Quesnel Highland Wolf Project Progress Report

November 2005 – March 2010

By Lara Roorda[1]

and

Randy Wright

[1] RPBio # 1913

Abstract

Following the project lapse in 2004, full support of the Quesnel Highland wolf sterilization and reduction program was received through the provincial Mountain Caribou Recovery Strategy in December of 2007. Since December 2007, wolf collaring, monitoring, sterilization and removal have resulted in a reduction of the wolf population by approximately 50%. The 2010 wolf density of 5.5 wolves/1000km^2 in the active control area is now below the recommended threshold of 6.5 wolves/1000km^2 reported by Bergerud (2007). Ten of the packs within the study area have been successfully sterilized. A significant amount of time and funding has been dedicated to achieve these sterilization and density objectives. Without continued support, the effectiveness of this program to help recover Mountain Caribou will remain unknown. Additional time and funding is still required to properly assess the results of wolf density reduction program and the response of the mountain caribou population to fewer wolves on the landscape.

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Introduction

In May 2000, Woodland caribou (*Rangifer tarandus caribou*) within the Southern Mountains National Ecological Area (SMNEA) were nationally listed as threatened by COSEWIC. According to direction received by the mountain caribou recovery strategy (MCTAC 2002), a recovery implementation plan for the Hart and Cariboo Mountains Recovery Area was produced (RIG 2005). This recovery implementation plan (RIP) identified 8 Mountain Caribou sub-populations within the Hart and Cariboo Mountains recovery area. The Science team divided the sub-populations into separate herds and then grouped the herd areas into planning units based on regional management boundaries. The Quesnel Highland planning unit (5-B) falls within Region 5 and contains both the Wells Gray North (7a) and Barkerville (9) caribou herds (Figure 1). Bowron Lake Park also falls within Region 5 boundaries but is considered part of the Upper Fraser Planning Unit (5-A) and North Cariboo Mountains caribou herd.

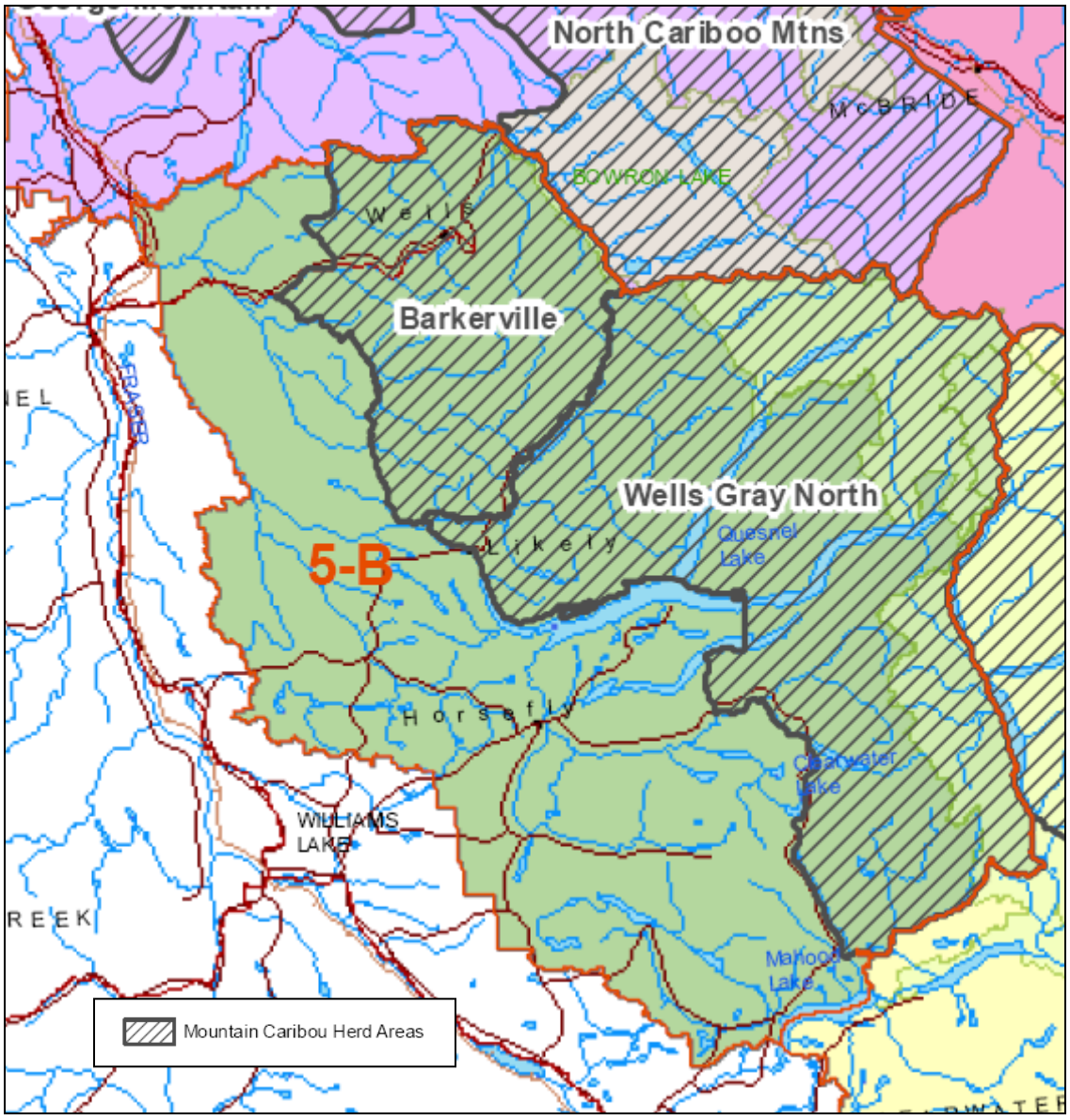


Figure 1. Mountain Caribou Planning Unit (MCPU) 5-B, entitled Quesnel Highland as outlined by SARCO Mountain Caribou Recovery Strategy, 2006.

The Mountain Caribou Science Team defined and mapped mountain caribou core habitat (for all seasons), movement corridors and matrix habitat. Matrix habitat was defined as habitat adjacent to core caribou habitat and is the source of predators that impact caribou populations (MCST 2006). In Region 5, the 2006 (WGN, Barkerville and North Cariboo Mountains) Mountain Caribou population estimate was 340 animals (Freeman and Stalberg 2006). This estimate was comprised of the Wells Gray North sub-population of 240 individuals, the Barkerville sub-population of 50 animals and approximately 50 caribou from the Bowron census block which is a small portion of the North Caribou Mountains sub-population. The 20 year objective is to recover regional Mountain Caribou numbers to the 1995 estimate of approximately 400 animals (300 in Wells Gray North, and 50 in each of the Barkerville and Bowron census blocks). The long term (60+ year) Mountain Caribou objective is to establish habitat conditions that allow a self-sustaining caribou population without the need for ongoing predator control (RIG 2005). However, recommendations were presented to immediately implement caribou recovery within the Cariboo Region. These recommendations involve all aspects of caribou recovery including zoning of backcountry recreation, modified timber harvest techniques, as well as the management of early seral ungulate habitats, alternate prey species and predators**.**

Background

The primary cause of declining mountain caribou populations in B.C. is predation (Seip 1992, Bergerud and Elliot 1998, Youds 2002, Wittmer et al 2005). Within the Quesnel Highland (5-B) planning unit caribou calf recruitment from 1995 to 2001 was predominately below population stabilizing levels (<15% calves), largely due to wolf predation (Young and Freeman 2001). Wolves' territorial behavior makes them well suited to fertility control because mated pairs will maintain and defend territories from other wolves, reducing the rate of re-colonization by other wolves. The combination of fertility control of dominant wolves and sub-dominant lethal control may be the most effective method to recover the Wells Gray North Mountain Caribou herds and maintain the Barkerville herd . Ultimately, reduced wolf numbers should result in a reduced predation rate on caribou, allowing the herd to increase annually (Farnell and McDonald 1988, Boertje et al. 1996, Bergerud and Elliot 1998). There is hope that if the core Mountain Caribou habitat and surrounding matrix areas are returned to a more natural seral distribution, populations within this planning unit will eventually become self-sustaining, eliminating the need for predator and primary prey control (RIG 2005, MCST 2006).

The initial phase of the Quesnel Highland wolf project occurred between June 2001 and March 2004 in conjunction with an ongoing caribou inventory and habitat utilization study. The primary objective was to radio-collar as many wolf packs as possible within the study area and monitor how wolf habitat use and pack territories overlapped with the radio-collared Mountain Caribou. The secondary objectives were to decrease wolf reproductive rates by sterilizing dominant animals and eventually reduce the size of wolf packs found to be negatively impacting Mountain Caribou. During this initial phase of the project a total of 27 wolves were radio collared; of which 9 males and 7 females were sterilized. These twenty-seven wolves constituted 11 different packs (Roorda and Wright 2004). Within the study area the wolf population was estimated at between 69 and 93 wolves in 2001 and between 52 and 65 wolves in March 2004. Thirty wolves were removed[2] from the study area during this period. From 2002-2004, wolf removal and sterilizations in 6 separate packs contributed to the overall decline in wolf density. Caribou calf recruitment in March 2004 averaged 17.4% in the five census blocks (Figure 2), which is above Bergerud's stabilizing recruitment level of 15% (Bergerud 1992). From 2002-2004, wolf sterilizations resulted in 11 instances of no-pup production.

Acknowledgements

We would like to thank Lawrence Aviation for safely piloting the telemetry flights, Bighorn Helicopters for their professional wolf capture services and the Williams Lake Veterinary Clinic for performing sterilizations and necropsies.

[2] Wolf "removal" from the study area was defined as any confirmed wolf mortality, regardless of cause.

Study Area

The study area (Wildlife Management Units 5-15 and 5-16) is located within south central British Columbia, east of Williams Lake, and includes portions of the Quesnel Highland, Bowron Valley and Cariboo Mountains Ecosections. The Bowron Valley and Quesnel Highland Ecosections are in the Columbia Highlands Ecoregion, while the Cariboo Mountains Ecosection is located within the Northern Columbia Mountains Ecoregion; all are within the Southern Interior Mountains Ecoprovince. Perviously the study area has been defined by the five caribou census blocks; Barkerville, Stevenson, Bowron, Junction and Upper Horsefly and totaled approximately 9,540 km^2 in area. The study area was modified as a result of SaRCO's designation of Mountain Caribou Planning Units and the delineation of caribou core and matrix habitats. The study area now consists of 8,830km^2 and encompasses all core and matrix caribou habitat within the Quesnel Highland (5-B) Mountain Caribou Planning Unit, including the Barkervillle, Stevenson, Junction and Horsefly census blocks (Figure 2). The Bowron Census block is also of interest as it lies within the Region 5 boundary, but is outside the Quesnel Highland Mountain Caribou Planning Unit.

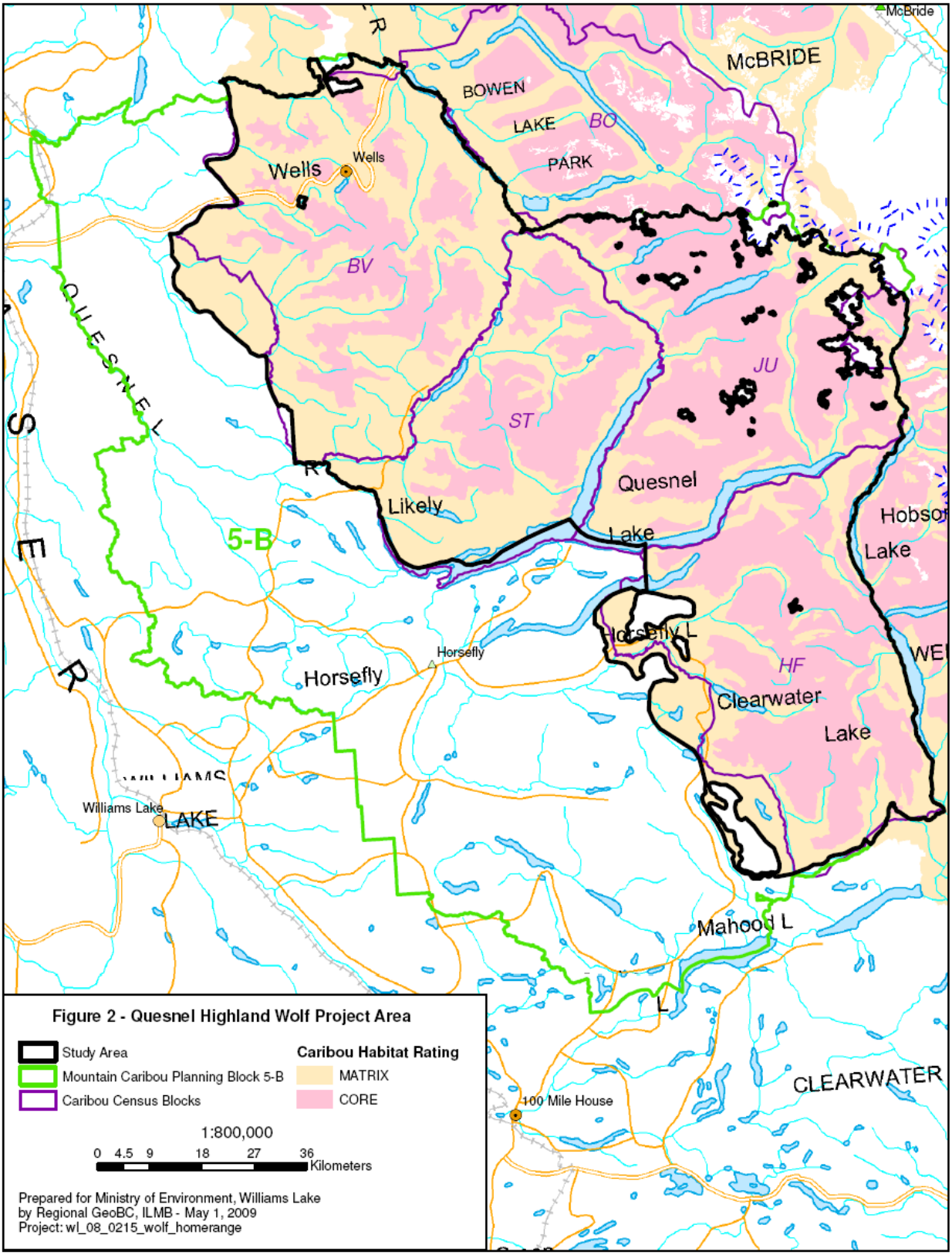
Wet climate and relatively high winter snow depths characterize this mountainous area, with winter snow depths exceeding 2 m in the mountains. Climatic moisture increases in an easterly direction and with elevation. Continuous, extensive high elevation caribou winter ranges occur on rounded sub-alpine mountain tops throughout the Quesnel Highland and Bowron Valley Ecosections. Within the higher and increased rugged terrain of the more easterly Cariboo Mountains, high elevation caribou winter ranges are present, but are more restricted and discontinuous in nature. The area is comprised of several biogeoclimatic zones including the Alpine Tundra (AT), Engelmann Spruce Sub alpine Fir (ESSF), Interior Cedar Hemlock (ICH) and Sub-Boreal Spruce (SBS) zones.

At lower elevations within the Bowron Valley Ecosection, the Sub-Boreal Spruce biogeoclimatic zone (SBS) dominates, while in the valley bottoms Quesnel Highland and Caribou Mountains Ecosections, the Interior Cedar-Hemlock zone (ICH) occurs at elevations below approximately 1250 meters (Figure 2). The Engelmann Spruce-Sub alpine Fir (ESSF) zone occurs at mid elevations within all three Ecosections, ranging from 1250 meters to about 2000 meters. Within the study area the ESSF zone is usually divided into three sub zones, with continuous forest at its lower (ESSF wk) and middle (ESSF wc) elevations and sub alpine parkland (ESSF wcp) at its upper elevations. The division point between the lower and middle sub zones is usually 1500 meters elevation while the division point between the middle and upper sub zones is approximately 1800 meters. The sub alpine parkland sub zone is transitional between true forest and alpine units and extends to about 2000 meters in elevation.

The SBS zone is dominated by stands of hybrid white spruce (*Picea engelmannii x glauca*) and sub alpine fir (*Abies lasiocarpa*), but lodgepole pine (*Pinus contorta*) and Douglas fir (*Pseudotsuga menziesii*) are often present in varying amounts. The main shrubs present are black huckleberry (*Vaccinium membranaceum*), birch-leafed spirea (*Spiraea betulifolia*), falsebox (*Paxistima myrsinites*) and thimbleberry (*Rubus parviflorus*).

The forest of the ICH zone is dominated by western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*), but hybrid white spruce, sub alpine fir, lodgepole pine and Douglas-fir are present on some sites. The shrub layer is moderately developed, with black huckleberry, oval-leafed blueberry (*Vaccinium ovalifolium*), falsebox, devil's club (*Oplopanax horridus*), thimbleberry, and black twinberry (*Lonicera involucrata*) being some of the more common shrubs.

The lower sub zone of the ESSF is dominated by closed stands of Engelmann spruce (*Picea engelmannii*) with some sub alpine fir present, whereas the middle sub zone is dominated by more open stands of sub alpine fir. The shrub layer of these two sub zones is generally moderately well developed, and contains varying amounts of white-flowered rhododendron (*Rhododendron albiflorum*), black huckleberry, black gooseberry (*Ribes lacustre*) and oval-leafed blueberry. In the upper sub zone clumps of sub alpine fir occur together with areas of heath and meadow.


McBride
McBRIDE
BOWEN
LAKE
PARK
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Wells
Wells
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QUESNEL
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5-B
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Horsefly
HF
Clearwater
Lake
Williams Lake
LAKE
Mahood L
100 Mile House
CLEARWATER
Figure 2 - Quesnel Highland Wolf Project Area
Study Area
Mountain Caribou Planning Block 5-B
Caribou Census Blocks
Caribou Habitat Rating
MATRIX
CORE
1:800,000
0 4.5 9 18 27 36
Kilometers
Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 1, 2009
Project: wl_08_0215_wolf_homerange

Methods

Wolves collared between 2005 and 2010 were either captured on the ground, or net gunned from helicopter. Telemetry relocations were obtained (in UTMs) using a GPS unit during Cessna 182 fixed wing flights (Standards for Components of British Columbia's Biodiversity No.5, 1998). Wolf dominance was determined by examining size, age and individual behavior as well as pack behavior. At times, the decision was made to also sterilize sub-dominant wolves in order to increase the number of radio-collars animals in each pack without increasing the potential for pup production within the pack.

In the absence of GPS collar pack data, year round ground trapping was attempted after determining an individual wolf pack's travel routes and cycle time (period of days or weeks in which the pack will return to a specific area). Establishment of cycle time often involved frequent ground visits to record wolf activity patterns and potential territory boundaries within specified areas. Ideally, each road was traveled every 3rd or 4th day with a four-wheel drive vehicle or snow machine. Observed sign and its approximate age were recorded and the location was identified with a portable GPS unit or map. This technique reduced trapping effort, as traps were only set when the probability was high that the pack or individual wolves would frequent the trap site in the near future. The use of special lures and their placement at the trap sites targeted the dominant males and females, increasing the probability that they would be the first wolves trapped. Bait stations involving road killed moose and deer were often established during the winter months and traps are set once wolves have visited the sites and fed on the baits.

Downloaded GPS collar data was used to locate den sites for trapping and pup removal when possible. In the spring and early summer, locating the den site and trapping on the roads in the vicinity of the den increased trapping success of dominant wolves for sterilization and sub-dominant animals for removal purposes.

Ground trapped wolves were sedated with the drug Telezol, muzzled, blind-folded and restrained (Standards for Components of British Columbia's Biodiversity No. 3, 1998 and Canadian Council on Animal Care, 2003). The sex, condition and approximate ages were determined, and animals were then fitted with Lotek VHF or GPS 4400 radio-collars. Sub-dominant wolves were either removed or released depending on their age, size and the number of collars already present in the pack.

When funding and timing allowed, baits (both horse and moose) were slung onto frozen lakes and cut-blocks throughout the study area with a Jet Ranger helicopter prior to arrival of helicopter capture crews. This was intended to attract wolves to open habitats to increase capture success. Helicopter captured wolves were net-gunned from a Hughes 500 helicopter. The animals were then restrained with a forked stick (to immobilize the head), removed from the net, hobbled, muzzled and blind-folded. At this time non-target, sub-dominant wolves were removed if necessary, and sterilization candidates were transported via helicopter to a road accessible location where the ground team placed the wolves in cages for transport to the Williams Lake Veterinary Hospital. Sterilized wolves underwent tubal ligations (females) or vasectomies (males) prior to collaring and release. Surgery time for these procedures was approximately one hour per wolf. Sterilized animals were monitored overnight at the veterinary hospital and released the following morning at or near the capture site. If capture crew time was limited, sub-dominant animals were sometimes fitted with a radio-collar and released immediately without undergoing surgical sterilization. For areas not easily accessible by road, sterilized wolves were again restrained, blind-folded and transported by the helicopter crew to the capture location for release.

Deployed Lotek VHF and GPS 4400 radio-collars are equipped with a motion sensor that alters the pulse frequency to allow identification of immobile animals. GPS 4400 collars were programmed with a schedule to obtain locations every two to eight hours and are remotely downloadable. Collared wolf mortalities were retrieved and a necropsy performed whenever funding and conditions allowed. Due to the often infrequent nature of aerial monitoring, some animals were not retrieved quickly enough to determine cause of death.

Project Costs

Wolf project costs from November 22, 2005 to March 31, 2010 totaled $670,420 (Table 1). Additional contributions from the Ministry Environment are not outlined in this chart but included the project leader's time and salary, fuel costs, trailer, snow machines, ATVs and equipment repairs.

An additional $73,740.82 was spent on two separate Mountain Caribou Inventories during this time period. All five census blocks were flown in March 2006 ($46,177.82) and the three census blocks of the Wells Gray North sub-population ($27,563) were surveyed in March 2010. A one day calf recruitment flight over the Junction and Stevenson blocks was conducted in March 2008 ($5,000).

As part of the alternated prey reduction strategy initiative $96,650 was spent on stratified random block moose inventories within MU 5-15A, B and C (2008).

Table 1. Quesnel Highland wolf project costs for December 2005 to March 31, 2009.

Period	Amount
December 2005 - March 2006	$36,763
April - July 2006 & August 2006 - March 2007	$25,918 + $47,237
May 2007 – April 2008	$284,890
April 2008 – March 2009	$204,420
April 2009 – March 2010	$71,192
Total	**$670,420**

Results

The Quesnel Highland wolf management program was halted due to lack of funding in April 2004. During this hiatus, 5 radio-collared wolves dispersed, 5 died and 1 collar failed, reducing the number of radio-collared wolves to four (one sterilized), within four separate packs (Roorda and Wright 2006). In December 2007, limited funding was provided following the project lapse, specifically to ground trap and monitor radio-collared wolves. As a result of reduced funding, only six wolves were captured and radio-collared between November 2005 and March 2007, resulting in a total of 9 radio-collared animals representing 6 of the 13 known wolf packs (Roorda and Wright 2007). No wolf sterilizations or removal occurred between April 2005 and March 2007, allowing the wolf population to increase substantially.

In December of 2007 the Ministry of Environment (Mountain Caribou Recovery Program) began to provide funding and endorsed the remaining components of the wolf program, including radio-collaring (VHF and GPS), wolf sterilization, and removal of sub-dominant animals. In order to achieve and maintain a wolf density less than the suggested 6.5 wolves/1000km2 (Bergerud 2007), the ultimate goal was to radio-collar and sterilize three animals (including at least one dominant) from each pack within the study area and to reduce the average pack size to 3 or 4 animals.

Between March 2007 and March 2009 intensive capture, sterilization and removal work was accomplished. Over these two fiscal years 74 wolves were captured in the study area. Forty of these wolves were radio-collared, 31 were sterilized and 34 were removed (Roorda and Wright 2008 and 2009). Detailed knowledge of pack territories, reproductive status and wolf numbers was acquired and wolf densities were successfully reduced.

In 2010, an unseasonably warm winter resulted in very poor ground trapping and helicopter capture conditions. In late March 2010, many study area lakes were no longer frozen, snow depths were minimal or non-existent and (where present) snow conditions were hard packed. Four wolves (2 male and 2 female) were net-gunned, sterilized, radio-collared and released (Table 2). These wolves represented three separate packs and all four are believed to be dominant members. Fourteen wolves were removed.

Table 2. Wolves collared for the Quesnel Highland wolf project during the 2009/2010 fiscal year.

ID	Freq.	Collar Type	Capture Date	Pack	Sterilization	Sex	Status in Pack
Olive	151.108	GPS	Mar-23-10	Niagara	Yes	F	Dominant
Popeye	150.240	VHF	Mar-23-10	Niagara	Yes	M	Dominant
George	150.465	VHF	Mar-23-10	Cariboo R.	Yes	M	Dominant
Blue	150.349	GPS	Mar-24-10	Crooked Lk.	Yes	F	Dominant

A number of unsuccessful fall and winter ground trapping sessions were conducted to collar and sterilize Peters Creek and Pendelton pack members. Winter freeze/thaw conditions coupled with increased pack wariness from previous trapping attempts may have contributed to low trapping success this fiscal year.

Denning and Sterilization

During the project lapse in April 2004 and until sterilization work was re-initiated in December of 2007, all dominant sterile wolves within the study area were eliminated. Cause of death and/or reason for dispersal for these wolves was undetermined. During the late winter of 2007/2008 project effort resulted in the successful sterilization of five of the project wolf packs.

During the 2008/2009 fiscal year, 10 of the 13 radio-collared packs were successfully sterilized prior to the 2009 breeding season, resulting in only two of the packs producing pups in the spring of 2009. During the 2009/2010 fiscal year, two un-sterilized radio-collared packs (Peters Creek and HenIngram) within the study area produced pups. Funding for spring den work was not available, resulting in an increased wolf

recruitment of approximately 4 pups in each of these two packs. The den for the GPS collared Peters Creek wolf pack was located but pups were mobile by July and the den had been abandoned. The HenIngram wolves were not GPS collared and no telemetry flights were conducted during the spring of 2009 to pinpoint the den site. Confirmation of pup absence for the Bowron wolf pack was not investigated due to limited flight time funding and the location of the pack's territory largely outside of the Quesnel Highland MCPU.

In the winter of 2010, four wolves were sterilized from three separate packs, resulting in a total of 10 sterile packs with 20 sterile, collared members. As a result of dominant wolf sterilization, 10 of the 13 core wolf packs are not expected to produce pups in the spring of 2010 (Table 3). After collaring and monitoring, the Patenaude and HenIngram wolf packs were found to reside outside, or almost entirely outside the core and matrix habitat of the study area. As these two packs increase, they will provide dispersers into the study area, and/or increase the probability of collared wolf mortalities within adjoining sterile packs. Larger packs have been observed displacing smaller packs and on occasion kill dominant or sub-dominant pack members.

Table 3. Fertility status of Quesenel Highland wolf packs in March 2010.

Pack	Pack Fertility Status	# members sterilized (sex)	# collars in pack	Collar type
Swift	Sterile	1(F)	1	VHF
Peters Creek	Fertile	2 (M/F)	2	1GPS[3]/1VHF
Keithley	Sterile	2 (M/F)	3	3VHF
Wasko	Sterile	1 (F)	1	VHF
Cariboo River	Sterile	3 (M/F/F)	3	2VHF/1GPS[4]
Sellars	Sterile	2 (M/F)	2	1GPS[5]/1VHF
Wartig	Sterile	1 (M)	1	VHF
Gotchen	Sterile	2 (M/F)	2	1GPS/1VHF
Crooked	Sterile	2 (F/F)	2	1VHF/1GPS
Hobson	Sterile	2 (M/F)	2	1VHF/1GPS
Bowron	Sterile	2 (M/M)	2	2VHF
Archer	Fertile	0	0	
Pendelton	Fertile	0	0	
HenIngram	Fertile	0	3	3VHF
Patenaude	Unknown	1 (M)	1	VHF

[3] GPS collar on subdominant male has likely failed, though it's possible this male has dispersed.
[4] GPS collar on subdominant female has failed, visual confirmation that she is still with the pack.
[5] GPS collared male has either dispersed or his collar has failed.

Aerial and GPS Relocation Data

During this reporting period a total of 99 aerial wolf relocations, 1 aerial caribou relocation and 8 general geographic locations for caribou (to confirm collar status) were obtained (Appendix 1). Downloaded GPS data has been obtained from the Sellars, Cariboo River, Gotchen, Keithley, Wasco, Swift and Peters Creek packs. Wolf pack kernel home ranges defined by both VHF and GPS locations can be seen in Figure 3 and individual wolf pack ranges and relocations can be founding Appendix 2. The six GPS 4400 collars active in the 09/10 fiscal year successfully recorded 2964 three dimensional fixes (Table 4).

Table 4. Three dimensional fixes from the GPS 4400 wolf radio-collars within the Quesnel Highland study area active during the 2009-2010 fiscal year.

Collar ID	Frequency	Pack	Dates active this fiscal year	# successful fixes	Status
1864	151.129	Wasco	Apr-01-09 to Aug-14-2010	334	Dispersed
1678	150.161	Cariboo R.	Apr-01-09 to Aug-14-2010	349	Failed
1671	150.030	Peters Cr.	Apr-01-09 to Oct-15-2010	606	Failed
1859	151.069	Swift	Jul-01-10 to Sept-11-2010	226	(see Keithley)
1860	151.010	Sellars	Apr-01-09 to Aug-14-2010	359	Failed/Dispersed
1679	151.129	Gotchen	Apr-01-09 to Jan-13-2010	850	Active
1859	151.069	Keithley	Apr-01-09 to Ju-30-2010	240	Died[6]
Total				**2964**	

During the 2009-2010 fiscal year one GPS collared wolf died (collar retrieved) and four either failed or dispersed. Due to the poor winter capture conditions, it was not possible to observe or retrieve GPS collars with failed VHF beacons. Two additional GPS 4400 were deployed on wolves from the Niagara and Crooked wolf packs in March 2010.

[6] The Keithley male joined up with aVHF collared Swift wolf in July until his death in September 2010.

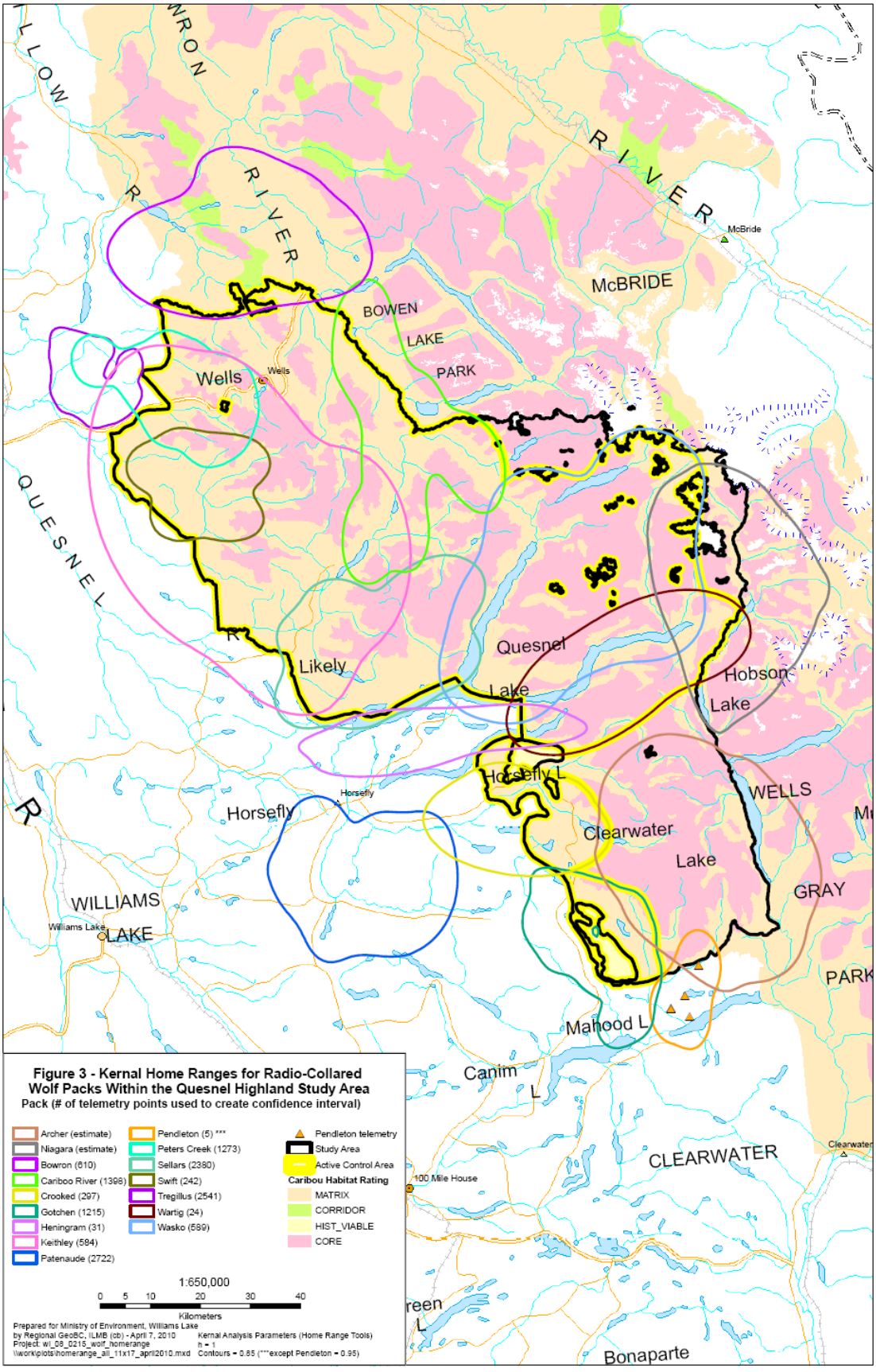

Figure 3 - Kernal Home Ranges for Radio-Collared Wolf Packs Within the Quesnel Highland Study Area
Pack (# of telemetry points used to create confidence interval)

Separate elevation analyses (based on wolf and caribou radio-collar relocations) were carried out for packs that overlapped the Barkerville (BV) and Wells Gray North (WGN) caribou sub-population areas. Data from 2009/2010 helped fill the gaps for wolf habitat use in summer months (Table 5). Caribou in the Wells Gray North sub-population appear to use lower elevations (1500m) during the calving period (May), likely to utilize new green forage available before climbing to slightly higher elevations (1600-1700m) during the summer months. Average monthly wolf and caribou elevations overlap for July through November within the WGN area (Figure 4).

Table 5. Number of relocation points for wolves and caribou within Wells Gray North and Barkerville areas (up to 2010).

Month	WGN Wolves	BV Wolves	WGN Caribou	BV Caribou
January	254	62	219	54
February	876	387	212	57
March	703	289	330	77
April	547	191	147	42
May	662	91	203	61
June	495	57	175	45
July	458	59	153	40
August	654	126	152	38
September	428	182	138	38
October	325	145	149	36
November	324	117	308	60
December	392	336	296	66
Total	**6118**	**2042**	**2482**	**614**

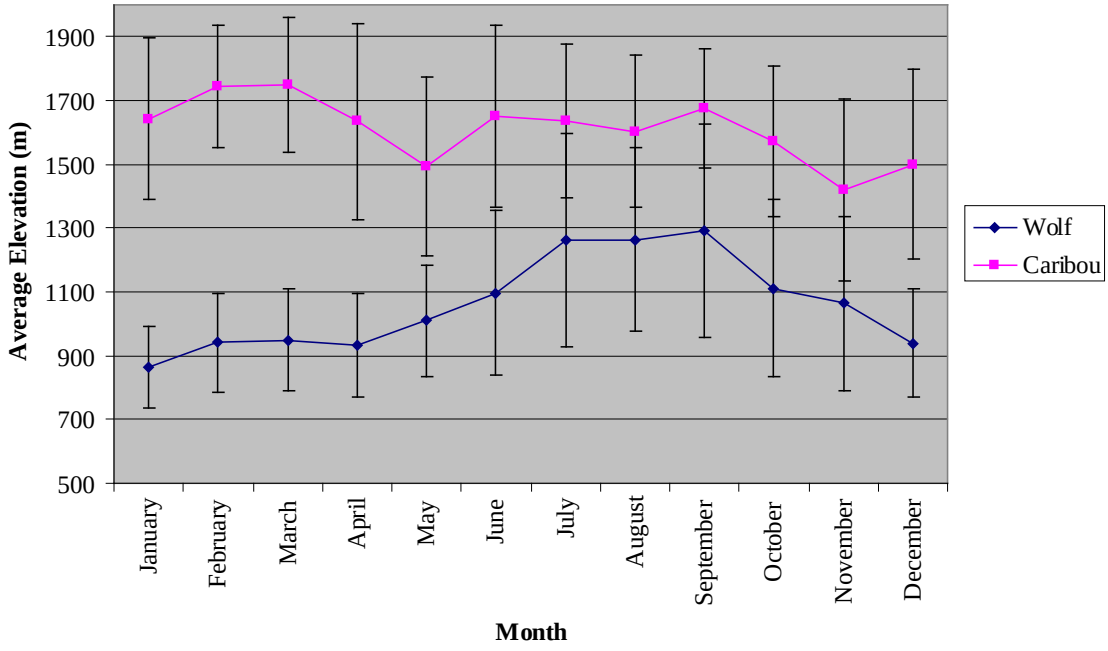

Figure 4. Average monthly wolf and caribou (1993-2000) elevation use with one standard deviation for the Wells Gray North area.

Within the Barkerville area there is overlap of wolf and caribou elevation use for the months of April and May as well as in October and November (Figure 5). Similar to WGN, caribou within the Barkerville area appear to move to slightly lower elevations (1500m) during the calving period (May) before returning to elevations between 1600 and 1700m for the remainder of the spring and summer. Wolves and caribou on average, appear to be using different elevations throughout the summer and late winter months.

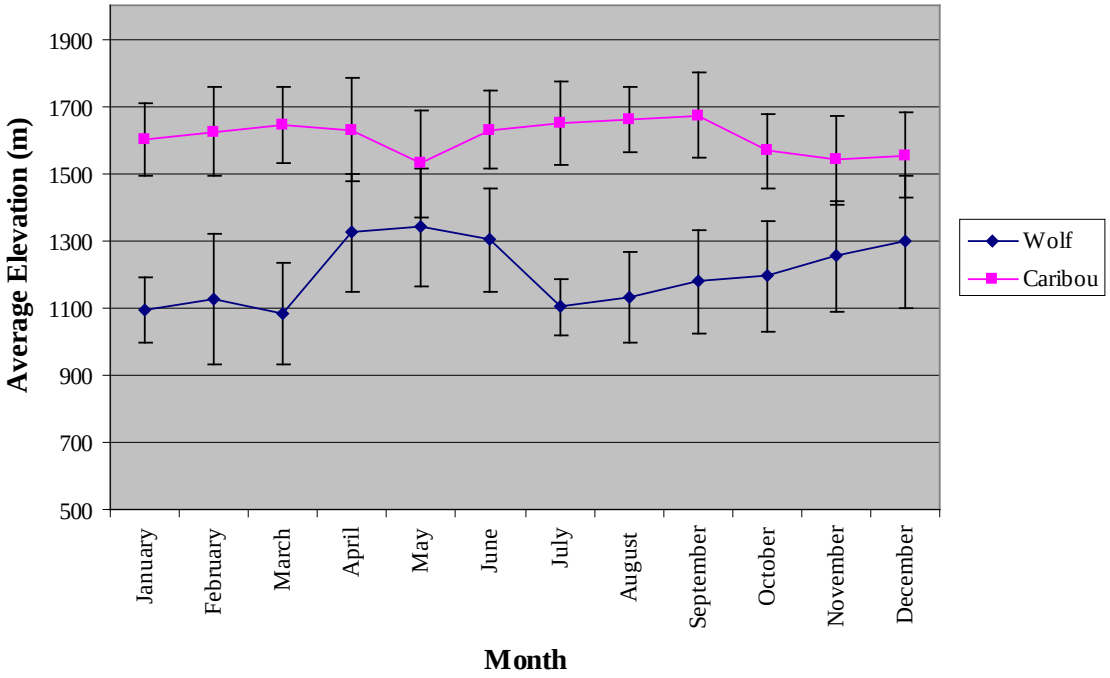

Figure 5. Average monthly elevation use by wolves and caribou (1993-2000) with one standard deviation in the Barkerville area.

Wolf Population and Density Estimates

The eleven core wolf packs within the study area are currently comprised of 34-44 wolves, with an average pack size of 3.5. The two additional un-collared packs with territories that are assumed to overlap the study area bring the total wolf population estimate up to 50-63 animals, resulting in a March 2010 study area density of 6.4 wolves/1000km^2 (Table 6).

Over the course of this ten year project, wolf pack territories have shifted slightly and names have been changed. Two separate density estimates are reported in the table below in order to better interpret the effectiveness of the project where active reductions and sterilizations have been possible (Table 6). The first density estimate of 5.5 wolves/1000km^2 in 2010 is based on the wolf population within the "active control" area of approximately 7100km^2 and is located outside of Wells Gray Park. The active control area represents approximately 80% of the study area (of core and matrix caribou habitat within the Quesnel Highland Mountain Cariboo Planning Unit). Extensive wolf removal efforts occurred mainly in this area due to ease of motor vehicle access and the lower costs associated with ground access. Wolf removal and sterilization efforts are more restrictive and costly for the packs that reside within Wells Gray Park.

The second density estimate of 6.4 wolves/1000km^2 in 2010 includes all wolf packs within the Quesnel Highland MCPU (caribou core and matrix habitat) study area of 8830km^2. There was insufficient data for density estimates in 2005 and 2006 due to the project lapse. The radio-collared HenIngram pack slightly overlaps matrix habitat within the Northern portion of the Horsefly census block but has been omitted.

Lone wolves vary by study area but may account for up to 14% of a wolf population and have not been included in these density estimates (Mech 1973).

Table 6. Wolf packs[7] and population estimates for March 2004, 2007, 2008, 2009 and 2010.

Pack[8]	**Mar-04**	**Mar-07**	**Mar-08**	**Mar-09**	**Mar-10**
Lynx/**Sellars**	3-4	3-7	7-10	3	1-2
Cariboo/**Keithley**	3	8	6	2	3
Babcock/**Peters**	1	2-4	7-9	6	7-9
Niagara/**Wasco**	3	6	6	3-4	2-3
Crooked Lk.	3	6-8	4-6	3	4
Bouldery/**Wartig**	2	3-5	2	2	1-2
Antler/**Cariboo R.**	1	3-6	8	5	4
Laneizi/**Bowron**	8	7-9	11-13	5-6	5-6
Spanish/**Gotchen**	3	5-7	5-7	3	2-3
Swift	8	5-6	8	4	1-2
Pendelton	6	6	3-6	5	4-6
Total in "active control area" (7100km^2)	**41-42 (41.5)**	**54-72(63)**	**67-81(74)**	**41-43 (42)**	**34-44 (39)**
"Active control area" wolf density (per 1000 km^2)	**5.8**		**10.4**	**5.9**	**5.5**
Archer	10	7-9	8-12	10	10
Summit/**Hobson**	12	8-12	6-12	7	6-9
Total in entire study area (8830km^2)	**63-64 (63.5)**	**69-93 (81)**	**81-105 (93)**	**58-60 (59)**	**50-63 (56.5)**
Study area wolf density (per 1000 km^2)	**7.2**	**9.2**	**10.5**	**6.7**	**6.4**
# Sterile Packs (/13)	**5**	**0**	**5**	**9**	**10**
Study area wolf density (per 1000 km^2)	**7.2**	**9.2**	**10.5**	**6.7**	**6.4**

[7] Yellow indicates pack size estimate based on average pack size prior to control efforts.
[8] Pack names in bold are current names for the packs.

Mountain Caribou Population Status

The Wells Gray North (WGN) Mountain Caribou sub-population was surveyed in late March 2010, resulting in a population estimate of 230 animals. A total of 200 caribou, including 181 adults and 19 calves, were observed in the Stevenson, Junction and Horsefly census blocks combined (Table 7). During the 2010 survey, visibility was good with bright, clear days; however lack of recent snow resulted in 2-3 weeks of wind-blown and melted out tracks. Snow was also hard-pack such that caribou could walk on top of it. Although increased search effort was required to locate fresh caribou track amongst the extensive older track, confidence is high that surveyors were able to locate caribou groups when tracks were sighted (Freemand 2010 in prep). The WGN caribou sub-population appears to be stable when compared to the two most recent (2005 and 2006) surveys (Figure 6).

Table 7. Caribou and calves observed during the March 2010 survey for the Junction, Stevenson and Horsefly census blocks (Freeman 2010 in prep).

Census Block	% Calves	Total Caribou	Calves	Adults
Junction	10	99	10	89
Stevenson	9.5	63	6	57
Horsefly	7.9	38	3	35
Wells Gray North Sub-population	**9.5%**	**200**	**19**	**181**

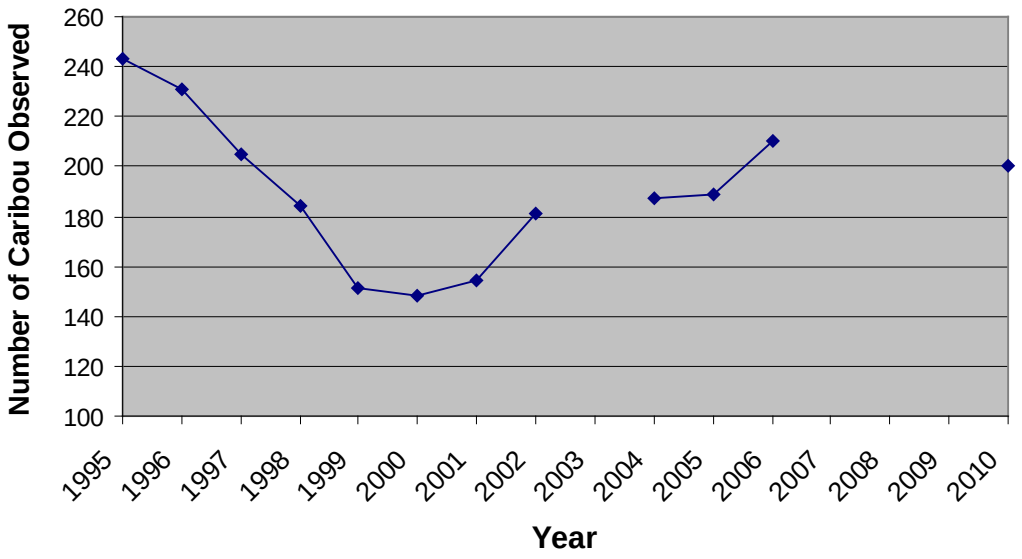

Figure 6. Mountain Caribou observed from 1995 to 2010 in the Wells Gray North sub-population (Junction, Stevenson and Horsefly census blocks).

Wells Gray North caribou calf recruitment was 9.5%, well below Bergerud's stabilizing rate of 16% (Freeman in press, DRAFT). Calf recruitment has been at or above 16% since 2000 with the exception of 2010 (Figure 7). With the recent reduction of wolf numbers over this range in the last three years, it is likely that additional and/or alternate factors were responsible for the low calf survival observed in 2010.

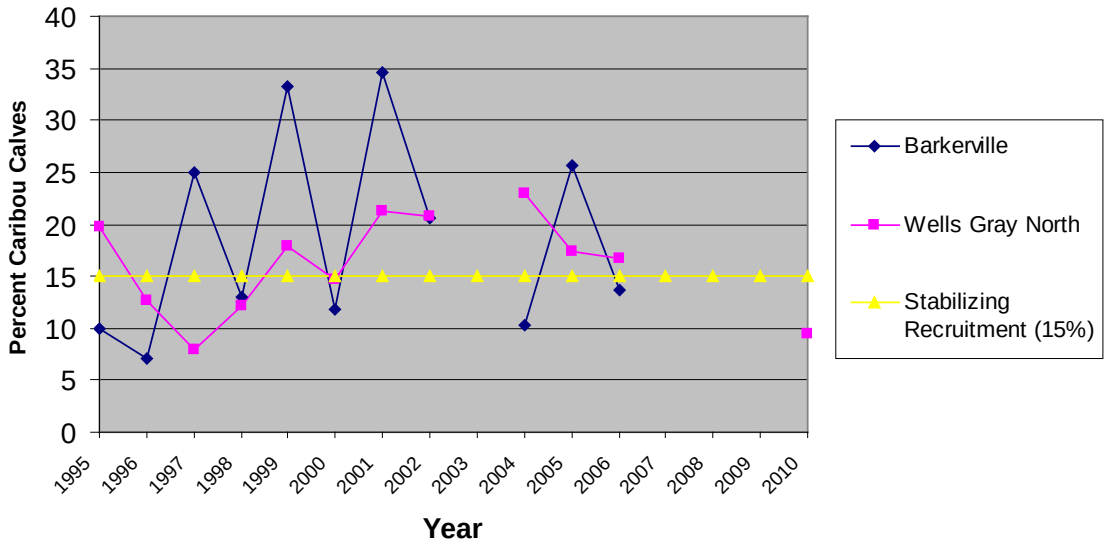

Figure 7. Caribou calf recruitment (% calves) in the Wells Gray North and Barkerville sub-populations from 1995 to 2010.

The Barkerville and Bowron (Northern Cariboo Mountains) census blocks were not surveyed in 2010 due to lack of funding and poor survey snow conditions. In 2006 the Barkerville sub-population was estimated at 50 animals and had been stable since 2002. The 2006 survey of the Northern Cariboo Mountains caribou within the Bowron census block observed 43 animals, similar to previous surveys.

Discussion

Based on our information analysis, regionally there is agreement the wolf reduction and sterilization program should continue for approximately another 2 or 3 years. The major impacts of this program will probably not be observed for another 2 or 3 years. Although the control and sterilization program began in 2001, minimal funding available from approximately 2004 to 2007 made it necessary (in terms of reduction) to virtually start from scratch in January of 2007. Additional time, continued monitoring and reduction of wolves is required to assess with confidence whether wolf sterilization and density reduction is having a positive impact on Mountain Caribou recovery in the Quesnel Highland.

The project was originally initiated as a test case for the province and due to factors beyond the project's control, did not achieve its main objective to reduce wolf densities below 6.5 wolves/ 1000 km^2 until 2009-2010. A significant amount of time and funding has been dedicated to achieve this goal and without continued support, questions relating to program effectiveness will not be answered. Additional time and funding is required to properly assess the results and maintain the existing program. An estimate of budget requirements for the next two fiscal years (2010-2011 and 2011-2012) can be found in Appendix 3.

Three years (2007-2010) of wolf control have been completed resulting in a wolf density estimate of 5.5 wolves/1000km^2 in the active control area. The estimate is below Bergerud's (2007) recommended threshold of 6.5 wolves/1000km^2 to aid in caribou recovery. The density estimate includes 10 sterilized packs (out of 13) within the active control area (Figure 8). Since 2007, fifty wolves have been removed via this program and additional animals were also eliminated through hunting, trapping, natural mortality and dispersal.

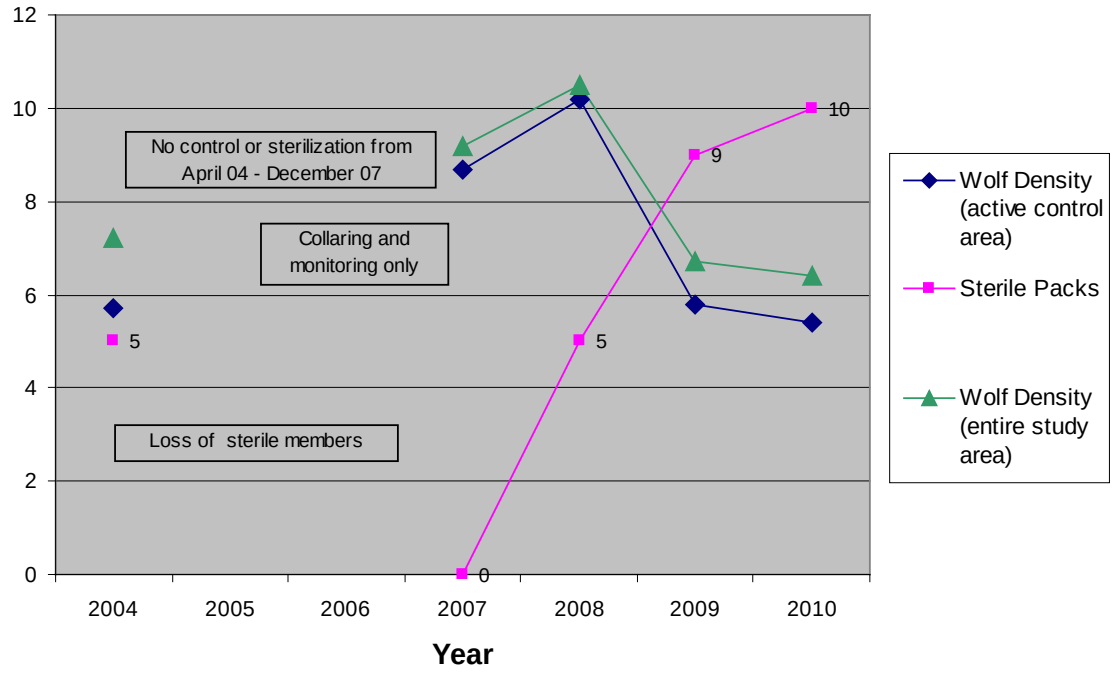

Figure 8. Wolf densities (per 1000km^2) from 2004 to 2010 within the "active control area" (7100km^2) and the Quesnel Highland study area (8830km^2). Number of sterile packs within the study area per year is also included.

In conjunction with continuation of monitoring and reducing wolf numbers, inventories of the caribou population are required annually to detect changes in calf recruitment and overall increases in population growth. The 3 year gap between caribou inventories (2007-2009) does not allow for a clear picture of the impacts of wolf density reduction on Mountain Caribou recovery. It is not good science to base the success or failure of this program on one year (2010) of caribou inventory data.

The 2010 census of the Wells Gray North Mountain Caribou sub-population observed stable overall caribou numbers but a low calf recruitment of 9.5% (Freeman 2010 in prep.). This calf recruitment value is well below Bergerud's stabilizing recruitment of 16% in order to balance natural adult caribou mortality. The number of caribou observed in 2010 indicates that it is unlikely the population has experienced a significant decline since 2006. This fact, coupled with the recent success of the Quesnel Highland wolf project to significantly reduce wolf densities in the last two years appears to indicate that wolf predation is not the main or sole cause of low calf recruitment in 2010.

Although it is widely accepted that predation is most often the primary cause of caribou calf mortality in British Columbia, it is important to recognize the potential cumulative effects that adverse climate conditions and predation can have on caribou calf recruitment. The nearest snow pillow station, located at Yanks Peak (1683m), reported snow accumulation well above average for the winter of 2008/2009 (Figure 9). In addition to higher than average snow accumulation from February to July 2009, new maximums were recorded daily from early May through early July 2009 indicating a green-up that may have been delayed by up to a month.

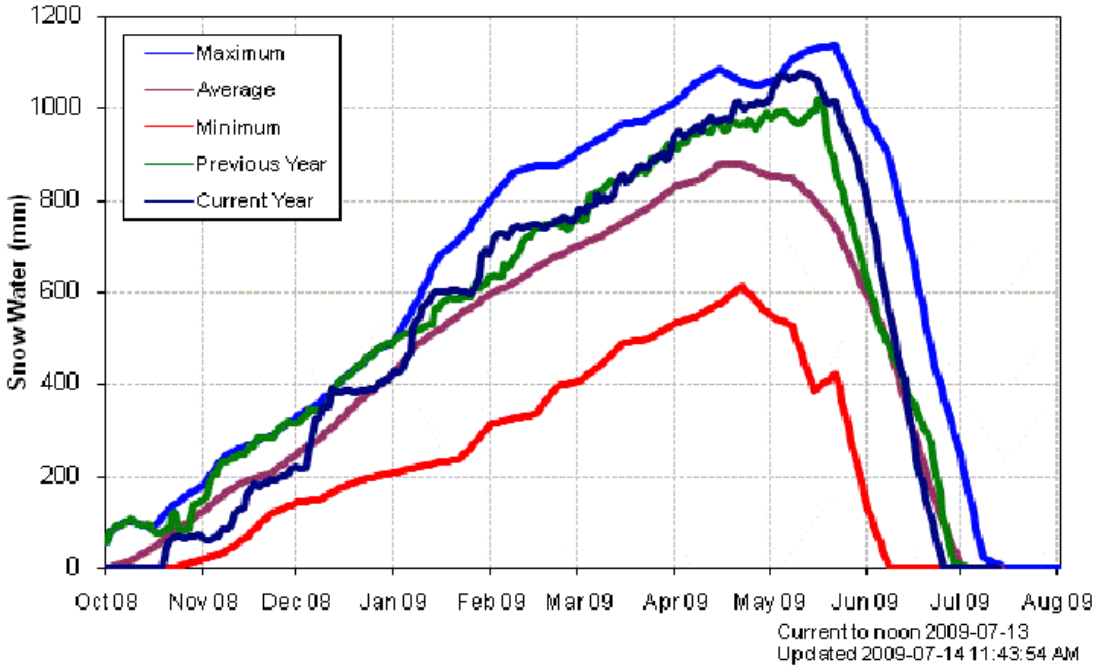

Figure 9. Yanks Peak snow pillow data (1683m) for 2008-2009.

Studies have shown that although caribou pregnancy rates are largely dependent on late fall cow body condition (Cameron et al. 1994), calf body condition and survival are negatively correlated with winter severity, late winter snowfall and untimely green-up conditions (White 1983, Cameron et al 1993, Dale et al 1995, Adams 2003, Valkengerg et al 2004, Gustine et al 2006, Post and Forchhammer 2008, Cebrian et al. 2008). For caribou cows late in pregnancy, severe winter conditions can negatively impact cow fat stores and body condition, subsequently affecting the condition of calves at birth (Adams 2003, White 1983, Cameron et al 1993, Dale et al 1995). Furthermore, untimely spring green-up conditions can impact the availability of high quality forage necessary for caribou cows to provide adequate lactation for newborn calves at a crucial time (Gustine et al 2006, Post et al 2008, White and Luick 1984, Cebrian et al 2008). Cumulatively, these weather effects have the potential to significantly reduce caribou calf recruitment (Figure 10).

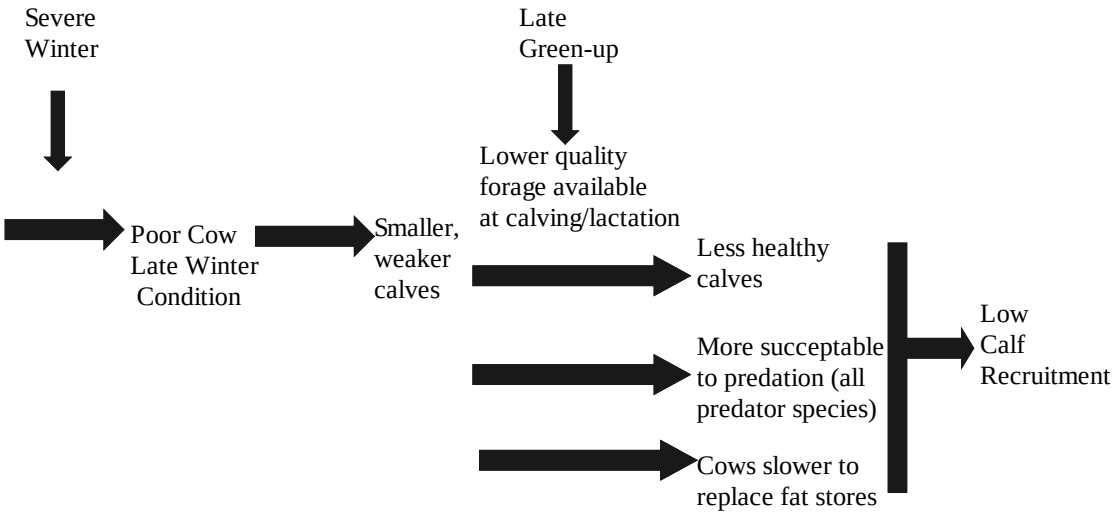

Figure 10: Flowchart outlining potential climatic impacts on Mountain Caribou calf recruitment (survival to March the following year).

Over the course of the Quesnel Highland Wolf project it has become apparent that 13 primary wolf packs have majority access to Mountain Caribou in the study area (Table 6). Two of these 13 packs (Niagara and Archer) reside to some degree in Wells Gray Park. This fact, coupled with vast and remote nature of the pack's territories has made them extremely difficult to collar and control. Approval to remove wolves from this area will be necessary to further reduce the wolf population in the Junction and Horsefly blocks. Allowing these two large packs to remain at full size will increase the risk of losing wolves from adjacent reduced packs and may further hamper caribou recovery efforts within the Horsefly census block.

The sterilization component of the wolf control program appears to successfully reduce wolf recruitment in the study area (Table 8). Aerial observations indicate that packs with sterile dominant members (prior to the breeding season) do not have pups traveling with them by the late summer. Similarly, downloaded data from GPS collared packs has shown no evidence of extended denning periods from April to June within these packs. Although some sterile GPS collared packs did stay near a potential den site for up to three weeks in early April, all resumed roaming behavior within the pack's territory within the month. Limited observations (5) of successful breeding in fertile packs within the study area indicates an average of 2.9 pups survived and remained with the pack until winter conditions allowed for an accurate pack/pup count (8-10 months of age) to occur. Based on a 2.5 pup/pack recruitment rate, the ten successfully sterilized packs within the study area could potentially equate to 25 wolves per year that would not need to be removed with lethal methods.

Table 8. Confirmation of successful wolf recruitment reduction due to dominant member sterilization for the spring of 2009.

Pack	Pups produced spring 2009	Method to determine pup presence
Sellars	0	GPS
Keithley	0	VISUAL
Wasco	0	GPS
Crooked	0	VISUAL
Wartig	0	VISUAL
Cariboo R.	0	GPS
Bowron	UNKNOWN	NO GPS COLLAR AND NOT TRACKED AERIALLY
Gotchen	0	GPS
Swift	0	GPS

Capture and sterilization of dominant males during or near the breeding season may increase the individual's risk of status loss within the pack. Over the course of the project, in the first two months after winter capture two male wolves were depredated by other wolves and at least three other collared males dispersed from their packs. For this reason, we recommend aerial capture work be done in the first two weeks of January, prior to the breeding season. In addition, accidental removal of a dominant member in combination with pack reduction on at least two occasions may have fragmented pack structure, resulting in a single pack member remaining in the area and consequently leaving the territory open for new packs.

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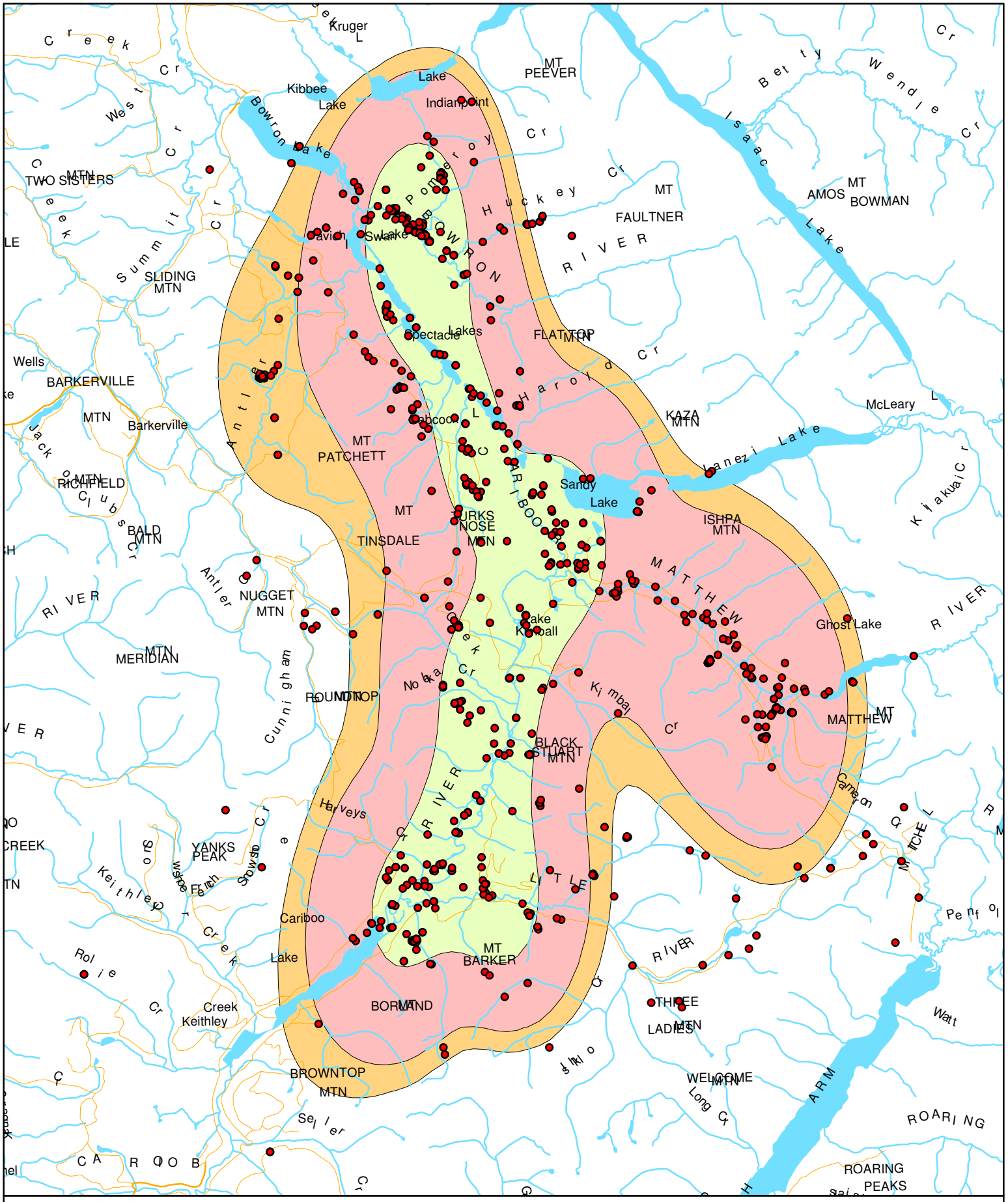
Appendix 1. Aerial telemetry radio-collared wolf relocations from April 2009 to March 2010.

Frequency	Name	Block or Pack	C/W	Date	Location	UTMX	UTMY	Visual	Comment
150.030	Shardik	Peters Creek	W	Jul-29-09	SE Peters	580629	5877329	N	regen, pups Apr. 25th
150.011	Daisy	Peters Creek	W	Jul-29-09	SE Peters	580629	5877329	N	regen, pups Apr. 25th
150.748	Barry	Keithley	W	Jul-29-09	Peters Cr.	576207	5879021	N	logging, no pups
150.269	Cinde	Keithley	W	Jul-29-09	E Ladies Cr.	616010	5849737	N	thick trees
151.129	Willy	Wasko	W	Jul-29-09	Niagara R.	670321	5839209	N	valley bottom, no pups
150.540	Christina	Wasko	W	Jul-29-09	Woltzke N	654570	5847496	N	high elevation
151.120	Russel	Cariboo River	W	Jul-29-09	E Ladies Cr.	616010	5849737	N	thick trees
150.390	Tank	Cariboo River	W	Jul-29-09	E Ladies Cr.	616010	5849737	N	thick trees
150.981	Inga	Sellars	W	Jul-29-09	Tassee Lk	631498	5826037	N	timber near cuts
151.050	Clay	Sellars	W	Jul-29-09	Tassee Lk	631498	5826037	N	timber near cuts
150.840	Festus	Wartig	W	Jul-29-09	Bill Miner/Wartig Rd	659833	5820168	N	near old horse baits
150.121	Mar	HenIngram	W	Jul-29-09	Antione Lk	630246	5814639	N	with mystery 150.116
150.959	Judy	HenIngram	W	Jul-29-09	Dilabough Lk	613307	5807229	N	no other collars
150.239	Camilla	Gotchen	W	Jul-29-09	Ruth Redford	665803	5770836	N	SW big meadow, no pups
150.116	Charles	Gotchen	W	Jul-29-09	Ruth Redford	665803	5770836	N	SW big meadow, no pups
150.780	Kyla	Crooked Lk.	W	Jul-29-09	Pickertow	652556	5793374	N	
150.899	Lucy	Swift	W	Aug-14-09	Little Swift R.	595611	5870856	N	
150.101	Bruce	Swift	W	Aug-14-09	Little Swift R.	595611	5870856	N	
150.030	Shardik	Peters Creek	W	Aug-14-09	Grub Mtn.	583953	5874065	N	
150.011	Daisy	Peters Creek	W	Aug-14-09	Grub Mtn.	583953	5874065	N	
150.748	Barry	Keithley	W	Aug-14-09	Fontaince Cr.	585951	5868345	N	downloaded at Lucy's location
150.269	Cinde	Keithley	W	Aug-14-09	Rollie Cr.	596506	5848938	N	withTank and Russel
151.129	Willy	Wasko	W	Aug-14-09	Mitchell Lk W	649951	5857003	N	
151.120	Russel	Cariboo River	W	Aug-14-09	Rollie Cr.	596506	5848938	N	
150.161	Octavia	Cariboo River	W	Aug-14-09	Cameron/Mitchell	644209	5857460	N	
150.390	Tank	Cariboo River	W	Aug-14-09	Rollie Cr.	596506	5848938	N	
150.720	Tina	Cariboo River	W	Aug-14-09	Cameron/Mitchell	644209	5857460	N	
150.981	Inga	Sellars	W	Aug-14-09	Sellars Cr.	614277	5836893	N	high up
151.050	Clay	Sellars	W	Aug-14-09	Sellars Cr.	614277	5836893	N	high up
150.121	Mar	HenIngram	W	Aug-14-09	Ussa Lk	614569	5811438	Y(2)	2 blacks cliff top
150.940	Larry	HenIngram	W	Aug-14-09	Ussa Lk	614569	5811438	Y(2)	2 blacks cliff top
150.239	Camilla	Gotchen	W	Aug-14-09	Ryan/Boss Cr.	648785	5771816	N	
150.780	Kyla	Crooked Lk.	W	Aug-14-09	McKusky R	649393	5797813	Y(1)	McKusky white wolf
150.880	Yogi	Tregallis	W	Sep-15-09	S. Abau Lk	559891	5895625	N	MORTALITY
150.101	Bruce	Swift	W	Sep-15-09		571112	5865885	N	with Barry, cows on road

150.030	Shardik	Peters Creek	W	Sep-15-09	SW of Jack of Clubs	590066	5879608	Y(4)	meadow edge
150.011	Daisy	Peters Creek	W	Sep-15-09	SW of Jack of Clubs	590066	5879608	Y(4)	meadow edge
150.748	Barry	Keithley	W	Sep-15-09		571112	5865885	N	with Bruce near cows
150.269	Cinde	Keithley	W	Sep-15-09	W Yanks	605138	5858931	Y(2)	2 blacks subalpine
150.540	Christina	Wasko	W	Sep-15-09	Penfold/Woltzke	661177	5845512	N	alpine, not with Willy
150.390	Tank	Cariboo River	W	Sep-15-09	W Yanks	605138	5858931	Y(2)	2 blacks subalpine
150.981	Inga	Sellars	W	Sep-15-09	Sellars Cr.	611352	5833271	N	trees no sign of Clay
150.840	Festus	Wartig	W	Sep-15-09	Quesnel Lk E ArmS	666356	5828891	N	near beach
150.121	Mar	HenIngram	W	Sep-15-09	HenIngram E	642519	5815837	N	ridge trees (no .116)
150.959	Judy	HenIngram	W	Sep-15-09	HenIngram E	642519	5815837	N	ridge trees (no .116)
150.940	Larry	HenIngram	W	Sep-15-09	HenIngram E	642519	5815837	N	ridge trees (no .116)
150.239	Camilla	Gotchen	W	Sep-15-09	Ruth Redford N	659345	5778896	N	near 10 horses
150.116	Charles	Gotchen	W	Sep-15-09	Ruth Redford N	659345	5778896	N	near 10 horses
150.780	Kyla	Crooked Lk.	W	Sep-15-09	near Pickertow den	652480	5793864	N	trees
150.101	Bruce	Swift	W	Dec-08-09	W Cariboo Mtn	578291	5861051	N	MORTALITY
150.011	Daisy	Peters Creek	W	Dec-08-09	Cariboo Mtn N.	588775	5861645	Y(3+)	2 moose with bloody beds
150.269	Cinde	Keithley	W	Dec-08-09	Sellars Cr.	607855	5838128	N	low cloud
150.540	Christina	Wasko	W	Dec-08-09	Ques.E Arm N Side	664395	5830772	Y(1)	beach
151.120	Russel	Cariboo River	W	Dec-08-09	Sellars Cr.	607855	5838128	N	with Cinde
150.161	Octavia	Cariboo River	W	Dec-08-09	Cariboo R/Little R	619632	5854240	Y(1)	kill site, 1 blonde bat fail mode
150.390	Tank	Cariboo River	W	Dec-08-09	Sellars Cr.	607855	5838128	N	with Cinde
150.720	Tina	Cariboo River	W	Dec-08-09	Cariboo R/Little R	619632	5854240	Y(1)	with Octavia
150.981	Inga	Sellars	W	Dec-08-09	Spanish Lk	613080	5825029	N	over cloud, no male
150.121	Mar	HenIngram	W	Dec-08-09	Viewland Mtn	628496	5810564	Y(2)	2 ran across clearing
150.959	Judy	HenIngram	W	Dec-08-09	Viewland Mtn	628496	5810564	Y(2)	with mar
150.940	Larry	HenIngram	W	Dec-08-09	Jaques Lk	627276	5815919	N	thick trees, moose near
150.899	Lucy	Swift	W	Jan-12-10	Swift R. Rd	567522	5869390	N	near rode, last of pack?
150.011	Daisy	Peters Creek	W	Jan-12-10	Cariboo Mtn NW	585590	5861117	Y(1)	black bed in trees, lots track
150.269	Cinde	Keithley	W	Jan-12-10	Sellar/Blk Bear	605835	5832174	N	regen-no kill
150.540	Christina	Wasko	W	Jan-12-10	Roaring R.	652809	5837829	Y(1)	looks like 2-3 track (blonde)
151.120	Russel	Keithley	W	Jan-12-10	Sellar/Blk Bear	605835	5832174	N	regen
150.161	Octavia	Cariboo River	W	Jan-12-10	Spectacle Lk	616290	5887803	N	bat fail mode (3-4 track)
150.390	Tank	Keithley	W	Jan-12-10	Sellar/Blk Bear	605835	5832174	N	regen
150.720	Tina	Cariboo River	W	Jan-12-10	Spectacle Lk	616290	5887803	N	with Octavia
150.981	Inga	Sellars	W	Jan-12-10	Cedar Creek	607776	5822220	N	trees, kill nearby?
150.121	Mar	HenIngram	W	Jan-12-10	S. Mitchell Bay	609393	5811692	N	thick trees
150.959	Judy	HenIngram	W	Jan-12-10	S. Mitchell Bay	609393	5811692	N	thick trees

150.940	Larry	HenIngram	W	Jan-12-10	S. Mitchell Bay	609393	5811692	N	thick trees
150.239	Camilla	Gotchen	W	Jan-12-10	SE Elbow Lk	642686	5784091	N	thick trees
150.116	Charles	Gotchen	W	Jan-12-10	SE Elbow Lk	642686	5784091	N	thick trees
150.780	Kyla	Crooked Lk.	W	Jan-12-10	Horsefly R N.	642227	5801418	Y(3)	3 on brushy road, all light col.
150.899	Lucy	Swift	W	Mar-19-10	E of Quesnel R	553566	5867238	Y(1)	blonde bed in trees, maybe more
150.011	Daisy	Peters Creek	W	Mar-19-10	E of Quesnel R	555983	5857782	N	low snow, far W from usual
150.540	Christina	Wasko	W	Mar-19-10	N of Wasco Lk	639589	5826426	N	fairly high in trees
150.269	Cinde	Keithley	W	Mar-19-10	Keithley Cr	605526	5847863	Y(1)	black bedded in snow
150.390	Tank	Keithley	W	Mar-19-10	Keithley Cr	605624	5847608	Y(1)	black on rd, russel in trees near
151.120	Russel	Keithley	W	Mar-19-10	Keithley Cr	605624	5847608	N	in trees near Tank
150.720	Tina	Cariboo River	W	Mar-19-10	W Cariboo R/Matthew	621256	5870336	Y(4)	moving up road, mostly blondes
150.981	Inga	Sellars	W	Mar-19-10	S of Tassee Lk	622023	5822329	N	more than 1 track, kill near?
150.121	Mar	HenIngram	W	Mar-19-10	NW Whiffle Lk	617282	5815840	N	lots track, good den site
150.959	Judy	HenIngram	W	Mar-19-10	NW Whiffle Lk	617282	5815840	N	lots track, good den site
150.940	Larry	HenIngram	W	Mar-19-10	NW Whiffle Lk	617282	5815840	N	lots track, good den site
150.116	Charles	Gotchen	W	Mar-19-10	SW of Bosk Lk	645924	5780123	N	cut edge, good snow, no Camilla
150.780	Kyla	Crooked Lk.	W	Mar-19-10	McKay/McKusky	651318	5799492	N	pretty hi, barely breaking snow

Appendix 2. Individual wolf pack kernel home ranges up to March 2010.



Kernal Home Range Analysis
Wolf Pack: Cariboo River

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:300,000

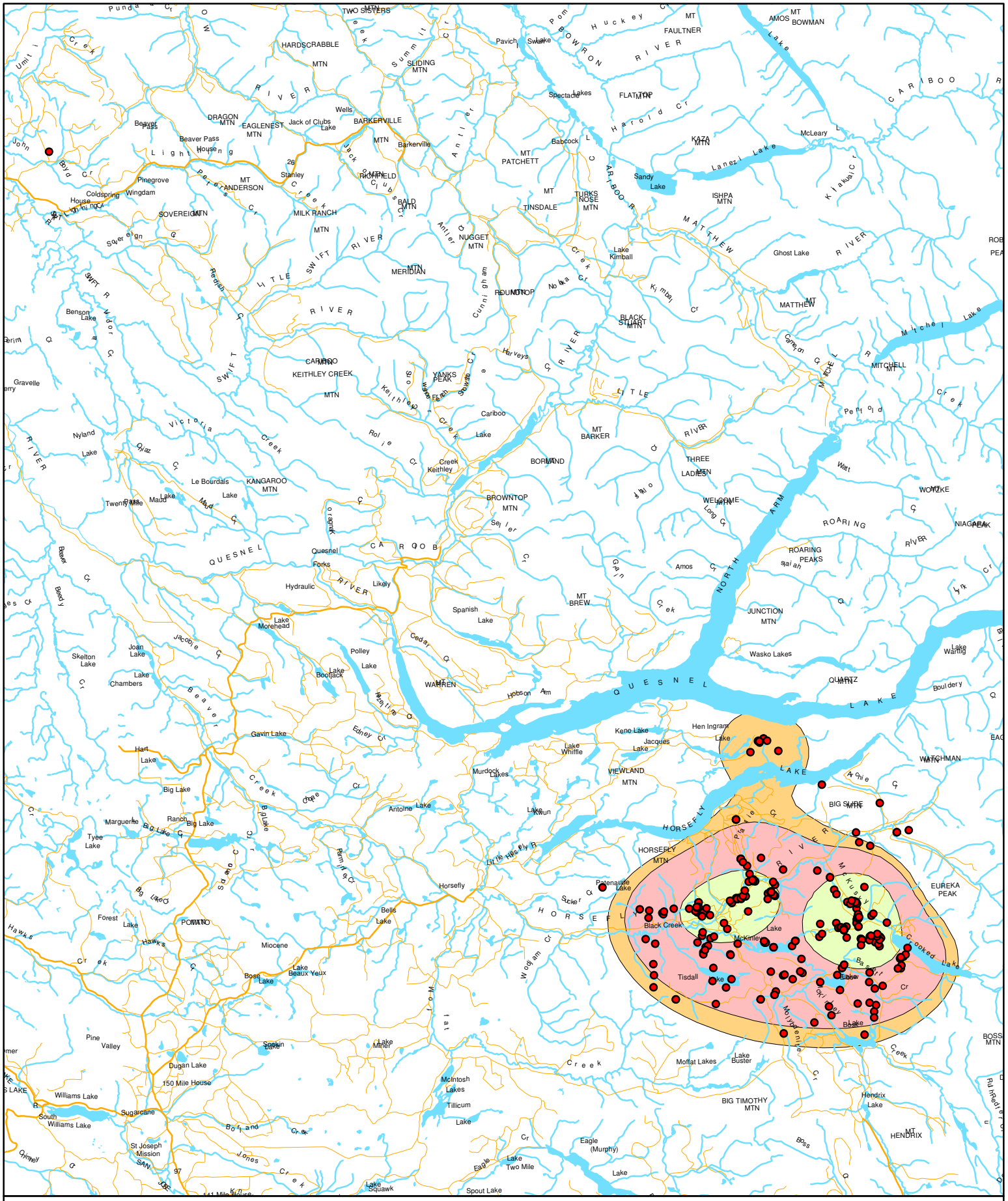
0 1.5 3 6 9 12

Kilometers

Kernal Home Range

Telemetry Point | 50% | 85% | 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 1398
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Crooked

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:550,000

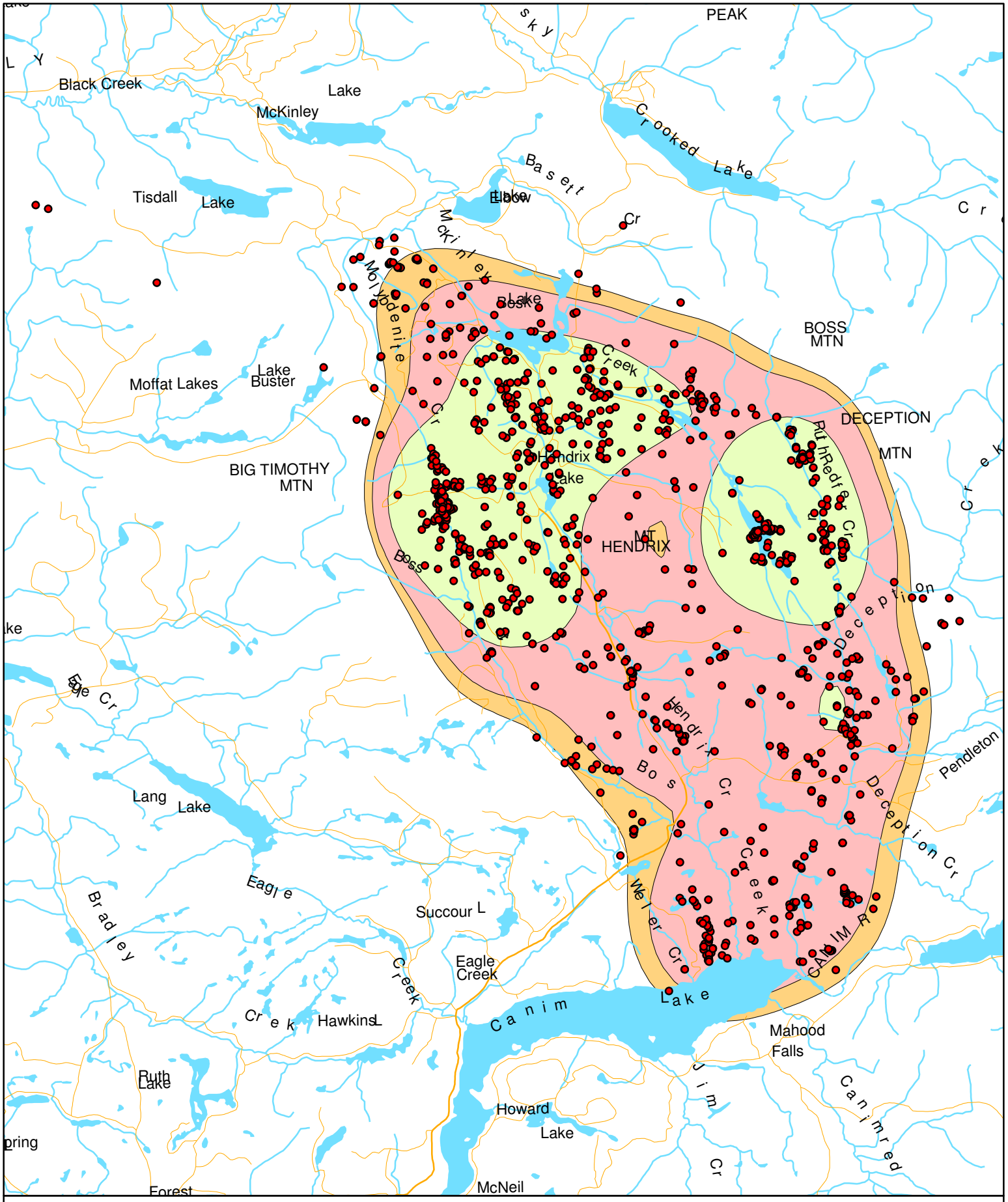
0 2.5 5 10 15 20

Kilometers

Kernal Home Range

Telemetry Point | 50% | 85% | 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 296
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Gotchen

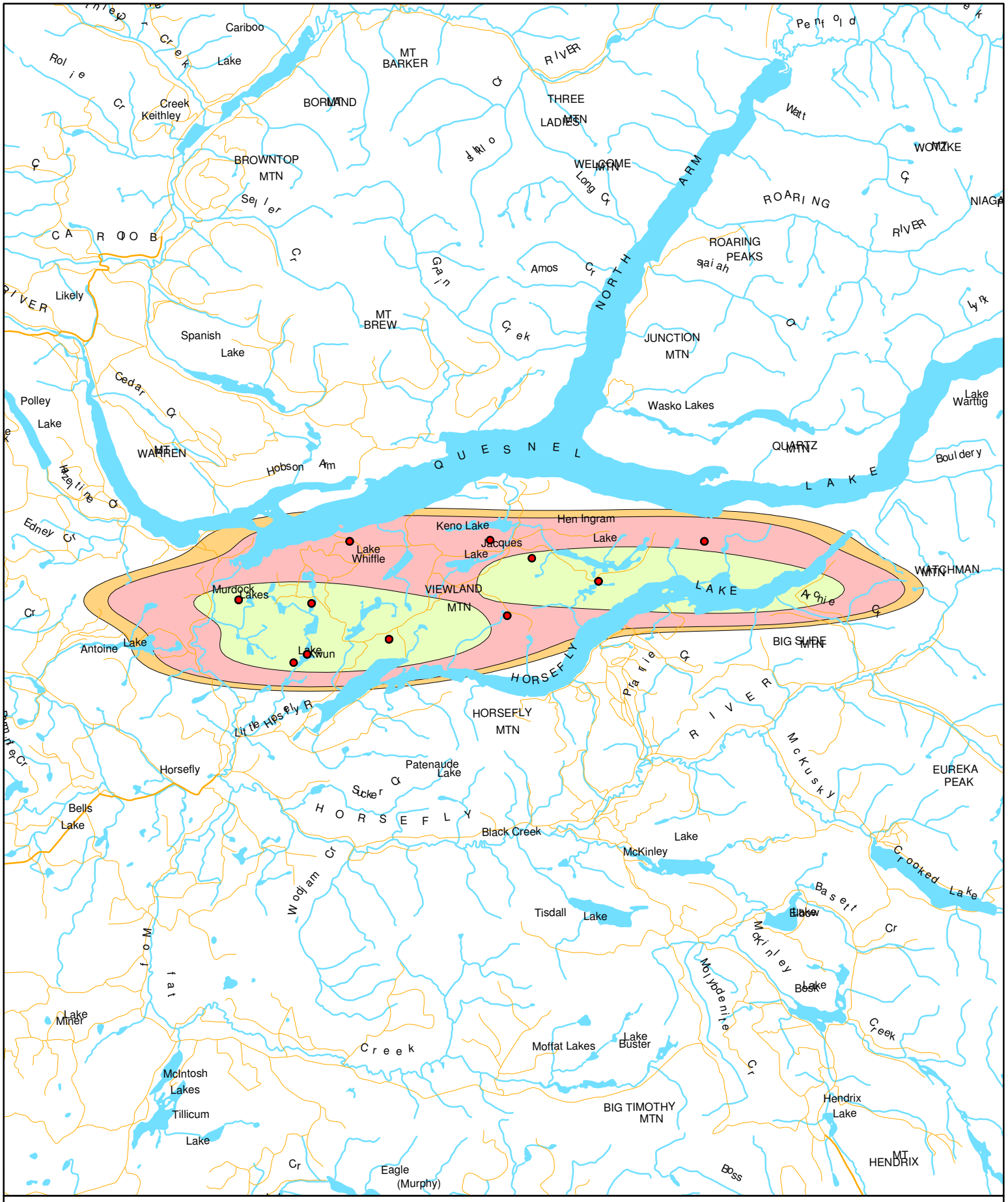
Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:250,000

0 1.25 2.5 5 7.5 10
Kilometers

Kernal Home Range
Telemetry Point
50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 1215
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Heningram

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:350,000

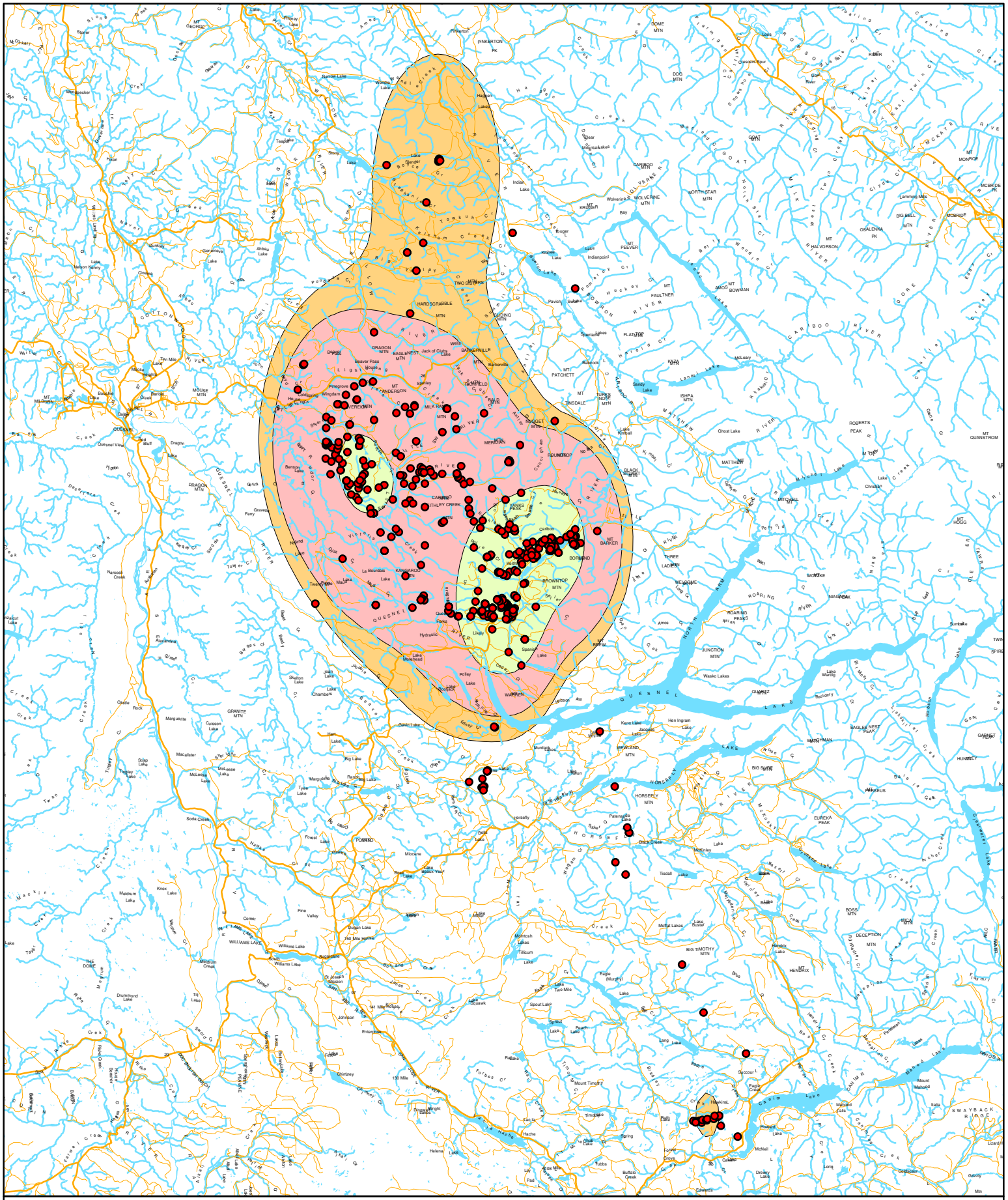
0 1.5 3 6 9 12

Kilometers

Kernal Home Range

Telemetry Point | 50% | 85% | 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 30
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Keithley

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:900,000

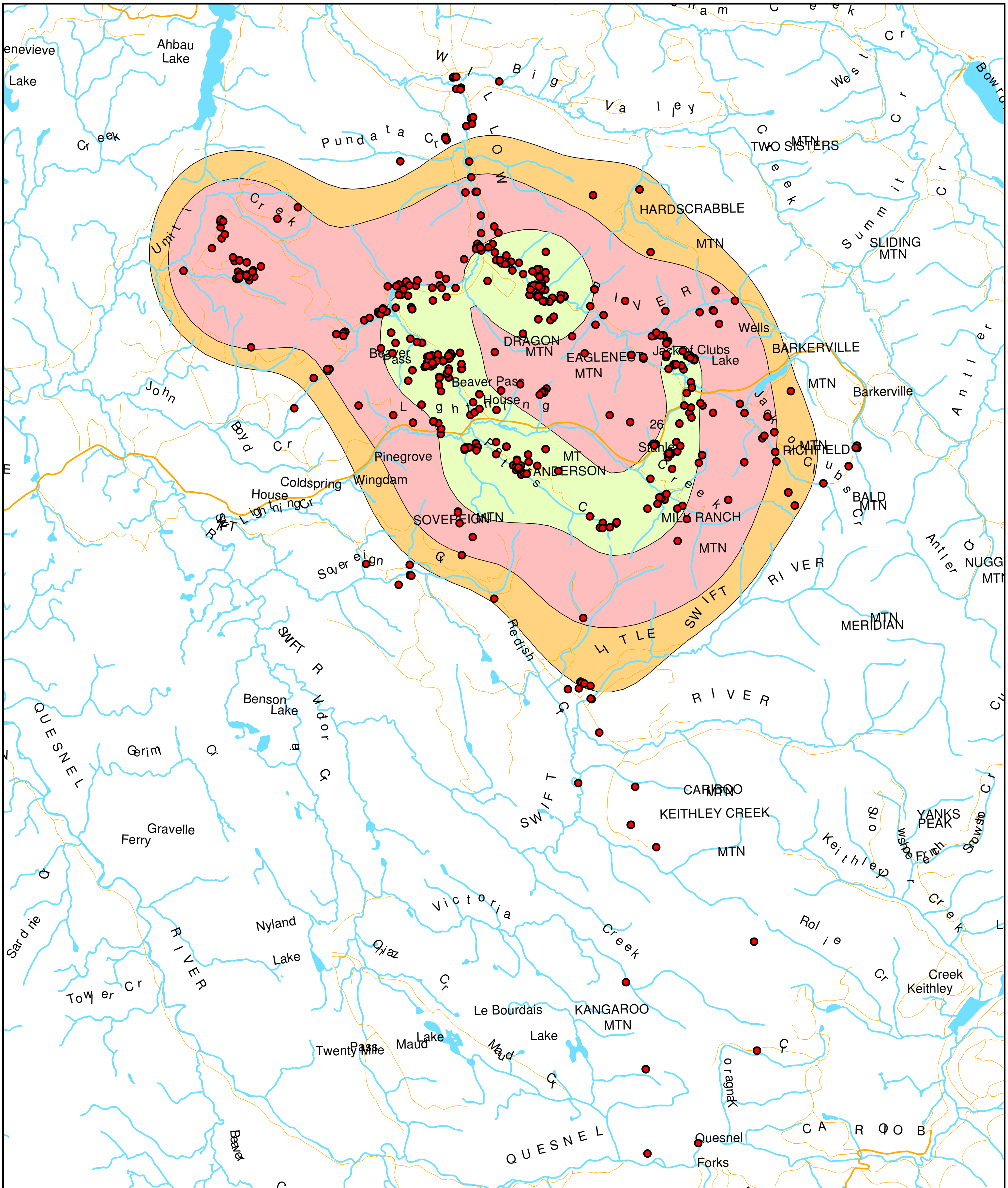
0 4 8 16 24 32

Kilometers

Kernal Home Range

Telemetry Point | 50% | 85% | 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 583
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Peters Creek

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:300,000

0 1.25 2.5 5 7.5 10

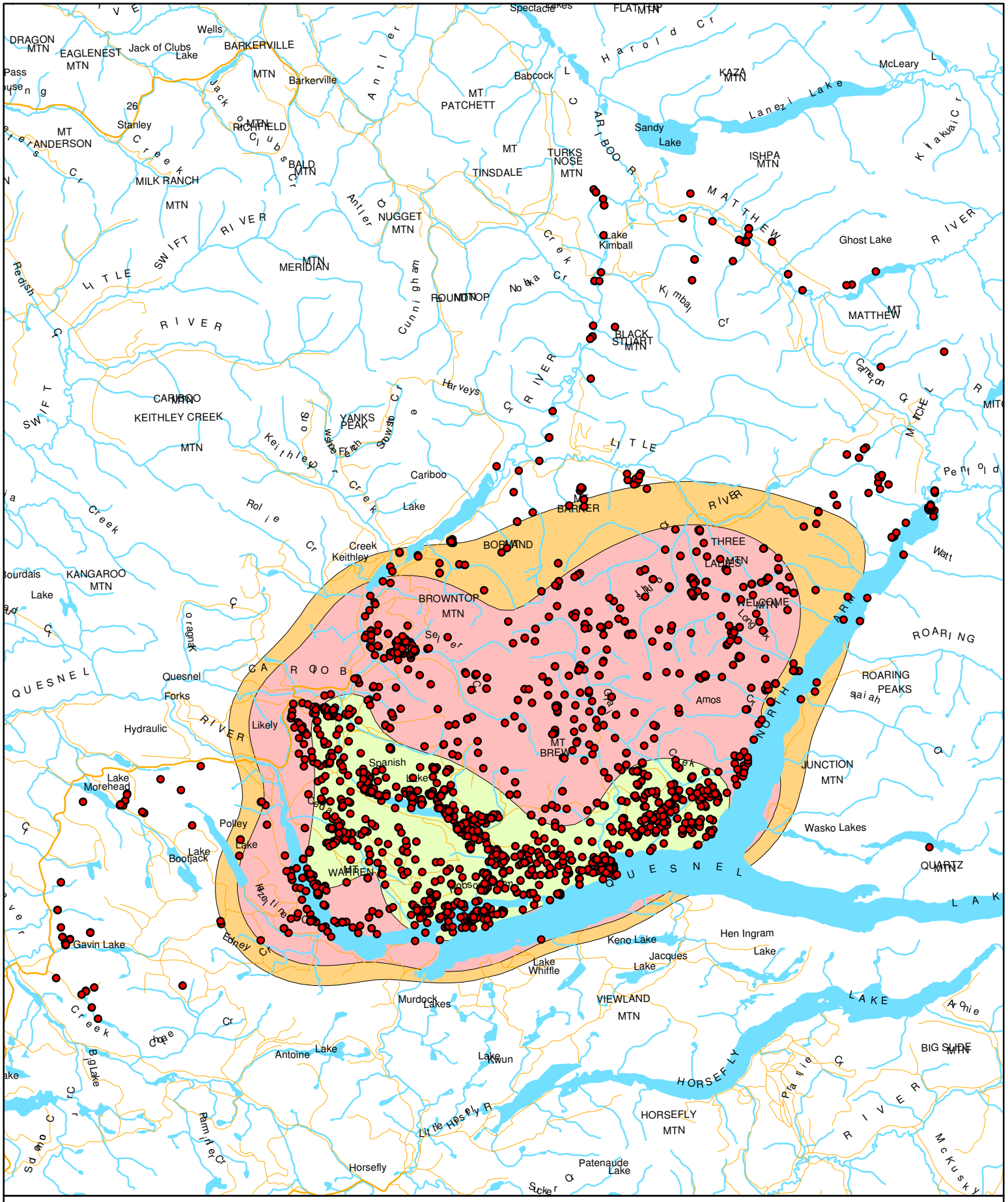
Kilometers

Telemetry Point

Kernal Home Range

50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 1273
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Sellars

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:375,000

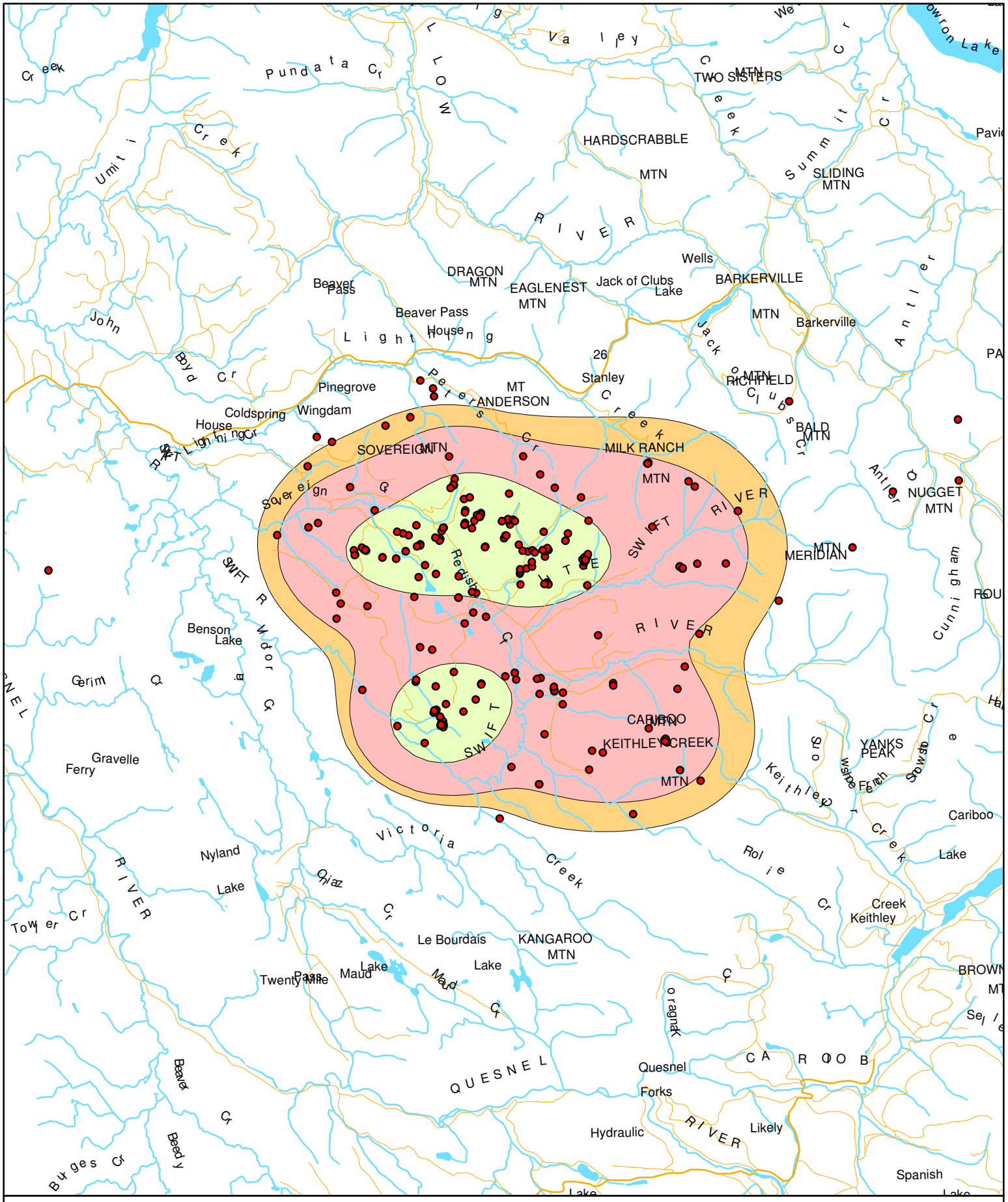
0 1.5 3 6 9 12

Kilometers

Kernal Home Range

Telemetry Point | 50% | 85% | 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 2380
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Swift

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

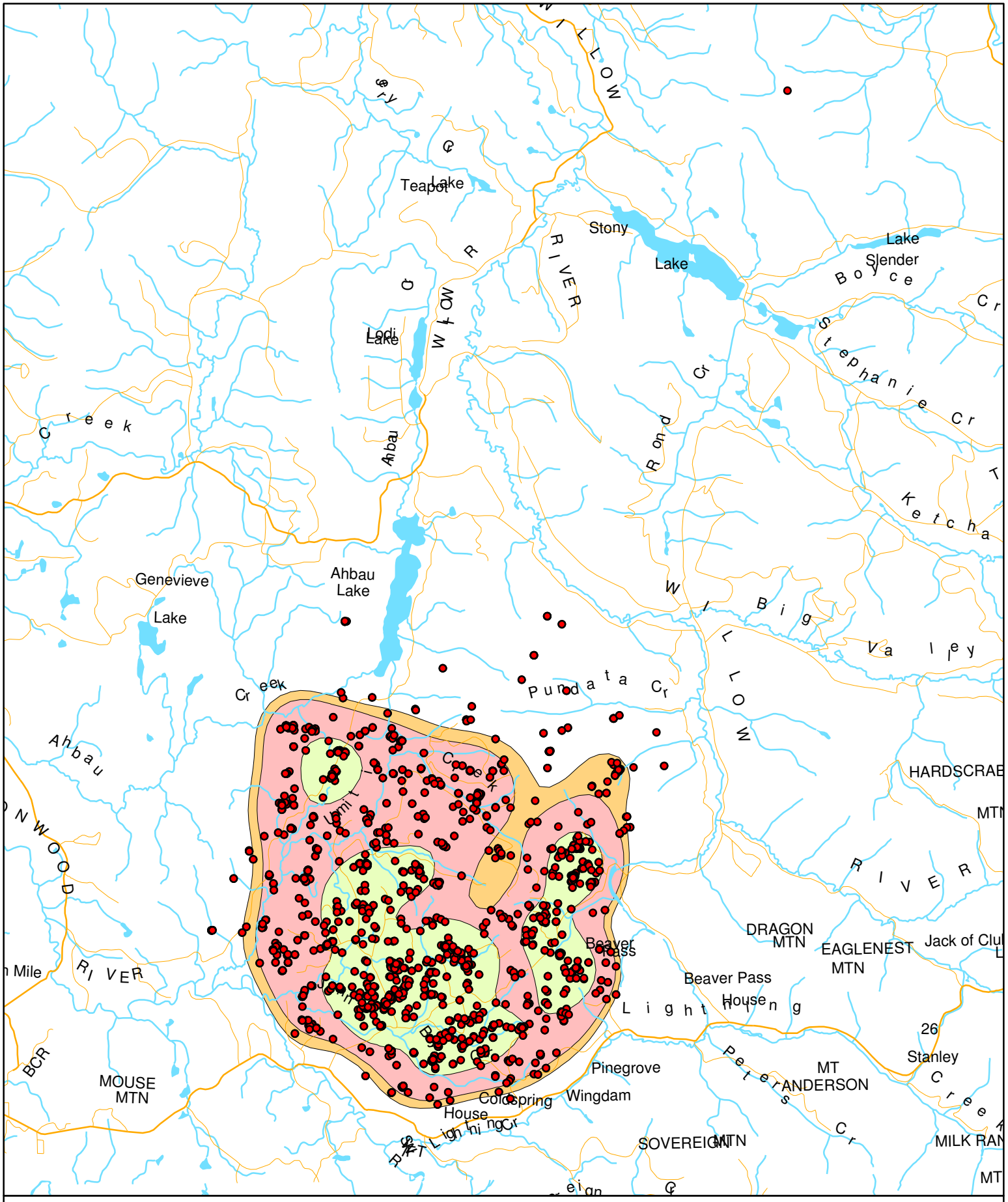
1:300,000

0 0.5 1 2 3 4
Kilometers

Telemetry Point

Kernal Home Range
50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 242
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Tregillus

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:250,000

0 1.5 3 6 9 12

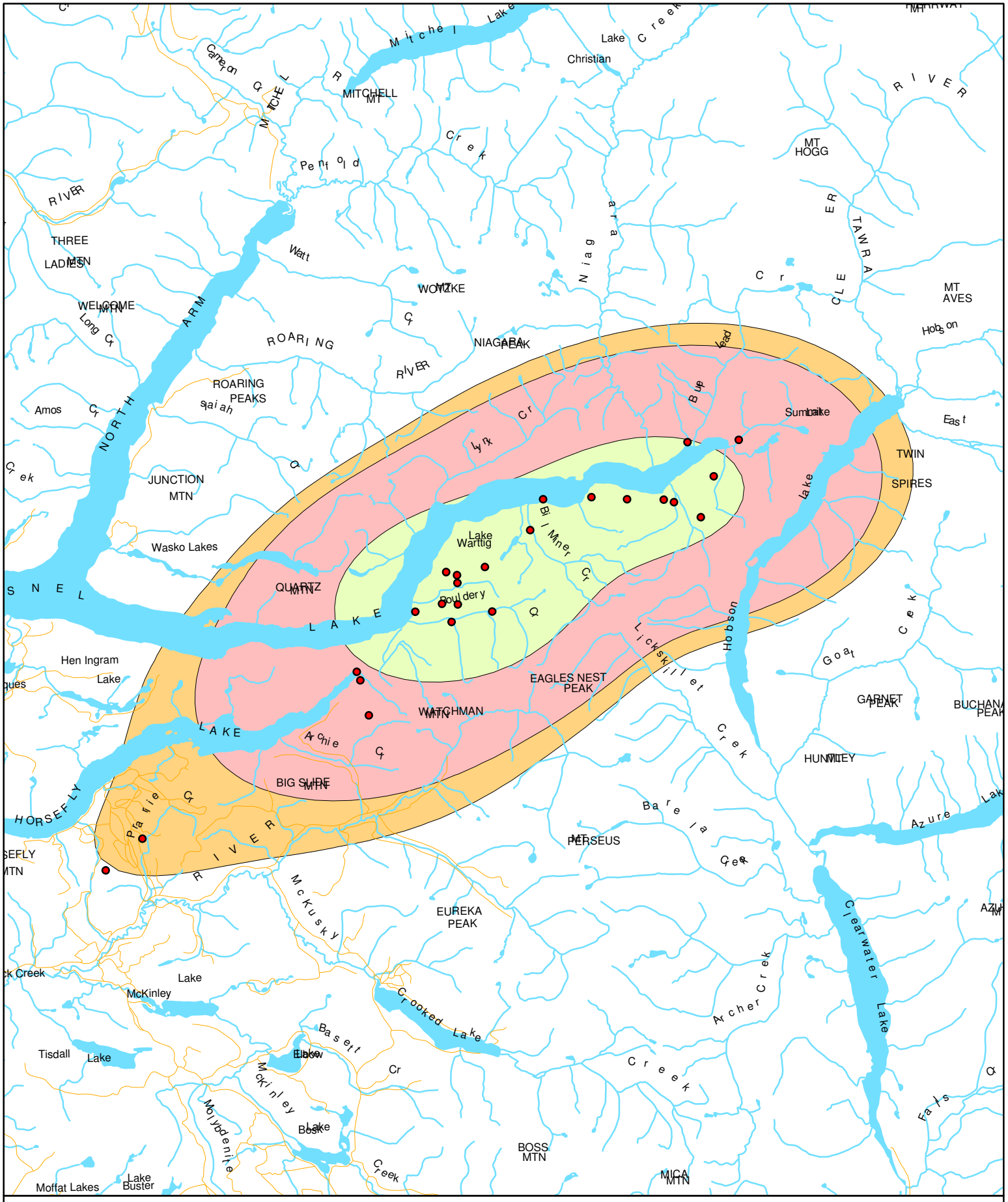
Kilometers

Telemetry Point

Kernal Home Range

50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 2541
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Wartig

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

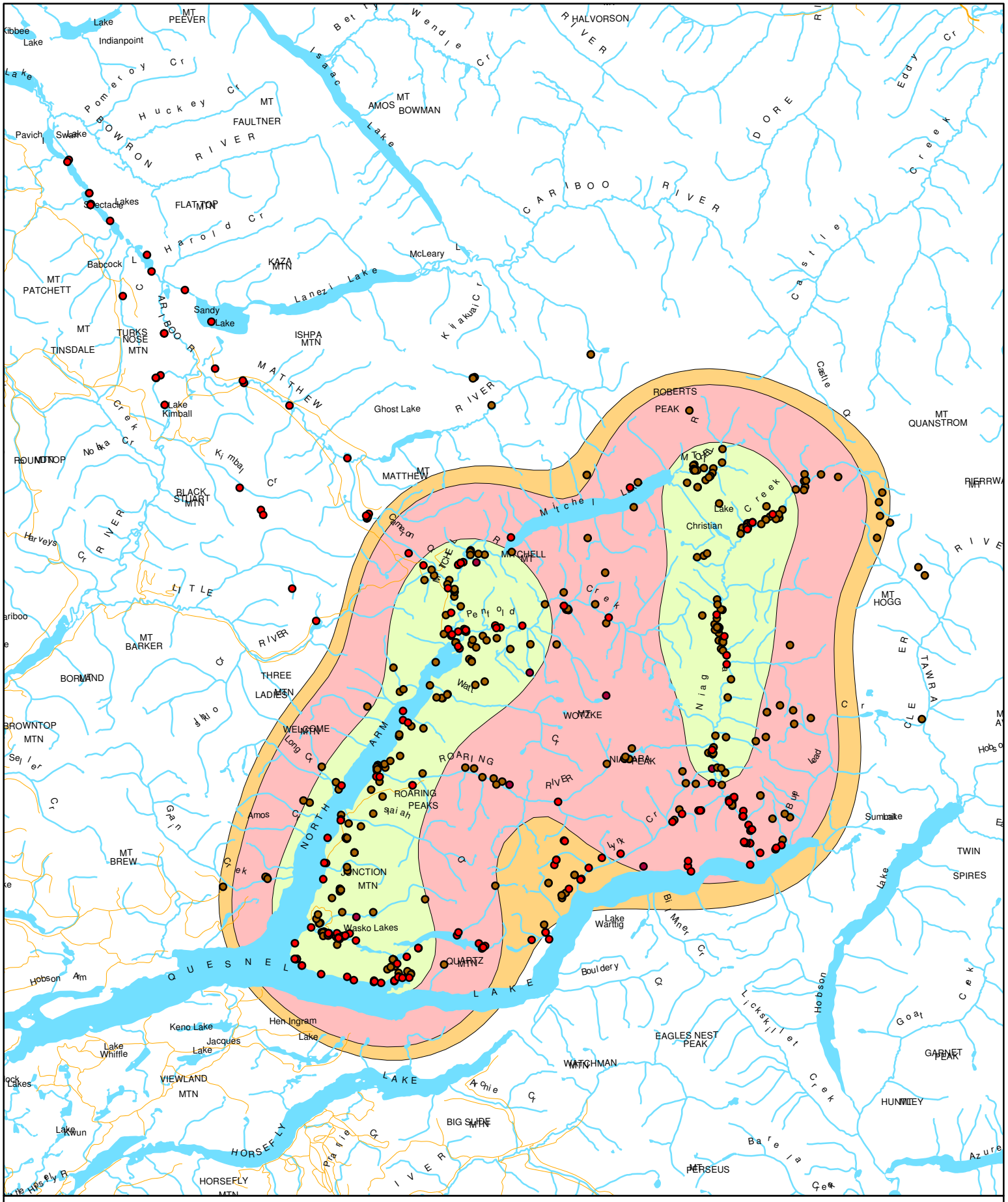
1:350,000

0 2 4 8 12 16
Kilometers

Telemetry Point

Kernal Home Range
50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 24
Contours = 0.5, 0.85, 0.9



Kernal Home Range Analysis
Wolf Pack: Wasko

Prepared for Ministry of Environment, Williams Lake
by Regional GeoBC, ILMB - May 5, 2010
Project: wl_08_0215_wolf_homerange

1:425,000

0 2.5 5 10 15 20

Kilometers

Kernal Home Range

Telemetry Point

50% 85% 90%

Kernal Analysis Parameters (Home Range Tools)
h = 1 # of telemetry points = 384
Contours = 0.5, 0.85, 0.9

Appendix 3. An estimate of budget requirements for the 2010-2011 fiscal years.

Wolf

Priority	Description	Cost
1	Conduct two fixed wing flights in late April early May 2010 to locate potential den sites. Fixed wing flight every 3 months after May to keep track of animals and download GPS collars.	**$12,600.00**
2	Project Assistant to conduct fixed wing flights, prepare technical reports and assist with ground trapping and aerial capture.	**$25,500.00**
3	Aerial wolf capture (Approximately 3days-remove 15 wolves). This cost will be reduced by approximately 1/3 if aerial removal is approved.	**$29,400.00**
4	Sterilize 6 wolves	**$6500.00**
5	Miscellaneous expenses	**$2000.00**
6	Continue to seek approval for aerial wolf removal.	
7	Consult with Kamloops sub-region to obtain approval to remove and sterilize wolves in the western portion of Wells Gray Park.	
8	Complete fiscal 2010/2011 fiscal report.	
Total		**$76,000.00**

Caribou

Priority	Description	Cost
1	Complete caribou inventory (WGN, BV and BW) WGN only cost= $30,000.00 (priority area) BV and BW only cost=$20,000.00	**$50,000.00**

Total 2010-11 Wolf and Caribou Estimated Project Costs= $126,000.00

Appendix 4. An estimate of budget requirements for the 2011-2010 fiscal year.

Wolf

Priority	Description	Cost
1	Conduct two fixed wing flights in late April early May 2010 to locate potential den sites. Fixed wing flight every 3 months after May to keep track of animals and download GPS collars.	**$12,600.00**
2	Project Assistant to conduct fixed wing flights, prepare technical reports and assist with ground trapping and aerial capture.	**$19,500.00**
3	Aerial wolf capture (Approximately 2 days-remove 10 wolves). This cost will be reduced by approximately 1/3 if aerial removal is approved.	**$20,800.00**
4	Sterilize 3 wolves	**$3000.00**
5	Miscellaneous expenses	**$1500.00**
6	Continue to seek approval for aerial wolf removal.	
7	Consult with Kamloops sub-region to obtain approval to remove and sterilize wolves in the western portion of Wells Gray Park.	
8	Complete fiscal 2010/2011 fiscal report.	
Total		**$57,400.00**

Caribou

Priority	Description	Cost
1	Complete caribou inventory (WGN, BV and BW) WGN only cost= $30,000.00 (priority area) BV and BW only cost=$20,000.00	**$50,000.00**

Total 2010-11 Wolf and Caribou Estimated Project Costs= $107,400.00