6.8.1.2 Indicators and Metrics

As described in Introduction and Background, Section 6.1.2.3, indicators were selected for the Pen Islands and Cape Churchill coastal caribou herds (Table 6.8.1-1). These indicators were used to assess the extent of environmental impacts occurring as a result of hydroelectric development and other forms of anthropogenic disturbance in the region.

Table 6.8.1-1: Indicators, Metrics, and Benchmarks for Coastal Caribou Populations

Indicator	Metric	Benchmark
Population size	Population size	Increasing, decreasing or stable based on available data
Disturbance	Percent Disturbance	Low = < 35% disturbance Moderate = 35–45% disturbance High = > 45% disturbance
Fragmentation	km/km^2 of linear features	Low = < 0.20 km/km^2 Moderate = 0.20–0.40 km/km^2 High = > 0.40 km/km^2

6.8.1.2.1 Response Indicator — Population Size

Population size is a common indicator of species health for wildlife populations. Population size calculations are often based on census techniques, where all animals in a population are counted, or through estimation when a complete count cannot be achieved (Pierce *et al.* 2012). For herds of migratory caribou, the most feasible (and often reliable) methods of estimating population size are based on surveys of calving grounds when caribou are typically located together in the open, and at a known location and time. Despite this, due to the large numbers of animals sometimes involved, the successful estimation of population numbers is difficult and can be prone to miscalculation.

METRIC – POPULATION SIZE

Recent population size estimates for the Pen Islands herd are based primarily on aerial photography of calving grounds. The caribou in the photos are counted after the entire calving ground has been photographed. Based on the estimated home range for a herd, it is possible to estimate population density by dividing the population estimate by the size of the home range. However, this is seldom done for migratory caribou populations as estimates are based on the area of the summer calving ground, which is much smaller than the size of the winter range. For Pen Islands caribou, comparison of multiple years of calving ground survey counts can be used to assess whether the population is increasing, decreasing or stable. While there have been successive attempts to estimate the size of the Pen Islands caribou herd, there has been limited effort to estimate the size of the Cape Churchill population. This leads to higher levels of uncertainty when assessing overall changes in Cape Churchill caribou population.

6.8.1.2.2 Driver Indicator — Fragmentation

Measurement of linear feature density provides a means of calculating cumulative change occurring due to anthropogenic development on the landscape (Dzus *et al.* 2010). The presence of linear features is associated with increased predator movements and the predation of ungulate species, including caribou (James and Stuart-Smith 2000). The presence of linear features is also associated with enhanced harvester access to populations and the potential for increased sensory disturbance based on vehicle traffic.

METRIC – KM/KM^2 OF LINEAR FEATURES

With linear feature density estimates, it is important to consider all linear features on the landscape in order to get the best measure of the cumulative changes that have taken place. If all types of linear features are not captured in the mapping data (*e.g.*, if small trails are not included), cumulative linear feature density may be underestimated. The location and size of the Pen Islands and Cape Churchill ranges limits the accuracy of mapping linear features both pre- and post-hydroelectric development. The Pen Islands range extends to 162,438 km^2 across two provinces, which is a large area to consider for accurately evaluating all linear features present. However, much of this area exists in a natural, undisturbed state.

6.8.1.2.3 Driver Indicator — Disturbance

The EC (2012) critical habitat model is one tool that can be used to assess habitat availability and disturbance levels that are suitable for population growth or recovery of boreal woodland caribou populations. Application of the EC (2012) model is expected to have only limited validity for identifying habitat quality for coastal caribou ranges because this model was developed specifically for boreal woodland caribou herds (Sorenson *et al*. 2008; EC 2011). The EC (2012) model results will not represent the potential for population growth in the coastal caribou herds, but will provide a means to measure and assess cumulative disturbances, including habitat loss or alteration. Habitat loss or alteration is considered an important population-limiting factor for coastal caribou.

METRIC – PERCENT DISTURBANCE

Based on the EC (2012) model, percent disturbance is measured using the combined, non-overlapping amount of natural and anthropogenic disturbance occurring in an identified caribou range (including waterbodies). Natural disturbance is measured by quantifying the habitat affected by fire in the past 40 y. Anthropogenic disturbance is measured by buffering human-made features by 500 m and calculating the area affected. Hydroelectric reservoirs are not considered disturbed habitat (EC 2011). Disturbed areas represent physical habitat lost or altered, and reduce habitat availability as caribou tend to avoid these areas because of their reduced forage quality, attractiveness to alternate prey species (particularly moose), and increased susceptibility to predation due to increased predator efficiency.

6.8.1.3 Benchmarks

To assess how hydroelectric development, as well as other anthropogenic and natural disturbance factors in the RCEA ROI has affected coastal caribou populations, benchmark values were established for the fragmentation and disturbance driver indicators (Table 6.8.1-1). Benchmarks form a standard or point of reference that provides an index of the degree of change suggested by the measured indicator. For the population size response indicator, consideration was given to whether the Pen Islands and Cape Churchill populations appeared to be increasing, decreasing or stable based on recent population surveys (Table 6.8.1-1).

Change in linear feature density was used to assess the potential magnitude of fragmentation effects from the pre- to post-hydroelectric development periods. Benchmarks were identified based on information described in previous studies (Salmo Consulting Inc. *et al.* 2003; Dzus *et al.* 2010), although no studies are specific to the Eastern Migratory caribou ecotype. Dzus *et al.* (2010) had established benchmarks for boreal woodland caribou, which were subsequently applied in the assessment of the Keeyask GP (KHLP 2012). A linear feature density of 0.6 km/km^2 was the benchmark value that marked the transition from a low to moderate level of effects for caribou populations. However, because the RCEA human footprint mapping did not include cutlines and trails (Intactness, Section 6.2.1.2), which the Salmo benchmarks had incorporated, the RCEA coastal caribou assessment has used lower benchmark values for consistency with Salmo Consulting Inc. *et al.* (2003) and as a precautionary measure. These benchmark values reflect the approach to a 'special resource management area,' with a low level of fragmentation occurring at a linear feature density of less than 0.2 km/km^2, a moderate level of fragmentation occurring between 0.2 and 0.4 km/km^2 and a high level of effects occurring over 0.4 km/km^2.

To assess disturbance levels for the RCEA post-hydroelectric development period, coastal caribou benchmark values applied are the same as those thresholds recognized by EC (2011, 2012) for boreal woodland caribou. While EC established these thresholds to assess population persistence in boreal woodland caribou ranges affected by levels of natural and anthropogenic disturbance, these values also indicate changes in range suitability. It is recognized that there are additional factors outside of range suitability affecting the persistence of coastal caribou populations, which are not reflected in the EC model predation. However, the model is useful in presenting some of the key cumulative factors, which have affected a range, making it less suitable for coastal populations. For assessing low, moderate or high levels of disturbance in the Pen Islands and Cape Churchill RAAs, the values prescribed by EC (2011, 2012), indicated in Table 6.8.1-1, were used.

6.8.1.4 Approach and Methods

A literature review was conducted for the Pen Islands and Cape Churchill populations to identify regional and local influences on coastal caribou in Manitoba. Particular interest was paid to assessing how changes in these populations could potentially be monitored through the use of measurable indicators for which information is currently available or could be obtained without performing additional field studies. As information specific to Pen Islands and Cape Churchill herds was often limited, factors affecting boreal woodland and barren-ground caribou populations were also reviewed.

The following indicators were selected to assess cumulative effects on coastal caribou (outlined in Section 6.8.1.2): population size, disturbance and fragmentation. Estimates of population size were available through a review of published literature. To assess how coastal caribou have been affected by habitat disturbance and fragmentation, RAAs were created based on radio-collaring work conducted by MCWS (Map 6.8.1-1). Available spatial data were interpreted for these RAAs, as well as levels of disturbance and fragmentation based on those benchmarks selected for describing these changes.

To examine how anthropogenic development in the caribou RAA may have affected coastal caribou, two distinct periods were considered: pre- and post-hydroelectric development. The division of these two periods is based on the initiation of hydroelectric development in the delineated RAA for the Pen Islands and Cape Churchill populations (Map 6.8.1-1).

6.8.1.5 Data Limitations

The principal data limitations for the coastal caribou assessment included:

- available reporting on the Pen Islands herd is primarily based on Ontario Ministry of Natural Resources and Forestry surveys, which focuses on those animals located within Ontario; there is limited comparable published information for Manitoba;
- lack of suitable fire history data from the pre-hydroelectric development period; and
- lack of pre- and post-hydroelectric development population information for the Cape Churchill herd.

As is the case in all long-term assessments (in this case covering more than 45 y), limitations in available information inevitably place constraints on the analysis possible. Despite these limitations, as outlined above in Section 6.8.1.4, sufficient information exists to provide data for the selected indicators and a reasonably robust assessment of the impacts of hydroelectric development on coastal caribou within the RCEA ROI. The assessments provided below discuss these limitations for those terrestrial regions where there was potential for them to substantively alter any conclusions regarding regional cumulative effects.

6.8.2 Before Hydroelectric Development

There is limited information available to evaluate the selected indicators for the pre-hydroelectric development period. The dividing date between the pre- and post-hydroelectric development periods for Pen Islands caribou is based on the start of construction of the Kelsey GS (1957). For the Cape Churchill herd, the division of the pre- and post-hydroelectric development periods was based on the start of construction associated with the Kettle GS (1966). For each of these herds, the maximum extent of their movements overlaps the area around the relevant generating station.

6.8.2.1 Population

PEN ISLANDS

There are few estimates available for the Pen Islands caribou population prior to hydroelectric development. It is understood that there have been wide-ranging caribou migrations occurring along the Hudson Bay coast since the 1700s. This included, in one year, the movement of approximately 10,000 caribou over the Hayes River in the course of two days (Lytwyn 2002). Based on the location of these migratory movements, these caribou were assumed to have been part of the Pen Islands herd. Uncertainty remains, however, since there are a number of migratory herds in the region and the distribution of migratory herds can shift markedly over a short number of years (Abraham *et al*. 2012).

CAPE CHURCHILL

The onset of hydroelectric development in the Cape Churchill RAA was in 1966, based on construction associated with the Kettle GS. There are no population estimates available for the Cape Churchill herd prior to this time. Harvest pressure was likely minimal in the recent pre-hydroelectric development period; for example, in 1955/1956, 20 woodland caribou were reported harvested in the Cape Churchill area (Manitoba Department of Mines and Natural Resources 1956).

6.8.2.2 Fragmentation

Fragmentation levels in the Pen Islands and Cape Churchill ranges are based on linear feature density. The model selected for this purpose is cumulative in nature, the results of which are presented in Section 6.8.3.2. Magoun *et al*. (2005) and Rebizant *et al*. (2000) reported that for Ontario and Manitoba disturbance levels over the Pen Islands range are low. By extrapolation, linear feature density during the pre-hydroelectric development was most likely negligible to low.

A limited number of linear features were present in the Pen Islands and Cape Churchill RAAs prior to hydroelectric development. Linear feature density in the Pen Islands RAA was 0.003 km/km^2 and 0.024 km/km^2 in the Cape Churchill RAA (Table 6.8.2-1). Although similar quantities of linear features occurred in both RAAs, linear feature density was different. The larger size of the Pen Islands RAA considerably reduced the overall linear feature density compared to the Cape Churchill RAA. Linear features present in the Pen Islands and Cape Churchill RAAs are shown in Map 6.8.2-1 and Map 6.8.2-2,

respectively. Further evaluation of those linear features that contributed to overall fragmentation levels is available as Tables 6.8A-1 and 6.8A-2[1]. The feature type 'ditch' accounts for 5.0% of all linear features present within the Pen Islands caribou range and 17.2% within the Cape Churchill caribou ranges post-hydroelectric development. In the remote sensing used for the human footprint mapping, the ditch feature type can be described as a narrow channel in the ground used for drainage, and containing surface water. While identified as a linear feature, it is not expected to be a barrier to caribou movement nor to facilitate predator movements.

Table 6.8.2-1: Fragmentation in Coastal Caribou Regional Assessment Areas Prior to Hydroelectric Development

RAA	Linear Features Intersecting Range (km)	Range Area (km^2)	Linear Feature Density (km/km^2)	Hydroelectric Development Contribution to Linear Feature Density (%)
Pen Islands	528	162,438	< 0.01	0
Cape Churchill	524	21,915	0.02	0

6.8.2.3 Disturbance

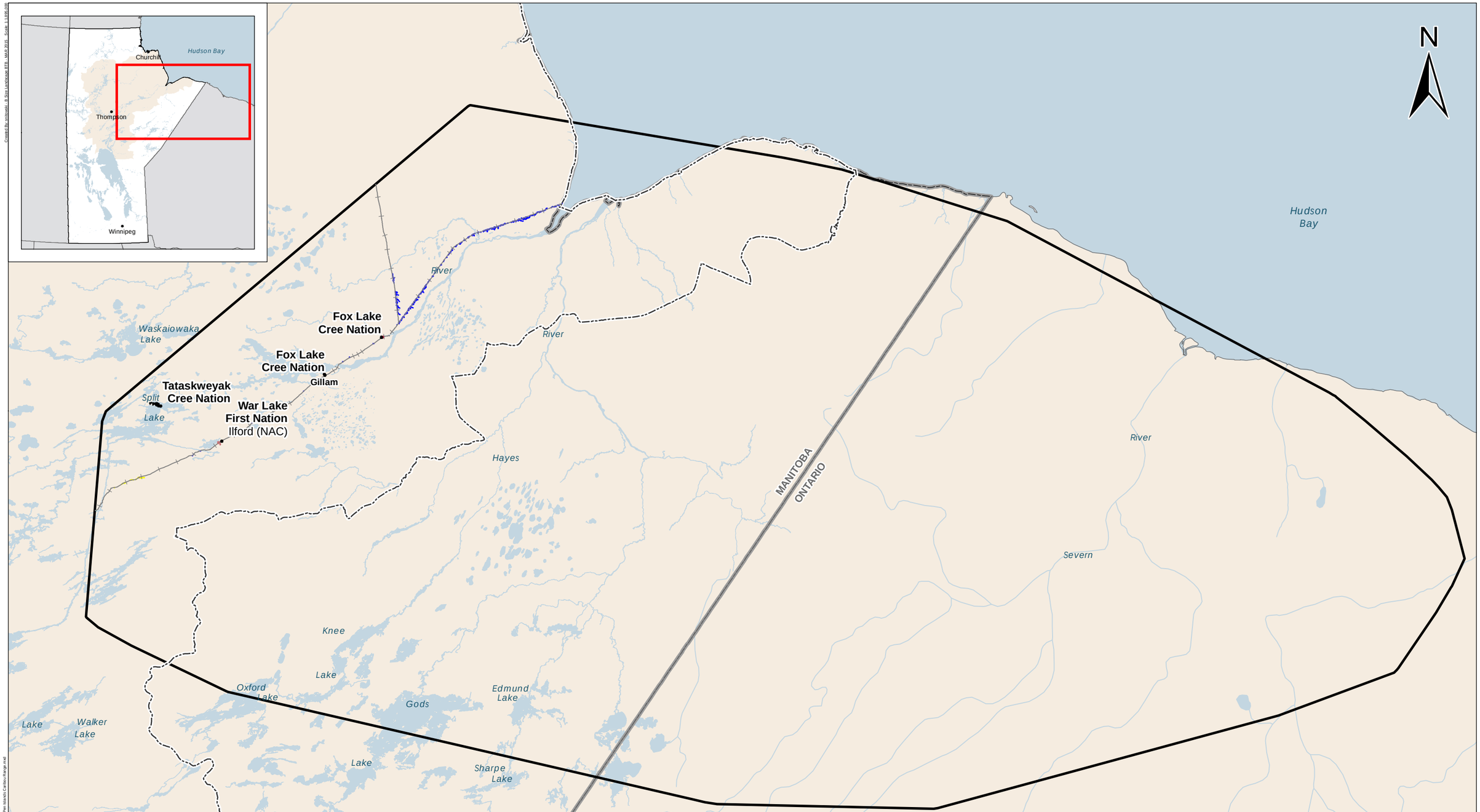
Historical information on the quality of habitat available to coastal caribou populations is limited for the pre-hydroelectric development period. The Pen Islands herd is recognized for its extensive migratory movements that cover parts of both Ontario and Manitoba. Based on available radio-collaring information, the selected range area for the Pen Islands caribou inside Manitoba, and portions of Ontario, is 162,438 km^2 in size (Map 6.8.1-1). This range within both Ontario (Magoun *et al.* 2005) and Manitoba (Rebizant *et al*. 2000) is currently characterized as having low levels of disturbance, either from hydroelectric development or from other anthropogenic factors. As such, negligible to low levels of anthropogenic disturbance may be extrapolated for the pre-hydroelectric development period.

The quantity of natural disturbance *(i.e*., fire) within the Pen Islands and Cape Churchill RAAs pre-hydroelectric development was likely similar to those levels present post-hydroelectric development. However, due to limitations on the availability of fire age information prior to 1970, it is difficult to verify this quantitatively (Terrestrial Habitat, Section 6.3.1.5).

The range of the Cape Churchill herd is largely restricted to the Cape Churchill Wildlife Management Area and Wapusk National Park (Campbell 1994), where there are considered to be generally low levels of disturbance. The designated RCEA Cape Churchill RAA covers an area of 21,915 km^2 and extends south of the Cape Churchill Wildlife Management Area based the recorded movements of radio-collared individuals. Some of the anthropogenic features present, prior to hydroelectric development, included the rail line to Churchill and the community of Bird.

[1] Tables, figures and maps with a letter in their number (*e.g.*, A) can be found in the appendices for this chapter.

In considering anthropogenic as well as natural disturbance, the EC (2012) Critical Habitat Model for Boreal Woodland Caribou was applied to assess habitat loss for coastal caribou populations (Section 6.8.1.2.2) both pre- and post-hydroelectric development. This model was selected as it is cumulative in nature and reflects past levels of anthropogenic disturbance as well those currently affecting the landscape. The results of this analysis are discussed in Section 6.8.3.3.



Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; JORO Consultants; RAA - 2010 to 2014 Manitoba Conservation telemetry data.

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	06-OCT-15	10-NOV-15
0 20 40 Kilometres / 0 10 20 Miles	VERSION NO: 1.0	QA/QC:

Legend

- Pen Islands Caribou Regional Assessment Area
- RCEA Region of Interest

Human Footprints

- Borrow Area
- Clearing
- Settlement

Infrastructure

- Ditch
- Highway
- Railway
- Road
- Winter road

Human Footprints in 1956

Pen Islands Caribou

Regional Assessment Area

Map 6.8.2-1

File Location: Z:\Workspaces\RCEA\Support\Mammal\Human Footprints in the 1965 Cape Churchill Caribou Range.mxd

Created By: snitowski - B Size Portrait BTB - MAR 2015 Scale: 1:758,000

N

Cape Churchill
Christmas Lake
Norton L
Farnworth L
craft
Twin Lakes
R
Warkworth L
Ritchie Lake
Mast
Klohn Lake
Whale
Alston
Warkworth
Brown L
White Mary Lake
Napper L
Creek
River
Hannah L
Creek
Ck
Bishop Lake
Rankine L
Sutton Lake
Salmon
Steele Lake
Munk
Herriot
Limestone Rapids
Fletcher Lake
Running Landing
River
Red Head Rapids
Place Rapids
Creek
River
Wise Lake
Kelsey
Creek
Ck
River
Churchill River
Laforte
Dog
Beale
Lake
Bad Cache Rapids
Kilnabad Rapids
Broad
Skidmore Lake
Crosswell
River
Ck
Ck
Bradshaw
Hoot
Lake
Moose
Deer
River
Lost
Turcotte L
Deer Lakes
Horn
Creek
Creek
Bear
Creek
White
Fly L
Owl
River
Owl Lake
Creek
Rupert
Creek
Noochewaywun
Black
Creek
Bear
Marsh Point
Long Lake
Silcox
North
Mistake
Dewar Lake
Seal
Port Nelson
Fountain
Whiting L
Weir L
Creek
Ck
Cooper
Strobus Lake
River
Creek
Whitecap L
Little Cygnet Lake
Myre L
Broten Lake
Weir
Cygnet L
River
Ck
Wasagamow L
Seal
River
Merrick River
Panco Lake
Limestone
Lake
Fox Lake Cree Nation
Angling L
Fifer Lake
Stephens

Legend

- Cape Churchill Caribou Regional Assessment Area
- RCEA Region of Interest

Human Footprints

- Borrow Area
- Clearing
- Settlement

Infrastructure

- Highway
- Road
- Winter Road
- Rail
- Ditch

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
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CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	06-OCT-15	10-NOV-15
0 9 18 Kilometers 0 7 14 Miles	VERSION NO: 1.0	QA/QC:

Human Footprints in 1965

Cape Churchill Caribou Regional Assessment Area

Map 6.8.2-2

6.8.3 After Hydroelectric Development

Considerable information is available for the assessment of the Pen Islands caribou population for the post-hydroelectric development period. Information is more limited for the assessment of the Cape Churchill population. The post-hydroelectric development period for the Pen Islands herd begins in 1957, when construction of the Kelsey GS began, and extends to 2013. For the Cape Churchill population, the post-hydroelectric development period is from 1966 (when construction of the Kettle GS began) to 2013. Other hydroelectric developments considered to have potentially affected coastal caribou populations include the Kettle, Long Spruce and Limestone GSs as well as construction associated with the Bipole III Transmission Project.

6.8.3.1 Population

PEN ISLANDS

Variations have been noted in the extent and size of the Pen Islands caribou herd during the post-hydroelectric period. Surveys conducted from 1957 to early in the 1970s were fairly sparse and conducted primarily within Ontario. However, since 1979 the Pen Islands herd has been more extensively surveyed, allowing for a review of population trends. It should be noted that not all survey regions or methods were entirely comparable, which may make the detection of, and certainty in, identified trends more difficult.

There are ranges of population estimates available to assess changes in population size for the Pen Islands herd (Table 6.8.3-1). The Pen Islands caribou population appears to have grown considerably in comparing survey results available for 1979 (2,300 caribou) with the estimate for 1994 (10,798) (Abraham and Thompson 1998; Abraham *et al.* 2012). Available estimates in 2011 indicated a further increase in the number of Pen Islands caribou to 16,638. For the estimates in 2008 and 2009, which are lower than previous years, Abraham *et al*. (2012) indicated that the majority of Pen Islands caribou had shifted their traditional calving ground to other areas that had not been surveyed. This resulted in lower than expected population estimates that were not representative of actual population trends and led in future years to larger areas being surveyed for a more accurate assessment of population trends.

Pen Islands caribou were surveyed in the Keeyask GP study area in February 2013 (LaPorte *et al*. 2013). The survey area covered 8,400 km^2 using strip transects located north and south of the Nelson River and Stephens Lake. The identity of the migrating caribou was confirmed as the Pen Islands herd using fecal pellet collection and genetic analysis (Klütsch *et al.* 2013). The estimated population size of 13,985 is lower than the 2011 estimate by Berglund *et al*. (2014); however, these estimates were derived from different survey methods and geographic areas.

In addition to estimates of population size for the Pen Islands herd on its traditional calving grounds, there have also been indications of subpopulations that join and migrate with the Pen Islands herd. The Nelson-Hayes herd was identified in 2000 as being at a 'low' conservation risk based on low levels of disturbance (Rebizant *et al*. 2000). Despite this, the Nelson-Hayes herd was later thought to have merged

with the Pen Islands population (Manitoba Conservation 2006). The addition of the Nelson-Hayes caribou herd into the Pen Islands population served to increase the population size of the Pen Islands herd. This suggests that not all population growth is based on the absence of population stressors, where instead there are complex intra-population dynamics that can result in the creation or disappearance of caribou herds over a relatively short period.

Table 6.8.3-1: Population Estimates for the Pen Islands Coastal Caribou Herd

Year	Estimate	Method	Reference
1959–1964	13,000	Unknown	Simkin 1965 in Hedman (1991)
1979	2,300	Aerial Photography	Abraham and Thompson (1998)
1986	4,660	Aerial Photography	Abraham and Thompson (1998)
1987	7,424	Aerial Photography	Abraham and Thompson (1998)
1990	5,000	Unknown	Crichton (1990); Hedman (1991)
1994	10,798	Aerial Photography	Abraham and Thompson (1998)
2008	409	Aerial Photography	Abraham *et al*. (2012)
2008	3,529	Aerial Photography	Abraham *et al*. (2012)
2009	3,304	Aerial Photography	Abraham *et al*. (2012)
2011	16,638	Minimum Count	Berglund *et al*. (2014)
2013	13,985	Winter Aerial Survey	LaPorte *et al*. (2013)

CAPE CHURCHILL

The Cape Churchill caribou herd has not been well studied, with few surveys of this area having occurred over time (Gunn *et al*. 2010; Abraham *et al*. 2011). Campbell (1994) indicated that the first aerial surveys of the Cape Churchill range did not begin until 1976, but no survey estimates for this date were provided (Table 6.8.3-2).

Gunn *et al.* (2010) indicated that, based on the low survey estimate of the Cape Churchill herd in 1965, this population had a rapid rate of increase with the population stabilizing over the past decade (approximately 2000–2010). As the assessment of a stable population by Gunn *et al.* (2010) was made prior to the population estimate of 3,500 to 5,000 Cape Churchill caribou reported by Hedman (2010 in Joro Consultants Inc. 2012), there is some potential that the Cape Churchill herd is now increasing. The potential for a growing population was supported by Elliot (1998), who indicated that some local residents of Churchill, MB, as well as biologists, believed herd growth in the Cape Churchill range was supported by immigration from the barren-ground Qamanirjuaq herd as levels of herd growth were in excess of those expected through recruitment alone. Based on surveys performed in 1987, 1995 and 1998, Elliot (1998) indicated recruitment rates of 15.7, 19.4 and 22.5%, respectively.

Table 6.8.3-2: Population Estimates for the Cape Churchill Coastal Caribou Herd

Year	Estimate	Survey Method	Source
1965	58	Unknown	Gunn *et al*. 2010
1985	1,237	Unknown	Kearney and Thorleifson 1987 in Campbell 1994
1987	1,700	Unknown	Elliot 1987
1988	1,800–2,200	Unknown	Campbell 1995 in Gunn *et al* 2010.
1998	3,013	Minimum Count	Elliot 1998
2005	644	Aerial Survey	Stewart 2009 in Gunn *et al*. 2010
2007	2,937	Aerial Photography	Abraham and McKinnon 2011
2012	3,500–5,000	Unknown	Hedman 2010 in Joro Consultants Inc. 2012

6.8.3.2 Fragmentation

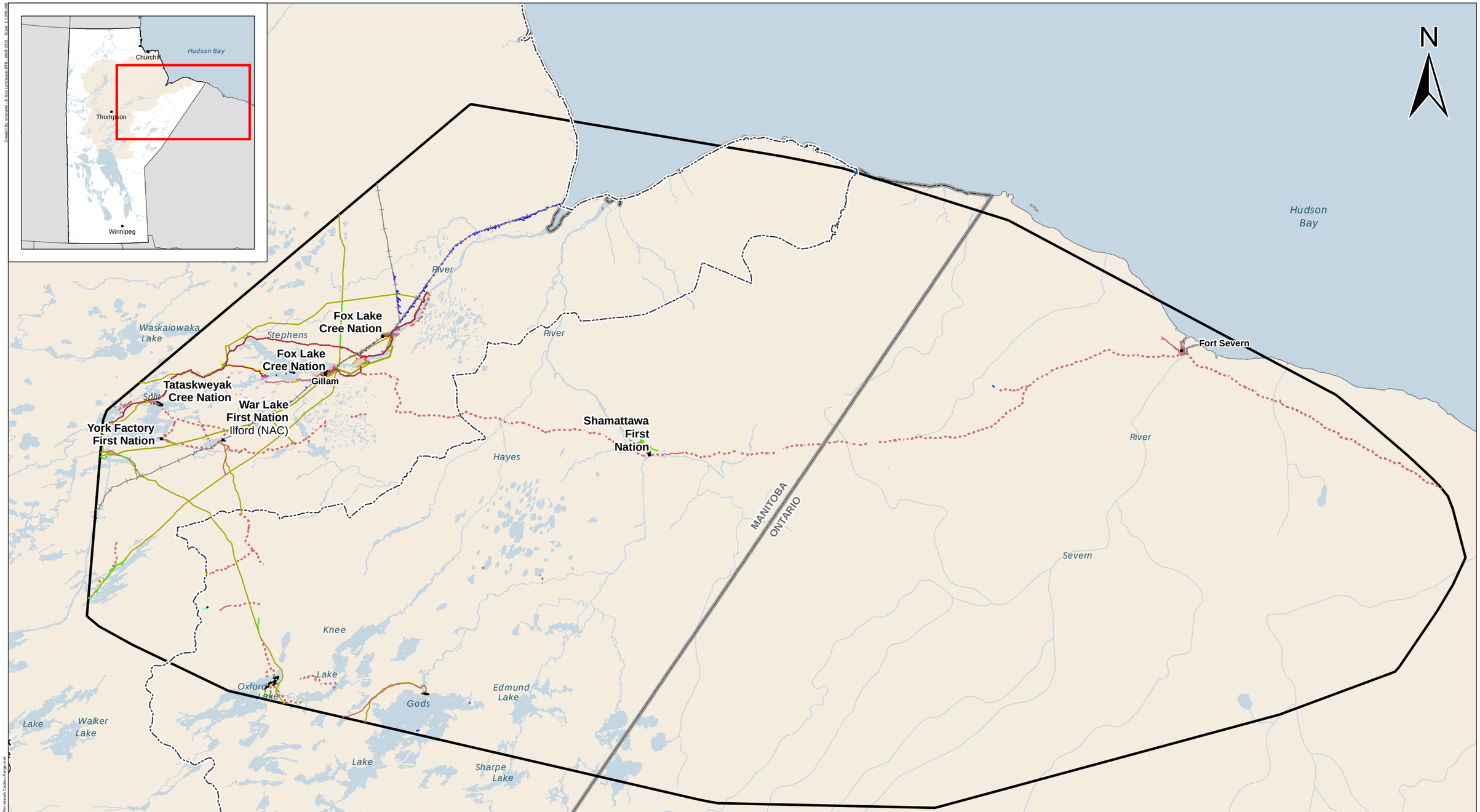
Increased fragmentation resulting from the hydroelectric development has been identified to have potential impacts on caribou populations, although this can be difficult to measure. In the technical report "Woodland Caribou in Manitoba," Johnson (1993) wrote, "the effects of hydro developments on woodland caribou cannot be quantitatively measured. The immediate physical effects of dam construction and flooding have minimal effects compared to the increased access associated with the development. Changes on the habitat allow for an increase in moose, deer and wolf populations. Increased human activity facilitates greater hunting losses." Based on the proposed construction of the Bipole III Transmission Project in the late 1980s, planned at that time to run down the east side of the province, Crichton (1990) similarly noted that a potential resulting effect on the Pen Islands herd, as well as other woodland caribou herds, could occur through increased harvester access. It is therefore important to assess the increased fragmentation of caribou ranges caused by the construction of linear features that may create harvester access, as well as act as access routes for predators and alternate prey species.

Current linear feature density estimates for the Pen Islands and Cape Churchill RAAs are low: 0.02 and 0.05 km/km^2, respectively (Table 6.8.3-3). Fragmentation of the Pen Islands range has primarily occurred through the development of transmission lines and winter roads, which together make up approximately 62% of all linear features. Transmission lines and railways comprised a large portion (35%) of linear features found in the Cape Churchill RAA. A further assessment of those linear feature types contributing to the overall levels of fragmentation in both RAAs is available in Tables 6.8A-3 and 6.8A-4. Linear feature locations within the Pen Islands and Cape Churchill RAA are primarily along the northern shore of the Nelson River (Map 6.8.3-1, Map 6.8.3-2) with the Pen Islands RAA also fragmented by transmission lines and a winter road.

Table 6.8.3-3: Fragmentation Within the Coastal Caribou Regional Assessment Areas Post-Hydroelectric Development

RAA	Linear Features Intersecting Range (km)	Range Area (km^2)	Linear Feature Density (km/km^2)	Hydroelectric Development Contribution to Linear Feature Density (%)
Pen Islands	3,791	162,438	0.02	48.8
Cape Churchill	1,003	21,915	0.05	40.7

Newton (2012) indicated that winter roads from Gillam to Shamattawa to Fort Severn facilitated ATV travel on the Hudson Bay coast. While the winter road does not extend throughout the former calving area used by the Pen Islands herd, it does create additional access into coastal areas for both ATVs and snow machines. As these coastal tundra areas are largely treeless, they facilitate travel in the area without the need for further linear feature development. Newton (2012) reported that increased vehicle traffic on the historic calving area of the Pen Islands herd was one of the reasons behind the shift in calving ranges.



Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; JORO Consultants; RAA - 2010 to 2014 Manitoba Conservation telemetry data.

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COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	03-SEP-15	10-NOV-15
0 20 40 Kilometres / 0 10 20 Miles	VERSION NO: 1.0	QA/QC:

Legend

- Pen Islands Caribou Regional Assessment Area
- RCEA Region of Interest

Human Footprints

- Generating Station
- Transmission Station
- Highway
- Road
- Airport
- Clearing
- Borrow Area
- Settlement

Infrastructure

- Ditch
- Dyke
- Highway
- Limited-use Road
- Transmission Line
- Winter Road
- Railway
- Road

Human Footprints in 2013

Pen Islands Caribou Regional Assessment Area

Map 6.8.3-1

File Location: Z:\Workspaces\RCEA\Support\Mammal\Human Footprints in the 2013 Cape Churchill Caribou Range.mxd

Created By: snitowski - B Size Portrait BTB - MAR 2015 Scale: 1:758,000

N

Cape Churchill
Christmas Lake
Norton L
Twin Lakes
Warkworth L
Ritchie Lake
Mast
Whale
Klohn Lake
Alston
Warkworth
Brown L
White Mary Lake
Napper L
Hannah L
Creek
Bishop Lake
Rankine L
Munk
Sutton Lake
Steele Lake
Salmon
Fletcher Lake
Limestone Rapids
Running Landing
Red Head Rapids
Place Rapids
River
Kelsey
Creek
Ck
Churchill River
Laforte
Bad Cache Rapids
Kilnabad Rapids
Crosswell
Bradshaw Lake
Deer
Deer Lakes
Turcotte L
Fly L
Owl Lake
Herchmer
Dog
Beale
Broad
Skidmore Lake
Hoot
Moose
Lost
Horn
Owl
Rupert
Noochewaywun
Black
Bear
Marsh Point
North
Port Nelson
Dewar Lake
Seal
Fountain
Long Lake
Mistake L
Whiting L
Strobus Lake
Weir L
Cooper
Lawledge
Whitecap L
Little Cygnet Lake
Myre L
Cygnet L
Weir River
Broten Lake
Panco Lake
Merrick
Amery
Limestone
Stephens
Bird
Fox Lake Cree Nation
Angling L
Fifer Lake

Legend

- Cape Churchill Caribou Regional Assessment Area
- RCEA Region of Interest

Human Footprints

- Borrow Area
- Clearing
- Generating Station
- Settlement
- Transmission Station

Infrastructure

- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Highway
- Road
- Limited-use Road
- Winter Road
- Rail
- Ditch

Manitoba Hydro

Regional Cumulative Effects Assessment

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COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	06-OCT-15	10-NOV-15
0 9 18 Kilometers 0 7 14 Miles	VERSION NO: 1.0	QA/QC:

Human Footprints in 2013

Cape Churchill Caribou Regional Assessment Area

Map 6.8.3-2

6.8.3.3 Disturbance

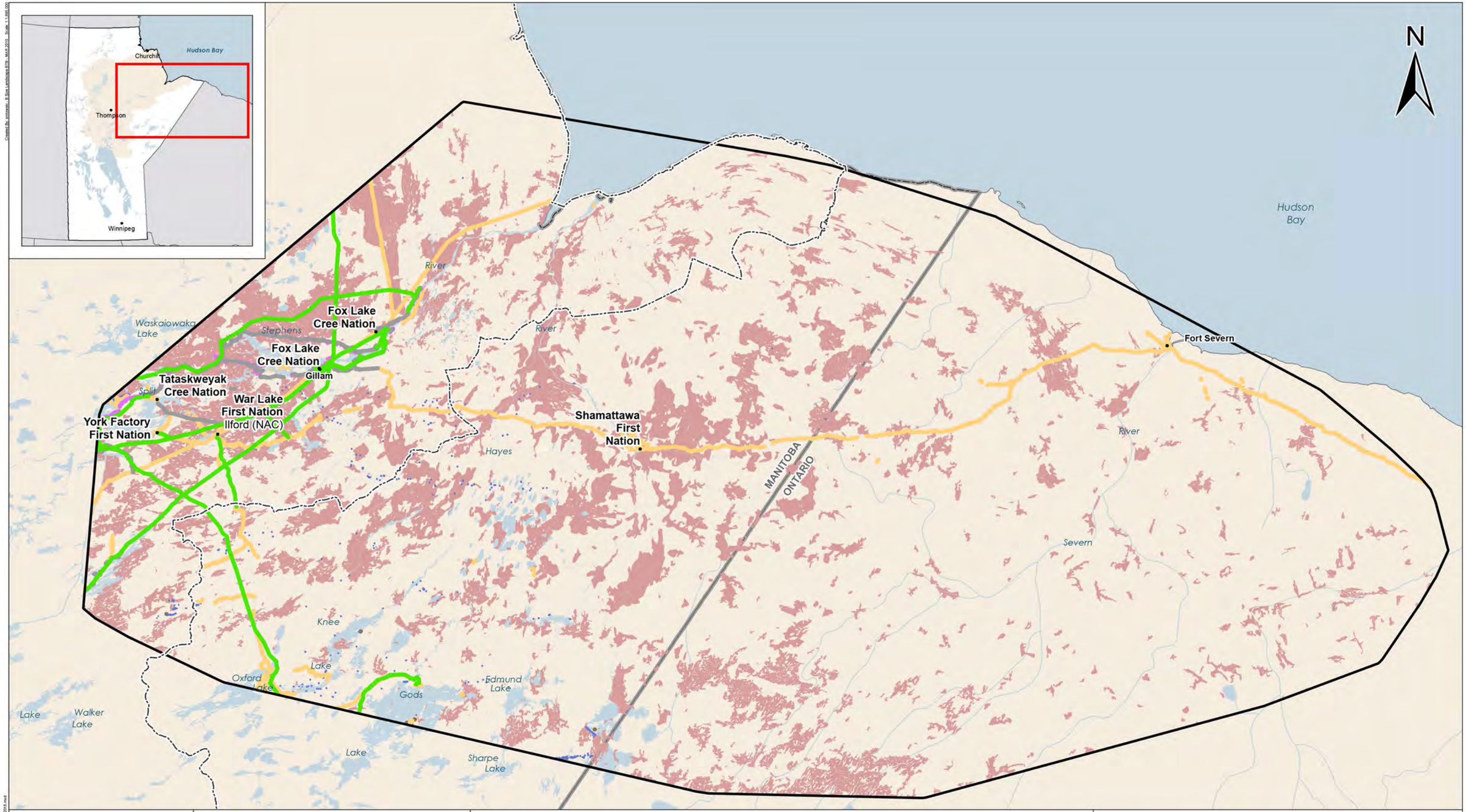
Using the EC (2011, 2012) model for calculating the amount of disturbance, disturbance in the Pen Islands and Cape Churchill RAAs was 21.1 and 29.3%, respectively (Table 6.8.3-4). For the Pen Islands RAA, levels of disturbance are attributed more to natural disturbance (19.4%) than to anthropogenic development (1.8%). Similarly, for the Cape Churchill RAA, there is a lower portion of disturbance attributed to anthropogenic development (5.8%) than to natural disturbance (23.7%). Total levels of disturbance for both the Pen Islands and Cape Churchill RAAs are mainly reflective of reduced winter habitat quality, with summer range activities often occurring over a much smaller area. Disturbances identified in the Pen Islands and Cape Churchill RAAs are illustrated in Maps 6.8.3-3 and 6.8.3-4, respectively.

The cumulative level of anthropogenic disturbance for the Pen Islands and Cape Churchill RAAs indicates that only low quantities of habitat are disturbed, based on the EC (2012) benchmark. A summary of the amount of disturbance, and the attributable sources, within the RAAs is provided in Table 6.8.3-4. Disturbance is documented further in Tables 6.8A-5 and 6.8A-6. These results indicate that linear features associated with human settlements (*e.g.*, roads) and transmission lines were the principal contributors to anthropogenic disturbance for both RAAs.

Table 6.8.3-4: Levels of Disturbance for the Pen Islands and Cape Churchill Caribou Herds in the Regional Assessment Areas

RAA	Hydroelectric Development Disturbance (%)	Non-Hydroelectric Development Disturbance (%)	Natural Disturbance (%)	Total Overall Disturbance (%)
Pen Islands	0.8	0.9	19.4	21.1
Cape Churchill	2.2	3.6	23.7	29.3

It is expected that the areas affected by natural disturbance (*i.e.,* fire) will regenerate over time and once again become ‘undisturbed’ habitat. This is demonstrated by the data shown in Maps 6.8.3-5 and 6.8.3-6, which show the age of previously burned areas inside the Pen Islands and Cape Churchill RAAs, respectively. Based on the EC (2012) model, the areas burnt in 1975 are expected to return to an undisturbed habitat state within the next year (40 y after the area burned). It is also inevitable that new fires will continue to occur and will create new patches of disturbed habitat on the landscape.



Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; JORO Consultants; RAA - 2010 to 2014 Manitoba Conservation telemetry data.

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COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
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Legend

- RCEA Region of Interest
- Pen Islands Caribou Regional Assessment Area

Cumulative Effects Disturbance Data

- Transmission Line (500m Buffer)
- Road for Hydro Development (500m Buffer)
- Generating Station for Hydro (500m Buffer)
- Other Development for Hydro (500m Buffer)
- Human Footprint not for Hydro Development (500m Buffer)
- Drill Hole (250m Buffer)
- Mine (500m Buffer)
- Natural Disturbance - Fire

Disturbance in 2013

Pen Islands Caribou Regional Assessment Area

Map 6.8.3-3

File Location: Z:\Workspaces\RCEA\Support\Mammal\Cape Churchill Disturbance 2013.mxd

Created By: snitowski - B Size Portrait BTB - MAR 2015 Scale: 1:758,000

N

Cape Churchill
Christmas Lake
Norton L
Farnworth L
Twin Lakes
R
Warkworth L
Ritchie Lake
Mast
Klohn Lake
Whale R
Alston
Warkworth
Brown L
White Mary Lake
Creek
Hannah L
Napper L
Creek
Ck
Sutton Lake
Salmon
Steele Lake
Fletcher Lake
Bishop Lake
Rankine L
Munk
Herriot
Limestone Rapids
Running Landing
River
Red Head Rapids
Place Rapids
Kelsey
Creek
River
Creek
Ck
River
Churchill River
Laforte
Bad Cache Rapids
Kilnabad Rapids
Crosswell
Bradshaw
Lake
Deer
Lake
Deer Lakes
Turcotte L
Dog
Beale
Broad
Skidmore
Lake
Ck
River
Ck
Hoot
Moose
River
Lost
Horn
Creek
Owl
Fly L
Owl Lake
Herchmer
Creek
Rupert
Creek
Noochewaywun
Black
Creek
Bear
Creek
White
Creek
Bear
Creek
Marsh Point
Long Lake
Mistake
Silcox
North
Port Nelson
Dewar Lake
Seal
Port Nelson
Fountain
Creek
Ck
Whiting L
Weir L
Strobus Lake
Cooper
Lawledge
River
Broten Lake
Whitecap L
Little Cygnet Lake
Myre L
Weir River
Shilling
Creek
Cygnet L
Weir
River
Ck
Wasagamow L
River
Seal
Panco Lake
Merrick River
Lake
Limestone
Amery
Angling L
Fifer Lake
Bird
Fox Lake Cree Nation
Stephens

Legend

- Cape Churchill Caribou Regional Assessment Area
- RCEA Region of Interest

Cumulative Effects Disturbance Data

- Transmission Line (500m Buffer)
- Road for Hydro Development (500m Buffer)
- Other Development for Hydro (500m Buffer)
- Human Footprint not for Hydro Development (500m Buffer)
- Drill Hole (250m Buffer)
- Natural Disturbance - Fire

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; JORO Consultants; Caribou RAA - 2010 to 2011 Manitoba Conservation telemetry data.

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COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
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Disturbance in 2013

Cape Churchill Caribou Regional Assessment Area

Map 6.8.3-4

N

Hudson Bay

Conawapa G.S.

Fox Lake Cree Nation

Limestone G.S.

Kettle G.S.

Long Spruce G.S.

Gillam

Keeyask

Fox Lake Cree Nation

Tataskweyak Cree Nation

War Lake First Nation

Ilford (NAC)

York Factory First Nation

Kelsey G.S.

Fort Severn

Shamattawa First Nation

MANITOBA

ONTARIO

Thompson

Pikwitonei (NAC)

Thicket Portage (NAC)

Pimicikamak Cross Lake (NAC)

Baldock Lake

Waskaiowaka Lake

Stephens

Split Lake

Cross Lake

Walker Lake

Moson Lake

Sipiwesk Lake

Oxford Lake

Knee Lake

Gods Lake

Edmund Lake

Sharpe Lake

Red Sucker Lake

Hayes River

Nelson River

Burntwood River

Churchill River

Limestone River

Gods River

Hayes River

Knee Lake

Oxford Lake

Gods Lake

Edmund Lake

Sharpe Lake

Red Lake

Sucker Lake

Moson Lake

Walker Lake

Cross Lake

Split Lake

Waskaiowaka Lake

Baldock Lake

Sipiwesk Lake

Thicket Portage (NAC)

Pikwitonei (NAC)

Thompson

Pimicikamak Cross Lake (NAC)

Ilford (NAC)

Gillam

Keeyask

Fort Severn

Shamattawa First Nation

Fox Lake Cree Nation

Tataskweyak Cree Nation

War Lake First Nation

York Factory First Nation

Kelsey G.S.

Conawapa G.S.

Limestone G.S.

Kettle G.S.

Long Spruce G.S.

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; RAA - 2010 to 2014 Manitoba Conservation telemetry data; Fire History - photo-interpreted stereo air photos, Manitoba Conservation Individual Fire Database, Government of Canada Large Fire Database and LANDSAT imagery.

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0 20 40 Kilometres / 0 10 20 Miles	VERSION NO: 1.0	QA/QC:

Legend

- Pen Islands Caribou Regional Assessment Area
- RCEA Region of Interest

Burn Year

- 2010 - 2013
- 2000 - 2009
- 1990 - 1999
- 1980 - 1989
- 1929 - 1979

Infrastructure

- Generating Station (Existing)
- Generating Station (Under Construction)
- Generating Station (Potential)
- Highway
- Rail
- Transmission Line (Existing)
- Transmission Line (Under Construction)

Fire History in 2013

Pen Islands Caribou

Regional Assessment Area

Map 6.8.3-5

File Location: Z:\Workspace\mxd\CE AS\Support\Mammals\Fire History in the Pen Islands Caribou Range.mxd
Created By: mcintoshm R Env Landscape RTS UMA 2015 Scale 1:2,000,000

File Location: Z:\Workspaces\RCEA\Support\Mammal\Fire History in the Cape Churchill Caribou Range.mxd

Created By: snitowski - B Size Portrait BTB - MAR 2015 Scale: 1:837,000

N

Cape Churchill
Christmas Lake
Norton L
Farnworth L
Twin Lakes
R
Warkworth L
Ritchie Lake
Mast
Whale
Klohn Lake
Alston
Warkworth
Brown L
White Mary Lake
Napper L
Creek
Hannah L
Creek
Ck
Sutton Lake
Salmon
Steele Lake
Fletcher Lake
Limestone Rapids
Running Landing River
Red Head Rapids
Place Rapids
Kelsey
Creek
River
Rankine L
Lake
Munk
Herriot
Wise Lake
Ck
River
Churchill River
Laforte
Bad Cache Rapids
Kilnabad Rapids
Crosswell
Bradshaw
Lake
Deer
Deer Lakes
Turcotte L
River
Dog
Beale
Broad
Skidmore Lake
Ck
River
Ck
Hoot
Moose
River
Lost
Horn
Creek
Owl
Fly L
Owl Lake
Creek
Rupert
Creek
Noochewaywun
Black
Bear
Creek
Marsh Point
Menahook
North
Seal
Ck
Fountain
Port Nelson
Long Lake
Mistake
Silcox
Dewar Lake
Creek
Cooper
Weir L
Strobus Lake
River
Broten Lake
Whiting L
Whitecap L
Little Cygnet Lake
Myre L
Cygnet
Weir
Wasagamow L
River
Conawapa G.S.
Ck
Seal
Merrick
Panco Lake
River
River Lake
Fifer Lake
River
Limestone
Fox Lake Cree Nation
Angling L
Limestone G.S.
Stephens
Lake
Long Spruce Rapids
River
Gods
Bastable Lake
Pennycutaway
Gull Lake
River
Fox Lake Cree Nation
Kettle Rapids
Kettle G.S.
Long Spruce G.S.
Keeyask G.S.
Creek
Angling
Angling
R

Legend

- Cape Churchill Caribou Regional Assessment Area
- RCEA Region of Interest

Burn Year

- 2010 - 2013
- 2000 - 2009
- 1990 - 1999
- 1980 - 1989
- 1970 - 1979

Infrastructure

- Generating Station (Existing)
- Generating Station (Under Construction)
- Generating Station (Potential)
- Highway
- Rail
- Transmission Line (Existing)
- Transmission Line (Under Construction)

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada; ECOSTEM Ltd.; RAA - 2010 to 2011 Manitoba Conservation telemetry data; Fire History - photo-interpreted stereo air photos, Manitoba Conservation Individual Fire Database, Government of Canada Large Fire Database and LANDSAT imagery.

CREATED BY: ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	06-OCT-15	10-NOV-15
0 10 20 Kilometers / 0 7.5 15 Miles	VERSION NO: 1.0	QA/QC:

Fire History in 2013

Cape Churchill Caribou Regional Assessment Area

Map 6.8.3-6

To assess the potential for sensory disturbance from active hydroelectric stations on the lower Nelson River, the locations of radio-collared Pen Islands (Photo 6.8.3-1) and Cape Churchill caribou in proximity to hydroelectric generating stations in this area were evaluated. The methods followed are in Appendix 6.8B.

Source: Wildlife Resource Consulting Services MB Inc., 2013

Photo 6.8.3-1: Radio-Collared Pen Islands Coastal Caribou

Radio-collared Pen Islands caribou were found to be largely absent from areas where generating stations are located. This absence was more apparent for the winter season (Table 6.8.3-5) compared to the summer season (Table 6.8.3-6). For both seasons, no radio-collared caribou were located within 500 m of generating stations. This confirms the assumption contained in the EC (2012) model that those areas within 500 m of anthropogenic disturbance are used less. Based on available radio-collaring data, no Cape Churchill caribou occurred within either 500 m or even 3 km of generating stations on the Nelson River. This was expected because the Cape Churchill caribou herd was traditionally limited to the Cape Churchill Wildlife Management Area (Campbell 1994), and the RAA did not extend as far south as the Kettle and Long Spruce GS locations.

Sensory disturbance modelling results indicated there were some locations of Pen Islands caribou within 3 km of existing generating stations during both the winter and summer seasons, but this was more likely during the summer (Tables 6.8.3-5 and 6.8.3-6). This seasonal difference may have been due to the wide

seasonal variations in winter range movements compared to levels of site fidelity demonstrated in the selection of calving and rearing areas during the summer (Schaefer *et al*. 2000). The potential for caribou to come within 3 km of an existing generating station is supported by Mahoney and Schaefer (2002), who noted migratory caribou returned to within 3 km of a generating station following its construction, but that during construction, caribou were largely absent. While there are short-term displacement effects related to the construction of large-scale hydroelectric developments, caribou will often return to areas within the general proximity of generating stations after the construction period.

Table 6.8.3-5: Number of Radio-Collared Pen Islands Caribou Occurring near Generating Stations (GS) on the Lower Nelson River during the Winter Season (December 1–March 31) from 2010 to 2014

Year	# Collared Caribou	# Caribou Considered [1]	Kettle GS		Long Spruce GS		Limestone GS	
			< 500 m	< 3 km	< 500 m	< 3 km	< 500 m	< 3 km
2010	8	8	0	0	0	0	0	0
2011	18	4	0	0	0	0	0	1
2012	21	6	0	0	0	0	0	0
2013	18	8	0	0	0	1	0	0
2014	19	13	0	0	0	0	0	0
All years	40	27	0	0	0	1	0	1

1. Number considered based on number of collared caribou with active radio-collars for ≥ 75% of season.

Table 6.8.3-6: Number of Radio-Collared Pen Islands Caribou Occurring near Generating Stations (GS) on the Lower Nelson River during the Summer Season (May 1-August 15) from 2010 to 2014

Year	# Collared Caribou	# Caribou Considered [1]	Kettle GS		Long Spruce GS		Limestone GS	
			< 500 m	< 3 km	< 500 m	< 3 km	< 500 m	< 3 km
2010	8	7	0	2	0	2	0	3
2011	18	12	0	0	0	1	0	0
2012	21	16	0	0	0	1	0	0
2013	18	13	0	0	0	0	0	0
2014	19	18	0	0	0	0	0	0
All years	40	36	0	2	0	2	0	3

1. Number considered based on number of collared caribou with active radio-collars for ≥ 75% of season.

6.8.4 Cumulative Effects of Hydroelectric Development

6.8.4.1 Regional Effects

6.8.4.1.1 Indicator Results — Population

PEN ISLANDS

The Pen Islands population has been increasing since the late 1970s. The most recent population information suggests that the Pen Islands population is at a high level relative to other population estimates of the last 50 y, numbering between 14,000 to16,000 animals. It is difficult to assess changes in the Pen Islands population occurring from the pre-hydroelectric to the post-hydroelectric development period based on the limited population information from the pre-hydroelectric development period. Based on the occurrence of an increasing, rather than a decreasing population, it would seem that, cumulatively, environmental and other disturbance factors have not yet substantially affected this herd.

CAPE CHURCHILL

While there is limited survey information available for the Cape Churchill coastal caribou herd, it is evident that the size of this herd has increased since the 1960s and then reached a period of stable population growth that lasted throughout the 2000s. Currently, there are indications of the Cape Churchill population remaining stable or experiencing positive growth. As there are no population estimates available for the period pre-hydroelectric development, it is difficult to assess what occurred in this period compared with the post-hydroelectric development period. However, it is apparent that during the post-hydroelectric period the Cape Churchill herd was increasing. This provides some support that cumulative effects on the landscape, including hydroelectric development, have not substantially affected the Cape Churchill population.

6.8.4.1.2 Indicator Results — Fragmentation

Both coastal caribou RAAs had increases in linear feature density when comparing the pre- and post-hydroelectric development periods. Linear feature density for the Pen Islands RAA prior to hydroelectric development was less than 0.01 km/km^2 and increased to 0.02 km/km^2 post-hydroelectric development. While this is roughly an eightfold increase in linear feature density, this increase occurred over approximately 60 y. Much of the RAA has seen little development. The area of increased linear feature density within the Pen Islands RAA primarily occurred around Stephens Lake as well the other hydroelectric generating stations on the lower Nelson River. Hydroelectric development has provided for much of the increase in linear feature density. As of 2013, hydroelectric development comprised 48.8% of the linear features in this area. The Cape Churchill RAA increased in linear feature density from 0.02 km/km^2 pre-hydroelectric development to 0.05 km/km^2 post-hydroelectric development. The doubling of linear feature density took place over approximately 45 y, where hydroelectric development now comprises of 40.7% of linear features in the Cape Churchill RAA.

Based on increases in linear feature density from the pre- to post-hydroelectric development period, there is potential for increased harvester and predator access to the Pen Islands and Cape Churchill populations. Increased accessibility of the Pen Islands RAA to ATVs was reported by Newton (2012) along the winter road from Gillam to Shamattawa, and extending to Fort Severn. The winter roads allowed motorized vehicles to reach the coast, and in particular the traditional Pen Islands calving area. While this increased access did not appear to cause population declines (see Section 6.8.4.1.1), there is the potential for these activities to have displaced Pen Island caribou from their traditional calving area (Newton 2012). There have not been similar effects (*i.e.*, a shift in the traditional calving areas) identified for the Cape Churchill RAA based on increased linear feature density.

Based on the benchmark used to identify how linear features could have affected coastal caribou, there is a low level of fragmentation for both the Pen Islands and Cape Churchill RAAs. It is recognized, however, that coastal tundra areas do not require cleared linear corridors to be travelled on by snow machine or ATV. Instead, low levels of access to these areas can facilitate greater hunter and vehicle traffic than is otherwise evident based on linear feature density estimates alone. As the coastal caribou populations are considered particularly susceptible to disturbances and overall environmental changes on their calving grounds, this is a potential cause for concern as something that could affect the sustainability of the Pen Islands caribou herd in the long term.

6.8.4.1.3 Indicator Results — Disturbance

Use of the EC (2011, 2012) disturbance model indicated low levels of disturbance in both the Pen Islands and Cape Churchill RAAs. Pre- and post-hydroelectric development disturbance results were not compared because of limitations in fire data for the pre-hydroelectric development period. For the Pen Islands RAA, the cumulative level of disturbance (21.1%) was comprised of low levels of anthropogenic disturbance (1.8%) and higher levels of natural disturbance (19.4%). The portion of anthropogenic disturbance attributed to hydroelectric development is 0.8% (or 47% of the total anthropogenic disturbance within the model). There is a potential for reduced Pen Islands caribou movements within proximity to existing generating stations. These effects would be most pronounced during the construction phase, and would likely decrease during operations.

The Cape Churchill RAA had higher levels of both anthropogenic disturbance (5.78%) and natural disturbance (23.7%) than the Pen Islands caribou RAA. The total level of disturbance for the Cape Churchill RAA was 29.5%, with hydroelectric development accounting for 2.2% of this (or 38% of the contribution of all anthropogenic disturbance within the model). With southerly movements of the Cape Churchill herd mostly limited to their traditional range use area (*i.e.*, the Cape Churchill Wildlife Management Area), little interaction is expected between this herd and the generating stations present on the lower Nelson River. Some possible exceptions to this are the Limestone GS, and the Bipole III Transmission Project.

6.8.4.1.4 Evaluation of Effects

Historically, caribou have always been present in northern Manitoba and Ontario. Caribou harvest was important and prevalent. Populations in the Pen Islands and Cape Churchill herds were likely widespread

and secure. However, the effects of overharvesting were apparent in the late 18th and early 19th centuries, when caribou populations declined and largely disappeared from the region. It is unclear whether or not this hunting pressure included barren-ground caribou, coastal caribou or both.

Coastal caribou populations remained one of the least studied caribou groups. They have only recently been defined as a unique ecotype that has the characteristics of both barren-ground and woodland caribou. The George River and Leaf River herds are considered the most directly comparable caribou populations to the Pen Islands and Cape Churchill herds, although these former herds have shown the potential for exponentially higher population growth, with population peaks of approximately one million animals.

Recent surveys of the Pen Islands and Cape Churchill herds have indicated stable to positive population growth trends. Much of this information is related to surveys that have occurred since the 1970s (for the Pen Islands herd) or the 1980s (for the Cape Churchill herd). Having survey information that covers only a portion of the post-hydroelectric development period somewhat limits the applicability of this indicator as a means of assessing changes between the pre- and post-hydroelectric development periods. However, as there continued to be increasing population growth during the post-hydroelectric period in northern Manitoba, there is a strong likelihood that the effects of hydroelectric development have had only a limited effect on these herds.

Indicators used to assess the status of coastal caribou in Manitoba show a low level of fragmentation and disturbance affecting the Pen Islands and Cape Churchill RAAs. This is based on the results of the fragmentation and disturbance models, which measured cumulative effects and allowed for the relative contribution of hydroelectric development activities to be quantified and compared with other disturbance types. Overall, the results of these models demonstrated that anthropogenic activities, including hydroelectric development, were of low magnitude when compared to the benchmark for both herds. The Pen Islands and Cape Churchill herds range over a landscape that has been largely unaffected by anthropogenic activities, including hydroelectric development.

The results of the fragmentation and disturbance models demonstrated an additive contribution of different disturbance types as reducing or affecting available caribou habitat. It should be understood, however, that the relationship between landscape alteration and population sustainability is not linear. The results of these models cannot be taken to mean that a particular range can sustain a specified additional amount of fragmentation or disturbance before becoming unsuitable for sustaining caribou. Rather, the model results form a precautionary guideline, and based on benchmark values, are meant to guide and inform on caribou population health, where other non-modelled factors, such as environmental conditions, caribou harvest and predation, are also important factors affecting caribou sustainability.

The Pen Islands caribou herd has demonstrated recent shifts in its calving range. While this population has begun to receive more research attention in recent years, the cause behind this shift remains an area of active study. Understanding why this shift occurred is important for understanding the resilience of this group to further environmental changes, including those caused by hydroelectric development. While there is a tendency for caribou to shift calving grounds, this often takes place incrementally as a slow change over many years. It was due to this sudden shift in the defined calving range that population estimates recorded in 2008 and 2009 were initially considered reflective of a population crash, as other

calving areas had received no coverage in the surveys. An initial review of some of the factors that may have caused this range shift includes changes in the availability of forage resources, as well as increased access of this area to motorized vehicles. The potential for these factors to affect habitat selection by coastal caribou is important because future range shifts may occur and more closely overlap with areas where disturbance has taken place. As a result, herds could be more susceptible to factors such as hunting or predation, in which anthropogenic disturbance may have played a role, but where the effects were presumably mitigated by the large ranges of these herds.

Overall, the Pen Islands and Cape Churchill coastal caribou have only been marginally affected by anthropogenic development, including hydroelectric development, and remain largely inaccessible to harvesters throughout most of their range. Exceptions occur during those years when caribou migrate close to communities in the RAAs, when many caribou could be harvested, both historically and in the period post-hydroelectric development.

6.8.4.1.5 Regional Cumulative Effects Conclusion

Based on the coastal caribou population, fragmentation and disturbance indicators, there has been a low level of cumulative environmental effects within the Pen Islands and Cape Churchill RAAs. Of note, both the Pen Islands and Cape Churchill herds demonstrate stable to positive population growth. This has likely been facilitated by these areas remaining largely intact with little anthropogenic disturbance. The contribution of hydroelectric development to increases in fragmentation and disturbance levels is low overall but comprises a large portion of the anthropogenic activities that have occurred in the two RAAs. It is important that the demographics and range use characteristics of the Pen Islands and Cape Churchill herds be considered in future development projects that involve the Hudson Bay coast. The availability of habitat areas along the Hudson Bay coast is a likely limiting factor for the growth and survival of coastal caribou populations (*i.e.*, the forest-tundra ecotype).

6.8.4.2 Local Effects

Communities in northern Manitoba provide accounts of migratory caribou herds, particularly the Pen Islands herd, periodically migrating into an area and facilitating harvest opportunities. Within northern First Nations communities, migratory caribou herds played an important role in the development of traditions, cultural identity and sustenance (Lytwyn 2002; Hummel and Ray 2008). To this extent, where changes in the availability of migratory caribou have been noted, northern First Nations have identified what factors have affected caribou herds, and most often cite hydroelectric development projects on the lower Nelson River.

While many on the available reports documenting changes in caribou populations on the lower Nelson River were prepared in anticipation for the Keeyask GP, the context of the findings of these reports is based on the interpretation of environmental effects on caribou as they occurred through previous hydroelectric developments. As such, the Kelsey, Kettle, Limestone, and Long Spruce projects provided a basis for assessing what further impacts future hydroelectric developments (*e.g.*, the Bipole III Transmission Project and the Keeyask GP) would have on caribou in the RAAs.

The cumulative effects of hydroelectric development on coastal caribou populations, particularly the Pen Islands herd, were reported to result in decreased population size (Fox Lake Cree Nation [FLCN] 2012). Fox Lake Cree Nation noted the occurrence of an additional migratory woodland caribou herd occurring in the area around Gillam, as well as the Angling and Hayes rivers, which consisted of 40–50 caribou. This herd was reported to interbreed and periodically join the Pen Islands herd. With the low population size noted for this group, it was noted as being at a particularly at high risk to effects from hydroelectric development.

In the construction and operation of hydroelectric generating stations, the Cree Nation Partners (2012) and FLCN (2012) indicated the potential for caribou habitat to be lost due to hydroelectric development. It was noted this could affect summer calving and rearing areas through construction occurring on jack pine ridges, as well as through the flooding of islands, which serve as important refuge from predators. FLCN (2012) indicated that the noise associated with the construction of hydroelectric developments would result in the additional loss of caribou winter habitat.

Hydroelectric generating stations were seen to increase water level changes (FLCN 2012). Due to the increased water levels, migrating caribou herds were reportedly no longer able to cross the Nelson River in historically used areas (FLCN 2012). FLCN (2012) indicated that the flooding of areas associated with hydroelectric development resulted in increased debris on shorelines, which impedes migratory caribou movements. To this extent, Pen Islands caribou currently are noted to migrate into the area south of Stephens Lake and the Nelson River, whereas the Qamanirjuaq herd migrates to the north side (FLCN 2012). If attempting to cross rivers with increased water levels, and due to changes in flow and current patterns, there is an increased potential for migrating caribou to break through the ice and drown (FLCN 2012).

Fox Lake Cree Nation sees the development of linear features associated with hydroelectric development (including trails, roadways and related infrastructure) negatively affecting migratory caribou populations through increased access for predators and hunters. As well as increased access, FLCN (2012) indicated there is also an increase in outside harvesters who enter the area to harvest caribou.

Churchill residents stated that hunting locations for all game were altered as a result of the Churchill River Diversion (McRae and Remnant 1997; Edye-Rowntree *et al.* 2006; Edye-Rowntree 2007). Post-hydroelectric development, Churchill residents were reported to hunt woodland caribou from the Canadian National Railway track and the area east of the rail line (I.D. Systems Ltd. 1984).

6.8.5 Effects of Hydroelectric Development in the Region of Interest on Coastal Caribou

The cumulative effects assessment outlined above (Section 6.8.4) considered the effects of hydroelectric development in all areas of the RCEA ROI in which coastal caribou might be affected. The RAAs provided context for the cumulative effects based on the overlap of coastal caribou ranges with the RCEA ROI. Therefore, that assessment — both its regional and local components — also serves as the summary assessment for the effects of hydroelectric development in the RCEA ROI.

6.8.6 Bibliography

6.8.6.1 Literature Cited and Data Sources

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6.9 Boreal Woodland Caribou

6.9.1 Introduction

Caribou, a Land Regional Study Component (RSC) for the Regional Cumulative Effects Assessment (RCEA), are generally divided into two major subspecies. Woodland caribou (*Rangifer tarandus caribou*) include both forest-dwelling (boreal woodland caribou) and forest-tundra ecotypes (coastal caribou, including the Pen Islands and Cape Churchill herds) (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2002). Barren-ground caribou (*Rangifer tarandus groenlandicus)* include the Qamanirjuaq herd, known to migrate occasionally into forested winter habitats within the northern portions of the RCEA Region of Interest (ROI) (Gunn *et al.* 2010).

Boreal woodland caribou were selected as an RSC subcomponent due to their conservation status and importance to people and ecosystems. They are an iconic symbol of Canadian wilderness and are designated as Threatened under the federal *Species at Risk Act* (SARA 2002) and *The Manitoba Endangered Species and Ecosystems Act* (MESEA 2014). Boreal woodland caribou are limited in their ability to recover from population decline because of habitat loss, habitat degradation, fragmentation, and increased predation resulting from overall habitat alteration (Environment Canada [EC] 2012). Effects of linear development, including hydroelectric development, can increase access and lead to increased mortality from predators and humans (EC 2008). The specialized habitat needs of boreal woodland caribou are not captured by other land RSCs. Boreal woodland caribou are often considered an indicator species as part of environmental assessments, given their ecological requirements to satisfy the life requisites (food, cover, and reproduction) of other mature boreal coniferous and bog-associated wildlife species (Kuhnke and Watkins 1999).

The RCEA Phase I report provided an overview of the available historical and existing environment information on population status and distribution of discrete populations throughout the RCEA ROI. Aboriginal traditional knowledge (ATK) on boreal woodland caribou within the RCEA ROI is general in nature, providing some context for assessing population trends through time. In recent decades, increased concern over boreal woodland caribou has resulted in expanded monitoring efforts using aerial telemetry and Global Positioning System (GPS) animal collars. Many of these efforts have been collaborative in nature, with the objective of gaining a better understanding of population ranges and habitat use relative to industrial development.

Management and conservation of boreal woodland caribou in Manitoba is based on both population ranges and management units. Although an ecozone-based approach has been used for other land RSCs, the approach in assessing the cumulative effect of hydroelectric development on boreal woodland caribou considers populations or ranges that often cross ecological and administrative boundaries, and extend outside of the regional ecosystem and RCEA ROI. Both approaches identify regional assessment areas that are ecologically relevant.

Manitoba identifies provincial boreal woodland caribou ranges and Management Units (Manitoba Boreal Woodland Caribou Management Committee [MBWCMC] 2015). Map 6.9.1-1 illustrates the location and

extent of boreal woodland caribou ranges that intersect the RCEA ROI as well as the Bog and Interlake ranges (nine of the 11 ranges have some overlap with the RCEA ROI).

The following sections describe the approach and methods used in the assessment of the cumulative effects of hydroelectric and other developments on boreal woodland caribou in the RCEA ROI, which include Harding Lake, Wapisu-Wimapedi, Wheadon, Wabowden, William Lake, Naosap Reed, Molson/Norway House and Charron Lake ranges.

6.9.1.1 Pathways of Effects

For boreal woodland caribou, a late successional forest species, pathways of effects due to hydroelectric development primarily relate to water level management, transmission line development and associated access. Boreal woodland caribou are generally sedentary in nature with seasonal fidelity to winter and summer range (Bergerud 1985). Boreal woodland caribou typically space away from each other during calving and the calf-rearing period as a predator-avoidance strategy (Bergerud 1985).

HABITAT

Boreal woodland caribou habitat requirements are complex, varying both spatially and temporally, and reflect a hierarchy of factors that may limit individual fitness. Boreal woodland caribou depend on mature coniferous forests for sustenance, as terrestrial lichens (*Cladina* spp.) are a primary source of food during winter and summer (Edwards *et al.* 1960; Ahti and Hepburn 1967; DesMeules and Heyland 1969; Stardom 1975; Darby 1979; Darby and Pruitt 1984; Bergerud and Mercer 1989; Godwin 1990; Schaefer and Pruitt 1991; Thompson *et al.* 2015). At the home range scale, they are limited by habitat availability across landscapes and within home ranges, they select microsites that maximize forage availability and minimize predation risk (Avgar *et al.* 2015). Boreal woodland caribou have large home range sizes, though much smaller than their migratory forest-tundra relatives. Boreal woodland caribou prefer old growth coniferous forests that harbour low densities of predators and other prey animals such as moose and deer, but are susceptible to activities that change the structure of their habitat (Vistnes and Nelleman 2008; Bergerud *et al.* 2007). Habitat loss is considered the leading cause of species extinction (Dyer *et al.* 2001). Hydroelectric development generally contributes a relatively small component of habitat loss when compared to forestry or other landscape developments (Joro Consultants Inc. [Joro] 2011).

DISTRIBUTION

During the last century, the southern limit of semi-continuous boreal woodland caribou distribution has retracted northward in Canada, as a result of the northward expansion of forestry and human land use that has decreased habitat suitability for boreal woodland caribou (Vors *et al.* 2007, Courbin *et al.* 2009). Habitat alteration through natural and human disturbance can affect the persistence of boreal woodland caribou through increased early seral-stage forest, promoting higher densities of moose, deer, and predators (EC 2008). Assessing the cumulative effects of hydroelectric development requires an understanding of the ecology of boreal woodland caribou and the potential role of hydroelectric development in combination with other human and natural influences. Human disturbance associated

with hydroelectric development and facility maintenance has the potential to impact caribou populations through the combined effects of habitat loss and fragmentation, including through sensory disturbance (Dyer *et al.* 2001).

LINEAR FEATURES

Linear corridors (comprised of human-created transmission lines, roads, seismic lines, pipelines, forest cuts, as well as natural formations such as rivers and streams) have been observed to influence the behaviour, distribution, and survival of woodland caribou populations (James and Stuart-Smith 2000). Available research indicates caribou avoidance of roads may be observed any distance from 100 m to 2,500 m depending on the herd and local dynamics (Northcott 1985; Dyer 1999; Dyer *et al.* 2001; Nellemann *et al.* 2001; Schindler *et al.* 2006). Dyer *et al.* (2001) found caribou to display an avoidance distance of up to 500 m from roads, with the frequency and occurrence of caribou road crossing events being dependent on season, the sex of the caribou, the amount of traffic, and the speed of vehicles (Murphy and Curatolo 1987; Forman and Alexander 1988). Schindler *et al.* (2006) found that the loss of functional habitat near a road may be up to one km from the feature. Reduction in the abundance of boreal woodland caribou near disturbed areas has been reported in most studies to range from 1–5 km (Weir *et al.* 2007), although reactions to disturbance vary among individuals. Boreal woodland caribou also avoid transmission lines to a varying degree, depending on a variety of factors, including the density of alternative prey, such as other ungulates, taking advantage of the edge habitat and young vegetative succession (Jalkotzky *et al.* 1997) as well as the presence of predators and their use of the linear feature. The assessment of linear feature effects through point density and path trajectory analysis of collared caribou for the BPIII Transmission Project indicated similar results as reported in the literature in that avoidance of linear features including roads was observed up to one km (Joro 2012).

Similar findings were identified by Ferguson and Elkie (2004) with research showing boreal woodland caribou avoidance of water bodies during travel seasons (early winter and spring) when water was frozen. Research specific to boreal woodland caribou avoidance of natural water corridors identified boreal woodland caribou avoidance of rivers at a distance from 250–500 m (Oberg 2001). The probable cause for avoidance of these natural linear features could be attributed to their utility as travel routes for alternative prey and predators, increasing the likelihood of their encounters with boreal woodland caribou. Hydroelectric developments in the boreal forest, such as the construction and operation of new roads, generating stations and transmission lines, are generally believed to cause avoidance behaviours in boreal woodland caribou (Dyer *et al.* 2001). Individual boreal woodland caribou, such as females with calves (which are less tolerant and more likely to avoid disturbances than other caribou), have been found to be sensitive to disturbances from human activities (Weir *et al.* 2007). Many studies have indicated that the avoidance of human development increases as the level of activity increases (Dyer *et al.* 2001). Effects of power line noise in Norway found semi-domesticated calving reindeer had a 73% lower density in areas less than 4 km from a power line without traffic, compared to areas over 4 km from the same power line, despite a high proportion of preferred habitat being included in this zone (Vistnes and Nellemann 2001).

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Other\Map 6.9.1-1 RCEA_PhaseII_Land_Caribou_Post_Boreal_ProvincialRangesandManagementUnits r2.mxd

Created By: Chris - B Size Portrait BTB - MAR 2015 Scale: 1:3,000,000

N

COLVIN LAKE PROVINCIAL PARK
NUELTIN LAKE PROVINCIAL PARK
CARIBOU RIVER PROVINCIAL PARK
Churchill
Hudson Bay
Tadoule Lake
SAND LAKES PROVINCIAL PARK
NUMAYKOOS LAKE PROVINCIAL PARK
WAPUSK NATIONAL PARK OF CANADA
Southern Indian Lake
Gauer Lake
O-Pipon-Na-Piwin Cree Nation
South Indian Lake
AMISK PARK RESERVE
Kamuchawie
Leaf Rapids
Granville Lake
Partridge Crop
Red Lake
Harding Lake Range
Nisichawayasihk Cree Nation
Nelson House (NAC)
Thompson
Pikwitonei (NAC)
Wheadon Range
Kississing Range
Wapisu-Wimapedi
Wuskwatim G.S.
Thicket Portage (NAC)
Wabowden (NAC)
Snow Lake
Herb Lake Landing (NAC)
Flin Flon
GRASS RIVER PROVINCIAL PARK
Naosap
Naosap-Reed Range
Wabowden Range
Pimicikamak Cross Lake (NAC)
Cross Lake
Jenpeg G.S.
Norway House Range
Norway House Cree Nation
Norway House (NAC)
William Lake Range
The Pas
The Bog
The Bog Range
Wabowden
LAKE WINNIPEG
Charron Lake Range
Interlake Range
CHITEK LAKE PARK RESERVE
Interlake
Atikaki-Berens
DUCK MOUNTAIN PROVINCIAL PARK
ATIKAKI PROVINCIAL PARK
RIDING MOUNTAIN NATIONAL PARK OF CANADA
LAKE WINNIPEG
NOPIMING PROVINCIAL PARK
Assiniboine
MANITOBA
Pine Falls G.S.
River
Conawapa G.S.
Fox Lake Cree Nation
Limestone G.S.
Fox Lake Cree Nation
Gillam
Long Spruce G.S.
Kettle G.S.
Tataskweyak Cree Nation
York Factory First Nation
Nelson Keeyask G.S.
War Lake First Nation
Ilford (NAC)
Kelsey G.S.
Shamattawa First Nation
Hayes
Gods Lake
Molson Island Lake

Legend

- 2013 Provincial Caribou Management Unit

2013 Provincial Boreal Caribou Ranges

- Charron Lake
- Harding
- Interlake
- Kississing
- Naosap-Reed
- Norway House
- The Bog
- Wabowden
- Wapisu-Wimapedi
- Wheadon
- William Lake

Infrastructure

- Generating Station (Existing)
- Generating Station (Under Construction)
- Generating Station (Potential)
- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Government of Canada, Province of Manitoba, Manitoba Hydro. Provincial Boreal Caribou Management Units and Provincial Boreal Caribou Ranges obtained from the Manitoba Boreal Woodland

CREATED BY:
Joro Consultants Inc.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	29-MAY-15	04-DEC-15
0 25 50 Kilometers / 0 25 50 Miles	VERSION NO: 2.0	QA/QC:

Provincial Boreal Woodland Caribou Ranges and Management Units

in the Regional Cumulative Effects Assessment Region of Interest

Map 6.9.1-1

PREDATION

Transmission corridors may also act as corridors for increased predator movements (James 1999; James and Stuart-Smith 2000; Dyer *et al.* 2001; McLoughlin *et al.* 2003; Cameron *et al.* 2005). Predators may use linear features to hunt boreal woodland caribou while expending less energy. New woody growth associated with land clearing may create food sources for moose and deer, which in turn may support higher predator numbers (Courbin *et al.* 2009; Whittington *et al.* 2011; Latham *et al.* 2013). Activities associated with hydroelectric development may also change how boreal woodland caribou and predators interact (Dyer *et al.* 2002). Construction of these linear features in areas with previously intact boreal woodland caribou habitat may open up corridors for predators, allowing them to travel further with greater efficiency. Boreal woodland caribou crossing these features may be at greater risk of predation mortality (Beauchesne *et al.* 2013) from natural predators, as well as human hunters, using these linear features to gain access to formerly secluded boreal woodland caribou habitat. As part of monitoring for the potential effects of predators, a gray wolf collaring program was undertaken for the Bipole III Transmission Project in 2010–2011. A total of 65 collars were deployed within a broad study region, including areas near the Harding Lake, Reed Lake, The Bog, Wabowden, and Wapisu-Wimapedi ranges. Based on collar functionality, data analyses occurred on only a subset of the GPS data points for 34 wolves. Overall, distance-to-feature analysis of wolf locations to linear transportation corridors (major/minor roads and railways) and natural features (shorelines, rivers and burns) revealed wolf locations were generally located further away from the anthropogenic corridors and closer to natural linear features (Joro 2012). Generally, the dataset was not robust; however, the data that were available and analyzed suggested linear anthropogenic travel corridors were not being selected over other habitat types.

DISTURBANCE

Disturbances associated with hydroelectric transmission line development occur mainly during the construction phase. Clearing and construction activities require right-of-way (ROW) clearing and subsequent tower construction and conductor stringing. Maintaining low vegetation in the ROW is required to ensure safe operation of the transmission line. Disturbance stimuli caused by human presence, objects, or sounds causes a deviation in an animal's behaviour from patterns that naturally occur without human influences with avoidance being the most common response of boreal woodland caribou to disturbance (Frid and Dill 2002). In addition, the noise from construction activity occurring near caribou habitat may elicit fear and flight responses, wasting energy reserves and increasing stress. Chronic exposure to noise disturbance may negatively affect body condition and exclude boreal woodland caribou from otherwise suitable habitat (Bradshaw *et al.* 1997).

From a safety and maintenance perspective, hydroelectric transmission line corridors must be kept clear of vegetative growth and debris. This can increase the sight lines of both predators and human hunters, allowing them to spot caribou more easily than if the forest were intact (James *et al.* 2004; Ehlers *et al.* 2014). In addition, off-road vehicle users (including all-terrain vehicles and snowmobiles) may use these linear features to harass caribou by chasing them, and can also disturb them with the sounds and smells associated with these vehicles (*i.e.*, sensory disturbance), or may physically strike an animal.

Within the RCEA ROI, activities associated with construction, operation, and project infrastructure may influence how boreal woodland caribou use space and interact with predators, consequently altering boreal woodland caribou fitness if disturbance patterns are intense. Direct loss of boreal woodland caribou habitat may result from the construction phase of a hydroelectric project, but studies conducted for Manitoba Hydro illustrate that habitat loss as a result of ROW clearing is minimal (Joro 2011). Clearing of forest for roads, utility corridors, or for the facility itself may directly remove habitats with lichen ground cover (Klein 1982; Hristienko 1985). This lichen ground cover is typically found within old coniferous forest and take many decades to regenerate.

HABITAT FRAGMENTATION

Range fragmentation by hydroelectric development may compromise how boreal woodland caribou use space to minimize predation risk to themselves and their calves (Leclerc *et al.* 2012; Lesmerises *et al.* 2013). Habitat fragmentation is the change in configuration of habitat as habitat cover decreases (Grossman *et al.* 2008). As boreal woodland caribou require intact coniferous forest, the effects of fragmentation include increased edge, reduced forest interior habitat, and increased isolation of forest patches. Fragmentation of boreal woodland caribou habitat creates edge habitats characterized by sharp changes in species composition. New plant growth along these edges is often dominated by disturbance-tolerant shrubs and forbs preferred by moose and deer, thereby increasing spatial overlap of boreal woodland caribou with those species and their associated predators (DeCesare 2012; Peters *et al.* 2013). Boreal woodland caribou may be unable to retreat to secluded areas to avoid predation if their range is subjected to a high level of fragmentation (Faille *et al.* 2010). If boreal woodland caribou ranges are permanently fragmented, calf recruitment is reduced, and may eventually lead to population decline (Faille *et al.* 2010). Boreal woodland caribou may be excluded from otherwise suitable habitat areas near hydroelectric projects due to human presence, traffic, noise, increased predation risk, or reduced forage availability. These interacting factors may lead to long-term boreal woodland caribou population decline through a combination of factors such as reduced body condition, increased predation mortality, and lowered calf recruitment (Leblond *et al.* 2011).

Longer-term operation of hydroelectric projects may magnify the habitat loss, fragmentation and sensory disturbance associated with the construction phase. Areas with preferred boreal woodland caribou forage, such as lichens, are unlikely to regenerate if removed for hydroelectric infrastructure development. Caribou may have to increase the length of foraging movements, negatively affecting their energy balance and increasing their exposure and vulnerability to predation. Conversion of old-growth forest into younger mixed-wood stands associated with transmission line ROWs has the potential to facilitate population increases of moose and deer, supporting higher predator populations, and thereby increasing predation pressure on caribou (Leclerc *et al.* 2012; Courbin *et al.* 2014).

FIRE

Disturbances in the forest, either natural or anthropogenic, can allow extensive vegetation regeneration and browse production. Forest fires create increased browse for moose and white-tailed deer (*Odocoileus virginianus*), and the large amount of forest burned since 1969 in the boreal and transitional forests has allowed these species to expand their range northward (Thomas 1995). Forest harvest can

open up old-growth areas of the forest used by caribou as well, and create habitats better suited to deer and moose. Widespread logging has increased the amount of early successional stages of vegetation, which increases the habitat suitability for moose and white-tailed deer due to colonization by deciduous species (Passmore 1989; Hins *et al.* 2009). Forests in early successional stages after forest fires or logging typically show increases in their populations of moose and deer due to the greater quantity and quality of regenerating browse (James *et al.* 2004; Weir *et al.* 2007).

Forestry operations can affect a variety of habitats and microclimatic characteristics, which allow for a diverse range of lichen species to grow (Brodo *et al.* 2001). The periodic disturbance of the substrate and the interruption to natural succession may adversely affect the diversity of both lichens and other species. Some lichen species appear to be restricted to only the oldest forest stands and the loss of older forests may threaten these species (Boudreault *et al.* 2002). Habitat alteration resulting from forestry operations and other human development are potential limiting factors in woodland caribou populations (Schaefer 2003).

DISEASE AND PARASITES

As a result of the optimal foraging found in ROWs and white-tailed deer natural dispersal behaviour, white-tailed deer may increase their range northward with the creation of linear ROW corridors. The potential northern range expansion of white-tailed deer may be positively correlated to the northern spread of parasites, including *Parelaphostrongylus tenuis* (*P. tenuis*). However, increased transmission of *P. tenuis* to boreal woodland caribou will also require northward expansion of intermediate hosts (specific species of slugs and snails, such as: Leopard Slug, *Limax maximus*; Eastern Forest Snail, *Anguispira alternata*; Disc Cannibal Snail, *Haplotrema concavum*).

Figure 6.9.1-1 provides a summary of the pathways of effects that were considered in the development of indicators and metrics to assess the cumulative effects of hydroelectric development on boreal woodland caribou in the RCEA ROI.

6.9.1.2 Indicators and Metrics

As discussed in Introduction and Background, Section 6.1.2.3, environmental indicators can provide a systematic approach in assessing the overall health of the various RSCs. In selecting indicators for the assessment, a number of factors were relevant, beginning with the nature of the pathways of effects from development. The indictors and metrics were also selected based on the availability of data. For boreal woodland caribou, range population estimates for pre-hydroelectric development are generally not available. Where estimates are provided in the literature, they are derived from the best available information and not on systematic surveys, as boreal woodland caribou are difficult to census due to their clumped distributions and low densities (Bradshaw and Hebert 1996; Thomas 1998). Similarly, current estimates on boreal woodland caribou numbers are based on the best available information through minimum counts and local estimations (MBWCMC 2015).

Available information that provides measurements of the selected indicator over time, facilitating comparisons of pre- and post-hydroelectric development is extremely limited. The indicators and metrics are based on an understanding of the drivers and stressors from all sources including natural,

non-hydroelectric, and other human disturbances that can affect boreal woodland caribou. In general, no one indicator is sufficient to describe the state of an RSC; rather, they are evaluated together as complementary sets of information (*e.g.,* disturbance to the landscape results in changes to the core areas).

In assessing boreal woodland caribou, indicators are measured using metrics, and then compared to a number of benchmarks as described in Introduction and Background, Section 6.1.2.4. As recognized benchmarks are not available for all metrics, they have been estimated using a combination of nationally accepted benchmarks (EC 2012), and comparisons between boreal woodland caribou ranges through time. For the RCEA, boreal woodland caribou disturbance indicators have been assessed in three periods. These include pre-hydroelectric development (pre-1960), mid-hydroelectric development (1980s), and post-hydroelectric development (existing environment). Table 6.9.1-1 provides a summary of the indicators, metrics and associated thresholds or benchmarks that were used to assess overall health of the boreal woodland caribou ranges intersecting the RCEA ROI.

The following sections provide a brief overview of the rationale for the indicators selected, including limitations in their utility.

6.9.1.2.1 Response Indicator - Population

Assessing wildlife populations through time can provide an indicator of population status and health. However, there are no statistically robust estimates for boreal woodland caribou in the RCEA ROI or for other populations in Manitoba. Data on populations are typically based on minimum counts or inferences from aerial telemetry studies or other aerial reconnaissance surveys specific to boreal woodland caribou or in combination with moose. Literature and heuristic Population viability analysis results suggest that greater than 300 animals are required for long-term population viability (EC 2008). Although some published estimates for boreal woodland caribou ranges fall below this threshold, Manitoba has identified Management Units that capture the overlap between local populations that would include larger population sizes that would meet the EC criteria. Population estimates and trends will serve as the metric for this indicator.

6.9.1.2.2 Driver Indicator - Core Area (high use areas)

Population ranges, the area occupied by a group of caribou that is distinct from that of other caribou groups, may be very large or very small. Population range sizes within Canada vary between 752 km^2 to more than 600,000 km^2, and within Manitoba, the average size estimate is 16,264 km^2 (range: 3,170–66,128 km^2) (EC 2012). Boreal woodland caribou are generally not distributed evenly within their range, often varying their habitat use seasonally and locally through selection of higher quality habitat patches. Overall range quality is the amount of high quality habitat (*i.e.*, mature coniferous forest with abundant lichen and low anthropogenic footprint) within a boreal woodland caribou population range, usually expressed as square kilometres (km^2). High quality habitat allows boreal woodland caribou to carry out life functions including foraging, reproducing, and minimizing predation risk. Habitat physiognomy is also important – large, contiguous blocks of habitat are more valuable to boreal woodland caribou than fragmented habitat, even if the absolute area of habitat is the same (EC 2012).

Boreal Woodland Caribou

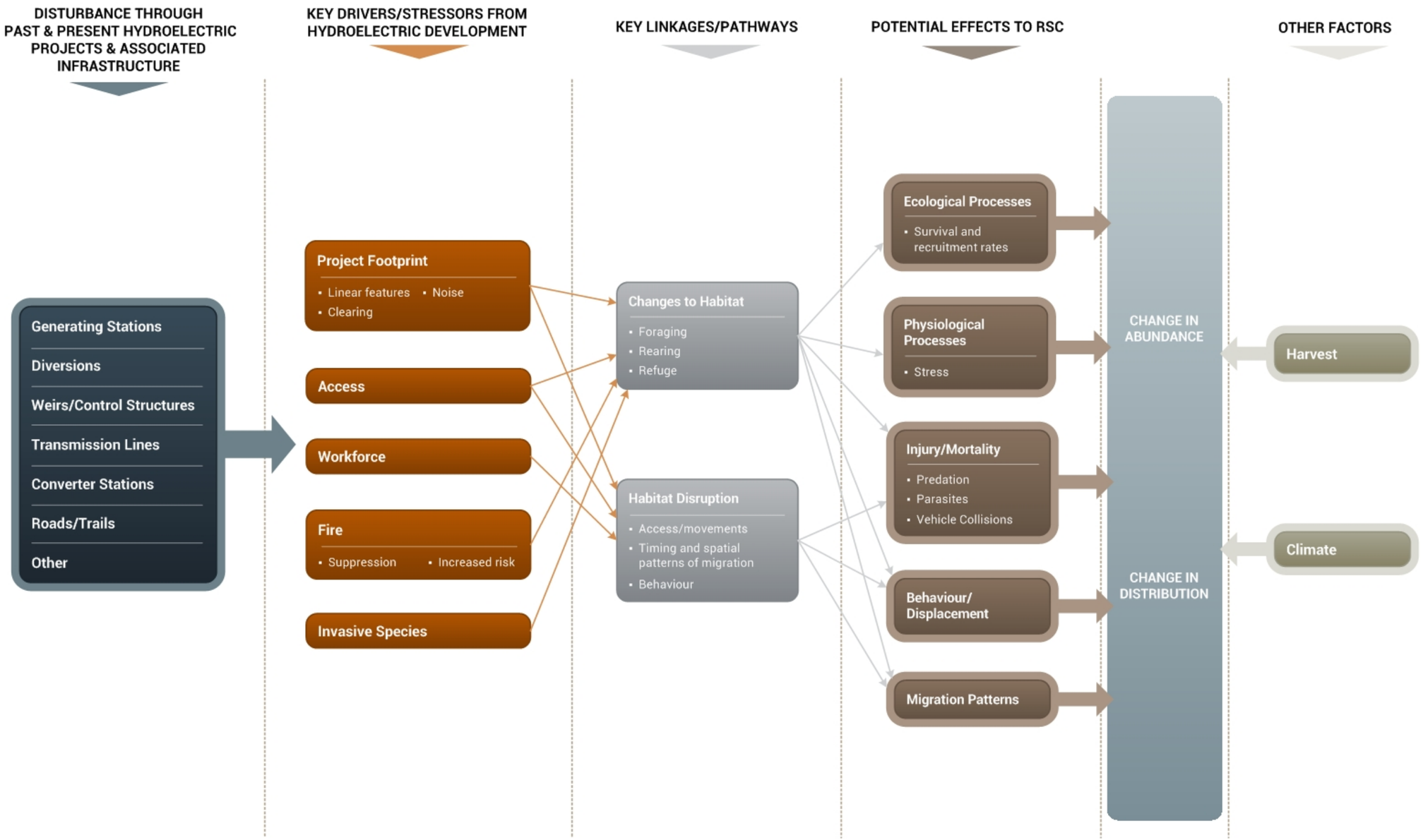


Figure 6.9.1-1: Pathways of Effects Diagram for Hydroelectric Development on Boreal Woodland Caribou

Table 6.9.1-1: Indicators, Metrics, Associated Thresholds, and Benchmarks for Boreal Woodland Caribou

Indicator	Metric	Benchmark
Population size	population estimates, trends	Increasing, decreasing or stable based on available data
Core area	km^2 of core area	Comparison among affected and non-affected populations (differences in use area)
Habitat	km^2 of high quality habitat	Comparison among populations (habitat modeling)
Fragmentation	km/km^2; linear intersect distance of all human made features	Comparisons among populations (degree of change)
Disturbance	% disturbance of all natural and human disturbances	Environment Canada threshold (35%)
Parasites	spatial distribution of white-tailed deer range expansion in km or km^2	Increasing, decreasing or stable based on available data

Core use areas are determined through ecological models of space and time to identify areas where animals spend the greatest amount of time (Vander Wal and Rodgers 2012). Using telemetry data in the identification of core areas is a common method in determining utilization distribution. Courtois *et al.* (2003) used 90% and 70% kernels to describe historical changes in boreal woodland caribou distribution and temporal changes in abundance in Quebec. Hazell and Taylor (2011) examined annual movement patterns and distribution to determine home range, calving areas and overwintering areas of boreal woodland caribou using adaptive kernels at 90% and 70% in the James Bay Lowlands, and Slater (2013) also reported that kernel estimates were best suited to GPS data in conservation planning for boreal woodland caribou. Powell (2000) compared various home range estimators, concluding that kernel methods provided the best option for determining animal home range. In keeping with this approach, telemetry data were used in this assessment to define core areas within home ranges used by boreal woodland caribou.

6.9.1.2.3 Driver Indicator – Habitat

Habitat is the physical environment that provides all necessary life requisites for survival including food, water, shelter, and refuge. All species have unique habitat requirements that vary both spatially and temporally. As described above, boreal woodland caribou require large home ranges consisting mainly of boreal forest and bog-peatland environments. These habitats are generally less diverse then mixed-wood and deciduous forests on deeper clay and mineral soils that are generally preferred by moose. The arrangement of habitat across the landscape (including size of patches, forage availability, and adequate space to avoid predators) is key in providing high quality boreal woodland caribou habitat.

The accelerated use of geographic information systems (GIS) in habitat and landscape assessment has resulted in significant advances in assessing topography and vegetation characteristics. This in combination with the use of animal-borne GPS collars has significantly increased the capability of researchers to assess habitat use and availability for many species. Boreal woodland caribou have been studied in various areas of the RCEA ROI through GPS collaring in an attempt to acquire data on distribution and habitat use to minimize potential industrial impacts.

The utilization of GPS collar data in a GIS can provide researchers with the ability to identify what resources are required by animals and assess the availability of those resources through Resource Selection Function (RSF) modeling (Manly *et al.* 2002). GPS collaring data can be used to determine the probability of a resource unit being selected by comparing used, unused and available units. For this study, RSF modeling was conducted using available GPS telemetry data to provide a more robust examination of potential habitat effects for the various boreal woodland caribou ranges in the RCEA ROI and to account for areas and habitat that may not have been occupied by collared individuals. Resource Selection Function modeling for important life cycle periods was undertaken for winter and summer habitat selection periods.

6.9.1.2.4 Driver Indicator - Fragmentation

Habitat fragmentation changes how boreal woodland caribou interact with other ungulates, predators, and humans via numerous interacting pathways including heightened predation risk, reduced foraging opportunities, increased predator efficiency and mobility through fragmented habitat, and increased risk of human-caused mortality (*i.e.*, vehicle collisions and hunting). Fragmentation can occur as a result of natural events such as fires or floods, which alter available habitat on the landscape. Furthermore, fragmentation can occur as the result of anthropogenic disturbances such as forestry and associated access, and all human-made linear features, including roads, rail lines, transmission line corridors, seismic lines, and trails. Other features that contribute to cumulative effects on boreal woodland caribou include petroleum infrastructure, mining, agriculture, tourism, infrastructure, and hydroelectric developments. Fragmentation is expressed as the average length (km) of linear features within 1 km^2 of habitat (km/km^2). The higher the density, the less suitable this habitat is for boreal woodland caribou.

6.9.1.2.5 Driver Indicator - Disturbance

Boreal woodland caribou are sensitive to habitat disturbance, including disturbance caused by forestry, roads, seismic lines, transmission corridors, various linear features, hydroelectric infrastructure, and other industrial activities. The amount of disturbance within a boreal woodland caribou population range is deemed an indicator of the range's capacity to support a self-sustaining boreal woodland caribou population. Environment Canada (2012) describes disturbance within boreal woodland caribou ranges to include wildfires less than 40 years old and all anthropogenic disturbances that are buffered by 500 m on each side. In applying population growth rates to disturbed boreal woodland caribou ranges, it was determined that a 65% undisturbed habitat (35% disturbed) threshold was the minimum required for a boreal woodland caribou population to be self-sustaining (EC 2008).

Environment Canada (2012) identifies threats as they relate to the persistence of boreal woodland caribou throughout their respective ranges. Protection of critical habitat is implicit as a requirement of EC's SARA, and EC identifies threats that include linear development and habitat loss associated with hydroelectric transmission and generation.

Short episodic disturbances such as noise can also pose long-term risks to boreal woodland caribou recruitment (Harrington and Veitch 1991). Furthermore, noise disturbances have been extensively studied by Harrington and Veitch (1991), Luick *et al.* (1996), and Bradshaw *et al.* (1997).

6.9.1.2.6 Driver Indicator - Parasites

Parelaphostrongylus tenuis meningeal worm, also known as "brainworm", is a common parasitic nematode of the central nervous system, whose natural host is white-tailed deer (Wasel *et al.* 2003; Kopcha *et al.* 2012). *P. tenuis* within white-tailed deer characteristically completes its life cycle without causing any significant adverse health effects (Kopcha *et al.* 2012). However, the occurrence of *P. tenuis* in other ungulates such as moose (*Alces alces*) and caribou (*R. tarandus*) causes serious physical deterioration and eventual death. The occurrence of *P. tenuis* is generally associated with the presence of white-tailed deer. Waring *et al.* (1991) demonstrated that white-tailed deer use ROWs to feed, especially when the available forage is more abundant or of better quality than in adjacent landscapes. ROWs have the potential to provide white-tailed deer with good forage opportunities, given that much of their diet consists of browse, grasses, forbs, fall mast, and succulents, many of which grow in ROW edge habitats. White-tailed deer, especially males, tend to disperse after their first year of age and may go as far as 25 km from their original home range (Fulbright and Ortega-Santos 2006). As a result of the optimal foraging found in ROWs and white-tailed deer natural dispersal behaviour, white-tailed deer may increase their range northward with the creation of linear ROW corridors. The potential northern range expansion of white-tailed deer may be positively correlated to the northern spread of parasites, including *P. tenuis*. However, increased transmission of *P. tenuis* to boreal woodland caribou will also require northward expansion of intermediate hosts (specific species of slugs and snails, such as Leopard Slug, Eastern Forest Snail, and Disc Cannibal Snail).

White-tailed deer may be considered an invasive species within boreal woodland caribou habitat, and pose a risk to boreal woodland caribou by facilitating predator population increases, expansion of the distribution of ectoparasites such as winter ticks (*Dermacentor albipictus*), and by harbouring parasites lethal to boreal woodland caribou. White-tailed deer expansion can be expressed as the change in density of deer, which can be assessed through review of aerial survey data for moose and boreal woodland caribou or through evidence from ground tracking surveys. Information pertaining to the presence of parasites and disease in boreal woodland caribou populations is not available. Although viral, parasitic, and bacterial diseases can affect individual boreal woodland caribou and may have effects at the population level in certain parts of the country, currently parasites and disease are not noted as one of the major threats affecting boreal woodland caribou at the national level (EC 2012). The federal recovery strategy for boreal woodland caribou lists parasites and disease as a low level of concern within unknown extent (EC 2012).

6.9.1.3 Benchmarks

Benchmarks for assessing the various indicators are based on comparisons among boreal woodland caribou populations within the RCEA ROI to assess degree of change, in effect using populations in areas of low or no disturbance as reference areas for other more highly disturbed populations. The EC (2012) threshold for disturbance is being applied to all populations to assess sustainability and the contribution of hydroelectric development to overall disturbance within a range.

6.9.1.4 Approach and Methods

In assessing the contribution of hydroelectric development to the cumulative effects on boreal woodland caribou in the RCEA ROI, the approach and methods were based on assessing the indicators using the metrics, thresholds, and benchmarks identified in the previous section. As discussed, robust historical and existing environment population data do not exist. A review of historical and current estimates based on best available information was undertaken in order to compare the relative abundance of boreal woodland caribou to detect trends. To augment historical information on boreal woodland caribou, observations and reported numbers from the Manitoba Department of Mines and Natural Resources (MDMNR) annual natural resource officer reports for various traplines for the 1950s were obtained and compared to the most current information available.

Telemetry data were also used in the assessment of cumulative effects. Table 6.9.1-2 provides a summary of available data for the RCEA ROI.

Table 6.9.1-2: Available Boreal Woodland Caribou Telemetry Data for Ranges within the Regional Cumulative Effects Assessment Region of Interest

Dataset	Date Range	Caribou Range	Data Type	Number of collared females	Number of Locations
GPS [1] Telemetry 2010 to Current_Charron Lake	Jan 2010–Oct 2014	Charron Lake	GPS	44	209403
GPS Telemetry 2010 to Current_Harding Lake	Jan 2010–June 2014	Harding Lake	GPS	28	112201
GPS Telemetry 2009 to Current_Wabowden	Feb 2009–Oct 2014	Wabowden	GPS	63	307144
GPS Telemetry 2010 to Current_Wheadon	Jan 2010–Feb 2014	Wheadon	GPS	29	128759
GPS Telemetry 2007 to Current_Wim/Wap	Jan 2007–2015	Wimapedi/Wapisu	GPS	49	306144
GPS Telemetry 2010 to Current_Naosap/Reed	Jan 2010–2015	Naosap/Reed	GPS	42	173534

1. Global Positioning System (GPS).

Core winter and summer areas were calculated using all available telemetry data for the boreal woodland caribou ranges and overlap of the RCEA ROI. Delineating core areas within a home range captures changing patterns of resource utilization and more precisely identifies important habitat components. Using methods from the Bipole III Transmission Project (described in Joro [2012] and outlined in the RCEA Phase I report), Adaptive Kernel analysis was conducted to form overall winter and summer boreal woodland core areas. These core areas were mapped and the linear distance and density of various human footprint features, including transmission lines, were calculated (Appendix 6.9A). For the purposes of these analyses, winter is defined as the period from December 1 to March 31, and summer is defined as May 1 to August 15.

Modeling of high quality habitat was undertaken using RSF modeling, based on available telemetry data. Predictive summer and winter habitat models were developed to identify potential high quality habitat areas impacted beyond those that have been used by collared animals using a 2 km^2 hexagon sampling grid (Appendix 6.9B). Calculations of linear features intersecting the modeled summer and winter high quality habitat were undertaken to compare overall linear feature intersect and transmission line contribution for each range.

Environment Canada's Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou Boreal Population, in Canada (EC 2008) provides a conceptual framework for the identification of critical habitat using a variety of analytical procedures and principles. The assessment framework addresses the "adequacy of the current range conditions to support a self-sustaining population based on three lines of evidence: percent total disturbance, population growth and population size" (EC 2012). The cumulative effects assessment of hydroelectric development for the boreal woodland caribou ranges utilized this disturbance assessment approach for the periods pre- and post-hydroelectric development.

Pre-hydroelectric disturbance analysis was conducted based on the RCEA terrestrial habitat and fire regime data (Terrestrial Habitat, Chapter 6.3) to assess levels of disturbance relative to the EC threshold. The results of this analysis are summarized in Appendix 6.9C.

White-tailed deer historical and current distribution was assessed using the best available information, to determine if white-tailed deer expansion into the boreal woodland caribou range has occurred.

6.9.1.5 Data Limitations

The major data limitations for the assessment of boreal woodland caribou in the RCEA ROI included the following:

- limited published ATK information available on boreal woodland caribou;
- lack of historical information on distribution and population;
- lack of predator (wolf and bear) numbers or density estimates;
- telemetry data for Norway House, and William Lake ranges; and
- lack of current information on recruitment and mortality.

As is the case in all long-term assessments (in this case covering more than 45 years), limitations in available information inevitably place constraints on the analysis possible. Despite these limitations, as outlined above in Section 6.9.1.4, sufficient information exists to provide data for the selected indicators

and a reasonably robust assessment of the impacts of hydroelectric development on boreal woodland caribou within the RCEA ROI. The assessments provided below discuss these limitations for those terrestrial regions where there was potential for them to substantively alter any conclusions regarding regional cumulative effects.

6.9.2 Indicators: Before Hydroelectric Development

The RCEA Phase I report provides a summary of historical information on boreal woodland caribou for the RCEA ROI including a number of specific references. Overall, data and information on boreal woodland caribou are very limited pre-hydroelectric development.

6.9.2.1 Population

6.9.2.1.1 Harding Lake, Wapisu-Wimapedi, Wheadon, Wabowden and Naosap-Reed Ranges

These ranges have been grouped, as population information for the pre-hydroelectric development period is not specific to the current range delineations. Overall, data and information on boreal woodland caribou are very limited pre-hydroelectric development. However, the available information includes some quantitative statements indicating low densities and variability of boreal woodland caribou populations in the 1950s that suggest that populations were low but stable (Bryant 1955; Howard 1960a). Bryant (1955) made qualitative statements about densities and distributions of boreal woodland caribou in the northern section of the Harding Lake Range. Howard (1960a, b) conducted aerial surveys and observed high variability of boreal woodland caribou densities and distribution. This aerial survey revealed eight boreal woodland caribou and many tracks; from these sightings, Howard (1960b) deduced that population levels were low.

Observations by conservation officers and local trappers from annual reports in the 1950s suggest that populations were generally low and stable. Based on historical information from MDMNR officer reports in the late 1940s and 1950s, boreal woodland caribou were sparse with few sightings reported by officers and trappers. They recorded that two to four boreal woodland caribou were harvested annually by Nelson House hunters during the 1950s, and none harvested by Split Lake hunters for this period, where the caribou harvest was all barren-ground animals.

6.9.2.1.2 William Lake Range

Observations by conservation officers and local trappers from annual reports in the 1950s suggest that populations were generally low and stable. Based on historical information from MDMNR officer reports in the late 1940s and 1950s, boreal woodland caribou were sparse with few sightings reported by officers and trappers.

6.9.2.1.3 Norway House Range

Observations by conservation officers and local trappers from annual reports in the 1950s suggest that populations were generally low and stable (MDMNR 1954). Documented boreal woodland caribou harvest beginning in the 1950s in the Norway House Area indicates a relatively stable number of boreal woodland caribou being harvested throughout the 1950s, with boreal woodland caribou numbers increasing in the early 1950s in the Minago and Hargrave areas (MDMNR 1953). Annual harvest reports

between the mid-to-late 1950s noted harvests of between eight and 56 animals (People, Part III). Howard (1960a, b) conducted aerial surveys and observed high variability of boreal woodland caribou densities and distribution, indicating that signs of boreal woodland caribou east of the Nelson River were scarce and that populations were low in this portion of the province (Howard 1960b).

6.9.2.1.4 Charron Lake Range

Population data for the Charron Lake Range are scarce. Larch (1971) reported a herd size for the Hudwin Lake area of 33 animals, which is located near the current day Charron Lake Range. Three years later, Crichton (1974) reported a minimum herd population of three for the Hudwin Lake Range. No other information exists for this herd prior to hydroelectric development. To date, hydroelectric development has not occurred in this range.

6.9.2.2 Core Areas

This metric cannot be calculated for most of the boreal woodland caribou ranges found in the RCEA ROI for the period prior to hydroelectric development, as boreal woodland caribou studies were limited and did not include the acquisition of telemetry data. Telemetry data are required to conduct these analyses and calculate this metric. The one exception is with respect to the telemetry data that were used to assess boreal woodland caribou distribution before (2007–2008) and after (2010–2011) the construction of the Wuskwatim Transmission Project, which overlaps with the Wapisu-Wimapedi range, allowing the opportunity to compare boreal woodland caribou core areas pre- and as post-hydroelectric development. Note that this period does not pre-date all hydroelectric development in the Wuskwatim Terrestrial Region, which began with the Churchill River Diversion (CRD) in the mid-1970s. However, these animals' core range is south of the CRD and therefore had not been previously subject to hydroelectric development.

Boreal woodland caribou core areas were defined in relation to the Wuskwatim transmission line ROW and were compared using the same core area methods as described in Appendix 6.9A for the pre- and post-construction period (Joro 2012). Map 6.9.2-1 illustrates the location of the proposed transmission line corridor and core areas prior to construction of the Wuskwatim Transmission Project.

6.9.2.3 Habitat

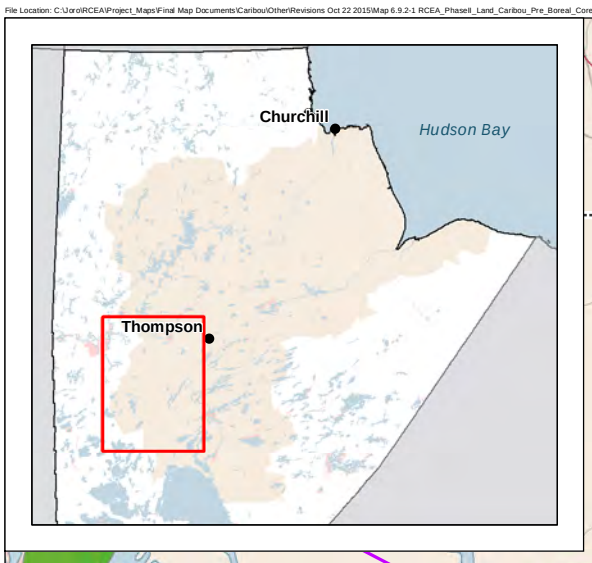
This metric could not be calculated for the pre-hydroelectric development period, as boreal woodland caribou studies were limited and did not include the acquisition of telemetry data. Telemetry data are required to conduct these analyses and calculate this metric.

6.9.2.4 Fragmentation

This metric could not be calculated for the pre-hydroelectric development period, as boreal woodland caribou studies were limited and there are no available data to determine range boundaries needed to calculate and compare fragmentation.

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Other\Revisions Oct 22 2015\Map 6.9.2-1 RCEA_Phasell_Land_Caribou_Pre_Boreal_CoresPreWuskConstruction r2.mxd

Created By: Chris - B Size Portrait BTB - MAR 2015 Scale: 1:625,000



N

Nisichawayasihk Cree Nation
Nelson House (NAC)
Notigi
Wuskwatim G.S.
Snow Lake
Wabowden (NAC)
Pipun
Dunlop
Odhill
Herb Lake Landing (NAC)
Cotes Landing
Tyrrell
Wekusko
Paterson
Dyce
Rawebb

Legend

2013 Provincial Boreal Caribou Ranges

- Harding
- Naosap-Reed
- Wabowden
- Wapisu-Wimapedi
- Wheadon

Caribou Cores

- Pre-Construction Summer Cores up to August 2011

Transmission Lines in the Wuskwatim Area

- Herblet Lake to Rall's Island H75P (60m ROW)
- Wuskwatim to Birchtree W76B (60m ROW)
- Wuskwatim to Herblet Lake W73H, W74H

Infrastructure

- Generating Station (Existing)
- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro, Province of Manitoba.
The 2013 Provincial Caribou Ranges were created from telemetry analysis by Manitoba Conservation. Caribou summer cores created from 2007-2013 telemetry by Joro.

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Joro Consultants Inc.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
NAD 1983 UTM Zone 14N	05-JUN-15	26-OCT-15
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Core Areas of Boreal Woodland Caribou Pre-Construction

Wuskwatim Transmission Project Area

Map 6.9.2-1

6.9.2.5 Disturbance

6.9.2.5.1 All Ranges

Table 6.9.2-1 provides a summary of the pre-hydroelectric development disturbance assessments using the EC (2012) approach. As illustrated in Table 6.9.2-1, the overall disturbance associated with boreal woodland caribou ranges falls well below the 65% undisturbed (or 35% disturbed) habitat threshold in this period. Summaries of the disturbance analyses are presented in Appendix 6.9C. Note that the small area of hydroelectric development present is an artifact of existing transmission line development prior to Lake Winnipeg Regulation (LWR) and hydroelectric development along the Nelson River. Maps 6.9.2-2 through 6.9.2-9 show the results of the disturbance analysis.

Table 6.9.2-1: Percent of Overall Disturbance Regime for Boreal Woodland Caribou Pre-Hydroelectric Development in 1960

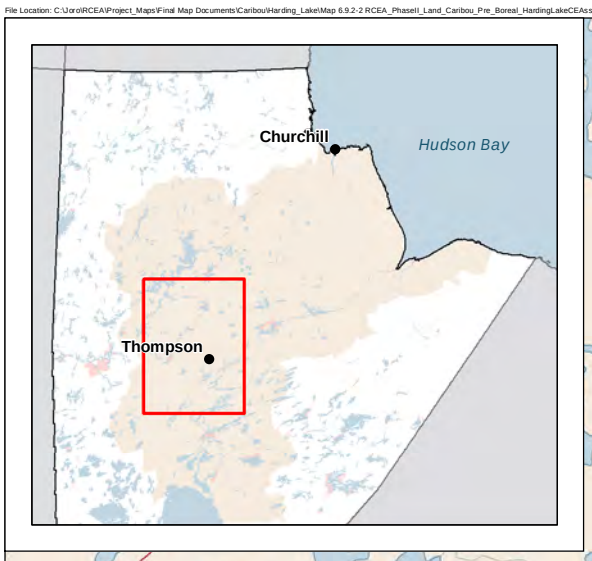
Boreal Woodland Caribou Range in 1960	Total Hydroelectric Development Disturbance (%)	Total Non-Hydroelectric Development Disturbance (%)	Total Natural Disturbance (%)	Total Overall Disturbance (%)
Harding Lake	0.25	1.97	0.89	3.11
Wapisu-Wimapedi	0.14	2.89	12.00	15.03
Wheadon	0.59	2.06	12.18	14.83
Wabowden	0.00	3.79	13.43	17.21
William Lake	0.00	2.30	15.29	17.59
Naosap Reed	0.01	8.09	8.10	18.07
Norway House	0.25	3.12	9.71	13.07
Charron Lake	0.00	0.27	13.03	13.30

6.9.2.6 Parasites

Historic census data from the MDMNR show that white-tailed deer were present in some localized areas within the RCEA ROI pre-hydroelectric development. A Nelson House annual wildlife report (MDMNR 1957) shows census numbers between five and ten white-tailed deer from the years 1953–1955. Another annual report from Pukatawagan (MDMNR 1957) shows larger numbers of white-tailed deer, ranging from 20–100 animals. A Wabowden annual report (MDMNR 1953) makes mention of white-tailed deer, with 40–80 animals reported as a crop in the area, however no census data are mentioned. Lastly, an annual report for the Cranberry Portage RTL section (MDMNR 1955) identifies nearly 300 white-tailed deer in the area.

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Harding_Lake\Map 6.9.2-2 RCEA_PhaseII_Land_Caribou_Pre_Boreal_HardingLakeCEAssesment1960 r2.mxd

Created By: Chris - B Size Portrait BTB - MAR 2015 Scale: 1:625,000



N

AMISK PARK RESERVE

Nisichawayasihk Cree Nation
Nelson House (NAC)

Wuskwatim G.S.

PAINT LAKE PROVINCIAL PARK

Legend

- 2013 Provincial Boreal Caribou Harding Lake Range

Cumulative Effects Disturbance Categories

- Transmission Lines (500m Buffer)
- Human Footprint not for Hydro Development (500m Buffer)
- Drill Holes (250m Buffer)
- Natural Disturbance - Fires

Infrastructure

- Generating Station (Existing)
- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro, ECOSTEM, Province of Manitoba, Tolko.
The 2013 Provincial Caribou Norway House Range was created from telemetry analysis by Manitoba Conservation. Disturbance data created by ECOSTEM.

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Disturbance in 1960

Harding Lake Caribou Range

Map 6.9.2-2

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Wapisu-Wimapedi\Map 6.9.2-3 RCEA_PhaseII_Land_Caribou_Pre_Boreal_WapWimCEAssessment1960.mxd

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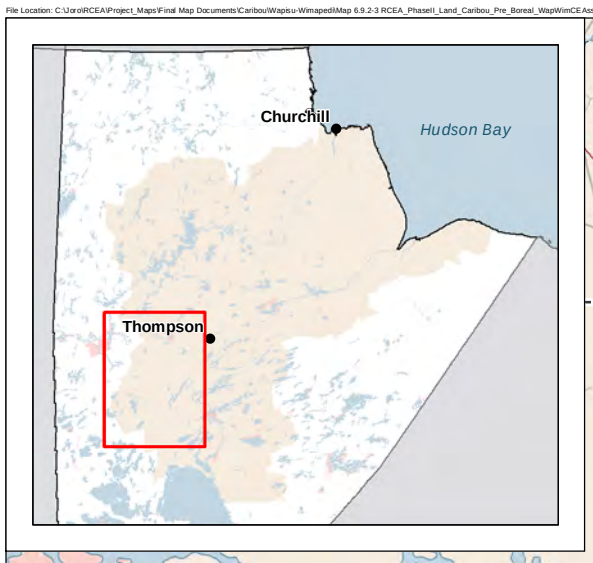

N

Lakes Lake
R
Leftrook
Nile L
Odei
Macheewin
Misinagu Lake
Fold L
L
Lake
Osik Lake
Hunter
Hall Lake
Notigi Lake
Notigi
391
Wapiso Lake
Nisichawayasihk Cree Nation
Nelson House (NAC)
Threepoint Lake
Birch Tree Lake
Apeganau R
Apeganau Lake
Opegano Lake
Ospwagan L
Wuskwatim Lake
River
Wuskwatim G.S.
Paint Lake
Burntwood
River
Burntwood Lake
Ck
River
Joey L
Driftwood
Parent Lake
Wheadon
Osborn
Riel
Lake
Craik Lake
Wimapedi
R
Wimapedi Lake
R
Tullibee Lake
Ck
River
Phillips Lake
Fergusson
Five Mile Lake
Halfway Lake
Odhill
Dowling L
Snow
Rosenberry Lake
Missipisew
Fish Lake
Loonhead L
Ck
Herblet Lake
Setting
Bear
Snow Lake
River
Niblock Lake
Davis L
Pakwa L
Wabowden (NAC)
Lake
Scatch
File Lake
Woosey Lake
Wekusko
Dion Lake
Grass
Pipun
Duck Island Lake
Kiski Lake
Collin Lake
Greenaway Lake
Dunlop
Clarke Lake
Herb Lake Landing (NAC)
Cotes Landing
Lindsay Lake
Gormley Lake
Tyrrell
Hargrave
Waskik L
River
Wekusko
Hargrave L
Fenton
Ck
Ck
Black Duck Lake
Metchanais I
Huzyk
River
Hill Lake
Horsfall Island
Playgreen Lake
Kiskitto Lake
Minago

Legend

- 2013 Provincial Boreal Caribou Wapisu-Wimapedi Range

Cumulative Effects Disturbance Categories

- Transmission Lines (500m Buffer)
- Roads for Hydro Development (500m Buffer)
- Human Footprint not for Hydro Development (500m Buffer)
- Drill Holes (250m Buffer)
- Mines (500m Buffer)
- Natural Disturbance - Fires

Infrastructure

- Generating Station (Existing)
- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro, ECOSTEM, Province of Manitoba, Tolko.
The 2013 Provincial Caribou Norway House Range was created from telemetry analysis by Manitoba Conservation. Disturbance data created by ECOSTEM.

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Disturbance in 1960

Wapisu-Wimapedi Caribou Range

Map 6.9.2-3

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Wheadon\Map 6.9.2-4 RCEA_Phasell_Land_Caribou_Pre_Boreal_WheadonCEAssessment1960.mxd

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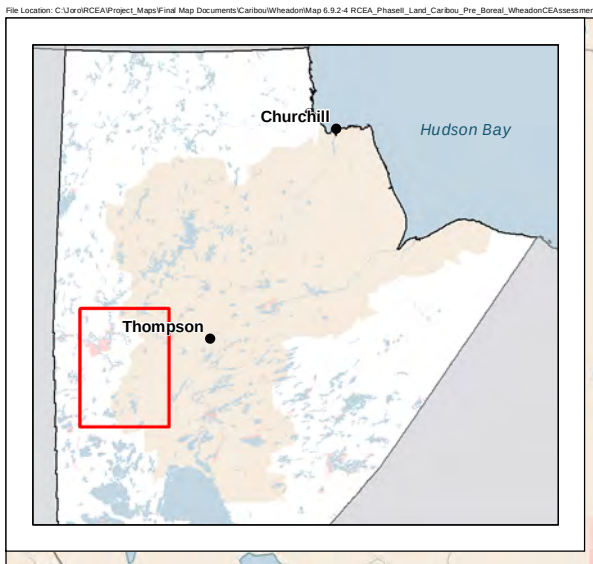

N

Granville Falls
Goodwin Lake
Mynarski Lakes
Rat River
Suwannee Lake
Suwannee River
Lake
R
Macheewin
Misinagu Lake
Fold L
Osik Lake
Highrock Lake
Hall Lake
Notigi Lake
Notigi
Wapiso Lake
Nelson Lake
Rafter
Flatrock Lake
River
Apeganau Lake
Apeganau R
Burntwood River
Takipy
Takipy Lake
Burntwood Lake
Ck
River
Kississing
Guthrie Lake
Driftwood
Three Finger L
Ruddock
Parent Lake
Wheadon
Osborn
Riel
Craik Lake
Batty L
Lake
Wimapedi
Cold Lake
Sherridon
R
Wimapedi Lake
Moody L
Nokomis Lake
Dowling L
Snow Ck
Rosenberry Lake
Missipisew
Fay Lake
Loonhead L
Herblet Lake
Snow Lake
File Lake
River
Niblock Lake
Davis L
Pakwa
Weesey Lake
Dion Lake
Grass
Wekusko
Kiski Lake
GRASS RIVER PROVINCIAL PARK
Herb Lake Landing (NAC)
Cotes Landing
Reed Lake
Lindsay Lake
Tyrrell
McClarty Lake
Wekusko
Hargrave Ck

Legend

- 2013 Provincial Boreal Caribou Wheadon Range

Cumulative Effects Disturbance Categories

- Transmission Lines (500m Buffer)
- Roads for Hydro Development (500m Buffer)
- Other Human Footprint for Hydro Development (500m Buffer)
- Human Footprint not for Hydro Development (500m Buffer)
- Drill Holes (250m Buffer)
- Mines (500m Buffer)
- Natural Disturbance - Fires

Infrastructure

- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
Manitoba Hydro, ECOSTEM, Province of Manitoba, Tolko.
The 2013 Provincial Caribou Norway House Range was created from telemetry analysis by Manitoba Conservation. Disturbance data created by ECOSTEM.

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Disturbance in 1960

Wheadon Caribou Range

Map 6.9.2-4

File Location: C:\Joro\RCEA\Project_Maps\Final Map Documents\Caribou\Wabowden\Map 6.9.2-5 RCEA_PhaseII_Land_Caribou_Pre_Boreal_WabowdenCEAssessment1960.mxd

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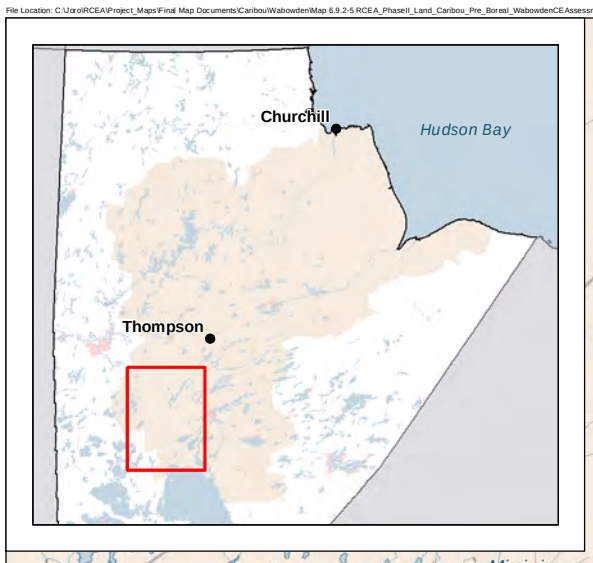

N

Snow Lake
Herb Lake Landing (NAC)
Cotes Landing
Wekusko
Paterson
Tyrrell
Wabowden (NAC)
Pipun
Dunlop
Odhill

Legend

- 2013 Provincial Boreal Caribou Wabowden Range

Cumulative Effects Disturbance Categories

- Human Footprint not for Hydro Development (500m Buffer)
- Drill Holes (250m Buffer)
- Natural Disturbance - Fires

Infrastructure

- Generating Station (Existing)
- Transmission Line (Existing)
- Transmission Line (Under Construction)
- Rail
- First Nation Reserve
- RCEA Region of Interest

Manitoba Hydro

Regional Cumulative Effects Assessment

DATA SOURCE:
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Disturbance in 1960

Wabowden Caribou Range

Map 6.9.2-5