



INFORMATION NOTE

Monitoring the Distribution of Radio-collared Caribou and Wolves in North-central British Columbia

FRASER MACDONALD¹

MARCH 2009

¹Wildlife Infometrics Inc., PO Box 308, Mackenzie, BC, V0J 2C0, wild_info@wildlifeinfometrics.com

Prepared for Canadian Forest Products Ltd., Mackenzie Division Contract #FIA08-773002-01 (Monitoring)

CITATION: MacDonald, F. 2009. Monitoring the distribution of radio-collared caribou and wolves in north-central British Columbia. Wildlife Infometrics Inc. Report No. 313. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

ABSTRACT

Radio-collared caribou (*Rangifer tarandus caribou*) and wolves (*Canis lupus*) within the Wolverine and Chase caribou herd areas were relocated on six occasions from May 24, 2008 to March 21, 2009 for the purposes of tracking their general spatial positions and to confirm their status as either dead or alive. In total, the telemetry crews collected 269 relocations and located seven collared caribou mortalities for subsequent investigation on a related FIA Forest Science Program project (Y093065). Due to an extended period of no snowfall in mid winter the distribution of caribou was different from that observed in previous monitoring projects during the mid to late winter months. Approximately half the caribou continued using low-elevation winter range instead of moving to high-elevation winter range. In late February and early March, field crew caught and replaced radio-collars on one caribou and established new collars for the first time on 26 caribou and 12 wolves. The animals that did not previously have collars were from three new wolf packs and possibly one new group of caribou apparently unknown to us in recent years. The total number of active radio-collars at year end was 73 caribou and 18 wolves.

ACKNOWLEDGMENTS

The study was funded by the BC Forest Investment Account Land-Based Investment Program and completed under contract to Canadian Forest Products, Ltd – Mackenzie Operations. We'd specifically like to thank Russ Laroche and Dan Szekely for their management and administration of the project funding. We also would like to thank: Nick and Mary Hawes of Lakes District Air Services; Altoft helicopters, pilots Greg Altoft and Ryan Madley along with Brad Culling and Glen Watts for performing excellent capture work; and Vicky Podarenko for her dispatch services. Telemetry biologists included Line Giguere and Fraser MacDonald. Animal handlers included Randy Sulyma, Adam Dillabough, Duane Kryschuk, and Fraser MacDonald. Appreciation also goes out to Jerry MacDermott for his knowledge and assistance with ground trapping wolves. Many thanks to Harold Patenaude, Jordy McAuley and the staff of Finlay River Outfitters as well as Ron and Ruth Repko for providing us with accommodations in the field.

TABLE OF CONTENTS

ABSTRACT	i
ACKNOWLEDGMENTS	ii
LIST OF tables	iv
LIST OF FIGURES	iv
INTRODUCTION	1
Background	1
Monitoring and Capture Objectives	1
STUDY AREAS.....	2
Wolverine	3
Chase.....	3
METHODS.....	4
Capture	4
Monitoring	5
RESULTS.....	6
Capture	6
Monitoring	7
DISCUSSION	8
Capture	8
Monitoring	10
RECOMMENDATIONS.....	10
LITERATURE CITED	11

LIST OF TABLES

Table 1. A Summary of animals captures (caribou and wolf) made from 2007 to 2009 in the Chase and Wolverine caribou herd areas of north-central British Columbia.....	7
Table 2. A summary of the 2008/09 flights conducted to monitor fate of radio-collared animals in the Chase and Wolverine herd areas of north-central British Columbia.	9

LIST OF FIGURES

Figure 1. Location of recovery plan areas (RPA) for herds (Wolverine, Chase, Takla, and Scott) of threatened woodland caribou in north central British Columbia.....	2
Figure 2. Radio collared caribou from Swannell Mountains, Chase herd area, March 2009.	5
Figure 3. Locations of animal captures (caribou and wolf) conducted during February and March 2009 in the Wolverine and Chase caribou herd areas of north-central British Columbia.....	8

INTRODUCTION

Background

Woodland caribou (*Rangifer tarandus caribou*) in north-central British Columbia (BC) have been regularly monitored to determine habitat selection and to aid the development of population estimates for the herds occupying that area (Giguere and McNay 2007, Rankin and McNay 2007). The purpose for monitoring caribou in the same general area was to establish the fate (i.e., alive or dead) of collared animals in the Chase and Wolverine caribou herds as part of a larger FIA Forest Science Program Project Y082065 entitled “*The use of adaptive management to mitigate risk of predation for woodland caribou in north-central British Columbia*”. Wolves (*Canis lupus*) were also monitored to aid the establishment of pack boundaries, determine pack size, and locate kill sites.

The larger project was to provide a comparison of two population recovery treatments and one experimental control treatment subjected to three different caribou herds in north-central BC. The first treatment implemented was an increased harvest on moose (*Alces alces*) within the Parsnip herd area south of Mackenzie where current moose population levels have historically supported a large wolf population. The Parsnip study is managed by the Ministry of Environment. The second treatment implemented was the direct removal of wolves through regulated trapping in the Chase herd area. The removal of wolves was intended to lessen the direct impact of wolf predation on caribou. The Wolverine herd area received no treatment and therefore was intended to act as the experimental control area. All mortalities to radio-collared animals within the study areas were investigated to determine the cause of death. In order to establish how caribou populations are responding to the treatments, caribou population surveys (Giguere and McNay 2007) were completed in each study area during late winter and spring and fall calving surveys were completed to determine recruitment.

Monitoring and Capture Objectives

As part of this larger project, my objectives were to:

1. deploy radio transmitter collars on caribou within the Chase and Wolverine caribou herds such that, and to the extent practicable, 5-10% of the estimated population was collared with collared animals being relatively evenly distributed among all caribou groups;
2. deploy radio transmitter collars on wolves within the Chase and Wolverine caribou herds areas such that, and to the extent practicable, all wolf packs would be represented by collared animals; and
3. monitor the status of deployed collars and their spatial locations.

STUDY AREAS

Monitoring of radio-collared animals and animal captures occurred within the Wolverine and Chase study areas (Figure 1), which are essentially the recovery planning areas (RPAs, McNay et al. 2008) for the two herds described by Heard and Vagt (1998). The Wolverine herd derived its name from the Wolverine Range, a range of mountains running north-south located on the south end of the study area, east of the Williston Reservoir. The Chase herd was named after Chase Mountain, which is centrally located within the Chase study area.

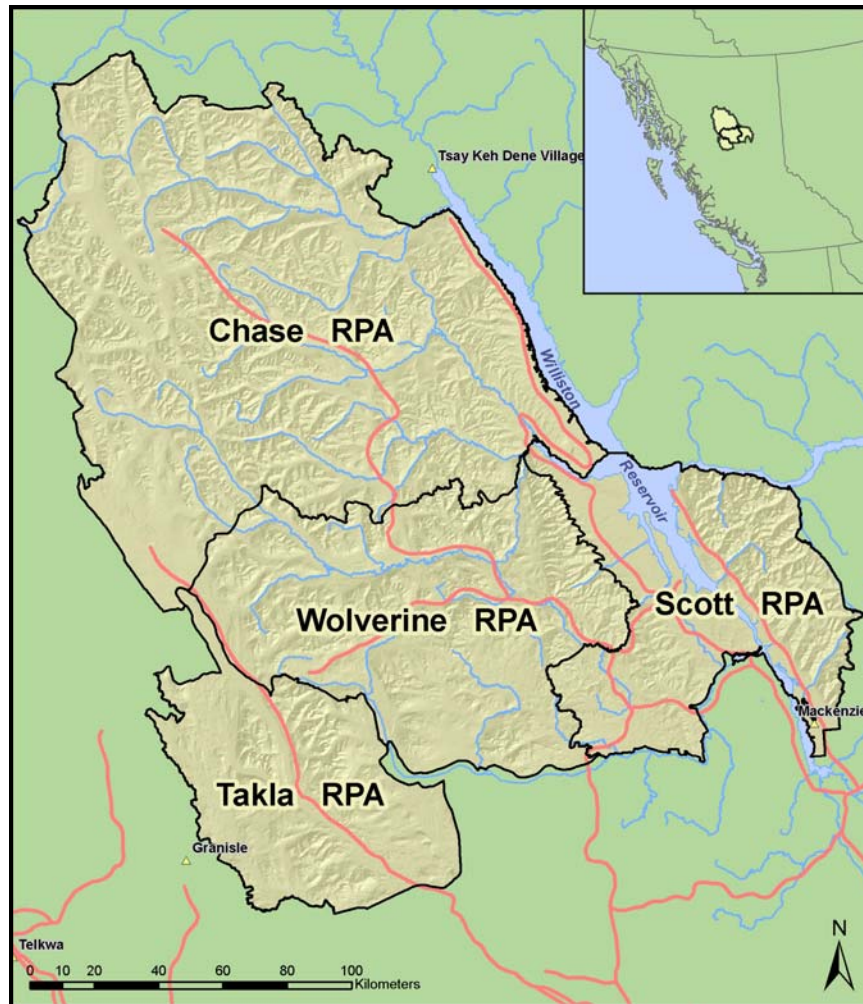


Figure 1. Location of recovery plan areas (RPA) for herds (Wolverine, Chase, Takla, and Scott) of threatened woodland caribou in north central British Columbia.

Wolverine

The Wolverine RPA is 844,313 ha, ranging in elevation from 676 to 2134m in rolling high-elevation foothills, and includes four major watersheds of the Omineca, Manson, Klawli, and Germansen Rivers. It is roughly bounded in the north by the headwaters of Goat, Nina, and Big Creeks, in the west by Takla, Tsayta, and Indata lakes, in the south by Tchentlo, and Chuchi lakes, and in the east by Sylvester and Gaffney creeks and the eastern slopes of the Wolverine Mountain Range.

The Wolverine RPA is located within the Sub-Boreal Interior Ecoprovince and the Omineca Mountains Ecoregion. The northern half of the RPA is included within the Southern Omineca Mountains Ecoregion, while the southern half of the RPA is within the Manson Plateau Ecoregion (Demarchi 1993). At low- to mid-elevations, the Wolverine Recovery Planning area is dominated by a Boreal White and Black Spruce subzone (BWBSdk1), two of the Sub-Boreal Spruce subzones (SBSmk1 and SBSmk2 variants), and an Engelmen Spruce-Subalpine Fir subzone (ESSFmv3) dominates the mid- to high-elevations. The Alpine Tundra (AT) prevails above tree line. Extensive areas within the study area have been managed for production of timber. Regulated hunting of mature bull caribou occurs in the northern half of the Wolverine study area for 12 weeks beginning every August 15th. Regulated hunting was discontinued in the southern portion of the Wolverine area prior to 1981. Hunting by aboriginal people is permitted in the entire study area.

Chase

The Chase RPA is 1,733,039 ha situated in steep mountainous terrain ranging in elevation from 671 to 2466m, and has three major watersheds including the Ingenika, Osilinka, and Mesilinka Rivers. It is roughly bounded in the north by the most northerly portion of the Finlay River, in the west by Thutade, Sustut and Driftwood rivers, in the south by Ominicetla Creek, back end of Osilinka River, headwater of Wasi and Flegez creeks, and in the east by the Williston Reservoir.

The Chase RPA is located within the Sub-Boreal Interior Ecoprovince and is composed of two Ecoregions; the Northern Mountains and Plateaus Ecoregion in the north and the Omineca Mountains Ecoregion in the south. The Cassiar Ranges Ecoregion encompasses the north part of the Chase Recovery Planning Area, while the Southern Omineca Mountains Ecoregion is found in the south part (Demarchi 1993). At low- to mid-elevations, the Chase Recovery Planning Area is dominated by the BWBSdk1 and SBSmk2 biogeoclimatic variants, and at mid- to high-elevations the ESSF Omineca variant (ESSFmv3) predominates. The Alpine Tundra (At) prevails above the tree line. Regulated hunting of mature bull caribou occurs in the Chase study area for 12 weeks beginning every August 15th. Hunting by aboriginal people is permitted throughout the entire study area.

METHODS

Capture

Caribou and wolf captures were conducted from a Bell 206 helicopter operated by an experienced pilot. All captures except one live-trapped wolf were done during the annual winter population census, February 24-March 6, 2009, that was part of the larger project. Captures and sample collection were permitted by a British Columbia Ministry of Environment permit (permit # V107-35799). The purpose of these captures was to place radio transmitters on 5-10% of the animals in each caribou herd so that transmitters were well distributed among all known groups of caribou. We also wanted to fix radio transmitters on at least 2 wolves within each known pack adjacent to the removal zone. If the occurrence of animals aligned with the suitable topographic and weather conditions, the pilot landed the helicopter and removed the doors, all excess gear, and the two animal handlers so that only the pilot and net gunner remained in the helicopter. Removing the excess weight increased the manoeuvrability of the helicopter. The pilot and net gunner then singled out one animal and using a net propelled by a modified rifle action (either .303 British or .308 calibre blank cartridges) netted the animal. Once the animal was netted the net gunner was dropped off to secure the animal and the pilot returned to pick up the handlers so they could assist processing the animal. Animals were processed in <15 minutes. First the net was taken off the animal and the caribou was blindfolded and hobbled. Then a collar and ear tag were affixed, followed by the collection of blood, skin and hair samples. Measurements (total length, chest girth, neck girth, shoulder height, hind foot length, hind hoof width and length) were recorded and notes on the condition of the animal (teeth, reproductive condition, scarring) were observed and recorded. The animal was then released and relocated within two-three weeks of capture to ensure that capture myopathy (Cattet et al. 2005) had not occurred. During capture the chase never exceeded the RIC guidelines for the live capture and radio collaring of wild mammals (BC MELP-1 1998).

Only female caribou were captured because the larger project objectives were focused on estimating population productivity and recruitment. Any previously collared caribou that had collars that emitted a weak or irregular signal had their collars replaced.

Both female and male wolves were captured since it was difficult to determine sex from the air. Therefore if a capture opportunity was presented it was taken. Wolves were captured using the immobilizing drug Telezol[®] (Fort Dodge Animal Health, Fort Dodge, Iowa) delivered intramuscularly either remotely with a dart or directly with a syringe. The darting system used was the Pnuedart^{INC} cartridge-fired system (Pneu-Dart Inc., Williamsport, Pennsylvania). Wolves were occasionally net gunned as well in order to slow them down which allowed for darts to be placed more accurately. After the target animal was netted well, the helicopter landed and the animal restrained using a forked stick placed over the neck. The immobilization drug was usually delivered by hand using a syringe because the internal charges in Pnuedarts were subject to failure.

Wolves were also captured using ground trapping methods. Ground trapping involved the placement of rubber padded Brawn No. 9 wolf traps in areas frequented by wolves. A large chain with a grapple on one end was attached to the trap so that when a wolf was caught the grapple would "hang up" and not allow the wolf to travel far. Once set

traps were checked daily in accordance with RIC standards (BC MELP-1 1998). If a wolf was found in a trap, it was immobilized using Telezol[®] delivered remotely with a Pneudart^{INC}. Then, the wolf was collared and information was collected in the same manner as described above. Ground trapping for wolves was done during late fall/early winter and mid winter to avoid capturing bears. Scents, rather than bait were used as the attractant.

The collars placed on caribou were LOTEK (Lotek Wireless Inc., Newmarket, Ontario) LMRT-4 transmitting a Very High Frequency (VHF) radio signal. Collars placed on wolves were either LOTEK LMRT-4 VHF or LOTEK Global Positioning System (GPS) 4400. VHF collars transmit non stop and were guaranteed to last for 4 years. The GPS collars were programmed to transmit a VHF signal for 8 hours a day and to take a GPS fix every 3 hours. The LOTEK GPS collars were guaranteed to transmit VHF signals for 2 years and were downloadable remotely in the field from aircraft using a UHF receiver. All collars were tested to ensure proper functioning prior to deployment. Mortality investigations on collared animals always included an inspection to determine if the collar had any effect on the animal's health.



Figure 2. Radio collared caribou from Swannell Mountains, Chase herd area, March 2009.

Monitoring

Monitoring of radio-collared caribou and wolves was completed remotely through aerial radio telemetry using either a Cessna 185 or Cessna 182 single engine fix-winged aircraft. All telemetry was performed between May 2008 and March 2009 on an irregular schedule that was dependent on availability of funds, aircraft, suitable weather, and priority periods when predation risk was highest for caribou. During the winter months the plane was affixed with landing gear composed of retractable wheel/skis to facilitate

landing on snow covered airstrips and for additional safety in the event of an engine failure. The aircraft was fitted with two directional-wing antennas and one non-directional, pod antenna mounted on the belly of the aircraft. Radio-transmitted signals from collared animals were heard in the form of a VHF pulse at either 60 beats per minute (BPM) for an active animals or 120 BPM for stationary animals. We presumed the latter to be either a dropped collar or animal mortalities. GPS collars emitted VHF pulses at lower rates to conserve battery power, either 48 BPM for an active animal or 96 BPM for a stationary collar. Both types of collars were designed to switch to the higher pulse rates after 8 hours of inactivity. Location of collars was determined by adjusting the gain on the LOTEK SRX_400 telemetry receiver and by manipulating the directional antennas.

Animal locations were recorded in form of UTM (Universal Transverse Mercator grid, NAD 83) positions along with the time and ancillary information regarding habitat and weather. Age, sex, activity, and a total group count were also recorded when it was possible. Locations of collared animals were given different status depending on how precisely the location was determined. Precision of relocations was assumed to be 100 m or 250 m for a visual or fix, respectively. Precision for a general position was assumed to be >250 m - 1000 m and a relocation recorded as "heard" (i.e., the signal was heard but no location recorded) had no associated precision. Weather was often the influential factor in determining the positional precision (i.e., visual, fix, general, or heard). Although no location was recorded for heard signals, the information was useful in determining the animal's status (alive or dead). Telemetry methods followed the British Columbia Resource Inventory Committee (RIC) Guidelines for radio telemetry (BC MELP-2 1998).

RESULTS

Capture

Twenty-six new caribou were captured in 2009 and 1 caribou was re-collared (Table 1). Of the 27 caribou collared, 2 were in the Wolverine herd area and 25 were within the Chase herd area (Figure 3). Four of the caribou were caught in low elevation pine-lichen winter range, while the remaining 23 were caught in the alpine at high elevation. Two of the caribou collars were added to a previously un-collared group on Mt. Melvin in the North end of the Chase herd area. The total number of caribou collared in the past 3 capture sessions was 80. Currently there are 73 active caribou collars, 28 collars are in the Wolverine herd area and 45 are in the Chase herd area. Based on the 2008 population estimates for the Wolverine and Chase herds of 381 and 556 animals respectively (McNay and Giguere 2008), the 28 collared animals in the Wolverine herd represented 7.3% of the population and the 45 collared animals in the Chase herd represented 8.1% of the population.

Twelve new wolves were collared in 2009 (Table 1). Two of the collars were added to the Blue Lake pack for which we had historical information (Appendix A). Three more collars were added to the previously unknown Manson pack. The remaining 3 collars were added to the Germansen pack. In the Chase herd area four of the collars were added to the Ingenika-Swannell Pack, for which there was only historical data before. It

is noteworthy that this pack was found in the alpine on two separate caribou kills. There were 18 active wolf collars after the 2009 capture session, 12 were in 4 packs within the Wolverine herd area and 6 were in 3 packs within the Chase herd area (Figure 3).

Capture crews experienced 100% success in the capture of caribou (i.e., none were missed and none died of capture myopathy). Capture was attempted on 15 wolves and 12 of them were successfully captured and collared for a success rate of 80%. All of the newly collared wolves have been relocated during post capture telemetry flights.

Table 1. A Summary of animals captures (caribou and wolf) made from 2007 to 2009 in the Chase and Wolverine caribou herd areas of north-central British Columbia.

Herd area	Year	Caribou					Wolf				
		New	Replaced	Captured	Inactive*	Active	VHF	GPS	Captured	Inactive*	Active
Wolverine	2006	NA	NA	NA	NA	16	0	0	NA	NA	0
	2007	6	9	15	4(0)	18	1	2	3	1(1)	2
	2008	13	1	14	2(0)	29	2	3	5	0(1)	6
	2009	2	0	2	3(0)	28	4	4	8	0(2)	12
	Total	21	10	31	8(0)		7	9	16	1(4)	
Chase	2006	NA	NA	NA	NA	16	0	0	NA	NA	0
	2007	4	7	11	5(0)	15	0	1	1	0(0)	1
	2008	12	1	13	2(0)	25	2	2	4	1(1)	4
	2009	24	1	25	4(0)	45	2	2	4	1(1)	6
	Total	40	9	49	11(0)		4	5	9	2(2)	
Total	61	19	80	19(0)		11	14	25	3(6)		

2006 data were prior to commencement of study

* Confirmed dead (missing/dropped collar)

Monitoring

I flew 110.7 hours during the monitoring of the Wolverine and Chase caribou herds in 2008/09 (Table 2). Of that time, 88.8 were flown performing actual telemetry, and the remainder was ferry time. Two hundred and sixty-nine positive animal relocations were determined and 94 animals were heard during flights. During the mid to late winter months of 2008/09 the spatial distribution of collared caribou differed from the distribution seen in other monitoring projects; approximately half the caribou continued using low-elevation winter range instead of moving to high-elevation winter range.

During fixed wing telemetry flights crews discovered seven collared caribou mortalities (Table 1). Three of the collared caribou mortalities were in the Wolverine herd area and four were in the Chase herd area. Six of the mortalities were a result of wolf predation, while one was a hunter kill (McNay et al. 2009). One wolf collar was found on mortality, but was determined to be a dropped collar upon investigation. No collared animals died as a result of the collar having adverse effects on their health.

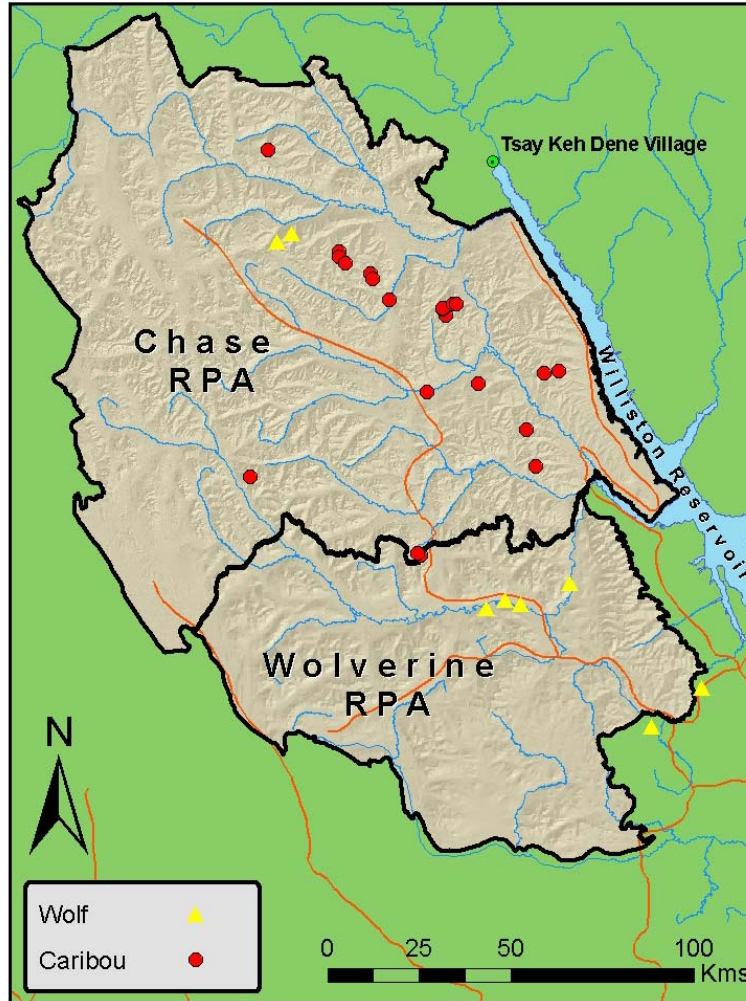


Figure 3. Locations of animal captures (caribou and wolf) conducted during February and March 2009 in the Wolverine and Chase caribou herd areas of north-central British Columbia.

DISCUSSION

Capture

The first objective was met by deploying 27 caribou collars; 2 in the Wolverine herd area and 25 in the Chase herd area to bring the number of active collared animals up to 28 (7.3%) in the Wolverine and 45 (8.1%) in the Chase. These collars were deployed in a fairly broad distribution.

Table 2. A summary of the 2008/09 flights conducted to monitor fate of radio-collared animals in the Chase and Wolverine herd areas of north-central British Columbia.

Flight Session	Date	Time b/w Flight Sessions (days)	Total Flight Time (hours)	Total Telemetry Time* (hours)	Number of Relocations (visual, fix or general location)	Collars Heard (heard but not relocated)
6	2009/03/21	28	5.5	4.0	0	90
	2009/02/20		1.7	0.5	1	0
5	2009/02/19	59	6	3.0	9	0
	2009/02/18		7.6	5.3	18	0
	2009/02/17		7.2	6.0	27	0
4	2008/12/19	45	5.5	3.6	21	0
	2008/12/18		6.3	6.0	25	1
	2008/12/17		0.7	0.3	1	0
	2008/12/13		3.6	2.7	6	0
3	2008/10/28	116	5	1.9	2	2
	2008/10/27		8.2	7.5	27	1
	2008/10/26		7.6	8.2	18	0
	2008/10/25		1	0	0	0
2	2008/06/30	31	7.4	7.1	22	0
	2008/06/29		6.7	5.9	17	0
	2008/06/28		5.1	4	10	0
	2008/06/27		3.1	1.9	7	0
1	2008/05/26	56	5.4	5.1	10	0
	2008/05/25		12.3	11.4	32	0
	2008/05/24		4.8	4.4	16	0
Total		Average = 61.4 days	110.7	88.8	269	94

The second objective was only partially met by deploying 12 wolf collars to bring the total number of active collars in the Wolverine herd area to 12 and 6 in the Chase. These 18 active collars were distributed among 7 distinct wolf packs however; we currently estimate 17-18 wolf packs within the herd areas (McNay et al. 2009).

Wildlife Infometrics has been involved with caribou captures since 1999 and has never had a caribou die from capture myopathy. Post capture telemetry flights found that all recently collared animals were alive. Net gunning, when done by experienced professionals, is a live-capture method that produces only low stress on captured animals. The animal is caught quickly and handled quickly. Once the blindfold is placed on the animal it becomes quite calm. Net gunning has proven to be superior to drugging for capture of caribou as the available drugs tend to be hard on both their nervous and muscular systems.

There are several explanations for the difference in capture success rates between caribou and wolves. Caribou are more easily found than wolves in open alpine and meadow areas, sink deeper in snow if pursued, and are larger than wolves. In addition there are no drugs used with caribou so success does not rely on a dart being delivered properly. Wolves are more able to seek proximity to obstacles and other sources of shelter from capture and learn about capture attempts thereby being even more elusive on subsequent capture attempts.

Monitoring

The objective to effectively monitor the status and spatial location of collared animals was achieved successfully with 269 positive animal relocations being determined in 2008/09 (Table 2). In addition, 8 collared animal mortalities were found and subsequently investigated. The observed difference in the spatial distribution of the collared caribou in mid to late winter of 2008/09 from the distribution seen in past years was likely due to an extended period of no snowfall during the mid-winter months.

The scheduling of flights was often difficult and led to considerable variance in duration between samples. Scheduling difficulties arose due to a combination of inclement weather, particularly during winter, and availability of the aircraft. Adding to the difficulty was the lack of accurate weather forecasts for the study area. It was not uncommon to encounter several different weather systems during one flight due to the size and mountainous terrain of the study areas. Regardless of these problems, the telemetry was always completed and flying was never pushed beyond safe limits. For the purposes of this study, a consistent schedule was not necessary as long as flights were close enough together that we could determine the animal's status. We knew from previous work that the crucial times of the year for monitoring mortalities was when caribou travel from high-elevation summer range, through valley bottoms, back to high-elevation winter range and flights were conducted during these times.

Despite having a plane with wheels and skis, pre-planned fuel locations could not always be used due to snow conditions. Therefore other less efficient fuel caches were required which contributed to more ferry time than anticipated.

RECOMMENDATIONS

In the future, having the runway at Osilinka maintained through the winter would be beneficial. This airstrip is located centrally within the study areas, has been relied on for the past decade of monitoring radio-collared animals, and has only recently been left unattended during winter months. Since the airstrip is adjacent to a road that is maintained year round it would seem efficient to arrange for the necessary maintenance. Although it's unlikely possible, more flexibility around scheduling flights (i.e., increased availability of fixed-wing aircrafts) would create more regular updates of animal status. The number of flights seemed adequate to serve our objectives.

LITERATURE CITED

- BC Ministry of Environment Lands and Parks (BC MELP-1). 1998. Live Animal Capture and Handling Guidelines for Wild Mammals, Birds, Amphibians and Reptiles. Standards for components of British Columbia's Diversity No. 3. Version 2. BC Resource Inventory Committee, Ministry of Environment, Lands and Parks, Victoria, British Columbia, Canada.
- BC Ministry of Environment Lands and Parks (BC MELP-2). 1998. Wildlife Radio Telemetry. Standards for Components of British Columbia's Diversity No.5. Version 2. BC Resource Inventory Committee, Ministry of Environment, Lands and Parks, Victoria, British Columbia, Canada.
- Cattet, M., T. Shury and R. Petenaude. 2005. The Chemical Immobilization of Wildlife. Second edition. Canadian Association of Zoo and Wildlife Veterinarians. 231pp.
- Demarchi, D.A. 1993. Ecoregions of British Columbia. Third edition. Province of British Columbia, Ministry of Environment, Lands, and Parks, Wildlife Branch, Victoria, British Columbia Canada.
- Giguere L. and R. S. McNay. 2007. Abundance and distribution of woodland caribou in the Chase, Wolverine, and Scott recovery plan areas. Wildlife Infometrics Inc. Report No. 225. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada
- Heard, D. C., and K. L. Vagt. 1998. Caribou in British Columbia: a 1996 status report. Rangifer, Special Issue No. 10:117-123.
- McNay, R. S. and L. Giguere. 2008. Population Estimates and Distribution of the Wolverine and Chase Caribou Herds in North-central British Columbia. Wildlife Infometrics Inc. Report No. 269. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.
- McNay R. S., F. MacDonald and L. Giguere. 2009. Mitigating risk of predation for woodland caribou in north-central British Columbia. Wildlife Infometrics Inc. Report No. 314. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.
- McNay, S., D. Heard, R. Sulyma, and R. Ellis. 2008. A recovery action plan for northern caribou herds in north-central British Columbia. FORREX Forest Research Extension Partnership, Kamloops, British Columbia. FORREX Series 22.
- Rankin, L. M. and R. S. McNay. 2007. An assessment of modeled high-elevation winter range in woodland caribou herd areas of north-central British Columbia. Wildlife Infometrics Inc. Report No. 224. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.