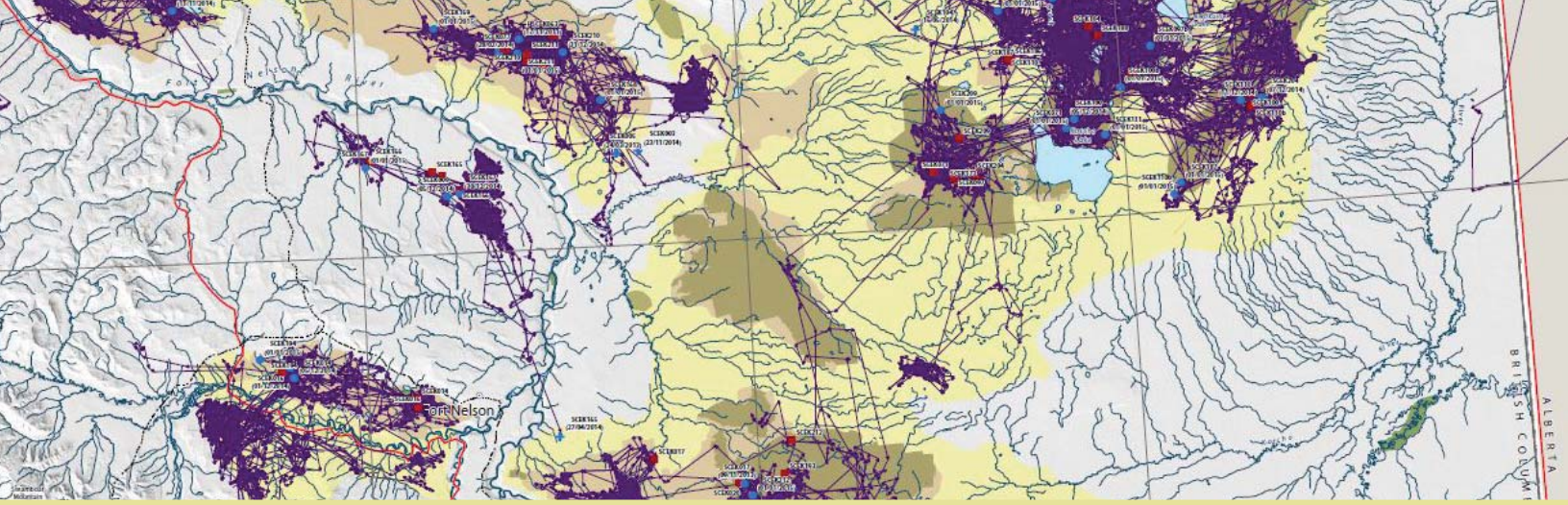
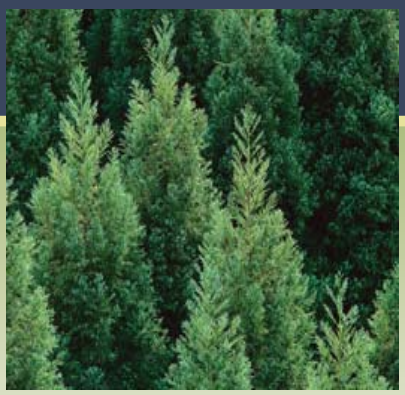


BOREAL TELEMETRY DATA MANAGEMENT AND REPORTING (2013/2018)



Summary Report - April, 2018

Prepared by:

CASLYS CONSULTING

BOREAL CARIBOU DATA MANAGEMENT AND REPORTING

Summary Report

Submitted to:

BC Oil and Gas Research and Innovation Society
300 – 398 Harbour Road
Victoria, BC
V9A 0B7

Submitted by:

Caslys Consulting Ltd.
Unit 10, 6782 Veyaness Road
Saanichton, BC, V8M 2C2

Contact: Jason Shaw
Tel: (250) 652-9268; Fax: (250) 652-9269
Email: jshaw@caslys.ca

April 2018

Copyright®
Caslys Consulting Ltd

.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

In support of the Government of British Columbia's management activities for boreal caribou, Caslys Consulting Ltd. (Caslys) was responsible for the data management and monitoring of boreal caribou, wolf, and moose GPS-collar data in northeastern B.C. The boreal population of woodland caribou (*Rangifer tarandus caribou*) are considered Threatened, under SARA Schedule 1, due to habitat destruction, hunting, disturbance by humans, and predation.

In 2013, the BC Oil and Gas Research and Innovation Society (BC OGRIS) (formerly the Science and Community Environment Knowledge (SCEK) fund), in conjunction with Research and Effectiveness Monitoring Board (REMB) as part of the Ministry of Forests, Lands, Natural Resource Operations & Rural Development (FLNRORD), initiated the development of a spatial dataset for the storage of boreal caribou telemetry locations and other ancillary information relevant to the long-term management and monitoring of the species. Since the project inception, Caslys has been responsible for the following tasks:

- Day-to-day management and monitoring of telemetry collars deployed on boreal caribou, wolf and moose in northeastern B.C.
- Development and maintenance of a spatial database to import and process the GPS-collar data from several different data providers.
- Identification of mortality and calving events from the GPS data.
- Tracking the status of VHF collars based on field monitoring surveys provided by the Project Authority.
- Managing data provided from mortality investigations provided by the Project Authority.
- Generating reports and maps on animal locations and movements.
- Data exports as requested by the Project Authority.

As part of the above analysis, Caslys developed a series of spatial analysis and modelling workflows to assist in the management and monitoring of the three species. The details of the analysis include:

- Examining and identifying predator-prey relationships by mapping and modelling caribou and wolf collar locations.
- Proximity analyses to monitor spatial relationships between caribou and developments (e.g., oil and gas facilities and pipelines).
- Development and integration of caribou walklines to identify core movement rates.
- Identifying key habitat and home ranges by examining the spatial relationships between collar locations and underlying biophysical attributes.
- Additional analysis to assist in management of the caribou and associated ranges, other scientific research and public consultation (such as step-length analysis and spatial analysis of movement corridors between herds).

Caslys utilized a variety of data systems while accessing the input data and developing the monitoring workflows. Source data for the GPS-collar telemetry data was obtained from various sources dependant on the data provider: Vectronics was acquired through GPS Plus, and later GPS Plus X, software; while data from ATS and Lotek were acquired via website access. Database design and management utilized Microsoft Access 2010; while spatial analysis and geoprocessing was performed using Esri ArcGIS 10.1 software, including custom tools and add-ins.

2.0 DATA MONITORING

As part of the data management activities by BC OGRIS (previously SCEK) and REMB, Caslys provided day-to-day monitoring of the GPS-collar telemetry data (from various source data providers), and ongoing tracking of VHF collars and mortalities monitored as part of regular field surveys, monitoring surveys, and mortality investigations conducted by the Project Authority.

From the three key telemetry data providers (ATS, Lotek, Vectronics), collar data was separated by those which were transmitting regular GPS signals via satellite (i.e., GPS collars) and those that were only heard in the field through VHF radio monitoring during field surveys (i.e., VHF collars). Movement tracking was only conducted on the GPS collars in which we received regular location transmissions. Data collected previously for the historic collars were not monitored as part of this project, but are included in the summary results.

A breakdown of the number of collars by type (i.e., GPS, VHF) and data provider (i.e., ATS, Lotek, Vectronics) for each species are outlined in the tables below. Note that some of these collars are not currently active (e.g., mortality, malfunction, released), are historic and have not been actively monitored as part of this project, or have not been deployed on an animal.

Figure 1. Caribou Collars by Type and Data Provider

Data Provider	Type of Collar	Number of Collars
ATS	GPS	39
	VHF	47
Lotek	GPS	14
	VHF	143
Vectronics	GPS	95
Historic / Unknown	-	29

Figure 2. Wolf Collars by Type and Data Provider

Data Provider	Type of Collar	Number of Collars
ATS	GPS	10
Lotek	GPS	55
	VHF	23
Vectronics	GPS	2

Figure 3. Moose Collars by Type and Data Provider

Data Provider	Type of Collar	Number of Collars
Vectronics	GPS	68

Additional details regarding the collars monitored as part of this project can be found in Appendix 1 (Collar Details) and Appendix 2 (Collar Maps).

2.1 GPS Telemetry Collars

A major component of this project was the ongoing monitoring of telemetry data collected from GPS collars deployed on boreal caribou, wolf and moose. The collection and analysis of this data allowed spatial analysis and

modelling to help track, interpret and predict animal movement with respect to herds and ranges, seasonality and migration, and underlying anthropogenic disturbance and biophysical landscape characteristics.

A detailed workflow for the processing and review of the GPS-collar telemetry data is outlined below:

1. Import
    a. Telemetry data is acquired from three separate data providers (i.e., Vectronics, Lotek, ATS).
    b. The raw telemetry data from each data provider is imported into quarantine tables in the MS Access import database.
2. Integration
    a. The source data is merged and standardized to a common data schema.
    b. The validated data is then imported into master datasets separated by species.
3. Spatial Analysis
    a. Spatial layers are generated from the telemetry locations and movement rates calculated.
    b. Walklines between points are interpolated to assess movement patterns for each animal.
4. Monitoring and Review
    a. The data is reviewed to track the number of records being imported for each collar and to identify any potential mortalities (e.g., movement analysis) and/or collar malfunctions (e.g., gaps in telemetry data).
5. Reporting
    a. Each collar exhibiting decreased movement or ones that have issues in data transmission will be listed in an email and sent to the Project Authority for review, along with an export of the data and a PDF map showing the movement patterns. This is usually done bi-weekly.
    b. Monthly reports and maps are also compiled to summarize collar movements and data transmission history.

The project comprised of a total of 283 GPS collars (148 caribou, 67 wolf, 68 moose), of which 253 were monitored spatially (146 caribou, 41 wolf, 66 moose). Differences between the total number of GPS collars in the dataset and those with spatial data can be attributed to the presence of collars not tracked (i.e., historic) or not deployed (i.e., active but not attributed to an animal) as part of this program.

The number of GPS collars by status (e.g., Active, Mortality) and data provider (i.e., ATS, Lotek, Vectronics) for each species are outlined in the tables below.

Table 1. Caribou GPS Collars by Status and Data Provider

Collar Status	ATS	Lotek	Vectronics
Active			30
In-Active	17	10	39
Malfunction	9		
Mortality	10	4	26
Released	2		
Replaced	1		

Table 2. Wolf GPS Collars by Status and Data Provider

Collar Status	ATS	Lotek	Vectronics
Active - VHF		3	
In-Active		16	
Malfunction	4	5	1
Mortality		15	1
Not Deployed		14	
Replaced		1	
Unknown	6	1	

Table 3. Moose GPS Collars by Status and Data Provider

Collar Status	Vectronics
Active	42
In-Active	5
Malfunction	3
Mortality	16
Not Deployed	2

Average lifespan of the GPS collars varied depending on several factors. Collars with more frequent signal transmissions (e.g., several times a day) experience shortened lifespans compared to those transmitting less frequently (e.g., once or twice per day). Vectronics collars, on average, had a longer lifespan than both ATS and Lotek collars.

The average lifespan (in days) for GPS collars by data provider and collar status for each species are outlined in the tables below. Details regarding the lifespan for each collar can be found in Appendix 1 (Collar Details).

Table 4. Average Collar Lifespan in Days - Caribou

Data Provider	Collar Status	Average Lifespan (Days)
ATS	In-Active	645
	Malfunction	576
	Mortality	311
	Released	498
	Replaced	95
Lotek	In-Active	889
	Mortality	196
Vectronics	Active	1077
	In-Active	924
	Mortality	420

Table 5. Average Collar Lifespan in Days - Wolf

Data Provider	Collar Status	Average Lifespan (Days)
Lotek	Active - VHF	350
	In-Active	421
	Malfunction	476
	Mortality	213
	Replaced	128
	Unknown	305
Vectronics	Malfunction	286
	Mortality	165

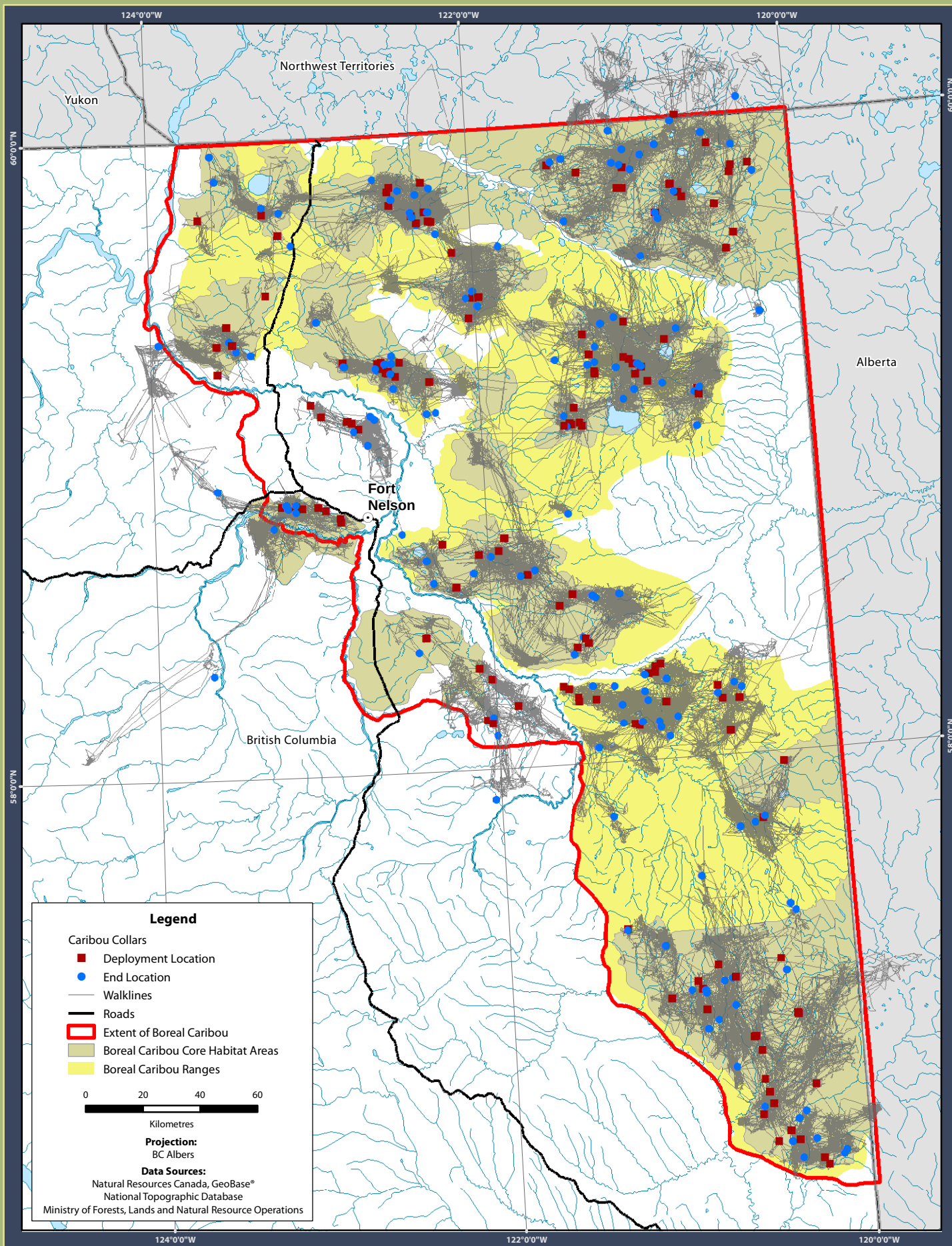
Table 6. Average Collar Lifespan in Days - Moose

Data Provider	Collar Status	Average Lifespan (Days)
Vectronics	Active	941
	In-Active	670
	Malfunction	116
	Mortality	341

The following maps display the start (i.e., deployment) and end (e.g., mortality, inactive) locations for each species. Movement is denoted through the development of walklines linking two telemetry points with a directional line feature.

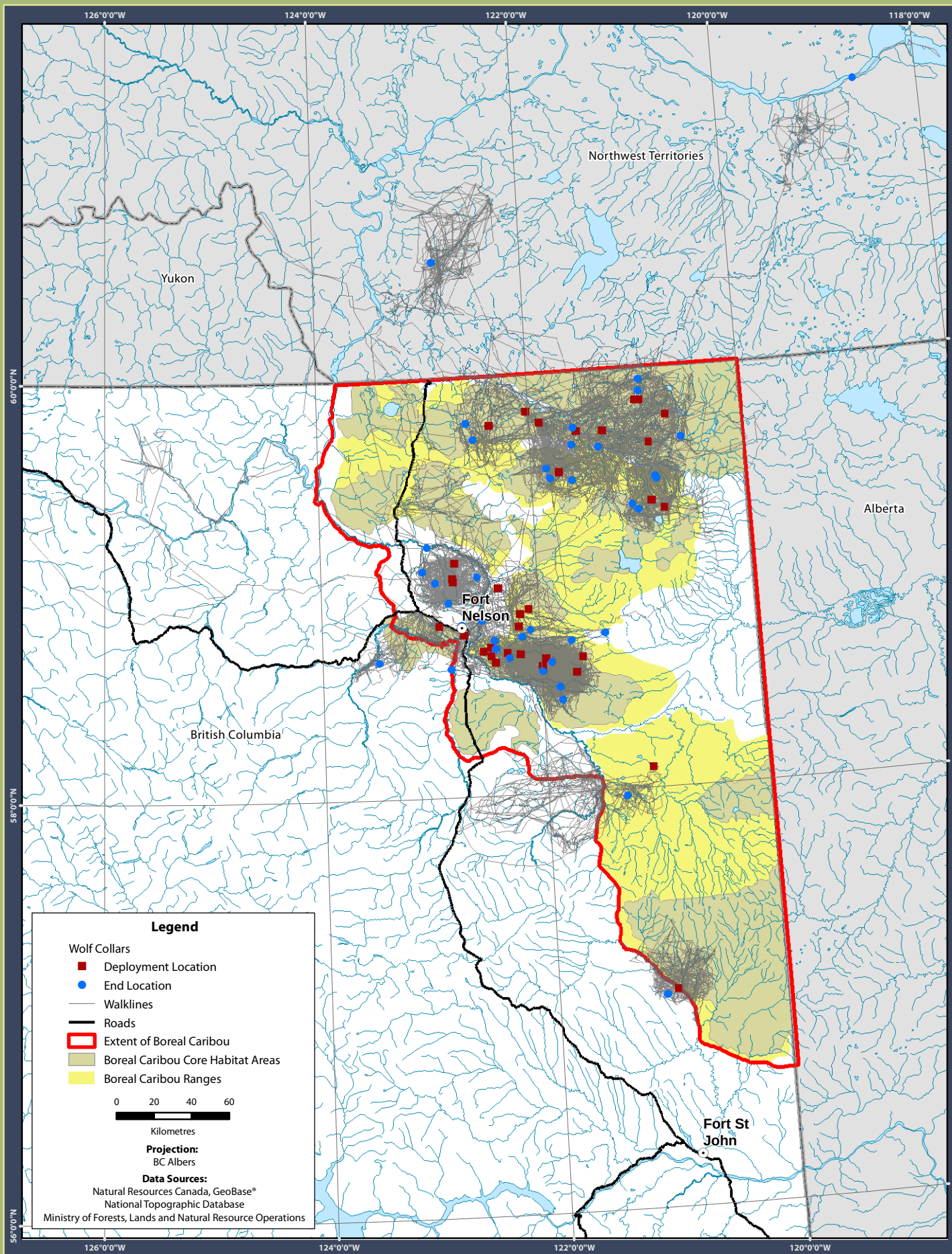
Boreal Caribou Locations

DRAFT



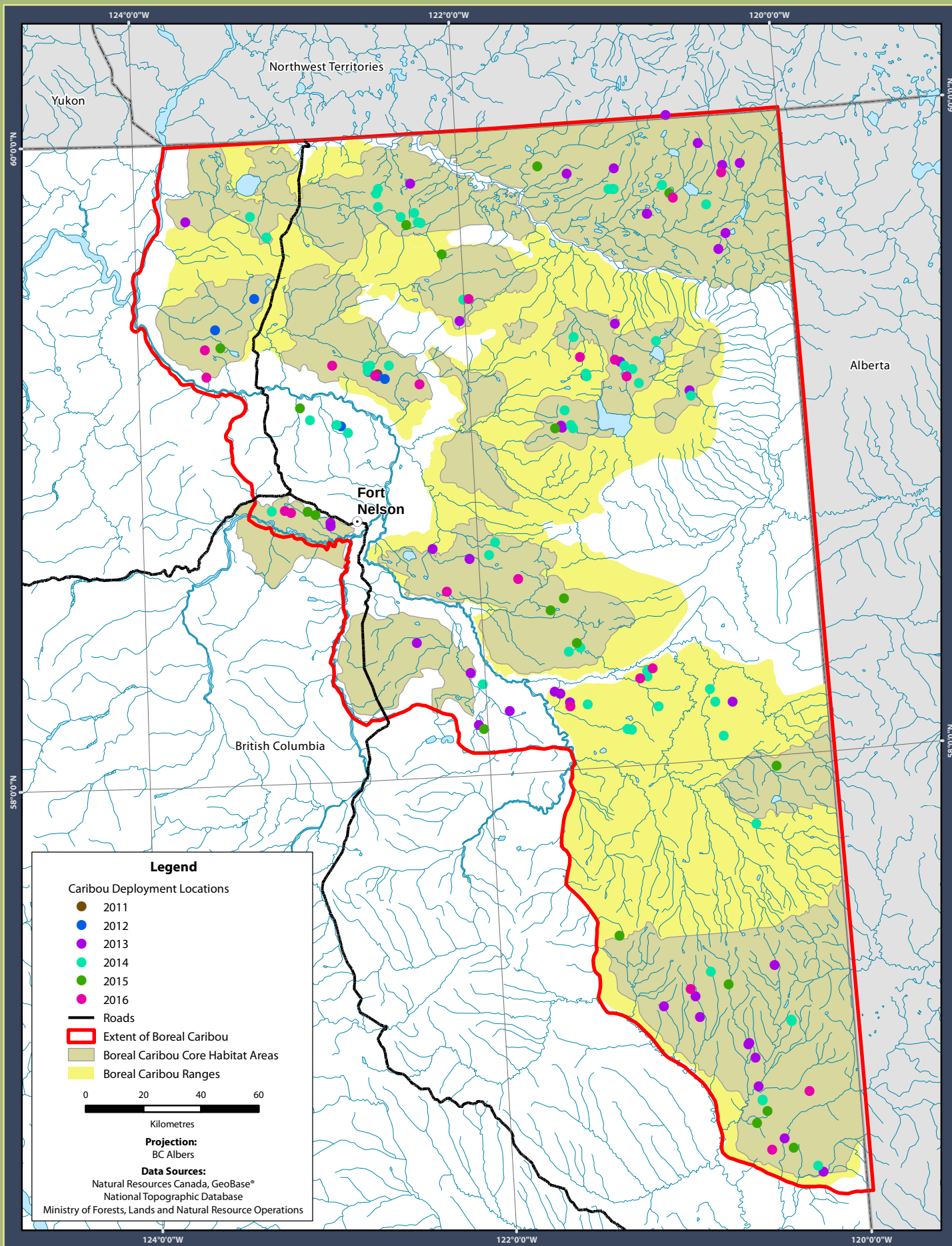
Wolf Locations

DRAFT



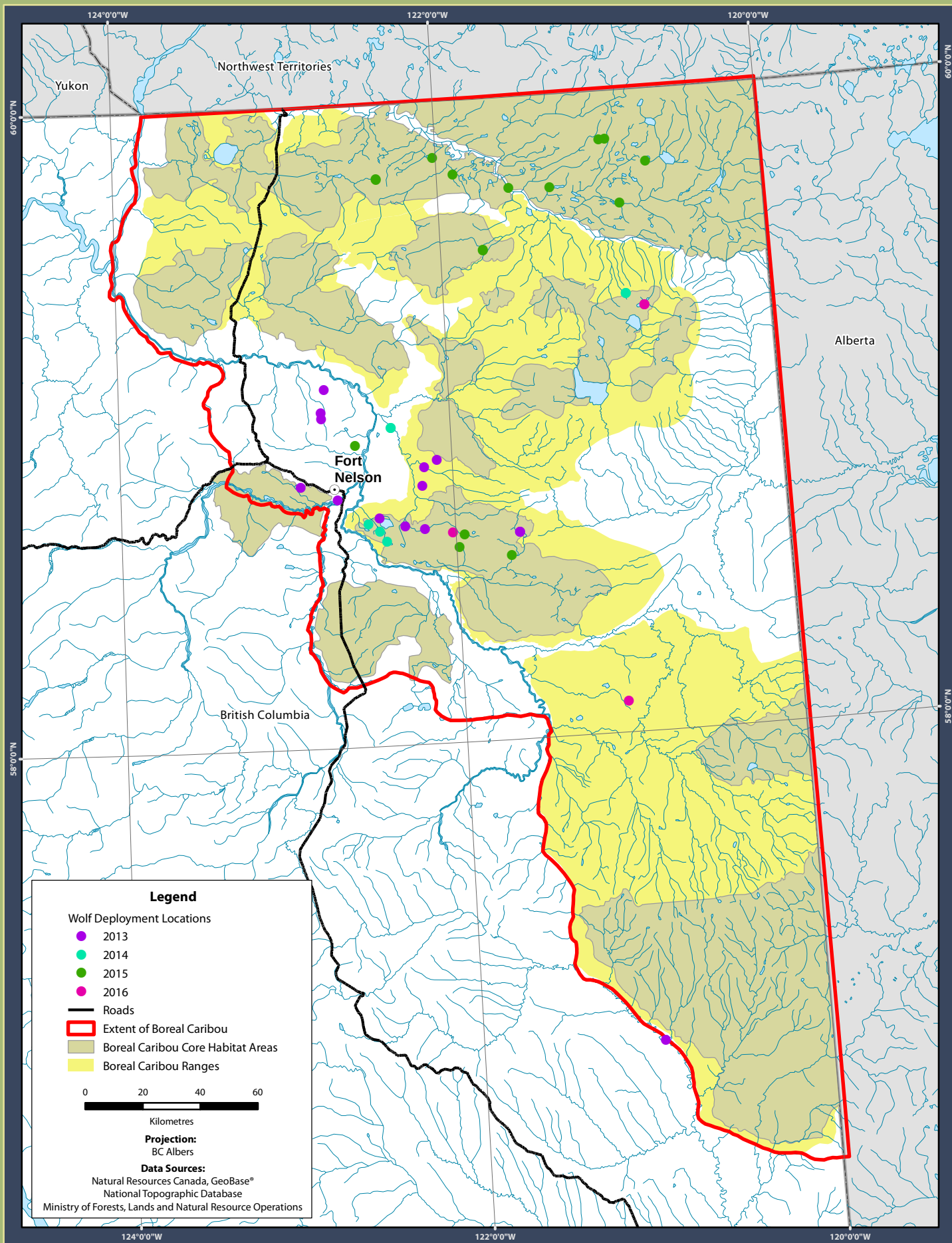
Boreal Caribou Deployment Locations

DRAFT



Wolf Deployment Locations

DRAFT



2.2 VHF Collars

The project also involved the monitoring of collars that were not GPS-enabled and could only be heard by VHF radio during field surveys. Details for such collars were provided by the Project Authority in the form of monthly field monitoring survey reports. These data were imported into a field survey MS Access database and the collar status and general location was monitored over time. Additional details regarding VHF collar status could also be taken from mortality investigation reports, when applicable. The ability to effectively monitor VHF collars as part of this project was dependant on receiving regular field survey results from the Project Authority.

The project comprised of a total of 239 VHF radio collars (216 caribou, 23 wolf). There were no VHF moose collars. The number of VHF collars by status (e.g., Active, Mortality) and data provider (i.e., ATS, Lotek) for caribou and wolf are outlined in the tables below.

Table 7. Caribou VHF Collars by Status and Data Provider

Collar Status	ATS	Lotek	Unknown
Active		54	1
In-Active	24	5	7
Malfunction		1	
Mortality	6	77	8
Unknown	17	6	10

Table 8. Wolf VHF Collars by Status and Data Provider

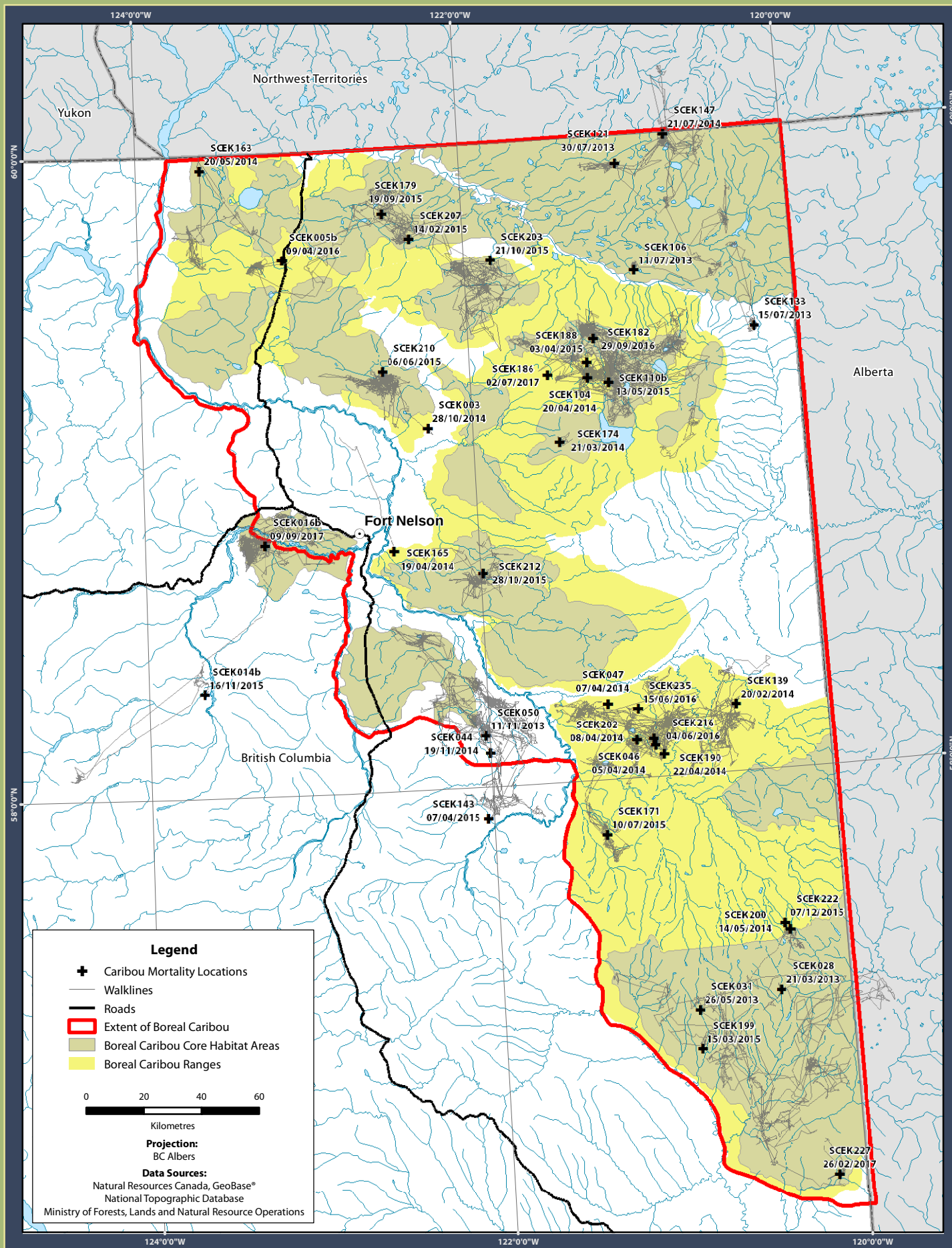
Collar Status	Lotek
Active	1
Mortality	7
Recovered	12
Unknown	3

2.3 Mortalities

The monitoring of animal mortalities was conducted both visually (i.e., spatial representation of movement) and through the acquisition of monitoring surveys and mortality investigation reports from the Project Authority. Animal movements were used to highlight potential mortalities as clustered movement in the telemetry data (i.e., 'star patterns') usually denoted a potential mortality. Results of this spatial review was delivered to the Project Authority bi-weekly which led to field investigation.

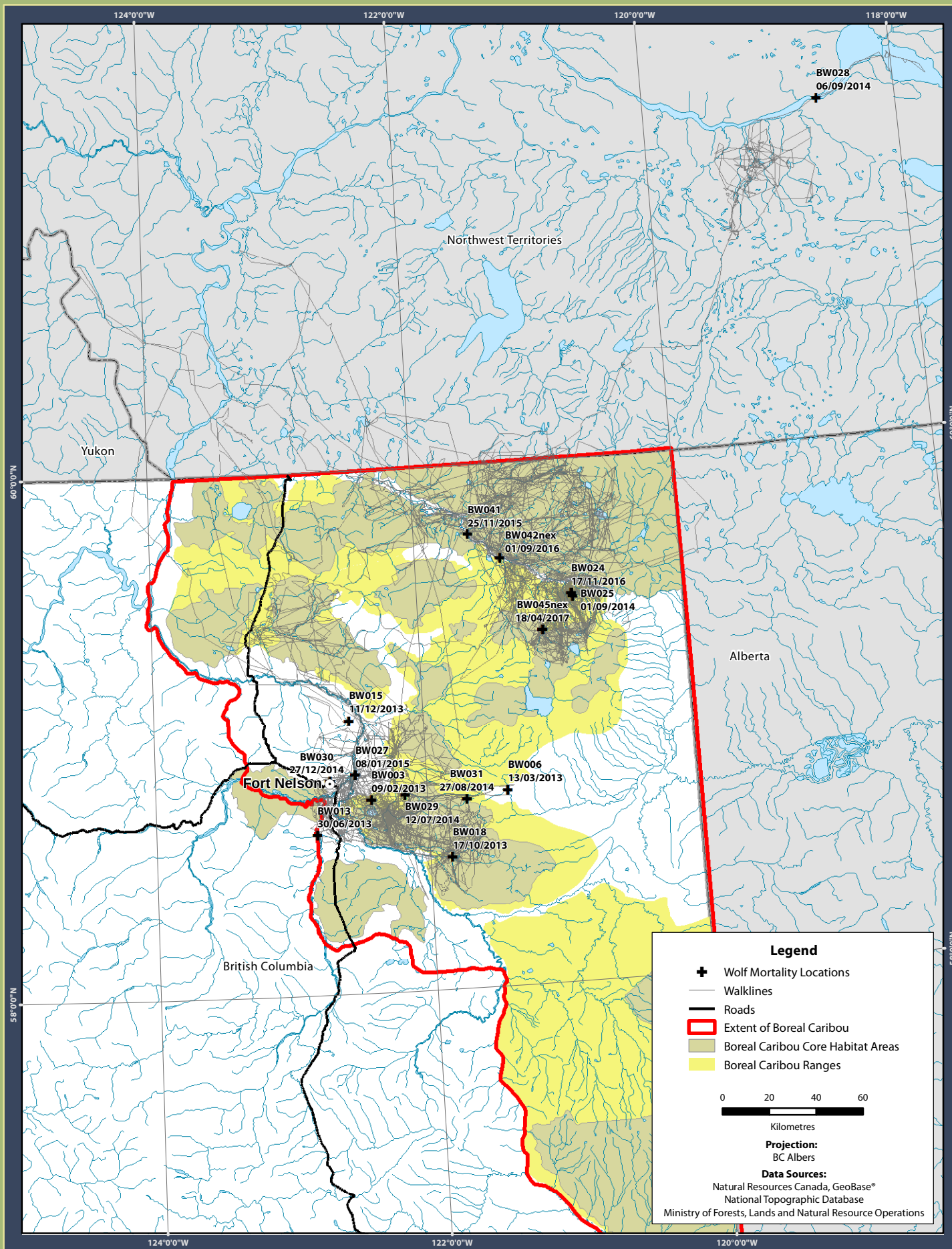
Boreal Caribou Mortality Locations

DRAFT



Wolf Mortality Locations

DRAFT



Of those collars that are confirmed as mortalities (i.e. through field investigation), the most common cause of death for both caribou and moose is wolf predation. However, the cause of death in many situations is unknown (e.g., inconclusive at field site, or a mortality investigation was never conducted). The number of mortalities by cause for each species is outlined in the tables below.

Table 9. Caribou Mortality Cause

Mortality Cause	Number of Collars
Hunter kill	2
Non predation death	3
Strangulation	1
Wolf kill	71
Wolf kill (probable)	7
Wolverine kill	4
Unknown	43

Table 10. Wolf Mortality Cause

Mortality Cause	Number of Collars
Hunter kill	4
Hunter kill (probable)	1
Moose kill	3
Road kill (probable)	1
Wolf kill	1
Unknown	13

Table 11. Moose Mortality Cause

Mortality Cause	Number of Collars
Hunter kill	1
Obstructed labour	1
Wolf kill	3
Wolf kill (probable)	8
Unknown	3

3.0 ANALYSIS

Over the entire project, specific analyses were performed on the data to assist in management of the caribou and associated ranges, other scientific research and public consultation. Our team was responsible for designing and modelling habitat scenarios that were evaluated by a team of biologists and were required to adhere to scientifically established guidelines. The produced results are grounded by previous studies or expert advice, and are presented in a way that allows alternatives to be compared and confidence to be placed in decisions reached. Considerations often included:

- Implementing an iterative approach related to posing questions, deriving answers and reviewing potential alternatives related to the identification of boreal caribou habitat.
- Experience with synthesizing information from multiple sources to produce a comprehensive picture, and understanding and documenting the limitations associated with the various data sources integrated to identify key habitats.
- Thorough documentation of the process throughout the project to ensure adherence to rigorous standards that provides an audit trail, enabling the rationale for all decisions to be easily understood, transparent and defensible.

The following sections describe some of the other analyses that were performed on the telemetry data as part of this project.

3.1 Step Length Analysis

To study the influence of freeze-thaw cycles and climate change on wolf and caribou movements, Caslys completed a series of analyses using telemetry data from GPS-collared animals to examine the variation in movement rate in relation to weather. Step length was calculated based on telemetry points from both caribou and wolf and spatially joined with climate data from B.C. provincial weather stations. Mortality rates were also reviewed to determine the relationship between mortality, movement rate, and weather events. More information regarding the step length analysis can be found in the internal report *Step Length Analysis for Boreal Caribou and Wolf in Northern British Columbia* prepared for MFLNRORD (Caslys, 2017).

3.2 Movement Corridors

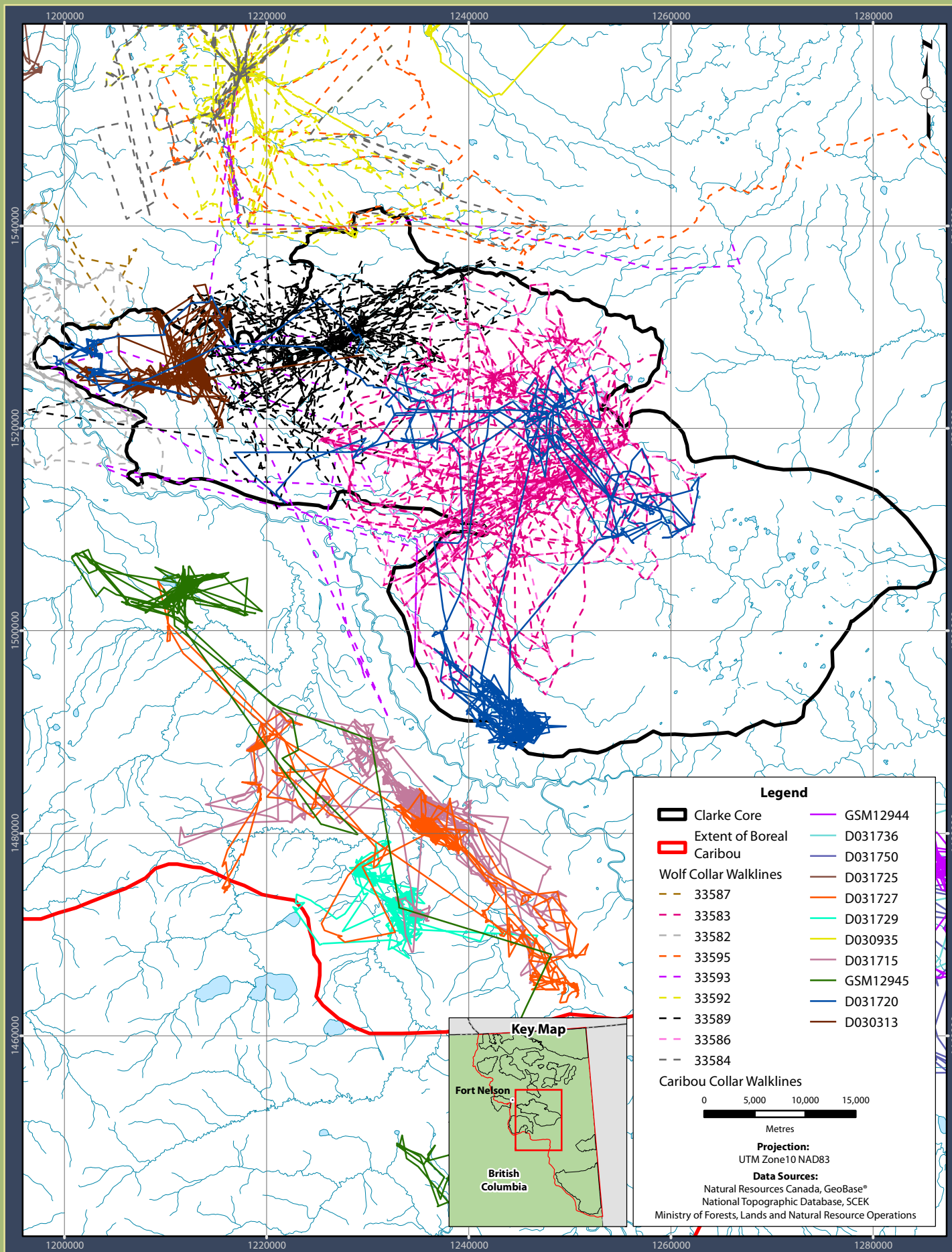
Tracking caribou movement through the modelling of telemetry data allows movement corridors between herds and ranges to be defined. Analysis done in 2015 utilized telemetry datasets from Alberta, British Columbia, and the Northwest Territories to examine density patterns and usage distribution for caribou movement within the northeastern B.C. study area. A kernel density was applied on both telemetry points and walklines to generate density rasters which highlighted movement pathways, or corridors, of boreal caribou within designated herds and ranges. This analysis was repeated in 2018 using revised methods and updated telemetry data, which highlighted new caribou movement patterns and confirmed previously defined corridors.

3.3 Data Exploration within Ranges

Also, as part of this project, Caslys generated figures and tabular summaries of caribou and wolf collars within specific ranges on an as-needed basis. An example map is provided below which outlines the movement of caribou and wolf within the Clarke core range over a specific time period.

Caribou and Wolf Movement Data for the Clarke Core

DRAFT



4.0 RECOMMENDATIONS

The monitoring of boreal caribou in northeastern B.C. is critical to the management of the species. The project generates quantitative data related to local population trends and distribution – both of which are vital to tracking the recovery progress and providing the basis for defining and initiating both provincial and national recovery actions. Management guidelines around hunting, and oil and gas development and operations in key boreal caribou habitat, are informed by the project's monitoring, mapping and analysis results.

The integration of data for the various species from multiple data providers into a single dataset with common attributes has proven to be a cost effective way to both manage and distribute the data. These data are used to better inform management decisions by providing an understanding of prey/predator relationships between the species on a regular reporting schedule.

The following recommendations should be considered regarding the ongoing management and monitoring of boreal caribou and other species:

- Given that this telemetry program has been successful at providing an efficient and cost effective method to track and monitor a variety of animal species over time, it is recommended that this program be continued into the future.
- To facilitate accurate data monitoring, communication protocols should be established between the Project Authority and those monitoring the data. This would allow the results of monitoring surveys, mortality investigations, and events such as deployment and redeployment of collars, to be attributed more thoroughly in the dataset, and changes in movement patterns between animals to be better understood.
- Research goals should be defined prior to collar deployment, as details such as transmission frequency (e.g., once a day, several times a day) can affect the type of analysis that can be performed on the data. However, adjusting the transmission frequency can also have impacts on collar life (i.e., those collars that transmit more frequently generally have lower lifespans).
- To make data collection and processing more efficient, limiting the number of data providers would reduce the amount of processing time required to incorporate source data.

5.0 REFERENCE

Kite, R., S. Alexander, and J. Shaw. 2017. Step Length Analysis for Boreal Caribou and Wolf in Northern British Columbia. Prepared by Caslys Consulting Ltd. for Ministry of Forests, Lands, Natural Resource Operations & Rural Development.

Appendix 1
Collar Details

Appendix1_Collar_Summary.xlsx

Appendix 2
Collar Maps

Caribou_Collar_Maps.pdf
Wolf_Collar_Maps.pdf
Moose_Collar_Maps.pdf