-listed protocol assessments have been used to revise data forms where necessary to improve data collection efficiency in 2002.

GENERAL DISCUSSION AND MANAGEMENT RECOMMENDATIONS

At the time of this report we are entering the last year of a large and extensive effort to facilitate an information base and a process for enhanced management of northern caribou populations and their habitats in the Mackenzie TSA (Table 2). All the necessary elements (policy direction, comprehensive inventories of habitats and focal animals, adaptive management at two spatial scales, and decision-based modeling tools) are now in place to work collaboratively toward implementation of improved decisions for both habitat and population management. The inventory reported here is fundamental to gaining support for the decisions that are made in the future and to aid in any policy revision, should that be necessary. The working hypothesis for all of this work is that the pattern of logging can alter the manner in which the moose and wolf predator-prey system can affect adult caribou survival and juvenile recruitment. Many small cut-blocks presumably fragment caribou habitat and enhance the likelihood that predation rates on caribou will increase. Conversely, a large patch strategy, which effectively concentrates moose and wolves in a more localized area, presumably provides opportunities for caribou to exist elsewhere with less risk of predation by wolves.

Although no analysis has been performed on our data yet, there are a number of observations that come to mind in considering what these data will eventually be used for and how they will either support or refute the main working hypothesis:

1) In a general way, most of our data seem consistent with the working hypothesis for the project. Few caribou locations occur in areas where habitat has been fragmented by many small cut-blocks and no caribou (of our collared population) spend prolonged periods in these areas. Notable exceptions to this pattern occur for short periods each spring when some caribou move into cut-blocks, presumably to forage on emergent forbs and herbs that are not available elsewhere. In apparent contrast to our main hypothesis, moose and caribou have been observed in the same general areas. However, this apparent overlap of the two species is only for short periods, possibly just during migration, or during winters when snow conditions are such that no advantage is afforded to caribou by moving to high elevations. Also, we recognize that overlap between these conspecifics is likely to occur in a minor way, and that our primary hypothesis addresses large increases in the magnitude of this overlap as a result of logging. From preliminary review of the mortality data collected so far, too few kills have been recorded to see much of a pattern; other than the fact that most of these kills occur when caribou are making long-range movements. Since kills will naturally occur everywhere, the only pattern that would be distinguished as being significantly associated with our hypothesis would be a change in the rate of caribou killed by wolves, and especially if those kills take place in caribou habitats that have been fragmented with moose habitat as a result of logging. Since we expect an increase in rate of kill, then it's unlikely this would be observable for prolonged periods. This "pulse" of increased mortality is therefore most likely to be observed in recently fragmented habitats. The Akie seems to have the highest adult mortality and so one might conclude this area to be the most fragmented (based on the working hypothesis). The area where most kills are occurring would indeed be classified as a high-risk area for caribou, but not because of logging-induced fragmentation. This area is naturally frequented by moose and therefore likely supports an abundant predator population. Habitat characteristics that bring all species together in this location are predominantly related to the topographical setting (a natural pass from the east to west side of the Rocky Mountains). Conversely, the more U-shaped valleys that characterize the Chase/Sustut area is where adult mortality is lowest, and the areas of predation risk seem limited to the valley bottoms of the Osilinka, Mesilinka, and Swannel Rivers (i.e., moose habitat and many cut-blocks). Caribou do not frequent these areas and there seem to be many options for caribou to make long-range movements (i.e., no topographic pinch points). This reference to topography leads to our second major observation.

2) The working hypothesis seems logical theoretically, but when one applies this theory a few major questions arise, the most puzzling of which has to do with the apparent interaction between the spatial scale of the theory (herd level) and topography (which is, of course, unique to each herd). Some topographic elements are central to seasonal movement patterns and habitat use displayed by caribou. Alpine areas,

mid-elevation areas of extensive wetlands, and migration pinch-points are the three most notable features that create unique interpretations of how our working hypothesis would play itself out in each herd area. None of these features are manageable, all are important aspects of caribou habitat, and yet our working hypothesis does not consider the interaction between these elements and the spatial scale at which we implement management of "logging pattern" (i.e., small or large patches and the spatial relationship between leave and harvest areas). Some of the more notable features are:

- Upper Swannell, Lay Creek, Wrede Creek, Sustut Lake
- Chase Mountain,
- Jackfish Lake, Adatay Lake,
- West Germansen Lake,
- Wolverine Range
- Middle and upper Akie River,
- Headwaters of the Paul River.

3) Habitat use by female caribou during the calving season is generally at higher elevations, initially in the upper ESSF, then progressing higher to alpine habitat 2-3 weeks after parturition. Male caribou apparently stay at lower elevations, presumably to take advantage of emergent vegetation during spring. Summer habitats tend to be mostly characterized by balsam-leading and alpine habitats.

4) Caribou within the three study areas exhibit movements and habitat selection that generally are not different from most of the northern caribou ecotype. They spend a large part of their lives in alpine and subalpine habitats, with apparently little use of managed landscapes. They live at these elevations in late-winter, eating terrestrial lichens on wind-blown slopes in relative safety from predators. They also have their calves there in the spring when they begin to spread out after snowmelt, existing at low densities during summer; presumably to reduce the chances of being detected by predators. Predators don't focus on these higher elevation areas because snow hampers access to alpine areas in winter, and caribou exist at low densities in summer (when access to the alpine is not hampered by snow). Alternatively, predators may simply find that hunting for prey is usually more profitable along valley bottoms. For short periods during early-winter, however, caribou also live at lower elevations in managed landscapes where they seek terrestrial lichens. Lichens occur in abundance in ecosystems that are flat, nutrient-poor, and usually characterized by poor-growing lodgepole pine. Here, it would seem, caribou live at greatest risk of predation from wolves. Nevertheless, they seem to persist in these places, apparently "tanking up" on lichens until snow accumulates to a point where digging for lichens becomes difficult. Or, it could be that the accumulating snow then affords some benefit to caribou that move to higher elevations in that this greatly reduces the risk of predation, as is commonly reported. Caribou, however, are infamous for being notoriously variable in their habitat selection year-to-year, both in how they relate to the model presented above and in the places that they inhabit. Because caribou

activities predominantly depend on the interaction between snow characteristics (notoriously variable from year-to-year in themselves) and predation, this high level of variability is not surprising. What is encouraging about this is that, if one has information on all the variables (food, predation, weather), the model seems to work fairly well; and we believe this is the case for the herds we are studying.

5) The data collected on caribou in the Akie/Ospika herd clearly indicate that the herd boundaries depicted in the Mackenzie LRMP are not consistent with the actual areas used. The herd descriptions depicted by Heard and Vagt 1998 more closely resemble the data that we have collected. Caribou from the middle Akie travel east and become part of the Pink Mountain herd. One animal from Kwadacha River appears to be part of the Kwadacha herd and all our animals from Pesika River north to Paul River belong to the Finlay herd. Most of the middle- and upper-Akie River would appear to be calving and/or summer range for the caribou that live there, while the animals in the Finlay herd do not migrate long distances between seasons.

6) We had good calf recruitment again in 2001 (both the Wolverine and Chase/Sustut herds) compared to poor recruitment in 1999. Some literature suggests that previous winter weather may cause poor recruitment even in the presence of apparently good calf production. Given that the winter of 1998/99 was one of the worst in recent years this may explain the difference between our observations of calf recruitment thus far.

APPENDIX 1. Geographic coverage of the project area - Map A

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

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

Map available for viewing at:

1011, 4th Avenue, 3rd Floor
Ministry of Water, Land, and Air Protection
Prince George, British Columbia
V2L 3H9

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 Abitibi Consolidated, Inc.

Project Coordinator: Scott McNay (Slocan) Wayne Lewis (Abitibi)

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	720952 (Activity Number), Workplan Number OPM02604

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, Williston Reservoir

Location Description:

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

MWLAP 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 Calendar of session dates -2000

APPENDIX 3B Calendar of session dates - 2001

APPENDIX 4. Data collection forms

a) Caribou survey navigation form

b) Caribou survey classification form

c) Caribou survey habitat form

d) Calving survey form

e) Capture/handling form

f) Telemetry form (also used for spring caribou calf survey)

g) Hourly weather form

h) Winter habitat form

i) Summer habitat form

j) Mortality form

k) Snow monitoring form

l) Resources Inventory Committee Wildlife sighting form

APPENDIX 4A. Caribou survey navigation form

APPENDIX 4B. Caribou survey classification form

APPENDIX 4C. Caribou survey habitat form

APPENDIX 4D. Calving survey form

APPENDIX 4E. Capture/handling form

APPENDIX 4F. Telemetry form (also used for spring caribou calf survey)

APPENDIX 4G. Hourly weather form

APPENDIX 4H. Winter habitat form

APPENDIX 4I. Summer habitat form

APPENDIX 4J. Mortality form

APPENDIX 4K. Snow monitoring form

APPENDIX 4L. Resources Inventory Committee Wildlife sighting form

APPENDIX 5A. 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: 2001 Aerial Radio-Telemetry Surveys

Survey Period: Start Date: 2000/11/05 End Date: 2001/11/02

Survey Type: Aerial Telemetry Surveys

Survey Intensity: PN $\propto$: RA $\propto$: AA ☐

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

Transport: Heli (Altoft Helicopters, Bell 206 Helicopters). **Avg Spd:** 80 Km/hr

Survey Coordinator:

First Given Name	*Second Given Name*	*Surname*
Line		Giguere

Surveyors:

First Given Name	*Second Given Name*	*Surname*
Line		Giguere
Landon		Wilson
Shannon		Walshe
Glen		Keddie
Doug		Heard
Glen		Watts
Karin		Schmidt
Keith		Connors
Pam		Hengeveld

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 5B. 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: 2001 Site Investigations (Habitat and Mortality)

Survey Period: Start Date: 2000/Nov/05 End Date: 2001/Nov/02

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: Heli (Altoft Helicopters, Bell 206 Helicopters) **Avg Spd**: 80 Km/hr

Survey Coordinator:

First Given Name	*Second Given Name*	*Surname*
Line		Giguere

Surveyors:

First Name	*Surname*	*First Name*	*Surname*
Shannon	Walshe	Jennifer	Penny
Glen	Keddie	George	Douglas
Landon	Wilson	Glen	Watts
Karin	Schmidt	Gord	Carl
Pam	Hengeveld	Westly	Luck
Jeff	Joy	Don	Doyle
Line	Giguere	Sue	Rankin
Scott	McNay	Ed	Hunt
Kathi	Zimmerman	Ian	LeBlanc
Roy	Blume	Jim	Mackenzie
Leslie	Yaremko	Leif	Scott
Greg	Altoft	Keith	Connors
Shari	Clare		

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 5C. Wildlife inventory survey description form - General: Part A (Caribou Survey)

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

Survey Name: 2001 Caribou Survey

Survey Period: Start Date: 2001/Mar/30 End Date: 2001/Apr/04

Survey Type: *Aerial Survey*

Survey Intensity: PN ∝ : RA ∝ : AA ☐

Target Taxa	**Class Level**
M - RATA	2

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

Survey Coordinator:

First Given Name	*Second Given Name*	*Surname*
Line		Giguere

Surveyors:

First Given Name	*Second Given Name*	*Surname*
Glen		Keddie
Landon		Wilson
Line		Giguere
Shannon		Walshe
Greg		Altoft

Survey Objectives: (continue on back side if needed)

1. Estimate caribou population size and composition
2. Characterize moose populations, which can then be used in conjunction with future surveys to determine population status

APPENDIX 5D. Wildlife inventory survey description form -

General: Part A (Caribou Calf Survey)

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

Survey Name: 2001 Caribou Calf Survey

Survey Period: Start Date: 2001/May/22 End Date: 2001/Jul/6

Survey Type: *Aerial Survey*

Survey Intensity: PN ∝ : RA ∝ : AA ☐

Target Taxa	**Class Level**
M - RATA	2

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

Survey Coordinator:

First Given Name	*Second Given Name*	*Surname*
Line		Giguere

Surveyors:

First Given Name	*Second Given Name*	*Surname*
Glen		Watts
Jeff		Joy
Kathi		Zimmerman
Line		Giguere
Pam		Hengeveld
Karin		Schmidt
Shari		Clare
Shannon		Walshe
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 5E. 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*
AKI01JAN	2001/01/21	2001/02/07	6 Days
CHA01JAN	2001/01/25	2001/02/04	5 Days
WOL01JAN	2001/01/28	2001/02/04	6 Days
AKI01MAR	2001/03/06	2001/03/06	1 Day
CHA01MAR	2001/03/05	2001/03/06	2 Days
WOL00MAR	2001/03/04	2001/03/05	2 Days
AKI01APR	2001/03/29	2001/04/11	2 Days
CHA01APR	2001/04/05	2001/04/26	2 Days
WOL00APR	2001/04/27	2001/04/27	1 Day
AKI01JUN	2001/06/12	2001/06/29	4 Day
CHA00JUN	2001/06/13	2001/06/30	4 Days
WOL00JUN	2001/06/14	2001/07/06	4 Days

Note: Completion of Part B of this form is only required if the survey type chosen involves animal capture during on or more specific time period(s) or capture session(s)

APPENDIX 5F. 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*		Location Description (Landscape Units)
Akie/ Ospika	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	1. Collins 2. Pesika
	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	3. Lower Ospika 4. Upper Ospika
	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	5. Davis 6. Chowika
	SWBmk:	Spruce - Willow - Birch, moist cool	7. Lower Akie
	ESSFmv4:	Engelmann Spruce - Subalpine Fir, moist very cold, Graham variant	8. Paul
	ATp:	Alpine Tundra, parkland	
Chase/ Sustut	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	1. Upper Osilinka 2. Lower Osilinka
	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	3. Tenakihi 4. Mesilinka
	SWBmk:	Spruce - Willow - Birch, moist cool	5. Carina Tomias
	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	6. Swannell 7. Aiken
	ESSFmv3:	Engelmann Spruce - Subalpine Fir, moist very cold, Omineca variant	8. Upper Ingenika 9. Lower Ingenika
	ESSFmv4:	Engelmann Spruce - Subalpine Fir, moist very cold, Graham variant	10. Factor Ross 11. Thutade
	ATp:	Alpine Tundra, parkland	
Wolverine	BWBSdk1:	Boreal White and Black Spruce, dry cool, Stikine variant	1. Manson 2. Klawli
	SBSmk1:	Sub-boreal Spruce, moist cool, Mossvale variant	3. Germansen 4. Wolverine
	SBSmk2:	Sub-boreal Spruce, moist cool, Williston variant	5. Upper Omineca 6. Lower Omineca
	SBSwk2:	Sub-boreal Spruce, wet cool, Finlay-Peace variant	7. Discovery 8. 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 6. Summary of snow station locations sampled during the winter of 2000-01 in north-central British Columbia

Study Area	Station ID#	Date Established	Priority 1 or 2*	Location Latitude	Location Longitude	General Location	Elevation (m)	Elevation Position
Akie/ Ospika	A10	11/23/00	1	57 29.25	125 09.97	Cirque Mine Rd	1747	Mountain Top
	A11	11/23/00	1	57 28.53	125 08.21	Cirque Mine Rd	1457	Mid-Slope
	A12	11/23/00	1	57 27.20	125 06.24	Cirque Mine Rd	1076	Valley Bottom
	A13	11/23/00	2	57 19.23	124 47.90	mid-Akie River	1832	Mountain Top
	A14	11/23/00	2	57 21.00	124 47.87	mid-Akie River	1518	Valley Bottom
	A15	11/23/00	2	57 14.67	123 39.32	Trimble Lake	1333	Valley Bottom
	A16	11/23/00	2	57 14.73	123 44.56	Trimble Lake	1842	Mountain Top
Chase/ Sustut	C01	11/13/99	1	56 10.30	125 10.10	Osilinka Airstrip	910	Bottom
	C06	11/26/99	1	56 14.50	125 17.00	Tenakihi Creek	1250	Mid-Slope
	C10	11/25/00	1	56 16.94	125 05.60	Jim May Creek	1850	Mountain Top
	C11	11/09/00	2	56 34.34	125 03.97	Tomias Lake	870	Valley Bottom
	C12	11/22/00	2	56 31.18	125 08.83	Tomias Lake	1870	Mountain Top
	C13	11/25/00	2	56 36.98	125 55.70	upper Swannell R	1600	Valley Bottom
	C14	11/25/00	2	56 40.32	125 43.98	Cutbank Creek	2100	Mountain Top
Wolv-erine	W20	11/15/00	1	55 41.40	124 21.97	Granite Creek	1311	Mid-Slope
	W21	11/28/00	1	55 41.99	124 19.56	Granite Creek	1900	Mountain Top
	W22	11/28/00	2	55 17.74	124 43.27	Adade Yus Mtn	2096	Mountain Top
	W23	11/15/00	1	55 39.66	124 23.72	Granite Creek	938	Valley Bottom
	W24	11/28/00	2	55 52.12	124 55.75	Nina Lk	1888	Mountain Top
	W25	11/28/00	2	55 52.48	124 50.44	Nina Lk	955	Valley Bottom
	W26	11/28/00	2	388331	6133738	Klawli Lk	1042	Valley Bottom

* Priority 1 sites were visited each session and had temperature dataloggers recording hourly temperature; Priority 2 sites were visited each season, with no temperature dataloggers

APPENDIX 7. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Map B1 - Inventory Locations of Focal Taxa and Element Occurrences:

Map B1a – Akie/Ospika Study Area

Map B1b – Chase/Sustut Study Area

Map B1c – Wolverine Study Area

Map B2 - Caribou Survey Information - Inventory Locations of Focal Taxa

Map B2a – Akie/Ospika Study Area

Map B2b – Chase/Sustut Study Area

Map B2c – Wolverine Study Area

APPENDIX 7A. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Inventory Locations of Focal Taxa and Element Occurrences:

Map B1a – Akie/Ospika Study Area

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

APPENDIX 7B. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Inventory Locations of Focal Taxa and Element Occurrences:

Map B1b – Chase/Sustut Study Area

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

APPENDIX 7C. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Inventory Locations of Focal Taxa and Element Occurrences

Map B1c – Wolverine Study Area

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

APPENDIX 7D. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Caribou Survey Information - Inventory Locations of Focal Taxa

Map B2a – Akie/Ospika Study Area

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

APPENDIX 7E. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Caribou Survey Information - Inventory Locations of Focal Taxa

Map B2b – Chase/Sustut Study Area

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

APPENDIX 7F. Position of survey sample units and locations where species were observed – Map B

An Inventory of Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia: Year 4 (2001)

Caribou Survey Information - Inventory Locations of Focal Taxa

Map B2c – Wolverine Study Area

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

APPENDIX 8. Wildlife sighting forms

APPENDIX 9. Marked animal identification form

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

Species	Age Class	Gen-der	Animal ID	Radio Freq-uencies	Mark Method	Model/Type	Serial #	Mark ID Eartag No.	Mark ID Eartag Color	Comments
M-RATA	Adult	Female	C113A	148.550	RT	Televilt GPS Collar	G01TX-038-DM	23	Yellow	Recapture
M-RATA	Adult	Female	C117A	148.000	RT	Televilt GPS Collar	G01TX-034-DM	4	Yellow	Recapture
M-RATA	Adult	Female	C098A	150.290	RT	Telemetry Solutions VHF Collar	NA	321	Yellow	Recapture
M-RATA	Adult	Female	C155A	148.612	RT	Televilt GPS Collar	G01TX-114-DM	37	Yellow	New Capture
M-RATA	Adult	Female	C114A	148.030	RT	Televilt GPS Collar	G01TX-040-DM	13	Yellow	Recapture
M-RATA	Adult	Female	C157A	149.420	RT	Televilt GPS Collar	G01TX-059-DM	319	Yellow	New Capture
M-RATA	Adult	Female	C158A	148.680	RT	Telemetry Solutions VHF Collar	NA	273	Yellow	New Capture
M-RATA	Adult	Female	C157A	148.050	RT	Televilt GPS Collar	G01TX-042-DM	119	Yellow	Recapture
M-RATA	Adult	Male	C118A	148.520	RT	Televilt GPS Collar	G01TX-045-DM	39	Yellow	Recapture
M-RATA	Adult	Male	C151A	149.540	RT	Telemetry Solutions VHF Collar	NA	222	Yellow	New Capture
M-RATA	Adult	Male	C156A	150.030	RT	Telemetry Solutions VHF Collar	NA	217	Yellow	New Capture
M-RATA	Adult	Male	C159A	148.950	RT	Telemetry Solutions VHF Collar	NA	271	Yellow	New Capture
M-RATA	Calf	Female	C171A	149.720	ES	Televilt Ear Transmitter	NA	320	Yellow	New Capture
M-RATA	Calf	Female	C174A	149.147	ES	Televilt Ear Transmitter	NA	285	Yellow	New Capture
M-RATA	Calf	Female	C188A	149.554	ES	Televilt Ear Transmitter	NA	204	Yellow	New Capture
M-RATA	Calf	Female	C195A	148.827	ES	Televilt Ear Transmitter	NA	278	Yellow	New Capture
M-RATA	Calf	Male	C173A	149.742	ES	Televilt Ear Transmitter	NA	287	Yellow	New Capture
M-RATA	Calf	Male	C196A	148.818	ES	Televilt Ear Transmitter	NA	213	Yellow	New Capture
M-RATA	Calf	Unkn	C172A	148.130	ES	Televilt Ear Transmitter	NA	295	Yellow	New Capture
M-ALAL	Adult	Female	M054A	148.740	RT	Televilt GPS Collar	G01TX-052-DM	257	Yellow	Recapture
M-ALAL	Adult	Female	M042A	151.470	RT	Telemetry Solutions VHF Collar	NA	119,30	Red,Yellow	Recapture
M-ALAL	Adult	Male	M046A	148.090	RT	Televilt GPS Collar	G01TX-052-DM	20	Yellow	Recapture
M-ALAL	Adult	Male	M053A	148.322	RT	Lotek VHF Collar	T9811022M	239	Yellow	Recapture
M-ALAL	Adult	Male	M073A	151.010	RT	Telemetry Solutions VHF Collar	NA	220	Yellow	New Capture
M-ALAL	Adult	Male	M074A	151.050	RT	Telemetry Solutions VHF Collar	6470	232	Yellow	New Capture
M-ALAL	Adult	Male	M075A	151.200	RT	Telemetry Solutions VHF Collar	6481	237	Yellow	New Capture
M-ALAL	Adult	Male	M017A	148.421	RT	Lotek VHF Collar	T9811032M	249	Yellow	Recapture
M-ALAL	Adult	Male	M015A	148.401	RT	Lotek VHF Collar	T9811030M	261	Yellow	Recapture

APPENDIX 9. (Continued)

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

Species	Age Class	Gen-der	Animal ID	Radio Freq-uencies	Mark Method	Model/Type	Serial #	Mark ID Eartag No.	Mark ID Eartag Color	Comments
M-RATA	Adult	Female	C047A	149.430	RT	Televilt GPS Collar	G01TX-060-DM	34	Yellow	Recapture
M-RATA	Adult	Female	C058C	148.540	RT	Televilt GPS Collar	G01TX-037-DM	14	Yellow	Recapture
M-RATA	Adult	Female	C060C	148.841	RT	Televilt GPS Collar	Unk	21,37	Yellow, Red	Recapture
M-RATA	Adult	Female	C067C	148.010	RT	Televilt GPS Collar	G01TX-035-DM	41,33	Red, Yellow	Recapture
M-RATA	Adult	Female	C119C	148.291	RT	Lotek VHF Collar	T9811009C	17	Yellow	Recapture
M-RATA	Adult	Female	C168A	148.882	RT	Lotek VHF Collar	T9811011C	167	Yellow	New Capture
M-RATA	Adult	Female	C047A	149.420	RT	Televilt GPS Collar	G01TX-059-DM	244	Yellow	Recapture
M-RATA	Adult	Female	C189C	148.632	RT	Televilt GPS Collar	G01TX-115-DM	318	Yellow	New Capture
M-RATA	Adult	Male	C152C	148.980	RT	Telemetry Solutions VHF Collar	NA	274	Yellow	New Capture
M-RATA	Adult	Male	C106C	149.450	RT	Televilt GPS Collar	G01TX-062-DM	42	Yellow	Recapture
M-RATA	Adult	Male	C102C	148.040	RT	Televilt GPS Collar	G01TX-040-DM	5	Yellow	Recapture
M-RATA	Adult	Male	C153C	150.310	RT	Telemetry Solutions VHF Collar	NA	266	Yellow	New Capture
M-RATA	Adult	Male	C154C	148.560	RT	Telemetry Solutions VHF Collar	NA	252	Yellow	New Capture
M-RATA	Adult	Male	C152C	150.141	RT	Lotek VHF Collar	8310	274	Yellow	Recapture
M-RATA	Adult	Male	C169C	150.160	RT	Lotek VHF Collar	T9811028C	214	Yellow	New Capture
M-RATA	Juv	Female	C085W	151.270	RT	Telemetry Solutions VHF Collar	NA	35	Yellow	Recapture
M-RATA	Calf	Female	C144C	151.460	RT	Telemetry Solutions VHF Collar - Expandable	NA	288	Yellow	Recapture
M-RATA	Calf	Female	C137C	151.450	RT	Telemetry Solutions VHF Collar - Expandable	NA	171	Yellow	Recapture
M-RATA	Calf	Female	C136C	150.920	RT	Telemetry Solutions VHF Collar - Expandable	NA	166	Yellow	Recapture
M-RATA	Calf	Female	C176C	148.167	ES	Televilt Ear Transmitter	NA	281	Yellow	New Capture
M-RATA	Calf	Female	C177C	148.646	ES	Televilt Ear Transmitter	NA	169	Yellow	New Capture
M-RATA	Calf	Female	C181C	148.866	ES	Televilt Ear Transmitter	NA	282	Yellow	New Capture
M-RATA	Calf	Female	C182C	148.787	ES	Televilt Ear Transmitter	NA	298	Yellow	New Capture
M-RATA	Calf	Female	C194C	148.617	ES	Televilt Ear Transmitter	NA	311	Yellow	New Capture
M-RATA	Calf	Male	C142C	151.430	RT	Telemetry Solutions VHF Collar - Expandable	NA	202	Yellow	Recapture
M-RATA	Calf	Male	C131C	150.400	RT	Telemetry Solutions VHF Collar - Expandable	NA	3	Yellow	Recapture
M-RATA	Calf	Male	C175C	149.702	ES	Televilt Ear Transmitter	NA	280	Yellow	New Capture
M-RATA	Calf	Male	C178C	148.857	ES	Televilt Ear Transmitter	NA	306	Yellow	New Capture
M-RATA	Calf	Male	C179C	149.509	ES	Televilt Ear Transmitter	NA	299	Yellow	New Capture
M-RATA	Calf	Male	C180C	148.810	ES	Televilt Ear Transmitter	NA	303	Yellow	New Capture
M-RATA	Calf	Male	C190C	149.493	ES	Televilt Ear Transmitter	NA	205	Yellow	New Capture
M-RATA	Calf	Male	C191C	148.182	ES	Televilt Ear Transmitter	NA	211	Yellow	New Capture
M-RATA	Calf	Male	C192C	NA	NA	NA	NA	NA	NA	Found Dead
M-ALAL	Adult	Female	M043C	148.720	RT	Televilt GPS Collar	G01TX-049-DM	10	Yellow	Recapture
M-ALAL	Adult	Male	M048C	148.750	RT	Televilt GPS Collar	G01TX-053-DM	24	Yellow	Recapture
M-ALAL	Adult	Male	M025C	149.121	RT	Lotek VHF Collar	T9811040M	288	Yellow	Recapture
M-ALAL	Adult	Male	M019C	149.041	RT	Lotek VHF Collar	T9811034M	262	Yellow	Recapture
M-ALAL	Adult	Male	M076C	151.090	RT	Telemetry Solutions VHF Collar	NA	300	Yellow	New Capture
M-ALAL	Adult	Male	M077C	151.480	RT	Telemetry Solutions VHF Collar	NA	277	Yellow	New Capture
M-ALAL	Adult	Male	M078C	151.190	RT	Telemetry Solutions VHF Collar	NA	310	Yellow	New Capture
M-CALU	Adult	Female	W033C	148.461	RT	Lotek VHF Collar	T9811060W	245	Yellow	New Capture
M-CALU	Adult	Male	W032C	149.922	RT	Lotek VHF Collar	T9811076W	247	Yellow	New Capture

APPENDIX 10. Seasonal comparison habitat sites

APPENDIX 11. Project product list

DOCUMENTATION (by year and author):

1. Becker, D. 1998. Preliminary woodland caribou habitat evaluation model for Mackenzie Timber Supply Area, British Columbia. Unpubl. Rep., Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 79 pp.

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

3. 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. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 10 pp.

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

5. 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. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 37 pp.

6. Demarchi, M. 2000. Moose inventory in and around the Tsay Keh Dene Traditional Territory February 2000. Unpubl. Report, BC Ministry of Environ., Lands, and Parks, Omineca Region, Prince George, British Columbia. 21pp.

7. Ellis, R. 2000. Mackenzie LRMP – Caribou Management Strategy modeling and adaptive management process: Status report (June 15, 2000). Unpubl. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 37pp.

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

9. Sulyma, R. 2000. A retrospective study of terrestrial lichen development in harvested areas located in the Omineca region of north central British Columbia. Unpubl. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 20pp.

10. 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. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 52 pp.

11. Zimmerman, K. In Preparation. A comparative analysis of Wildlife Habitat Interpretation Ratings in north-central British Columbia. DRAFT. 21pp.

12. McNay, R.S. 2001. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 4 (2001/02) Inventory Sampling Plan. Unpubl. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 13 pp.

13. Sulyma, R. and S. Wawryszyn. 2001. Adaptive Management Project Plan: Adaptive Management of Forestry Practices in Pine-Lichen Winter Range for Northern Caribou in North-Central British Columbia. Unpubl. Report., Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 39 pp.

14. Windle, T. and R. Sulyma. 2001. Methodology for field assessments in the project: adaptive management of forestry practices in Pine-Lichen Winter Range for northern caribou in north central British Columbia. Unpubl. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 13pp.

15. Zimmerman, K. L., R. S. McNay, J. B. Joy, and L. Giguere. 2001. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 3 (2000) Inventory Results. Unpubl. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 95 pp.

16. Zimmerman, K. L., R. S. McNay, R. Ellis, R. Sulyma, A. Walton, D. Heard, D. Seip. In Preparation. Omineca Northern Caribou Project: Modeling and Adaptive Management Process to Assist Strategic Planning, and Operational Planning in the Mackenzie LRMP. DRAFT – Oct. 2001.

PROGRESS REPORTS:

a) Vol. 1, Issue 1: Session 6 (Mar. 28 - May 8, 1999)
b) Vol. 1, Issue 2: Session 7 (May 9 - Jun. 19, 1999)
c) Vol. 1, Issue 3: Session 8 (Jun. 20 – Jul. 3, 1999)
d) Vol. 1, Issue 4: Session 9 (Sep. 12 - Oct. 23, 1999)
e) Vol. 1, Issue 5: Sessions 10-13 (Oct. 24 - Dec. 18, 1999)
f) Vol. 2, Issue 1: Sessions 1-5 (Jan. 3 – Mar. 11, 2000)
g) Vol. 2, Issue 2: Sessions 6-10 (Mar. 12 – May 20, 2000)
h) Project Update (Oct. 24, 2000)
i) Vol. 2, Issue 3: Sessions 11-18 (May 21 - Sep. 9, 2000)
j) Vol. 2, Issue 4: Sessions 19-25 (Sep. 10 - Dec. 16, 2000)
k) Vol. 3, Issue 1: Sessions 1-4 (Jan. 1 - Feb. 24, 2001)
l) Vol. 3, Issue 2: Sessions 5-7 (Feb. 25 - Apr. 7, 2001)
m) Vol. 3, Issue 3: Sessions 8-10 (Apr. 8 - May 19, 2001)
n) Vol. 3, Issue 4: Sessions 11-13 (May 20 - Jun. 30, 2001)
o) Vol. 3, Issue 5: Sessions 14-16 (Jul. 1 - Aug. 11, 2001)
p) Vol. 3, Issue 6: Sessions 17-19 (Aug. 12 - Sep. 22, 2001)

WEB SITE:

The Northern Forest Research and Extension Partnership (NFREP) hosts a website for the Omineca northern Caribou Projects at the following URL:http://www.nfrep.org/content/default.asp?NavBarID=12&SideBarID=37

Project information available at this site includes:

- Introduction
- Map of Study Sites
- Executive Summary: 2000 Inventory Results
- Progress Reports
- Wildlife Society Conference Poster
- 2000 Inventory Results Poster
- Product List and Extension Activities
- Related Papers and Links
- Slocan Forest Products Ltd. Website Link
- Abitibi Consolidated Inc. Website Link
- Forest Renewal B.C. Website Link

DATABASES:

a) Animal Captures - 1998, 1999, 2000, 2001
b) Caribou Survey - 2000, 2001
c) Moose Census - 1998, 2000
d) Caribou Calf Survey - 1999, 2000, 2001
e) VHF Telemetry Locations – 1998, 1999, 2000, 2001
f) GPS Telemetry Locations – 1999, 2000, 2001
g) Habitat Site Investigations - 1999, 2000, 2001
h) Mortality Site Investigations - 1999, 2000, 2001
i) Weather Monitoring - Snow Measurements - 1999, 2000, 2001
   Weather Monitoring - Temperature Measurements - 2000, 2001
j) Wildlife Information Management System (WIMS) - MS Access database incorporating above-listed datasets - 2001

EXTENSION ACTIVITIES AND WORKSHOPS (by date):

1. Zimmerman, K. Poster (What can radio-telemetry tell us about wildlife habitat use patterns?) and equipment display presented at the Northern Forest Products Association (NFPA) convention, April 8, 1999, Prince George, B.C.

2. Yaremko, L. Poster display (What can radio-telemetry tell us about wildlife habitat use patterns?) presented at the Mackenzie Showcase '99 trade show, May 7 - 9, 1999, Mackenzie, B.C.

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

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

5. McNay, R.S., K.L. Zimmerman, J.B. Joy, R.M. MacKinley, R.K. McCann, and L. Giguere. Poster presentation (Ecological factors affecting northern caribou in the

Omineca Region, British Columbia) to The Wildlife Society's 6th Annual Conference, Austin, Texas. September 7-11, 1999.

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

7. Marcot, B. (Senior Wildlife Biologist, USDA For. Serv. PNW Research Lab). Specialist's Tutorial (Modeling wildlife habitats using "belief" networks.) conducted for the ONCP modeling group, Portland OR. October 20, 1999.

8. Zimmerman, K.L. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.) To Slocan Forest Products, Mackenzie Woodlands Division. June 12, 1999.

9. McNay, R.S. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.) by Scott McNay to the Ministry of Forests, Mackenzie Region. November 19, 1999.

10. Zimmerman, K.L. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.). Tsay Keh Dene first nations community. December 10, 1999.

11. Zimmerman, K.L. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.). Fort Ware first nations community. December 10, 1999.

12. Northern Caribou Management Model Workshop 1. Ecological Factors Affecting Northern Caribou in the Omineca Region, B.C. Slide presentation by Kathi Zimmerman. February 16-17, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

13. Northern Caribou Management Model Working Group Meeting. Prince George, B.C. March 1-3, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

14. Northern Caribou Management Model Workshop 2. Prince George, B.C. March 16-17, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

15. Northern Caribou Management Model Workshop 3. Prince George, B.C. May 1-2, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

16. McNay, R.S. Slide presentation (Wildlife habitat interpretations: Strategic and operational planning tools.) for the community of Germansen Landing. June 5, 2000.

17. Marcot, B. (Senior Wildlife Biologist, USDA For. Serv. PNW Research Lab). Specialist's Tutorial (modeling wildlife habitats using "belief" networks) conducted for the ONCP modeling group, Mackenzie, B.C. June 6, 2000.

18. Zimmerman, K.L. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.) for the Mackenzie Forest District Office. June15, 2000.

19. Zimmerman, K.L. and R.S. McNay. Slide presentation (Ecological factors affecting northern caribou in the Omineca Region, B.C.) for Northern Caribou Biologists Meeting, Prince George, B.C. June 27-28, 2000.

20. Northern Caribou Management Model Workshop 4. Prince George, B.C. September 19, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

21. Biologist Technical Committee Meeting. Prince George, B.C. October 24, 2000.

22. McNay, R.S. Slide presentation (Wildlife habitat interpretations: Strategic and operational planning tools.) for the Mackenzie Land Use Planning Team, Mackenzie, B.C. October 25, 2000.

23. Northern Caribou Management Model Workshop 5. Prince George, B.C. November 28 - 29, 2000. Facilitator: Rick Ellis (R. Ellis & Assoc.).

24. Zimmerman, K.L. Slide presentation (From stand level to herd areas: Developing multi-scale models as a planning tool to enhance management of northern caribou.) for the North-eastern B.C. Wildlife Inventory and Research Workshop, Chetwynd, B.C. February 28, 2001.

25. McNay, R.S. Slide presentation (From stand level to herd areas: Developing multi-scale models as a planning tool to enhance management of northern caribou.) for a Habitat Supply Modeling Workshop, Richmond, B.C. February 28 - March 1, 2001.

26. Northern Caribou Management Model Workshop 6. Prince George, B.C. March 7 - 8, 2001. Facilitator: Rick Ellis (R. Ellis & Assoc.).

27. Northern Caribou Management Model Workshop 7. Caribou Ecology and Range Types. Slide presentations by Scott McNay, Adrian Walton, Kathi Zimmerman, Randy Sulyma, and Rob McCann. Prince George, B.C. May 31 - June 1, 2001. Facilitator: Rick Ellis (R. Ellis & Assoc.).

28. McNay, R.S. Slide presentation (From stand level to herd areas: Developing multi-scale models as a planning tool to enhance management of northern caribou.) to B.C. Ministry of Forests, Ft. St. James, B.C. June 12, 2001.

29. Zimmerman, K.L. Poster presentation (Omineca Northern Caribou Project: Year 3 (2000) Inventory Results.) displayed at: 1) Slocan Forest Products, Mackenzie Division; 2) Abitibi Consolidated Inc., Mackenzie Operations; 3) Germansen Landing; 4) Tsay Keh Dene; 5) Fort Ware; 6) Finbow Camp; and 7) Prince George Ministry of Water, Land and Air Protection. July 20, 2001.

30. Northern Caribou Management Model Workshop 8. Prince George, B.C. Sep. 17-18, 2001. Facilitator: Rick Ellis (R. Ellis & Assoc.).

31. Zimmerman, K.L. and R. Sulyma. Slide presentation (Implications of pine-lichen woodlands to northern caribou.) for the Association of Professional Biologists Symposium: "The Biologist in Modern Society - Balancing control of forest insects with maintenance of forest ecology", Prince George, B.C. October 13, 2001.

32. McNay, R.S. Slide presentation (From stand level to herd areas: Developing multi-scale models as a planning tool to enhance management of northern caribou.) for

the Northern Caribou Technical Advisory Committee, Prince George, B.C. Oct. 17, 2001.

33. Northern Caribou Management Model Workshop 9. Prince George, B.C. Oct. 19, 2001. Facilitator: Rick Ellis (R. Ellis & Assoc.).

34. McNay, R.S. Slide show (From habitats to herd areas: Developing multi-scale models as a planning tool to enhance management of habitat for northern caribou.) for the Mackenzie LRMP Monitoring Group Meeting, Mackenzie, B.C. Oct. 27, 2001.

35. Zimmerman, K.L. Poster presentation (Wolverine herd study area: Calving and summer range - LRMP disturbance scenario.) for the Mackenzie LRMP Monitoring Group Meeting, Mackenzie, B.C. Oct. 27, 2001.

36. McNay, R.S. Slide show (From habitats to herd areas: Developing multi-scale models as a planning tool to enhance management of habitat for northern caribou.) for the ONCP Staff Administration Meeting, Mackenzie, B.C. Oct. 30, 2001.

37. Zimmerman, K.L. Poster presentation (Wolverine herd study area: Calving and summer range - LRMP disturbance scenario.) for the ONCP Staff Administration Meeting. Mackenzie, B.C. Oct. 30, 2001.

38. Barrett, T. and R. McCann. Model development presentation (Northern caribou management model) for a GIS Working Group meeting and project introduction for B.C. Government GIS Technicians, Prince George, B.C. Nov. 16, 2001.

39. McNay, R.S. Lecture presentation (From habitats to herd areas: Developing multi-scale models as a planning tool to enhance management of habitat for northern caribou.) for UNBC Wildlife Ecology class, Prince George, B.C. Nov. 19, 2001.

40. Northern Caribou Management Model Working Group meeting. Prince George, B.C. Nov. 20, 2001.

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 - three proposals submitted November 1999 - not approved:
   - Wolf Ecology
   - Adaptive Enhancement Of Early-Winter Habitat For Northern Caribou,
   - Caribou Population Health

3. Habitat Conservation Trust Fund (HCTF) - proposal submitted November 1999 - not approved: Wolf Ecology And Predator-Prey Dynamics in the Omineca Region, British Columbia.

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

5. Environment Youth Team (EYT) application – approved, however unable to hire due to Slocan Forest Products' hiring freeze - September, 2000.

DATA CONTRIBUTIONS TO EXTERNAL PROJECTS:

1. Delong, C. In prep. Descriptions of coarse woody debris in the ecosystems of northern British Columbia. British Columbia Min. of Forests, Prince George, B.C.

2. Douglas, G.W. In prep. Rare Plants of British Columbia. British Columbia Min. of Water, Land and Air Protection, Victoria, B.C.

3. Lance, A.N. 2001. Caribou monitoring at Valleau Creek. FRBC Project #PG-45-96-0212-0. Report for Year 4 (2000). Canadian Forest Products, Ltd., Fort St. James, BC. 31pp.

4. Johnson, C.J. 2000. A multi-scale behavioural approach to understanding the movements of woodland caribou. PhD Thesis. Univ. of Northern B.C., Prince George, B.C. 210 pp.

5. Sulyma, R.G. 2001. Towards an understanding of the management of pine-lichen woodlands in the Omineca Region of British Columbia. MSc Thesis, Univ. Northern British Columbia, Prince George, B.C. 99pp.

Partnership Agreements:

- Abitibi Consolidated, Mackenzie Region (official partnership)
- B.C. Ministry of Forests (draft partnership)
- Canfor Corporation, Prince George Region (draft partnership)
- B.C. Ministry of Water, Land and Air Protection (draft partnership)
- Peace-Williston Fish and Wildlife Compensation Program (draft partnership)

APPENDIX 12. 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 1. Study statistics associated with the Omineca Northern Caribou Project located in north-central British Columbia, 2001.

Area inventoried (ha):	3,000,000
Caribou herds monitored:	3
Caribou monitored:	167
Moose monitored:	55
Wolves monitored:	11
Animal locations recorded (VHF):	6,458
Animal locations recorded (GPS estimated):	21,745
Sites Investigated (and investigations conducted):	199 (653)
Population surveys conducted:	8
Reports (administrative):	3
Reports (informative brochures):	6
Reports (technical):	2
Extension activities:	17

Table 2. Financial statistics for the Omineca Northern Caribou Project located in north-central British Columbia, 2001.

Funding Source	Spent ($)	Employment (days)	Employee Positions	Employees
FRBC	1,375,000	2571	17	19
FRBC(OH)	15,000	100	2	2
EnvYT	0	0	0	0
MWLAP (CLIB)	0	0	0	0
Abitibi	0	0	0	0
Peace/Williston F&WCP	0	0	0	0
Slocan	42,514	175	2	2
	1,432,514	2,786	21	23

REFERENCES

Antifeau, T.D. 1998. Identification of issues involved in the process of developing and applying caribou habitat suitability models. Unpubl. Report. B.C. Environment, Kootenay Region. 26 pp.

Apps, C. and T. Kinley. 1998. Development of preliminary habitat assessment and planning tool for mountain caribou in southeast British Columbia. Rangifer, Special Issue No. 10:61-72.

Armleder, H.M., S.K. Stevenson, and S.D. Walker. 1992. Estimating the abundance of arboreal forage lichens. B.C. Ministry of Forests, Land Management Handbook Field Guide Insert 7.

B.C. Ministries. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. B.C. Ministry of Forests and B.C. Environment, Victoria, B.C., Canada. 99pp.

B.C. Environment. 1996. Ft. St. James draft recommendations for an interim caribou management for the Ft. St. James Land and Resource Management Plan Planning areas. Unpub. Rep. 8 pp.

Backmeyer, R.J. 1991. Wildlife Distributions and Habitat Use South of the Peace Reach of Williston Reservoir, February 1991. Peace/Williston Fish and Wildlife Compensation Program Report No. 7. 19 pp.

Becker, D.Q. 1992. Upland furbearer problem analysis. Peace/Williston Fish and Wildlife Compensation Program Report No. 21. 35 pp. plus appendices.

Bergerud, A.T. 1974. Decline of Caribou in North America Following Settlement. J. Wildl. Manage. 38:757-770.

_______. 1978. The status and management of caribou in British Columbia. B.C. Fish and Wildlife Branch Report. Victoria, B.C.150 pp.

_______. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Proc. 2nd Internat. Reindeer/Caribou Symposium, 1979. Roros, Norway 556 – 581.

_______. 1988. Caribou declines in central and southern British Columbia. In: Page, R. (ed.) Caribou Research and Management in British Columbia: Proceedings of a workshop. B.C. Ministry of Forests, Research Branch, WHR-27. B.C. Ministry of Environment, Wildlife Branch, WR–41. Victoria, B.C. 201-225.

_______ and H.E. Butler. 1978. Life history studies of caribou in the Spatsizi Wilderness Park 1977-78. Min. of Rec. and Cons., Parks Branch, Province of British Columbia. 156 pp.

_______ and J.P. Elliot. 1986. Dynamics of caribou and wolves in north British Columbia. Can. J. Zool. 64:1515-1529.

_______. and R.E. Page. 1987. Displacement and dispersion of parturient caribou as an antipredator tactic. Can. J. Zool. 65:1597-1606.

_______, H. Butler, and D. Miller. 1984. Antipredator tactics of calving caribou: Dispersion in mountains. Can. J. Zool. 62:1566-1575.

Biggs, J.R., K.D. Bennett, and P.R. Fresquez. 2001. Relationship between home range characteristics and the probability of obtaining successful global positioning system (GPS) collar positions for elk in New Mexico. Western North American Naturalist 61: 213-222.

Blake, S., Douglas-Hamilton, I., Karesh, W. B. 2001. GPS telemetry of forest elephants in Central Africa: Results of a preliminary study. African Journal of Ecology 39: 178-186.

Bloomfield, M.I. 1980. Patterns of seasonal habitat selection exhibited by mountain caribou in central British Columbia, Canada. Pages 10-18 in: E. Reimers, E. Gaare, S. Skjenneberg (eds), Proc. 2nd Internat. Reindeer/Caribou Symp. Røros, Norway.

Boonstra, R. and A.R.E. Sinclair. 1984. Distribution and habitat use of caribou, *Rangifer tarandus caribou*, and Moose, *Alces alces andersoni*, in the Spatsizi Plateau Wilderness Area, British Columbia. Canadian Field-Naturalist 98(1):12-21.

Bradshaw, C.J.A., S. Boutin, and D.M. Hebert. 1997. Effects of petroleum exploration on woodland caribou in northeastern Alberta. J. Wildl. Manage. 61(4):1127-1133.

Brown, W.K. 1994. Synthesis/conclusions. Pp.6-1 to 6-12 *In* The Greater Jasper Ecosystem Caribou Research Project. Sentar Consultants (eds.). Stanley Technology Group, Calgary, Alberta.

Bunnell, F.L., R.S. McNay, and C.C. Shank. 1985. Trees and snow: the deposition of snow on the ground – a review and quantitative synthesis. BC Ministry of Environment and BC Ministry of Forests, Research. IWIFR-17. Victoria. 440pp.

CCLUP. 1998. 1998 Caribou strategy update. Caribou Mid-Coast Interagency Management Committee. Ministry of Environment, Lands, and Parks. William's Lake, BC. 28pp. with attachments.

Cichowski, D.B. 1989. Seasonal movements, habitat use and winter feeding ecology of woodland caribou west-central British Columbia. M. Sc. Thesis. Univ. of B.C., Vancouver, B.C. 143pp.

_______. 1996. Managing woodland caribou in west-central British Columbia. Rangifer, Special Issue No. 9:119-126.

_______. In Preparation. Recovery plan for the northern Caribou (Rangifer tarandus caribou) in the Southern Mountains National Ecological Area in British Columbia. Northern Caribou Technical Advisory Committee. Ministry of Water, Land and Air Protection, Victoria, BC. 98pp.

_______ and A. Banner. 1993. Management strategy and options for the Tweedsmuir-Entiako caribou winter range. B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 83. 48pp.

Corbould, F.B. 1993. Chase Mountain/Butler Range Caribou Inventory, March, 1993. Unpubl. Report Peace/Williston Fish and Wildlife Compensation Program. 5 pp.

COSEWIC. 2000. Canadian species at risk, November 2000. Committee on the Status of Endangered Wildlife in Canada. Environment Canada, Ottawa. 24pp.

Coxson, D.S., J. Marsh, and R. Sulyma. 1998. Factors Affecting Terrestrial Lichen Abundance in Woodland Caribou Habitat. Forest Renewal British Columbia Report OP 96029-RE; Fiscal Year 1997/98.

Cummings, H.G. 1992. Woodland caribou: Facts for forest managers. The Forestry Chronicle 68(4).

Dana, P.H. 1994. The Geographer's Craft Project. Department of Geography, The Univ. Colorado, Boulder, CO. http://www.colorado.edu/geography/gcraft/notes/gps_f.html

Darby, W.R. and W.O. Pruitt. Jr. 1984. Habitat use, movements, and grouping behavior of woodland caribou, *Rangifer tarandus caribou*, in southeastern Manitoba. J. Wildl. Manage. 98:184-190.

_______, H.R. Timmerman, J.B. Snider, K.F. Abraham, R.A. Stephanski, and C.A. Johnson. 1989. Woodland caribou in Ontario: Background to a policy. Ont. Min. Natur. Resour., Queen's Printer, Toronto. 38 pp.

Demarchi, D., L. Bonner, and C. Tolkamp. 1998. British Columbia wildlife habitat ratings standards. Review Draft, April, 1998. Wildlife Interpretations Subcommittee, Wildlife Branch, Resources Inventory Committee, Ministry of Environment Lands and Parks, Victoria, B.C. 58 pp.

Demarchi, M.W. 2000. Moose inventory in and around the Tsay Keh Dene traditional territory. B.C. Ministry of Environment, Lands, and Parks, Prince George, B.C. 24 pp.

Dyer, S.J., J.P. O'Neill, S.M. Wasel, and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. J. Wildl. Manage. 65:531-542.

Edmonds, E.J. 1988. Population status, distribution, and movements of woodland caribou in west central Alberta. Can. J. Zool. 66:817-826.

_______. 1991. Status of woodland caribou in western North America. Rangifer, Special Issues No. 7:91-107.

Edmonds, E.J. and M. Bloomfield. 1984. A study of woodland caribou (*Rangifer tarandus caribou*) in west central Alberta, 179 – 1983. Alta. Energy and Natural Resources, Fish and Wildl. Div., Edmonton, Alta. 203 pp.

Elliot, J.P. 1988. The caribou and wolves of the Horseranch Range of northeastern B.C. In: Page, R. (ed.) Caribou Research and Management in British Columbia: Proceedings of a workshop. B.C. Ministry of Forests, Research Branch, WHR-27. B.C. Ministry of Environment, Wildlife Branch, WR–41. Victoria, B.C. 135-145.

Ellis, R. 2000. 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. Report, Forest Renewal B.C., Prince George Region, Prince George, British Columbia. 10 pp.

Fancy, S.G. and R. G. White. 1987. Energy expenditures for locomotion by barren ground caribou. Can. J. Zool. 65:122 – 128.

Farnell, R. and J. McDonald. 1989. Inventory of Yukon's Wolf Lake caribou herd. Yukon Fish and Wildl. Br., Whitehorse, Yukon.

_______. 1990. The distribution, movements, demography, and habitat use of the Little Rancheria caribou herd. Yukon Fish and Wildl. Br., Whitehorse, Yukon.

_______, R. Sumanik, J. McDonald, and B. Gilroy. 1991. The distribution, movements, demography, and habitat characteristics of the Klaza caribou herd in relation to the Casino trail development, Yukon Territory. Yukon Dept. of Renewable. Res., Whitehorse, Yukon.

Fenger, M. A., D.S. Eastman, C. J. Clement, and R. E. Page. 1986. Caribou habitat use on the Level Mountain and Horseranch Ranges, British Columbia. Ministry of Environment and Parks, Wildlife Working Report #WR-8. Victoria, B.C.

Frid, A. 1998. Crater site selection by woodland caribou of the Southern Lakes herd, Yukon: Differential effects of congeneric lichen species. Abstract in 8^{th} North American Caribou Workshop, April 20 – 24, 1998. In press.

Fuller, T.K and L.B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. J. Wildl. Manage. 45(10):197-213.

Gray, D.R. 1999. Updated Status Report on the WOODLAND CARIBOU, (caribou des bois) Rangifer tarandus dawsoni and Rangifer tarandus caribou, in Canada. Committee on the Status of Endangered Wildlife in Canada. 38 pp.

Harris, A. 1996. Post-logging regeneration of reindeer lichens (*Cladina* spp.) as related to woodland caribou winter habitat. Northwest Science & Technology. Ont. Min. Natur. Resour., Thunder Bay, Ont. TR-69. 40pp.

Hatler, D.F. 1986. Studies of radio-collared caribou in the Spatsizi Wilderness Park area, British Columbia, 1980-1984. Rep. No. 3, Spatsizi Assoc. for Biol. Res., Smithers, B.C.

_____. 1989. Moose winter distribution and habitat use in the southern Williston Reservoir area, British Columbia, 1989. Peace/Williston Fish and Wildlife Compensation Program Report No. 1. 25 pp. plus appendices.

_____. 1990. Wildlife distribution and habitat use in the northern Williston Reservoir area, British Columbia, winter 1990. Peace/Williston Fish and Wildlife Compensation Program Report No. 3. 17 pp. plus appendices.

Hatter, I. 1999. A mountain caribou conservation strategy for British Columbia. B.C. Ministry of Environment, Lands, and Parks. Victoria, BC. 35pp.

Hays, R.L. and J.E. Heasley. 1985. Habitat Suitability Index modeling software for microcomputers. Western Energy and Land Use Team. U.S. Fish and Wildlife Service. 69 pp.

Heard, D. and K.L. Vagt. 1998. Caribou in British Columbia: A 1996 status report. Rangifer, Special Issue No. 10:117-123.

Hervieux, D., J. Edmonds, R. Bonar, and J. McCammon. 1996. Successful and unsuccessful attempts to resolve caribou management and timber harvesting issues in west central Alberta. Rangifer, Special Issue No. 9:185-190.

Hirst, S.M. 1990. Ungulate census of north shore and adjacent areas, Peace Arm, Williston Reservoir, March 1989. Peace/Williston Fish and Wildlife Compensation Program Report No. 2. 10 pp. plus appendices.

Holman, S.P. 1998. California wildlife habitat relationship modeling for habitat conservation plans. http://www.vestra.com/whr_usfws

Johnson, C.J. 2000. A multi-scale behavioural approach to understanding the movements of woodland caribou. PhD Thesis. Univ. of Northern B.C., Prince George, B.C. 210 pp.

Johnson, C.J. and K.L. Parker. 1996a. Foraging habits of woodland caribou, Takla Lake B.C. Unpubl. report prepared for the Wildlife Section, Ministry of Environment Lands and Parks, Prince George, B.C.

_____. 1996b. Inventory of woodland caribou habitat use in the vicinity of Takla Lake in the Fort St. James Forest District. Progress Report prepared for the Wildlife Section, Ministry of Environment Lands and Parks, Prince George, B.C.

Kansas, J.L. and R.N. Riddell. 1995. Grizzly bear habitat model for the four contiguous mountain parks, second iteration. July, 1995. Parks Canada, Alberta Region. File No. 2702A39(DW). 95 pp.

Kesting, S. and J. Teversham. 1999. Terrestrial ecosystem mapping of the Klawli study area. Forest Renewal B.C., Omineca Region, Prince George, B.C. 176pp

Kesting, S. 2000. Interim predictive ecosystem mapping of the Germansen study area. Unpubl. report. Forest Renewal B.C., Omineca Region, Prince George, B.C. 62pp.

KTPW-Geo. 2000. Terrestrial ecosystem mapping (TEM) with wildlife habitat interpretations for the Akie and Pesika landscape units of the Mackenzie timber supply area: Volume 1 – TEM. Unpubl. report. Forest Renewal B.C., Omineca Region. Prince George, B.C. 205pp.

Lance, A.N. 2001. Caribou monitoring at Valleau Creek. FRBC Project #PG-45-96-0212-0. Report for Year 4 (2000). Canadian Forest Products, Ltd., Fort St. James, BC. 31pp.

_______ and W. Eastland. 2000. Caribou monitoring at Valleau Creek. FRBC Project #PG-45-96-0212-0. Report for 1999. Canadian Forest Products, Ltd., Fort St. James, BC. 26pp.

_______ and B. Mills. 1996. Attributes of woodland caribou migration habitat in west-central British Columbia. Rangifer, Special Issues No. 9:355-364.

McNay, R.S. 1999. An inventory of ecological factors affecting northern caribou in the Omineca Region, British Columbia: 1999 Sampling plan. Unpub. Rep., Forest Renewal B.C., Omineca Region, Prince George, B.C. 37pp.

_______. 2000. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 3 (2000) Inventory Sampling Plan. Unpubl. Report, Forest Renewal B.C., Omineca Region, Prince George, B.C. 9 pp.

_______ and W. Lewis. 1998. Wildlife habitat assessment (#10251) / Wildlife migration monitoring (#10288) project collaboration details. Unpub. Rep., Forest Renewal B.C., Omineca Region, Prince George, B.C. 11 pp.

_______, J.B. Joy, and L. Giguere. 1999. Ecological Factors Affecting Northern Caribou in the Omineca Region, British Columbia. Year 1 (1998) Inventory Results. Unpubl. Report, Forest Renewal B.C., Omineca Region, Prince George, B.C. 37 pp.

MCTAC. In Preparation. Recovery plan for the mountain ecotype of Woodland Caribou (Rangifer tarandus caribou) in British Columbia. Mountain Caribou Technical Advisory Committee. Ministry of Water, Land and Air Protection, Victoria, BC. 89pp.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. Special Report Series 6. Ministry of Forests, Victoria, B.C.

MLRMP. 2000. Mackenzie land and resources management plan. http://www.luco.gov.bc.ca/slupinbc/mackenzi/home.htm

Moen, R., J. Pastor, Y. Cohen, and C.C. Schwartz. 1996. Effects of moose movement and habitat use on GPS collar performance. J. Wildl. Manage. 60:659-668.

Murray, L.J. 1992. Habitat use and seasonal movements of radio collared caribou in the Peace subregion, 1988-1990. Unpubl. Report, B.C. Environment, Ft. St. John. 61 pp. plus appendices.

O'Donoghue, M. 1996. Southern Lakes caribou recovery program, progress report 1992-1996. Yukon Territories.

Oosenbrug, S.M. and J.B. Theberge. 1980. Altitudinal movements and summer habitat preferences of woodland caribou in the Kluane ranges, Yukon Territory. Arctic 33:59-72.

Page, R. 1988. Early caribou calf mortality in northwestern British Columbia. In: Page, R. (ed.) Caribou Research and Management in British Columbia: Proceedings of a workshop. B.C. Ministry of Forests, Research Branch, WHR-27. B.C. Ministry of Environment, Wildlife Branch, WR–41. Victoria, B.C.

Paquet, M. 1997. Toward a mountain caribou management strategy for British Columbia: Background report. Ministry of Environment, Lands, and Parks. Wildlife Branch, Victoria, B.C. 72 pp.

Poole, K.G., D.C. Heard, and G. Mowat. 2000. Habitat use by woodland caribou near Takla Lake in central British Columbia. Can. J. Zool. 78:1552-1561.

Racey, G.D., K. Abraham, W.R. Darby, H.R. Timmerman, and Q. Day. 1991. Can woodland caribou and the forest industry coexist: The Ontario scene. Rangifer, Special Issue No. 7:108-115.

Racey, G.D. and T. Armstrong. 1998. Woodland caribou occupancy in northwestern Ontario: Past and present. Unpubl. Report Ontario Ministry of Natural Resources. 33pp.

Rayner, M.R. and K.J. Bennett. 1985. Ecological land classification based wildlife habitat evaluation in west-central Alberta: Woodland caribou winter habitat suitability. In: Stelfox, H.A. and G.R. Ironside (eds.) Land/Wildlife integration no. 3: Proceedings of a technical workshop, September 1985. Ecological Land Classification Series, Lands Directorate, Environment Canada.

Reed, R. A., J. Johnson-Barnard, and W.L. Baker. 1996. Contribution of roads to forest fragmentation in the Rocky Mountains. Conservation Biology 10(4).

Resources Inventory Committee. 1997a. Standards for broad terrestrial ecosystem classification and mapping for British Columbia. Review Draft. Ministry of Environment, Lands, and Parks. Victoria, B.C. 244 pp.

_______. 1997b. Standard inventory methodologies for components of British Columbia's biodiversity: Aerial based inventory techniques for selected ungulates. Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 1997c. Live animal capture and handling: Guidelines for wild mammals, birds, amphibians & reptiles: Standards for components of British Columbia's Biodiversity No. 3. Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 1998a. Standard for terrestrial ecosystem mapping in British Columbia. Resources Inventory Committee. Ecosystems Working Group. Victoria, B.C. 97 pp. (http://www.for.gov.bc.ca/ric)

_______. 1998b. Standardized inventory methodologies for components of British Columbia's biodiversity: Introduction to RIC wildlife species inventory. Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 1998c. Inventory dataforms for species inventory fundamentals: Standards for components of British Columbia's biodiversity No. 1 (Forms). Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 1998d. Aerial inventory dataforms for selected ungulates: Bison, Mountain Goat, Mountain Sheep, Moose, Elk, Deer and Caribou: Standards for components of British Columbia's biodiversity No. 32 (Forms). Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 1998e. Field manual for describing terrestrial ecosystems: Standards for components of British Columbia's Biodiversity No. 25. Ministry of Environment, Lands, and Parks. Victoria, B.C.

_______. 2000. Standards for predictive ecosystem mapping (PEM) - Digital data capture. Predictive Ecosystem Technical Standards and Database Manual. Version 1.0. Ministry of Environment, Lands, and Parks. Victoria, B.C.

Ritchie, C.D. 1991. Wildlife survey summary report. Unpubl. Report. B.C. Environment, Prince George Region. 4 pp.

_______. 1992. Kennedy Siding caribou survey. Unpubl. Report. B.C. Environment, Prince George Region. 4 pp.

Rock, T.W. 1992. A proposal for the management of woodland caribou in Saskatchewan. Forestry Canada. 28 pp.

Rominger, E.M. and J.L. Oldemeyer. 1989. Early-winter habitat of woodland caribou, Selkirk Mountains, British Columbia. J. Wildl. Manage. 53(1):238-243.

Russell, D.L. and A.M. Martell. 1984. Winter range ecology of caribou (*Rangifer tarandus*). Pp. 117-144 *In* Northern ecology and resource management. Univ. Alta. Press. Edmonton.

Seip, D.R. 1989. Caribou – moose – wolf interaction in central British Columbia. *In:* Wolf-Prey Dynamics and Management – Proceedings. Wildlife Working Report No. WR-40: 57 -69

_______. 1991. Predation and caribou populations. Rangifer Special Issue No. 7:46-52.

_______. 1992. Habitat use and population status of woodland caribou in the Quesnel Highlands. B.C. Wildlife Branch, Wildlife Bulletin No. B-71, Victoria, B.C.

_______. 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. Can. J. Zool 70:1494 – 1503.

_______. 1998. Ecosystem management and the conservation of caribou habitat in British Columbia. Rangifer, Special Issue No. 10:203 – 211.

_______ and D.B. Cichowski. 1996. Population ecology of caribou in British Columbia. Rangifer, Special Issue No, 9, 73-80.

Shoesmith, M.W. and D.R. Storey. 1977. Movements and associated behavior of woodland caribou in central Manitoba. Proc. Int. Congr. Game Biol. 13:51-64.

Simpson, K. 1985. The effects of snowmobiling on winter range use by mountain caribou. Ministry of Environment and Parks, Wildlife Branch. Wildlife Working Report WR-25. 13 pp.

Simpson, K., K. Hebert, and G. P. Woods. 1987. Critical habitats of caribou (*Rangifer tarandus caribou*) in the mountains of southern British Columbia. Wildl. Working Rep. No. WR-23. B.C. Ministry of Environment and Parks, Nelson, B.C.

Simpson, K., E. Terry, and D. Hamilton. 1997. Toward a mountain caribou management strategy for British Columbia – habitat requirements and sub-population status. Ministry of Environment, Lands, and Parks. Wildlife Branch, Victoria, B.C. Wildlife Working Report No. WR-90. 29 pp.

Stevenson, S.K. 1991. Forestry and caribou in British Columbia. Rangifer, Special Issue No. 7:124-129.

_______ and D. Hatler. 1985. Woodland caribou and their habitat in southern and central British Columbia. B.C. Ministry of Forests, Land Management Report Number 23. Vol. I &II. 355 pp. and 112 pp.

_______, H.M. Armleder, M.J. Jull, D.G. King, E.L. Terry, G.S. Watts, B.N. McLellan, and K.N. Child. 1994. Mountain caribou in managed forests: Preliminary recommendations for managers. B.C. Ministry of Forests Research Branch. Victoria, B.C. 33pp.

Steventon, J.D. 1996. Caribou habitat use in the Chelaslie River migration corridor and recommendations for management. B.C. Ministry of Forests, Land Management Handbook No. 37.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert, and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. J. Wildl. Manage. 61(2):622-633.

Terry, E. and R. Handler. 1998. Aerial ungulate survey - Finlay River. Unpubl. Report. B.C. Ministry of Environment, Lands and Parks, Prince George Region. 9pp.

_______ and M. Wood. 1999. Seasonal movements and habitat selection by woodland caribou in the Omineca Mountains, north-central British Columbia. Phase 2:1994-1997. Peace/Williston Fish and Wildlife Compensation Program Report No. 204. 36 pp.

University of California. 1998. Developing a predictive approach for relating landscape attributes to carnivore distribution: A case study in the Greater Yellowstone. (http://www.best.com/~worktree/f/90/277f.htm)

Unsworth, J.W., F.A. Leban, E.O. Garton, D.J. Leptich, and P. Zager. 1998. Aerial Survey: User's Manual. Electronic Edition. Idaho Department of Fish & Game, Boise, ID.

Van Ballenberghe, V. 1985. Wolf predation on caribou: The Nelchina Herd case history. J. Wildl. Manage. 49(3):711-720.

Walsh, N.E., S.G. Fancy, T.R. McCabe and L.F. Pank. 1992. Habitat use by the Porcupine caribou herd during predicted insect harassment. J. Wildl. Manage. 56(3):465-473.

Watts, G.S. 1990. Wrede Range, Ingenika Range, and Lay Range survey. Unpubl. Report. B.C. Environment, Prince George Region. 8 pp. plus appendices.

Watts, G.S. and K.N. Child. 1986. Survey of caribou and mountain goats in the Lawyers Pass Area (M.U. 7-39). Unpubl. Report. B.C. Environment, Prince George Region. 10 pp.

Waypoint Consulting Inc. 2000. GrafNav/GrafNet and GrafNav Lite. Operating Manual version 6.02. 271 pp.

Weir, R. D. and A.S. Harestad. 1997. Landscape-level selectivity by fishers in south-central British Columbia. *In*: Martes: Taxonomy, ecology, techniques, and management. Prov. Museum of Alta. Edmonton, Alta. 252-264.

White, R.G. and J. Trudell. 1980. Habitat preference and forage consumption by reindeer and caribou near Atkasook, Alaska. Arctic and Alpine Research 12(4):511-529.

Wood, M.D. 1993. Wolverine Range woodland caribou inventory, February, 1993. Peace/Williston Fish and Wildlife Compensation Program. Rep. No. 25. 4 pp.

_______. 1994. Muskwa Range (east of Finlay River) winter ungulate inventory. March 1994. Peace/Williston Fish and Wildlife Compensation Program Report No. 32. 6pp.

_______. 1996. Seasonal habitat use and movements of woodland caribou in the Omineca Mountains, north central British Columbia, 1991-1993. Rangifer, Special Issues No. 9:365-378.

_______. 1996. Omineca Mountains Woodland Caribou Study. B.C. Hydro. Peace/Williston Fish and Wildlife Compensation Program. Presentation to Mackenzie Land and Resource Management Planning Table.

_______. 1998. Inventory of woodland caribou on the Wolverine Mountain Range, March, 1996. Peace/Williston Fish and Wildlife Compensation Program Report No. 128. 16 pp. plus appendices.

_______ and P.E. Hengeveld. 1998. Woodland caribou inventory in the Upper Moberly River and McAllister Creek drainages, March 1996. Peace/Williston Fish and Wildlife Compensation Program Report No. 183. 13 pp. plus appendices.

_______ and E. Terry. 1999. Seasonal movements and habitat selection by woodland caribou in the Omineca Mountains, North-central British Columbia. Phase 1: The Chase and Wolverine herds (1991-1994). Peace/Williston Fish and Wildlife Compensation Program Report No. 201. 41 pp.

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. Report, Forest Renewal B.C., Omineca Region, Prince George, B.C. 52 pp.