BC Boreal Caribou Research and Effectiveness Monitoring Board

FINAL REPORT 2018

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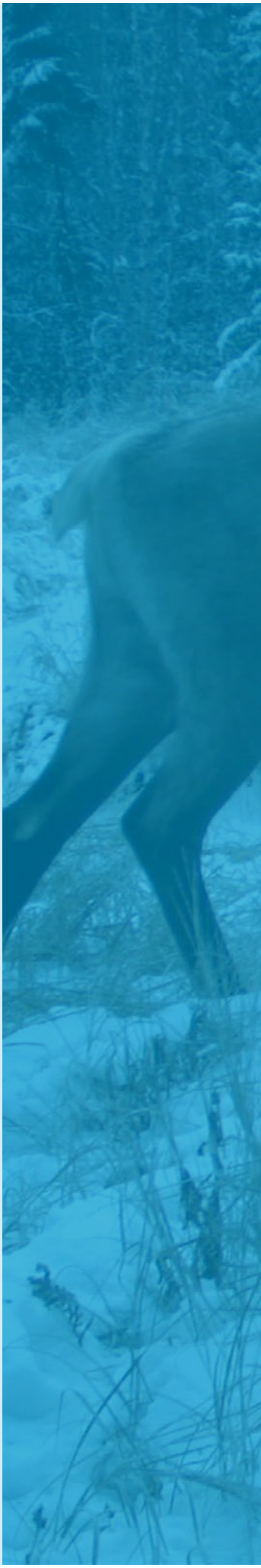
WE THANK PROJECT PARTNERS AND CONTRIBUTORS FOR SHARING THEIR PHOTOS FOR USE IN THIS REPORT



Highlights



NEARLY $7.9M INVESTED IN MORE THAN 40 PROJECTS AND SERVICES OVER THE PAST FIVE YEARS

TRANSFORMATIVE UNDERSTANDING OF BOREAL CARIBOU HERD SIZES, RANGE USE, AND POPULATION DYNAMICS

SIGNIFICANT ADVANCES IN OUR UNDERSTANDING OF THE RELATIVE EFFECTS OF DIFFERENT STRESSORS, INCLUDING HABITAT CONDITION, PREDATOR-PREY DYNAMICS, HEALTH AND CLIMATE

INITIATION OF CANADA'S FIRST RANGE-WIDE HABITAT RESTORATION PROGRAM

UNIQUE COMMITMENT TO OPEN DATA TO MAXIMIZE COLLABORATION AND RETURN ON INVESTMENT

DEMONSTRATED BENEFITS TO LOCAL COMMUNITIES

SUCCESSFUL INDUSTRY-GOVERNMENT COLLABORATION

Background

The BC Boreal Caribou Research and Effectiveness Monitoring Board (REMB) was established in 2011 to support the BC government's Implementation Plan for the Ongoing Management of Boreal Caribou. The Plan outlines measures to achieve objectives for Boreal Caribou in northeast BC, which include:

- establishing Resource Review Areas where petroleum and natural gas tenure sales were deferred for a minimum of five years;
- identifying and designating under the *Oil and Gas Activities Act* Boreal Caribou habitat areas where oil and gas activities are mitigated;
- establishing operating practices to be applied to oil and gas activities in designated Boreal Caribou habitat areas;
- restoring Boreal Caribou habitat;
- managing Caribou predators and their primary prey; and,
- conducting research on Boreal Caribou and their habitat.

The REMB was established through a Memorandum of Understanding signed in August 2011 by the BC Ministry of Forests, Lands and Natural Resource Operations (now Forests, Lands, Natural Resource Operations & Rural Development), BC Ministry of Energy, Mines and Natural Gas (now Energy, Mines & Petroleum Resources), BC Ministry of Environment (now Environment & Climate Change Strategy), the Canadian Association of Petroleum Producers, and the Explorers and Producers Association of Canada.

Industry partners supported the REMB through a levy on oil and gas permitting and production, which provided $6.7 million over 3.5 years. The BC Oil and Gas Commission provided an additional $2M. Funds were administered through the BC Oil and Gas Research and Innovation Society.

This report presents highlights of the REMB's program from 2012 to its conclusion in 2018.

The Setting

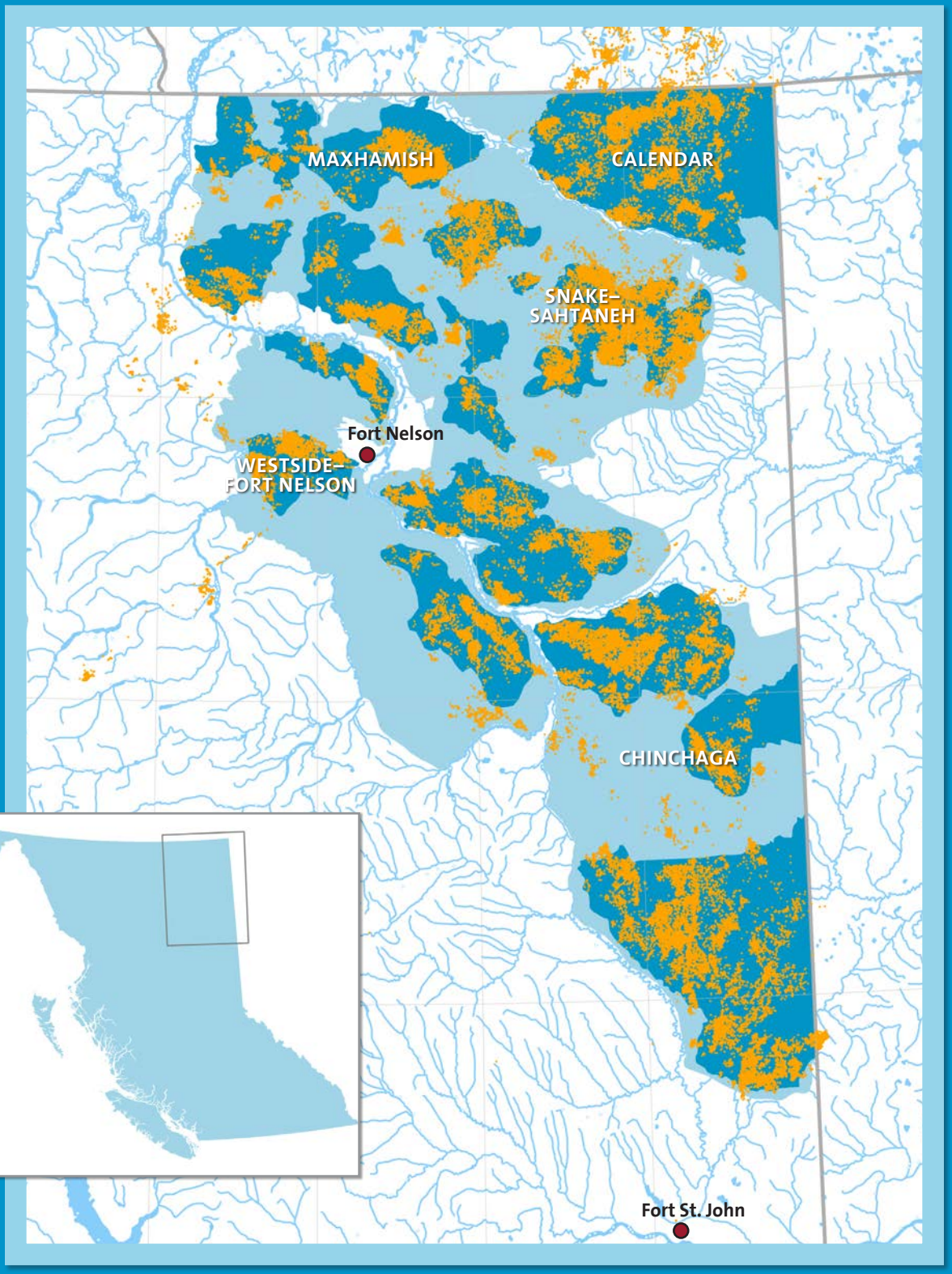
Boreal Caribou are an ecotype of Woodland Caribou (*Rangifer tarandus caribou*), which occur throughout the boreal forest from Alaska to Newfoundland. They are closely related to the Barren Ground Caribou of northern Canada and Alaska and also to Reindeer, which are native to northern Scandinavia and Russia. The boreal ecotype is the least common of three ecotypes of Woodland Caribou found in British Columbia and number about 1000 animals. Their range in BC is limited to the North Peace region and is continuous with Alberta and the Northwest Territories.

Northeast British Columbia is dominated by a taiga ecosystem of deciduous and mixed-wood uplands, riparian forests and extensive, low-lying forested bogs and fen habitats.

This area of BC is dominated by a taiga ecosystem of deciduous and mixed-wood uplands, riparian forests and extensive, low-lying forested bogs and fen habitats. Winters are long and cold and summers are short and warm. Moose and Caribou are the dominant ungulates, although White-tailed Deer and Elk occur along major river corridors and near agricultural areas. Wolves and Black Bears are common, and Lynx, Wolverine and Grizzly Bears also range throughout the region.

The North Peace is the traditional territory of the Treaty 8 First Nations, who continue to depend on its land, wildlife and resources today as they have for millennia. Fort Nelson is the major community in the region and was established when the Alaska Highway was constructed. Agriculture and forestry have been common land uses near the city, but more recently industrial development has been dominated by oil and gas exploration and development. This has led to extensive networks of seismic lines, pipelines, roads, and associated facilities throughout much of northeast BC.

Proposed Boreal Caribou herd ranges (light blue) and core areas (dark blue) in northeast British Columbia. Points are telemetry locations from 240 radio-collared Caribou.



The Challenge

Environment and Climate Change Canada established critical habitat requirements for Woodland Caribou based on an observed correlation between "footprint" (i.e., human-related infrastructure, land clearing and fire) and Caribou recruitment (calves surviving until they are "recruited" into the reproductive population).[1] However, this relationship is mediated through complex causal pathways that are only partly understood.

Woodland Caribou occur in small groups and predominantly use lowland bog and fen habitats that are characteristic of Canada's boreal plains. Traditionally, these habitats have provided a refuge from predation for Caribou because Wolves, their primary predator, tend to remain in upland areas and hunt Moose and other locally abundant ungulates.

Scientists believe that changes in the boreal forest, caused by industrial development, wild fire, climate change and other stressors, are altering both the abundance and distribution of Wolves and their primary prey, and that these changes are leading to more frequent encounters between Wolves and Caribou.[2] The major drivers of this system are captured in an overall "management model" that framed the work of the REMB (see illustration on the following page).

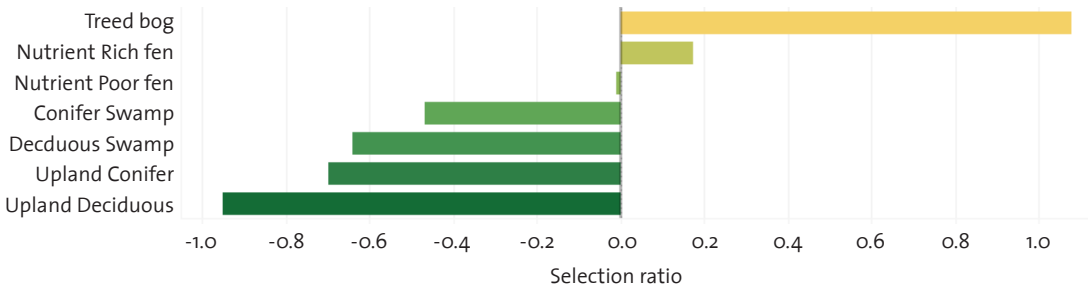
A warming climate is expected to generate larger and more frequent forest fires. This increases the abundance of early seral habitats (e.g., young forests) that are generally characterized by abundant shrubs and forbs. These are attractive to Moose, Elk and Deer, and their numbers tend to increase when more food is available. As winters become less severe, larger populations of Moose, Elk and Deer can be supported farther north, bringing these species into closer proximity with Caribou. Wolf populations increase in response to this "prey enrichment" and in turn encounter and kill more Caribou. Moose, Elk and Deer fare better than Caribou in this situation because they tend to have more offspring and can withstand higher predation rates than Caribou. We call this phenomenon "apparent competition" because Moose, Elk and Deer seem to be out-competing Caribou, but the process is mediated through predation by Wolves.[3]

Pathways to decline in Caribou populations are complex and only partly understood

Industrial development can clear forests and result in effects similar to fires. In areas of oil and gas development, linear features such as seismic lines, roads and pipelines can also facilitate the movement of Wolves, allowing them to travel farther (higher "predator efficiency") and penetrate deeper into Caribou habitat ("loss of spatial separation"), thereby increasing the likelihood that they encounter and kill Caribou.[4]

The challenge of Caribou conservation is understanding the relative importance of these different effects and how they interact, and subsequently designing and implementing management actions that will benefit Caribou.

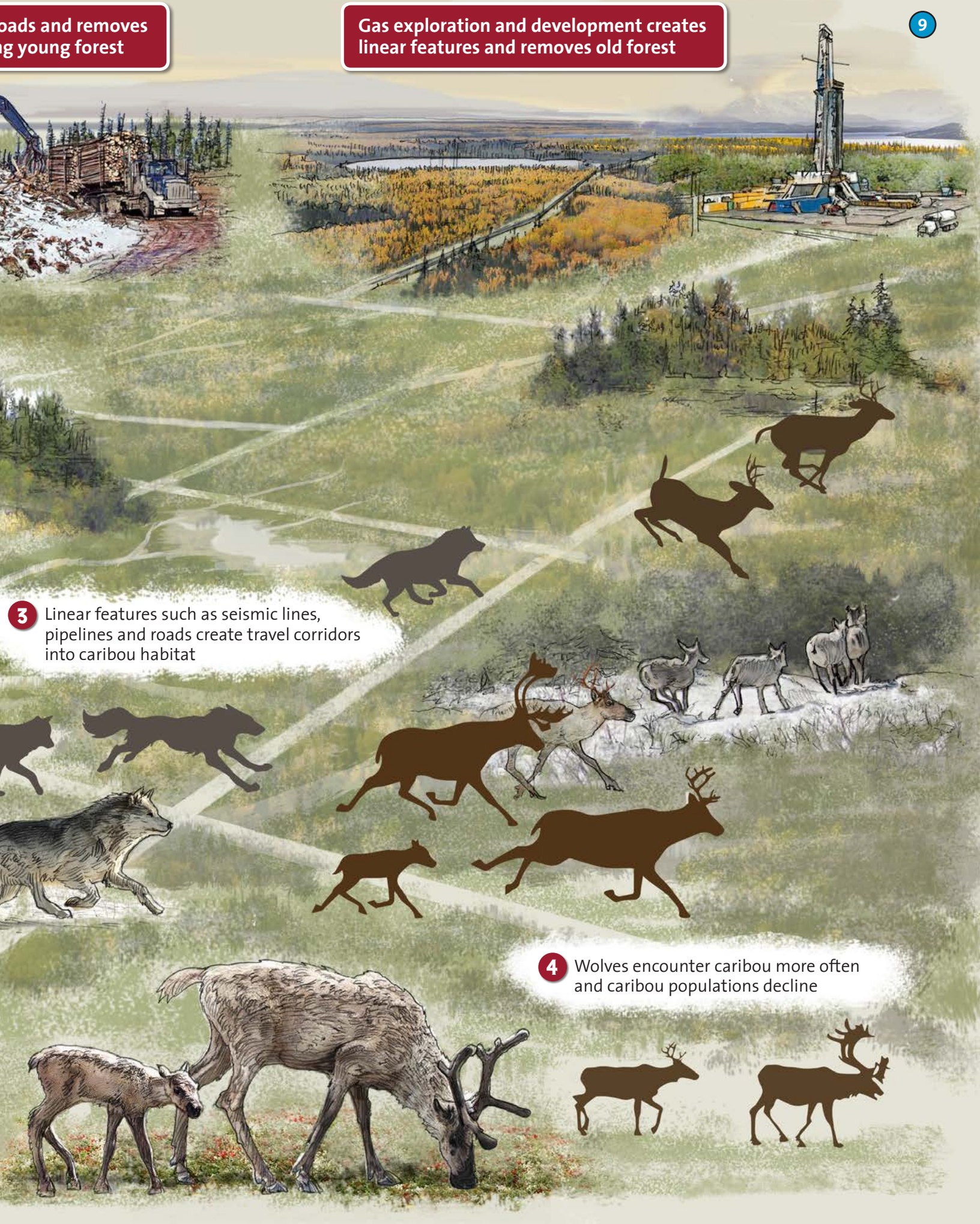
Boreal Caribou have a strong affinity for lowland bog and fen habitats during all seasons.




A warmer climate generates larger and more frequent fires, resulting in more young forest
Logging requires r
older trees, creatin
1 Young regenerating forests provide abundant forage for moose, deer and elk populations that are expanding northward with warmer temperatures
2 Wolf populations increase with abundant moose, deer and elk

oads and removes
g young forest

Gas exploration and development creates linear features and removes old forest



3 Linear features such as seismic lines, pipelines and roads create travel corridors into caribou habitat

4 Wolves encounter caribou more often and caribou populations decline

Critical Hypotheses

The REMB focused its work on testing and characterizing a series of "critical hypotheses" regarding the mechanistic links described by the management model. Understanding the nature and relative importance of these mechanisms is important for designing effective and efficient management actions for Boreal Caribou recovery.

PREY INCREASE IN RESPONSE TO EARLY SERAL HABITAT

We first needed to understand the extent to which human-caused landscape change is increasing the availability of prey for Wolves. To do so required the REMB to survey Moose population densities and to study their habitat use in Caribou ranges that vary in the extent of human-caused habitat change.

PROJECTS

1 **Surveying Moose populations in Caribou ranges** (Eco-Web Ecological Consulting Ltd., Wildlife Infometrics Inc.)

2 **Characterizing Moose habitat use in relation to landscape characteristics** (University of Northern British Columbia, BC Ministry of Forests, Lands and Natural Resource Operations)

MAJOR FINDINGS

REMB-sponsored surveys found that there were significant differences in the density of Moose in different areas of northeast BC, with the lowest density occurring in the Calendar Boreal Caribou range, and the highest occurring near Fort Nelson. The best predictor of Moose density was habitat type. Moose densities were lower in areas with a high proportion of bogs (a habitat type preferred by Caribou), but were higher in areas where the landscape was dominated by hardwood swamps and burns. Features associated with human-caused disturbance were not significant drivers of Moose density. Research conducted outside northeast BC has established that Moose populations respond to forestry activity because they prefer the forage that regrows in recent cutblocks.[5] But forestry activity in northeast BC has been limited and is unlikely to have been a significant driver of Moose density. The exception is the area near Fort Nelson, where high Moose densities are coincident with the most extensive forestry history, but also with the highest availability of habitat types preferred by moose.

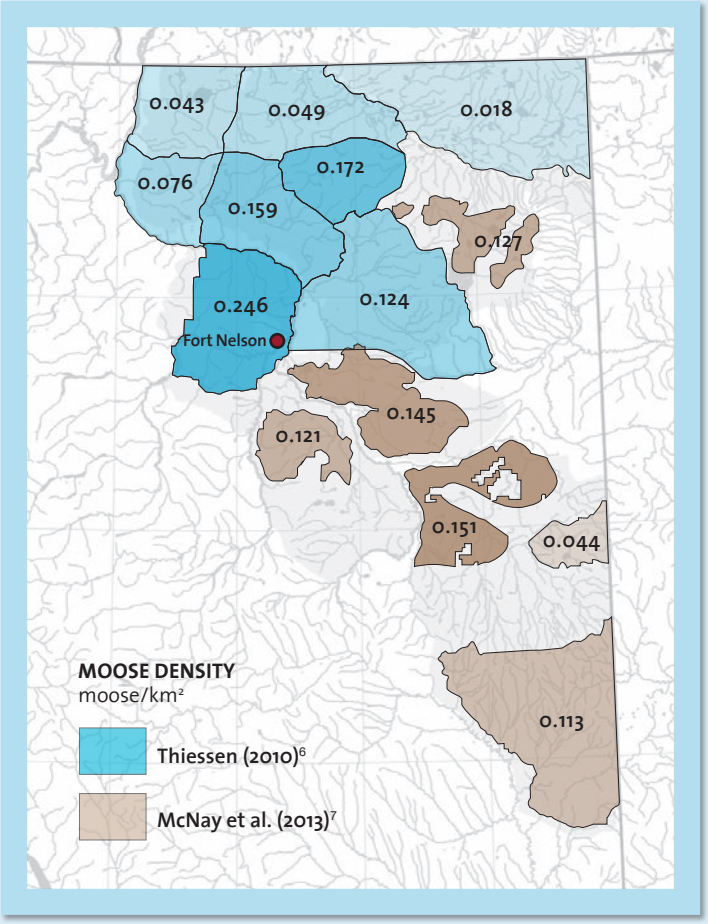
Looking at Moose behaviour in relation to human-caused landscape disturbance, Moose tended to avoid areas of high road density in most, but not all seasons. Males tended to select areas with high densities of seismic lines but females avoided them.

The results of these studies suggest that the distribution and abundance of early seral habitat related to human-caused landscape disturbance is not a major driver of Moose population density or of habitat use, likely because of the limited history of forestry in BC's northeast. More importantly, linear features such as seismic lines, pipelines and roads do not appear to be redistributing Moose into areas that are more characteristic of Caribou habitat, nor increasing their population density in caribou ranges. This is an important finding that is contrary to the prevailing opinion that Moose are making extensive use of the forage growing on seismic lines and pipeline corridors and are moving into Caribou habitat.

CRITICAL HYPOTHESES | Prey Increase in Response to Early Seral Habitat *continued*

The distribution and abundance of other ungulate species associated with early seral habitats (i.e., Elk and White-tailed Deer) have not been studied extensively in northeast BC. These species are locally abundant near the City of Fort Nelson and in valleys associated with major rivers in the region. In general, they are not nearly as abundant as Moose and are not considered a major factor in the predator-prey system affecting Caribou. However, the range of both White-tailed Deer and Elk have been expanding northward for several decades and the species are considered a significant factor in other parts of Caribou range.

Moose densities estimated from aerial surveys in areas overlapping Boreal Caribou herd ranges in northeast BC.



Linear features are not redistributing Moose into Caribou habitats

Wolf densities vary widely among Boreal Caribou ranges

Critical Hypotheses

WOLF POPULATIONS INCREASE IN RESPONSE TO PREY

The second critical hypothesis is related to the increase in Wolf abundance that is expected to occur where prey is more abundant. This required the REMB to estimate Wolf densities in areas where Moose differ in abundance to determine if there is evidence of a correlation.

PROJECTS

1 **Censusing Wolves to determine associations between industrial activity and caribou population growth rates** (Alberta Biodiversity Monitoring Institute)

MAJOR FINDINGS

Assessing the size and distribution of Wolf populations is difficult because packs have large home ranges and use forested habitats that make Wolves difficult to see and count. The Alberta Biodiversity Monitoring Institute (ABMI) has been refining aerial survey techniques in order to increase the reliability of Wolf population estimates, and the REMB partnered with ABMI and with Alberta and Northwest Territories to derive Wolf density estimates in various regions with different habitats characteristics and associated prey densities.

Six study areas have now been surveyed in BC, Alberta and Northwest Territories, and the work suggests that Wolf densities vary widely, from 1.6/1000 km^2 in the Hay River Lowlands of the Northwest Territories to 15.6/1000 km^2 in the Chinchaga North core area of BC.

Although Moose densities are available for the areas censused for Wolves in BC, they are not yet available for areas censused in Alberta and Northwest Territories. With such limited data, the relationship between Wolf and Moose abundance cannot be established definitively, although the available data suggest that Wolves are more common where a larger prey base of Moose exists.

Wolves and Moose are the dominant predator and prey species in BC that are hypothesized to be indirectly affecting Boreal Caribou populations. The same is true in the Northwest Territories. White-tailed Deer are now common in northern Alberta and have become an important prey species for Wolves and, as a result, Wolf densities are likely higher there than they would have been without the expansion of White-tailed Deer.[8] The increase in White-tailed Deer in northern Alberta has been linked to climate change and, secondarily, to human-caused habitat alteration.[9] White-tailed Deer have also expanded northward in BC over the past several decades and, although locally abundant, they are still sufficiently rare to make only a minor contribution to the regional prey base.

Critical Hypotheses

LINEAR FEATURES REDUCE SPATIAL SEPARATION BETWEEN WOLVES AND CARIBOU

While an increase in the Wolf population as a result of an expanding prey base is one mechanism by which Caribou could be exposed to a greater risk of predation, another mechanism involves the spatial relationships between the species. Specifically, the importance of linear features as travel corridors for Wolves and how these features increase the likelihood that Wolves will encounter and kill Caribou. This is a challenging topic to study and the REMB supported several projects that sought to characterize this hypothesized driver of caribou population decline.

PROJECTS

1. **Caribou and Wolf behaviours in relation to oil and gas development: are all disturbances created equal?** (Foothills Research Institute)
2. **Assessing spatial factors affecting predation risk to Boreal Caribou calves** (University of Alberta)
3. **Predicting the effects of restoring linear features on Woodland Caribou populations** (Alberta Biodiversity Monitoring Institute)
4. **Characterizing Moose habitat use in relation to landscape characteristics** (University of Northern British Columbia, BC Ministry of Forests, Lands and Natural Resource Operations)

MAJOR FINDINGS

Wolves are known to use linear features such as roads, seismic lines and pipeline corridors as travel routes, and a focus of recent research has been on whether the abundance, distribution, and condition of linear features leads to Wolves travelling faster, penetrating deeper into Caribou habitat, and encountering Caribou more often as a result. A secondary question is related to how Caribou might be responding to this risk by avoiding linear features, thereby rendering otherwise suitable Caribou habitat less suitable.

This is a difficult question to study in the field because it requires fine-scale knowledge about the simultaneous movements, habitat use and population sizes of Moose, Caribou, and Wolves. The REMB supported a variety of studies that combined available field data with theoretical modelling to generate insights about this complex system.

Recent work from Alberta has demonstrated that wolves travel up to three times faster on some linear features during some seasons than they do in adjacent forests.[10] This provides strong evidence that Wolf use of linear features could create the opportunity to encounter more Caribou. REMB-supported work in northeast BC then demonstrated that Wolves largely avoided preferred Caribou habitat (i.e., large, lowland peat complexes) when linear features were absent, but selected Caribou habitat when linear features were present.

REMB's Moose research demonstrated that linear features were not redistributing Moose into caribou habitat, so there is no evidence that Wolves were using these features to follow Moose. Rather, Wolves seemed to be altering their behaviour in response to the linear features themselves. In effect, the presence of linear features was sufficient to turn non-wolf habitat into Wolf habitat and bring Wolves and Caribou into closer proximity.

Wolves avoid Caribou habitat unless linear features are present

CRITICAL HYPOTHESES | Linear Features Reduce Spatial Separation Between Wolves and Caribou *continued*

Further theoretical simulations suggested that Caribou population declines were being driven more by this proximity of Wolves and Caribou than by how much faster Wolves were travelling on linear features; however, these causes are difficult to disentangle because they are both a consequence of the creation of linear features.

Where the removal of all linear features was simulated, Caribou populations rebounded strongly, while population effects on both Wolves and Moose were minimal. It is important to caution against assuming that the results of these simulated experiments will hold in the real world, but they suggest that reducing linear feature density in core Caribou habitats could be a significant benefit to Caribou populations.

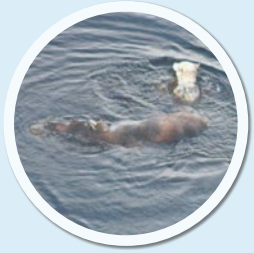
One of the questions that remains from this work is how easily this effect of linear features on Caribou predation risk could be swamped by an increasing Wolf population that may be caused by other factors (e.g., in response to more Moose and Deer). As of yet, there is no clear answer to this question, other than to say that the lower the density of linear features in core Caribou habitat, the more resilient will be Caribou populations to increases in Wolf density.

In this dynamic system, we could expect Caribou to respond to the risk of predation by avoiding linear features. But while making themselves safer, this behaviour might also reduce their access to suitable habitat. There is evidence that Caribou do in fact avoid linear features, at least in some seasons, and that adult female Caribou who don't are more likely to lose their calves.

Although there is evidence that Caribou are avoiding linear features (as well as other types of human-related infrastructure, such as well sites and facilities, especially if these sites are active), there is little evidence from field data that Caribou are packing into remaining undisturbed habitat. Instead, they remain spread out on the landscape. This could also be a strategy, because grouping together into smaller areas could increase their risk of being detected and killed by Wolves. In fact, theoretical work suggests that a Caribou's best strategy when facing this trade-off between avoiding features and grouping together is to be ambivalent to linear features.

As a result, we find that Caribou avoid infrastructure at a site level, but that at the landscape scale they continue to use habitats the federal government considers "disturbed," as long as those habitats are otherwise providing suitable habitat characteristics.




Critical Hypotheses

CARIBOU DECLINES ARE CORRELATED WITH LANDSCAPE, PREDATOR AND PREY FACTORS

The hypothesized relationship between landscape condition and Caribou demography is indirect. That is, the effect on Caribou of anthropogenic and natural habitat alteration is mediated through other factors that themselves interact. As a result, separate lines of evidence need to be integrated to understand whether there is support for the hypothesis. Previous sections have presented evidence of the effects of landscape change on the population dynamics of Moose and Wolves. The projects presented in this section address the population dynamics of Caribou and how they are affected by the broader predator-prey system.

PROJECTS

1. **Caribou, Wolf and Moose telemetry work** (Diversified Environmental Services, Inc., BC Ministry of Forests, Lands and Natural Resource Operations)
2. **Caribou and Moose mortality investigations** (Diversified Environmental Services, Inc., BC Ministry of Forests, Lands and Natural Resource Operations, Shifting Mosaics Consulting)
3. **Assessing Caribou survival in relation to the distribution and abundance of Moose and Wolves** (University of Northern British Columbia)
4. **Predicting the population-level response of Boreal Caribou to seismic line restoration** (Alberta Biodiversity Monitoring Institute)
5. **Predation risk to Caribou calves** (University of Alberta)
6. **Adaptive management of Woodland Caribou under current and future change to climate and human footprint** (University of Alberta and the Alberta Biodiversity Monitoring Institute)

MAJOR FINDINGS

Since 2012, the REMB funded the monitoring of approximately 240 Caribou, 60 Moose and 20 Wolves throughout northeast BC. Monitoring of both adult female survival and recruitment of Caribou among all of the ranges in northeast BC suggested that the population growth rate was negative in most ranges in most years of the research. Growth rates were particularly poor in 2013-2014, likely due to difficult winter conditions and perhaps an outbreak of the bacterial pathogen *Erysipelothrix rhusiopathiae* (see discussion of Caribou health below).

Population growth rates have generally improved since 2013-14. Unfortunately, the trend in the Westside Fort Nelson range remains consistently negative.

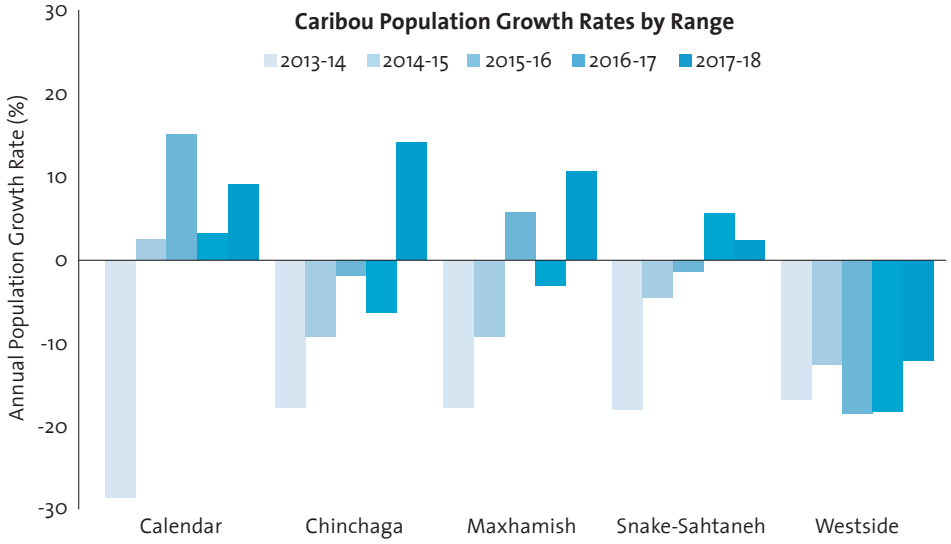
The REMB funded 113 mortality investigations of collared and uncollared Caribou, and results indicated that Wolves were the most common cause of mortality. This was not unexpected because predation is generally the most common cause of mortality in ungulate populations. But where mortality is too high to sustain Caribou populations, the current evidence overwhelming points to Wolves as the proximate cause.As noted above, excessive predation could be a result of higher-than-historical Wolf densities or less spatial separation between Wolves and Caribou on the landscape, primarily as a result of linear features in Caribou habitat.

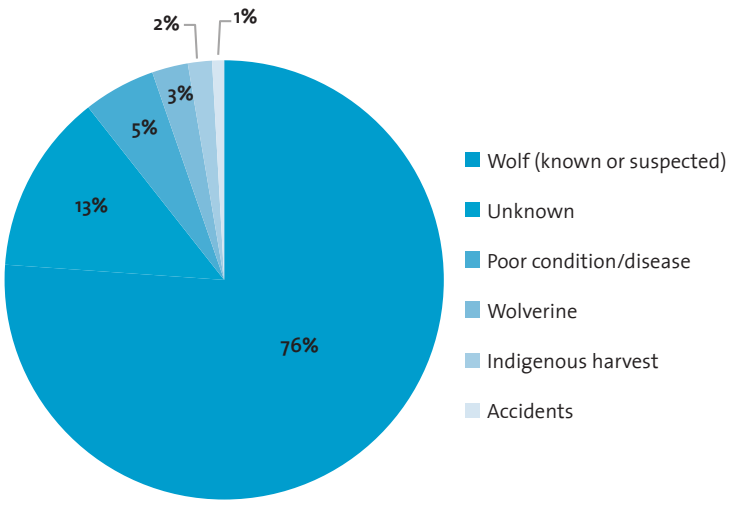
CRITICAL HYPOTHESES | Caribou Declines are Correlated with Landscape, Predator and Prey Factors
continued

Although the number of ranges examined to date is still small, correlative evidence suggests that caribou populations are declining more steeply where Wolves occur at higher densities, and that these higher densities are in turn correlated with a higher anthropogenic footprint.

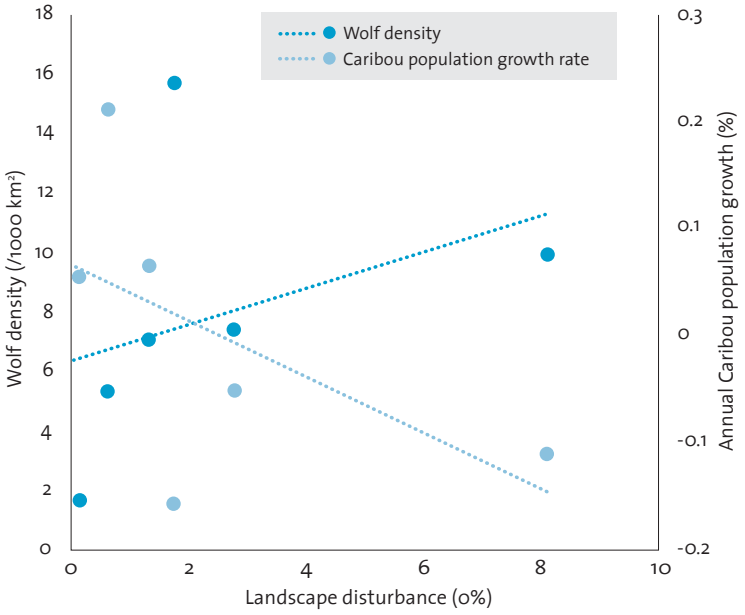
Data from northeast BC suggest a correlation between the density of Wolves and observed Moose densities; however, the density of Wolves is generally higher than predicted by our predator-prey models. This could result from Wolf populations being supported significantly by other prey sources (e.g., Beavers),[11] or by making more efficient use of existing densities of Moose by exploiting the benefits of linear features.

Untangling these different factors will require the analysis of additional data from other Caribou ranges.





Sources of mortality determined from site investigations of collared Caribou.



Caribou density is negatively correlated with anthropogenic footprint but Wolf density is positively correlated (data from BC, AB, and NWT).

Caribou population growth rates have improved recently, but remain negative in some areas

The REMB has contributed significantly to pioneering work on Caribou health and nutrition

Critical Hypotheses

HEALTH AND NUTRITION

Although our confidence in the REMB management model is increasing as additional studies are conducted in BC and elsewhere, it is critical to continue to test alternatives and to advance our understanding of other aspects of Boreal Caribou ecology. As part of this effort, the REMB has contributed significantly to pioneering work on health and nutrition.

PROJECTS

1. **Boreal Caribou health study** (University of Calgary)
2. **Nutritional condition of Caribou in northern British Columbia** (National Council for Air and Stream Improvement)

MAJOR FINDINGS

The REMB has been supporting research at the University of Calgary Veterinary School of Medicine to better understand the role of Caribou health in population decline. Although predators are the leading documented cause of death of Caribou, predators are known to target young, old and sick animals. If there are factors leading to a higher incidence of infectious diseases or chronic health problems, it could be contributing to Caribou declines. This in turn could point to alternative management actions that could benefit Caribou conservation.

The research has already identified the first known incidence of the bacterial pathogen *Erysipelothrix rhusiopathiae* in Caribou. Mounting evidence suggests that an acute outbreak of this pathogen was responsible for a higher than expected mortality rate observed in 2013-14. Although mortality rates have since declined, understanding factors that led to the outbreak and possible steps to mitigate the risk of future outbreaks has important conservation implications. More broadly, integrating a comprehensive suite of health indicators into Caribou management is addressing an important gap in our current approach.

Recent work has begun correlating indicators of health with landscape condition, in order to understand whether range conditions could explain the distribution of issues that have been identified during Caribou capture and mortality investigations.

Synthesizing Scientific Information

The REMB has funded a variety of projects intended to synthesize existing scientific and traditional use knowledge. This information has supported development of the overall program by identifying major themes and gaps.

PROJECTS

1. **Scientific Update for Boreal Caribou in BC** (Caribou Ecological Consulting and Diversified Environmental Services, Inc.)
2. **REMB performance review**
3. **Caribou/Moose traditional knowledge study** (Blueberry River First Nations, Firelight Group)
4. **Historical wildlife distribution mapping**

MAJOR FINDINGS

Collectively, all of the REMB's supported projects, as well as contributions by the broader network of Caribou researchers and managers, have made significant progress in increasing our understanding of both the proximate and ultimate challenges facing Caribou populations in northeast BC and elsewhere. Some of the major conclusion of this work include:

1. Different landscape disturbances are associated with different pathways of decline and have unequal effects on Caribou populations.
2. Linear features in lowland habitats (particularly treed bogs) likely have a disproportionate effect on Caribou mortality by reducing the spatial separation between Wolves and Caribou.
3. Caribou declines in northeast BC have occurred in both the presence and absence of an increase in the abundance of early seral habitat.
4. Observed Wolf densities are higher than predicted by predator-prey models and warrant further investigation.
5. Natural regeneration on low-impact seismic lines is extensive and this footprint is unlikely to be contributing significantly to facilitating Wolf movements in caribou habitat (see below).
6. Pathogens could play a significant role in observed Caribou mortality in some years.

Science and traditional knowledge are converging on major themes

Management Responses

The work of the REMB has also included direct actions to address pathways to Caribou population decline, including planning and conducting habitat restoration, assessing the rate and characteristics of natural regrowth on linear features, as well as projects to understand the feasibility and benefits of direct, population-related management actions, such as Wolf management and captive breeding of Caribou.

These projects establish the basis for the next phase of Boreal Caribou recovery activities in northeast BC.

HABITAT RESTORATION-RELATED PROJECTS

1. **Restoration of the Parker Range and a vegetation monitoring framework** (Golder Associates Ltd.)
2. **Developing and monitoring the efficacy of functional restoration of linear features for Boreal Woodland Caribou** (Matrix Solutions Inc.)
3. **Management actions to decrease predator use of petroleum development roads** (Nexen)
4. **Testing functional restoration of linear features within Boreal Caribou range** (Alberta Biodiversity Monitoring Institute)
5. **Habitat restoration framework** (Golder Associates)

HABITAT RECOVERY-RELATED PROJECTS

1. **Determination of when habitat is functional** (Foothills Research Institute)
2. **Natural recovery on low impact seismic lines in NEBC** (Golder Associates Ltd. and Explor)
3. **Image age classification system for anthropogenic features and accuracy assessment** (Caslys Consulting Ltd.)

POPULATION MANAGEMENT-RELATED PROJECTS

1. **Pilot research on reducing the threat of predation utilizing FN expertise and resources** (Wildlife Infometrics Inc.)
2. **Facilitated workshop: exploration of conservation breeding and translocation tools to increase wild caribou populations in western Canada** (Calgary Zoo)
3. **Feasibility of direct management options to recover boreal caribou populations in core habitat areas** (Wildlife Infometrics Inc.)

Future Direction

The objectives of the REMB have been comprehensively addressed over the past 5 years, with projects supporting the development and implementation of mitigation measures, habitat restoration, and supporting research. The foundation has been laid for the next phase of Boreal Caribou recovery in northeast BC. Specifically:

1. **Completion of the remaining phases of habitat restoration in the Parker range;**
2. **Habitat restoration planning and implementation in other ranges, particularly in lowland areas where Wolves are penetrating core Caribou habitat;**
3. **Ongoing theoretical and empirical research to attribute different causal pathways to observed trends in Caribou survival and recruitment;**
4. **Ongoing monitoring of the size and trend of Caribou populations by range;**
5. **Support for the development and implementation of innovative management interventions to disrupt pathways to decline; and,**
6. **Policy and legislative support for habitat restoration activities.**

Financial Summary

	2017	2016	2015	2014	2013	2012	Cumulative
Revenue ($000)							
Interest	41	61	27	7	5	0	**141**
Contributions	122	2025	0	25	20	0	**2192**
Fees	0	0	508	414	321	54	**1297**
Levies	0	16	1801	1671	1503	785	**5776**
Total	**163**	**2102**	**2336**	**2117**	**1849**	**839**	**9406**
Expenses							
Project costs	2199	2122	935	765	604	100	**6725**
Professional and Management fees	167	161	188	100	76	5	**697**
Extension and communication	36	26	14	0	0	0	**76**
Other expenses	30	14	0	8	4	0	**56**
Amortization expense – monitoring collars	137	93	67	30	4	0	**331**
Total	**2569**	**2416**	**1204**	**903**	**688**	**105**	**7885**
(Deficiency) excess of revenue over expenses	**-2406**	**-314**	**1132**	**1214**	**1161**	**734**	**1521**
Fund balance, opening	**3927**	**4241**	**3109**	**1895**	**734**	**0**	**0**
Fund balance, ending	**1521**	**3927**	**4241**	**3109**	**1895**	**734**	**1521**

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NOTES

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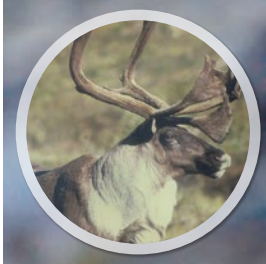

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