Bipole III Transmission Project

Caribou Technical Report

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Manitoba Hydro

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EXECUTIVE SUMMARY

Manitoba Hydro has completed a Site Selection and Environmental Assessment (SSEA) and Environmental Impact Statement (EIS) as part of the environmental assessment (EA) process for the Bipole III Transmission Line Project (hereafter referred to as the Project). This report was prepared for Manitoba Hydro as one of several biophysical technical reports contributing to the larger EA and EIS for the Project. The primary valued environmental components (VEC) described in this report for the Project include barren-ground (*Rangifer tarandus groenlandicus*) and woodland caribou which include the coastal or forest/tundra ecotype and boreal woodland caribou (forest dwelling (*Rangifer tarandus caribou*). Boreal woodland caribou are listed as a threatened species under the federal Species at Risk Act (SARA) as well as the Manitoba Endangered Species Act (MESA). The forest/tundra ecotype is not listed under SARA or MESA.

Manitoba Hydro has collaborated with Manitoba Conservation since 2007 in the collaring and monitoring of boreal woodland caribou ranges intersected by the Project. Base-line studies of boreal woodland caribou ranges intersected by the Project have recently focused on the use of satellite-based collaring and telemetry studies aimed at contributing to and assessing pre-project data collection for environmental effects assessment for the Project. Seventy-eight collars were deployed in 2010 and were supplemented by an additional 70 collars in winter 2011. These collars supplement earlier deployments of 24 UHF downloadable collars between 2007 and 2009, as well as historical data collected from 1969-2006. As a result, a total of 202 female caribou have been collared and tracked in relation to the Project to date across various ranges within the Project Study Area.

This study also utilized ancillary data from a Manitoba Conservation led telemetry study on coastal caribou populations. A total of ten and nine females were collared from the Cape Churchill herd and Pen Island herd, respectively, in 2010. Thirteen Pen Island females were collared in 2011. These data were used to assess movements of coastal caribou in and out of the Project Study Area.

Additional studies undertaken included the collaring of grey wolf (*Canis lupus*), aerial surveys, and use of trail cameras to assess the overlap of boreal woodland caribou range occupancy with grey wolf and moose (*Alces alces*). Recruitment surveys of collared females were conducted to

determine the numbers of calves surviving and mortality of collared females has been documented in a number of local populations to asses Lambda (λ), which is the rate of population growth or decline. This report includes data gathered up to March 31, 2011. Data from collared caribou continue to be collected and ongoing research and monitoring will continue in support of Manitoba Hydro's monitoring program for the Project.

Results to date indicate that the new data have provided valuable information on boreal woodland caribou ranges identified in the "*Manitoba Conservation and Recovery Strategy for Boreal Woodland Caribou*" (2006). Based on the new data, boreal woodland caribou range delineations defined in the provincial strategy were modified for monitoring and assessment purposes for the Project. In total, eleven boreal woodland caribou ranges were defined by Manitoba overlap with the Project Study Area by Manitoba Conservation (Manitoba Conservation, 2006). Of these eleven ranges, three boreal woodland caribou ranges were identified as being potentially impacted by the Final Preferred Route (FPR). These include the Bog Range, the Reed Lake Range (paralleling the existing Wuskwatim Transmission Line), and the Wabowden Range.

The degree and magnitude of environmental effects on caribou vary among the three boreal woodland caribou ranges potentially intersecting the FPR; however, the overall description of the environmental effects assessment is similar. Potential threats to these boreal woodland caribou ranges, in relation to industrial development, include habitat loss, fragmentation, and disturbance (Manitoba Conservation, 2006). Direct mortality factors in the boreal forest include overhunting and predation. Mortality from indirect causes include the potential introduction of parasites such as the nematode parasite or brainworm (*Parelaphostrongylus tenuis*) from white-tailed deer through increased contact between deer and caribou via habitat modification (Pitt and Jordan, 1994). The responses of alternate prey species and parasites to anthropogenic activities such as forestry and recreational development could also potentially contribute to decline of caribou (Dzus, 2001; Manitoba Conservation, 2006).

Based on analysis and potential environmental effects outlined in this report, residual effects of the Project on The Bog, Reed Lake, and Wabowden, and coastal and barren-ground caribou are anticipated to include direct and functional loss of habitat, range fragmentation, increased predation, mortality due to hunting and mortality due to introduction of pathogens (with potential residual effects varying between ranges). Overall, it is anticipated that with proper application of mitigation measure and ongoing monitoring that these residual effects will not significantly affect these populations.

As discussed, this report contains data current to March 31, 2011. Manitoba Hydro's collaborative monitoring of boreal woodland and coastal caribou is scheduled to continue for approximately three additional years. The data from this monitoring program will provide further insight and support to the predicted effects and allow for adaptive management if required. Monitoring the effects of transmission lines on boreal woodland caribou will require a multi-year commitment as the effects of anthropogenic disturbances are not easy to detect within typical environmental monitoring cycles. Recruitment and mortality studies will continue and telemetry data will be used in assessing the effects of disturbance regimes and to study the response and effects of transmission lines on boreal woodland caribou persistence over time. Supplementary reports using current and up to date data are expected to be submitted as the environmental licensing process proceeds in 2012.

1.0 INTRODUCTION

1.1 Background

This report was prepared for Manitoba Hydro as one of several biophysical technical reports that is part of a comprehensive environmental monitoring program for the Bipole III Transmission Project (hereafter referred to as the Project). The Project is a 500 kilovolt (kV) high voltage direct current (HVdc) transmission line proposed for the west side of Manitoba. The Project undertook a Site Selection and Environmental Assessment (SSEA) process which had supported the subsequent Environmental Impact Statement (EIS) that will be filed to Manitoba Environment (2011).

As it is not possible to describe and investigate every aspect of the terrestrial environment; a Valued Environmental Components (VECs) approach was used in the Project SSEA and EIS (Appendix A). Mammal VEC selections were made by the Project study team through a structured process assessing a number of key attributes including: 1) the species' provincial or federal status and regulatory status; 2) its importance to local cultures; 3) its ability to function as an umbrella species; 4) its ability to function as an indicator species; 5) its ability to function as a keystone species; 6) information available to construct models of habitat preference for the species; and 7) the relative influence that a transmission line may have on the species population and habitats.

Caribou are generally identified by two major sub-species and both are found within the Project Study Area. These include boreal woodland caribou (*Rangifer tarandus caribou*), the coastal or tundra/forest ecotype (*Rangifer tarandus*) and migratory barren-ground caribou (*Rangifer tarandus groenlandicus)* (Linnaeus). The costal or forest/tundra ecotype is genetically similar to the boreal woodland caribou and is generally characterized by its migratory behaviour, use of taiga/tundra transition forest and group calving behaviour in coastal tundra habitats along Hudson Bay. Barren-ground, coastal, and boreal woodland caribou have all been identified as VECs for the Project. As part of the overall SSEA and EIS for the Project, Joro Consultants Inc. has conducted various field studies, desktop analysis, and subsequent assessments for caribou.

Boreal woodland caribou (*Rangifer tarandus caribou*) are designated as Threatened under the federal Species at Risk Act (SARA, 2002) and under the Manitoba Endangered Species Act (MESA, 1990). Environment Canada has the responsibility under SARA to develop a National Recovery Strategy for schedule 1 listed species, which includes boreal woodland caribou. In 2009, Environment Canada began public consultations for the preparation for the "*National Recovery Strategy for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada*" (Environment Canada, 2009). These consultations, which included a parallel Aboriginal consultation process, concluded in late 2010. In August 2011, Environment Canada released "*Recovery Strategy for the Woodland Caribou, Boreal Population (Rangifer tarandus caribou) in Canada*" for public consultation and review (Environment Canada, 2011a). Simultaneously, Environment Canada also released "*Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada*" (Environment Canada, 2011b). This draft recovery strategy included consultations, Aboriginal traditional knowledge, and scientific studies on boreal caribou habitat needs. The national recovery strategy and the scientific assessment of critical habitat both aim to address threats as they relate to the persistence of boreal woodland caribou throughout their respective ranges. These reviews identified several key issues and knowledge gaps at both national and regional scales. Of particular significance is that boreal woodland caribou are experiencing a range recession across the southern limits of the Canadian boreal woodland caribou zone due to land use, linear development, and other anthropogenic disturbance (Schaefer, 2003; Vors et al., 2007). Although climate change has resulted in northern shifts in distribution of many species, the relatively high speed of range shift suggests that climate change is an unlikely explanation for these observed changes (Vors et al., 2007). The primary threat to Canada's boreal woodland caribou as identified in the draft recovery strategy is habitat alteration as a result of anthropogenic development and natural stressors and subsequent increases in predation (Environment Canada, 2011a).

Manitoba also released the "*Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou*" in 2006 (Manitoba Conservation, 2006). Provincially, this strategy is scheduled to be updated in 2012 and will include revised strategies for boreal woodland caribou

management and conservation, new population estimates, and updated conservation risk assessments for all Manitoban caribou ranges. The Manitoba strategy provides a policy framework for boreal woodland caribou recovery in Manitoba and is considered as the regulatory policy pertaining to the protection and management of boreal woodland caribou and their habitat.

1.2 Project Description

The Project comprises of a 500 kV HVdc transmission line originating at a new converter station to be located near the site of the proposed Conawapa Generating Station on the Nelson River and terminating at a second new converter station, to be located at the Riel site east of Winnipeg. The right-of-way (ROW) width for the Project is 66 m. The Project will also include new 230 kV transmission lines linking the northern converter station to the northern collector system at the existing 230 kV switchyards at the Henday Converter Station and Long Spruce Generating Station. Each of the converter stations will require a ground electrode facility connected to the station by a low voltage feeder line. The overall Project Study Area is illustrated on Map 1.

Approximately 75% of Manitoba Hydro's generating capacity is delivered to southern Manitoba via the existing HVdc Interlake corridor, which is shared by the Bipole I and II transmission lines. Due to the heavy reliance on one transmission corridor and a single converter station in the south (Dorsey), the system is vulnerable to extensive power outages from severe weather (e.g. major ice storms, extreme wind events, and tornados), fires, or other events. Studies have concluded that a new transmission line and associated facilities would improve system reliability and reduce dependency on Dorsey Station and the existing HVdc Interlake corridor. The Project would also establish a second converter station in southern Manitoba, to provide another major point of power injection into the transmission and distribution system. In addition, the Project will reduce line losses on the existing Bipoles I and II and provide additional transmission line capacity from north to south. Following an assessment of system reliability options and review by the Manitoba Hydro Electric Board and the Province of Manitoba, the decision was made to develop the Project on the west side of the province

1.2.1 Bipole III General Structure[1]

Two basic tangent structure types will be used for the straight line sections of the Project HVdc transmission line. In northern Manitoba, the line conductors will be suspended from guyed lattice steel structures. Guyed structure design and construction is beneficial in northern Manitoba as it can be adjusted to accommodate difficult or shifting foundation conditions, while also enabling periodic adjustment of the guys at their anchors, to accommodate for such movement. This is particularly important where permafrost may affect foundation stability and where construction access and maintenance may be hampered by difficult soil and terrain conditions. In the densely developed areas of southern Manitoba, self-supporting lattice steel structures will be used to reduce land acquisition requirement of tower foundations, reduce structural footprints and minimize potential impacts on adjacent farming practices.

1.2.2 Converter Stations

Two converter stations will be constructed at both ends of the Project. In the north, the new Keewatinoow Converter Station will include converters with associated equipment and ancillary facilities. This arrangement is required to terminate the 230 kV transmission line connections to the northern collector system, to convert the alternating current (AC) power from the collector system to dc power at the +/- 500 kV level, and to provide the HVdc switching facilities necessary for termination of the new Project HVdc transmission line. The new southern converter station will include the HVdc switchyard facilities necessary to terminate the new HVdc transmission line. The southern station (Riel) will consist of the converters and the ancillary facilities required to convert the dc power from the Project transmission line to ac power at the 230 kV level which is necessary for injection into the southern receiving system. Although otherwise similar in concept to the Keewatinoow Converter Station, the Riel converter facilities will include synchronous compensators used for voltage control, strengthening the

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[1]*NOTE: Section 1.2.1 to 1.2.5 – Project Description – are based on Bipole III Transmission Project: A Major Reliability Improvement Initiative provided by MMM (Date April 7th, 2011).*

system, supporting the Project converters, and adding system inertia for stability (Manitoba Hydro, 2010).

1.2.3 Ground Electrodes

Ground electrodes will be required at both the northern and southern Project converter stations to enable ground return of electric current in the event of monopolar operation. The electrode site selection process was an iterative process of identifying and evaluating sites. Thirteen candidate electrode sites were initially identified within 50 km (approximately 31 mi.) of the proposed Keewatinoow converter station and later expanded to include an additional ten sites on the basis of technical criteria (Manitoba Hydro, 2010). Final site selection was based on the SSEA process and involved aboriginal interests in the site selection (Manitoba Hydro, 2010). For the northern ground electrode, two potential sites were considered acceptable for development. In rank order of technical preference, these sites are NES6 and NES7. The technically preferred site has been established as NES6, located within the Fox Lake Resource Management Area (See- *Bipole III Transmission Project: A Major Reliability Improvement Initiative, 2011* (Manitoba Hydro, 2010), for further details).

The Riel ground electrode site selection process identified 11 candidate sites. Final site selection was based on the SSEA process and with potentially affected landowners, residents, and stakeholders within the R.M. of Springfield. As a result of this process, Site SES1c, a variation of SES1, ranked highest in technical review for the four alternatives and was selected as the final southern electrode site (See- *Bipole III Transmission Project: A Major Reliability Improvement Initiative, 2011* (Manitoba Hydro, 2010), for further details).

1.2.4 Connection Line Between Electrode and Converter Station

The low voltage connecting line between the electrode and the converter station dc switchyard will be an overhead pole line strung with two conductors, similar in scale to a distribution line. The electrode line conductor will be similar to that of the pole conductor in the HVdc line. If the electrode site is situated along the access road, the electrode line is expected to be routed within the access road right-of-way (ROW) (Manitoba Hydro, 2011a).

1.2.5 Collector Lines

Based on prior design experience in northern Manitoba, guyed lattice steel structures have been identified as the preliminary design standard for straight (tangent) sections of the 230 kV northern collector kV transmission lines. As for the northern portion of the Project HVdc line, guyed structures provide flexibility for tower construction and maintenance in difficult foundation and terrain conditions. Self-supporting lattice steel structures will be used for angle or dead-end towers where rock foundation conditions are present. Guyed lattice steel structures will be used in angle or dead-end locations where soil conditions are poor (Manitoba Hydro, 2011a).

1.2.6 Site Access Roads

Site access roads will be used at various sites within the Project footprint (see Glossary), with the majority of existing and planned access routes occurring in the northern Project Study Area. The majority of site access roads required for the Project are pre-existing roads created through other projects and will be re-purposed for use in this project; however, some new site access roads will be required to be created for the Project. The roadway network will permit on-site tractor trailer access for site development and equipment installation and maintenance, as well as access for employees and smaller service vehicles. Access roads will be used by heavy construction equipment for the duration of the construction phase of the Project. Where access roads currently exist and can be rehabilitated for the Project use, rehabilitation and maintenance will be undertaken as soon as authorization for the Project is received. The extent of the required access road upgrading will experience ongoing assessment.

Precise layout and design requirements for the access and haul roads will be determined on the basis of the contractors' proposed construction methodology and subject to Manitoba Hydro approval.

1.2.7 Borrow Sites

Aggregates required for use in foundation construction will generally be transported from established and appropriately licensed sources off-site. Suitable materials for backfill of excavated organic soils may be hauled from newly developed borrow areas along the ROW. Typically, borrow pit locations will be located along the ROW to minimize environmental

disruption, haul distances, and cost. Where suitable sources are not available along or close to the ROW, nearby deposits may have to be identified and the surrounding brush cleared to gain access to the line. Selection, development, and reclamation of new borrow sites will be undertaken in accordance with provincial regulations and with the approval of the local Natural Resources Officer and local government authorities. Where borrow pits are required, exposed soils will be reclaimed by promoting re-growth of native vegetation and other mitigation measures in accordance with *The Mines and Minerals Act* (1991).

1.3 Caribou within the Project Study Area

Risk assessments[2] have been completed for local caribou populations in both the Manitoba and National strategies based on range delineations illustrated in the 2006 Manitoba strategy. It should be noted that these delineations were based on the best available data in 2006. Since that time there have been a number of major collaborative monitoring activities between Manitoba Hydro and Manitoba Conservation that have been undertaken to improve the knowledge on boreal woodland caribou distribution within the Project Study Area. The respective risk assessments conducted for the described 2006 local populations were ranked as to their level of conservation risk (Manitoba) and degree of sustainability (National). A number of factors were used including the presence/absence of threats that potentially influence boreal woodland caribou population viability and long term persistence (Manitoba Conservation, 2006). Based on these assessments, none of the local caribou populations found in the Project Study Area are considered to be at High Risk or unsustainable.

In Manitoba, there are several boreal woodland caribou ranges that are considered to be at risk to decline and are considered to be borderline sustainable (Manitoba Conservation, 2006; Environment Canada, 2009). Based on the Manitoba Strategy, there is only one range (Neosap) that is identified to be at high risk within the Project Study Area (Table 17: Manitoba Conservation Risk Assessment Ranking and intersection with the Project infrastructure for ranked boreal woodland caribou ranges contained in the Project Study Area). A catastrophic fire

[2] Manitoba – Conservation Risk Assessment; Canada – Integrated Sustainability Assessment

in 2010 resulted in the majority of the habitat in this range being destroyed. The Project's Final Preferred Route (FPR) does not intersect this range and studies are being developed to assess the long-term effects of the fire on this range. The following is a summary of the boreal woodland caribou ranges that are known to exist in the Project Study Area as well as the current Manitoba Risk Assessment Ranking.

Table 17: Manitoba Conservation Risk Assessment Ranking and intersection with the Project infrastructure for ranked boreal woodland caribou ranges contained in the Project Study Area

Range	Risk Rank	Intersected by FPR
Naosap	High	No
Reed Lake	Medium	Yes
Wabowden	Medium	Yes
Wapisu	Medium	No
The Bog	Low	Yes

Based on new data acquired through the Project caribou studies, updated information was used in the SSEA and EIS to re-define evaluation units for the purpose of assessing the potential negative effects on boreal woodland caribou in the Project Study Area and to assess the impacts of the FPR on boreal woodland caribou. Manitoba Hydro also identified potential gaps in data and information in order to effectively identify and mitigate impacts to boreal woodland caribou by avoiding critical habitat and local populations to the extent possible as part of the SSEA process within the Project Study Area.

1.3.1 Status of Caribou Data within the Project Study Area

In understanding the dated nature of information and the need for current data to conduct the Project SSEA, Manitoba Hydro collaborated with Manitoba Conservation on a number of strategic monitoring and research initiatives to acquire current data to be used in the selection of a FPR that would minimize overall impacts on caribou ranges in the Project Study Area by avoiding core use areas and critical habitat. Most importantly, these collaborative monitoring initiatives were guided by an objective evaluation of the potential threats to boreal woodland caribou as a result of transmission line development and operation. The monitoring conducted by

Manitoba Hydro was anchored by scientific evidence and were developed and peer reviewed by outside experts prior to execution of project specific monitoring and research. This involved an independent assessment of threats to boreal woodland caribou using Environment Canada's guidelines for species at risk recovery planning.

Manitoba Hydro's boreal woodland caribou threat assessment utilized workshops with external caribou experts to provide an objective assessment of the various potential effects associated with the construction and operation of transmission lines on boreal woodland caribou (Scurrah and Schindler, 2011). This threat assessment provided the basis for a draft corporate strategy for boreal woodland caribou monitoring, research and mitigation. Specific issues addressed in the threat assessment and associated draft corporate strategy include; loss of forage (both direct and functional loss due to sensory disturbance), range fragmentation, increased predation, northward encroachment of white-tailed deer, parasites, changes in prey/predator dynamics and increased mortality from hunting. This process provided a critical path for Manitoba Hydro in the implementation of targeted monitoring and research activities aimed at mitigating the potential impacts of the Project on caribou through effective routing to avoid caribou range and the identification of site specific mitigation. Some of these studies are also linked to effects monitoring being conducted for the Wuskwatim Transmission Line project which currently intersects core caribou use areas within the Project Study Area. Initial indications of this effects monitoring to date have illustrated minimal to no effect on boreal woodland caribou range use and occupation. Results of this monitoring have been included in this report and are described in later sections as they relate to assessing the potential effects of the Project.

1.3.2 Development of the Final Preferred Route for the Project

Since 2006, the results of the above described monitoring have provided significant new information allowing for a more accurate characterization of local populations in the Project Study Area. It is anticipated that many of the current range designations and boundaries may change with the development of the revised Manitoba Strategy anticipated in 2012. The results of recent Project specific telemetry studies have provided a significant source of new information previously not available to Manitoba and Canada at the time of their respective recovery strategy development. These new data combined with several decades of historical information and ATK gathered for the Project provided a basis for evaluating alternative routes, selecting a FPR, and assessing residual effects of the Project. Information acquired from other ancillary studies such as aerial distribution surveys conducted for ongoing DNA research and other multispecies surveys in the Project Study Area also contributed to the delineation of the Project boreal woodland caribou evaluation ranges.

From the Project perspective, the main objectives of the targeted collaborative monitoring focused on attaining data to more accurately describe local population ranges, to avoid to the extent possible, core use areas and to assess animal response to existing anthropogenic linear development. These data were strategically used in the SSEA process to select a route that minimized intersection with local populations, their calving and calf-rearing areas, core winter use areas, and/or other potential critical habitat. These data combined with historical knowledge and ATK gathered specifically for this project were utilized in evaluating alternate routes and selecting a Preliminary Preferred Route (PPR). Based on this new information, 11 potential local populations were identified within or intersecting the Project Study Area (Kississing, Naosap, Reed Lake, Wapisu, William Lake, Wabowden, the Bog, Wimapedi, Wheadon River, Harding Lake, and Swan Pelican). The associated provincial and federal status of these are listed in Chapter 9 of the *Bipole III- Mammal Report* (Joro, 2011). Also listed in this table are potential ranges identified by new data that were used as constraining elements in the evaluation of alternate routes and the selection of the PPR.

The PPR selection was considered to be the optimal route from a caribou perspective due to the overall minimization of potential impact on boreal woodland caribou within the Project Study Area. In the Wabowden area, a minor deviation in the PPR paralleling existing linear features along PTH # 6 was necessary due to local land use and technical constraints resulting in a detour into a small portion of known caribou calving and wintering areas.

After the selection of the PPR, competing resource interests in the Wabowden area resulted in further modification to the FPR. These entailed concerns relating to the Thompson Nickel Belt and the potential loss of future exploration capability and subsequent mine development by Crow Flight Minerals as a result of the electromagnetic shadow created by the HvDC. The resulting FPR in Wabowden area was not a preferred alternative from the caribou SSEA perspective.

Residual effects were considered to be not significant after the development of significant mitigation measures that are recommended and further described in Section 6.0.

1.3.3 Potential Effects Associated with the Final Preferred Route

Overall and relative to various range status, there are no high risk or un-sustainable populations being traversed and the majority of core winter areas and important calving and calf-rearing habitats for boreal woodland caribou ranges were avoided. Of the 11 potential ranges, only three are traversed and include Wabowden, Reed Lake, and The Bog ranges. The FPR as selected reduces overall fragmentation across the larger landscape; following, where possible, the existing linear development and disturbed areas, thus mitigating and reducing the majority of residual effects anticipated by the Project. The exceptional concern in one area associated with the Wabowden Range where previously intact core winter range is intersected by the FPR.

1.3.3.1 Coastal and Barren-Ground Caribou

The Manitoba barren-ground and coastal caribou populations are located above the northern extent of the boreal woodland caribou range and are not protected or listed under MESA or SARA. There are two recognized coastal populations considered to be forest tundra ecotypes and include the Cape Churchill and Pen Island herds. During winter the Cape Churchill animals will migrate south into the Project Study Area, particularity into the Conawapa and Keeyask areas (D.Hedman, pers. com.). In the mid-1980s, this population was estimated at 1,700 animals in the area between Cape Churchill and Nelson River (Elliot, 1986). Manitoba Conservation now estimates the Cape Churchill population at approximately 3,500 – 5,000 animals (D.Hedman, pers. com.). This herd spends more time in tundra habitats along the Hudson Bay coast near Churchill and does not typically cross the Nelson River to the south (D.Hedman, pers. com.).

The Pen Island caribou are found mainly south of the Nelson River and conduct post calving migration northward from calving areas along the Hudson Bay coast in Ontario and Manitoba. They will move inland and amalgamate during the fall and occasionally move into the Project Study Area. The results of limited telemetry data illustrate that during early winter, they will often stage in areas south of the Nelson River and near Gillam and west near Stephens Lake. There is also some periodic use of areas in the Stephens Lake and Gillam area during the spring

calving period (V.Trim, pers. com.). This population was estimated to be approximately 10,000 animals in 1997. Incidental observations of Pen Island caribou have seen a decline since 2000 (D. Hedman, pers. com.).

Annual variation of range occupancy has been documented with significant movements back and forth across the Manitoba/Ontario boundary since this population has been studied in the late 1980s. Results of ongoing monitoring suggest calving area selection by animals along the Hudson Bay coast and summer post-calving range use is variable and has changed significantly (Thompson and Abraham, 1990; Magoun et al., 2004; V. Trim, pers. com). Conversely, at an ecoregion level, wintering areas have remained relatively constant, though the location of core winter areas in Ontario is regionally variable Magoun et al., 2004).

Barren-ground caribou are also an occasional winter resident known to migrate temporarily into the northern portion of the Project Study Area. The Beverly-Qamanirjuaq caribou are migratory barren-ground caribou that occupy their traditional calving grounds in Nunavut and exhibit a significant, multi-jurisdictional migration south during winter into the northern taiga. This population is considered to be in significant decline (Beverley Qamanirjuaq Caribou Management Board, 2010). Surveys conducted during the 1980s estimated the population between 125,000 and 190,000 animals. In 2009, the NWT government found less than 100 caribou on the traditional calving grounds, compared to 5,737 in 1994 (Beverley Qamanirjuaq Caribou Management Board, 2010). Occasionally, but not consistently, the Beverley-Qamanirjuaq herd will migrate as far south as Thompson (D. Hedman, pers.com). Therefore, there is potential that this population could be present during the construction or operation of the Project transmission line and its associated infrastructure. The known ranges of both coastal and barren-ground populations are illustrated on Map 2**.**

In the north, a small portion of Cape Churchill, Pen Island costal population ranges are intersected by the FPR as well the occasional southern reaches of the Beverly and Qamanirjuaq barren-ground population.

Traditional Ecological Knowledge (TEK) suggests that Pen Island caribou frequent the study area and that local woodland caribou are also present. The results of Bipole III specific studies indicate the sporadic presence of both Cape Churchill and Pen Island animals in the northern

portion of the Project Study Area. Data from satellite collared caribou has illustrated variation in annual range selection with the identification of local caribou exhibiting both sedentary (boreal woodland caribou) and migratory (barren-ground and coastal) behaviour. Data also illustrates annual variation in these behaviours with some animals switching from sedentary to migratory. Aerial survey and satellite telemetry data also demonstrated significant annual variation in winter presence throughout the northern portion of the Project Study Area. Aerial surveys conducted in 2009 yielded little caribou sign in the area compared to 2010 when a significant migration of Cape Churchill caribou inundated the Gilliam area. During this period, mortality to legal hunting was estimated at approximately 100 caribou (Pers. Com, Manitoba Conservation, 2011).

1.3.3.2 Summary of Residual Effects on Barren-Ground and Coastal Caribou

Due to the spatial and temporal variability in occurrence of these populations in the narrow northerly portion of the Project Study Area, there are limited mitigation needs. Sensory disturbance due to clearing and ongoing access of the ROW by construction crews during clearing and construction of the HVdc and converter station may result in short-term avoidance of a relatively small area by these coastal/migratory caribou, however, habitat is not limiting and there are no effects relative to habitat loss. The unpredictable nature of periodic migrations into the Project Study Area will result in little disruption to the overall migration paths of migratory and coastal caribou.

With the establishment of the HVdc ROW, there is potential for increased movement of grey wolves following construction, however based on the short period of time that these populations occur in the area, there would be little effect. With increased access as a result of the HVdc, it is possible that there may be increased opportunity for hunting by humans during the periodic migrations of caribou which can include hundreds of animals into the area potentially resulting in increased harvest during these periodic migration events.

In order to address the various potential project effects the following mitigation measures have been developed:

- Recreational use along the ROW will be limited to reduce sensory disturbances and minimize functional habitat loss during caribou migration events which are infrequent and unpredictable;
- Existing satellite collared animals from the Cape Churchill and Pen Island herds will be monitored during construction. Aerial surveys will be conducted to verify numbers and concentrations of animals that may or may not migrate into construction areas. Manitoba Hydro will maintain access control onto the ROW and cooperate with Manitoba Conservation in measures that will protect excessive harvest in the area including signage and no hunting areas during construction to protect both workers and migrating caribou. Manitoba Hydro will work cooperatively on with Manitoba Conservation include access control through joint access management plan, hunting closures (Health Safety and Workplace Act) and hunter education or information initiatives with Manitoba Conservation to reduce the effects of overharvest and wastage;
- Hunting by project personnel will be prohibited and firearms restricted in work camps and associated areas to minimize caribou mortality.

Based on the mitigation measures outlined here, the residual effects expected include potential excessive harvest of animals on and along the new ROW as a result of improved local access, when and if significant migration events occur These residual effects for coastal and barren-ground caribou are characterized as negligible in direction, moderate in ecological importance, moderate in societal importance, small in magnitude, local study area in geographic extent, short term in duration, sporadic/intermittent in frequency, and reversible, and therefore considered not significant. The definitions used to describe residual effects are found in Appendix B.

1.3.3.3 Boreal Woodland Caribou

The main issues identified through literature and outside expert review and threat assessments relate to human landscape disturbance that potentially promote and sustain various mechanisms of population decline. It is thought that human development and use of landscapes from activities such as large scale forestry, linear development (including all weather and seasonal access), hydroelectric transmission, and mining activities can collectively contribute to significant changes in the demographic mechanisms that lead to boreal woodland caribou population decline (Thomas, 1995, James and Stuart-Smith, 2000, Dyer et al., 2001, Courbin et al., 2009). These mechanistic changes are dependent upon the temporal and spatial nature of the development and the associated disturbance regime that can include short and long term habitat alteration, fragmentation, ecological changes in food web, changes in predator/prey relationships, introduction of pathogens and human disturbance (Environment Canada, 2008).

Boreal woodland caribou range in the Project Study Area extends from the Lynn Lake area on the west side of the province south to approximately Weekwaskan Lake on the east side of Manitoba. The southern boundary of boreal woodland caribou range in the Project Study Area is found south of the Red Deer Lake area (Map 3).

1.4 Summary of Threats to Boreal Woodland Caribou

Boreal woodland caribou are typically found in large, un-fragmented tracts of mature coniferous dominated boreal forest with inherently low ecological diversity and low predator densities (Bradshaw et al., 1995; Stuart-Smith et al., 1997; Rettie and Messier, 2000). In these areas, succulent biomass associated with young regenerating forests is limited, resulting in low prey densities across the larger landscape (Cumming and Beange, 1987 and 1993; Siep, 1992; Boutin et al., 2004). Boreal caribou are not found in large numbers, nor are they evenly distributed across boreal landscapes. They occur at very low densities across boreal landscapes, congregate during winter in traditional wintering areas, and disperse during the spring, exhibiting solitary behaviour during the calving and calf-rearing season which is thought to be a predator avoidance strategy (Environment Canada, 2011a).

Predators such as grey wolf (*Canis lupus*) are mainly associated with more evenly distributed and higher density larger prey species such as moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*) (Messier, 1985; Bergerud and Elliott, 1998; Zager and Beecham, 2006; Bergerud, 2007). Moose and deer are typically associated with disturbed forests through anthropogenic activities such as forest harvest and natural disturbance events including fire and insect infestation (Peek et al., 1976; Rempel, 1997; Fisher and Wilkinson, 2005). Woodland caribou are typically not associated with these early seral forests; their strategy to avoid predators

results in their spacing away from the primary prey of wolves and black bear (*Ursus americanus*) (Bergerud et al., 1990).

The sustainability of a local population can be encapsulated by Lambda (λ, the population growth rate); which describes a ratio of recruitment (calf fecundity and survival) against mortality (number of surviving adult females). Predation by wolves is typically the main cause of population decline (Dyer, 2001 and 2002; Wittmer, 2005 and 2007). Black bears are also known to be a factor in limiting some ungulate populations through predation of calves (Boutin, 1992; Ballard, 1994).

Although an important factor in boreal woodland caribou distribution and abundance, habitat supply, quality and availability, are not typically considered as limiting factors in most boreal caribou populations in the boreal forest when predators are present (Seip, 1992; Rettie and Messier, 2000; Johnson et al., 2001). The dynamics of habitat alteration from human development including forestry and hydro transmission development in boreal caribou range can result in increased forage (due to the lush and succulent growth that follows tree removal) for primary prey species (such as deer, moose, hare and rodents), thus increasing the biomass availability for high-end predators such as wolves and bears (Peek et al., 1976; Monthey, 1984; Clarke et al., 2006; Zwolak, 2009). Additionally, it is hypothesized that linear development and the types of anthropogenic activities associated with linear features may lead to a cumulative effect response that could influence Lambda (λ) and possibly lead to decline in local or regional populations (Dyer et al., 2001; McLoughlin et al., 2003).

Linear development as a cumulative pathway of decline is not clearly understood in the scientific literature and Manitoba Hydro is being proactive in their research and monitoring initiatives to gain insight into these potential effects. These effects include the possibility of changing the natural distribution of primary prey into critical boreal woodland caribou habitat, followed by increased interaction between high level carnivores (in search of primary prey such as moose, etc.) with boreal caribou (James et al., 2004). The potential for increased incidental predation on boreal caribou can have significant implications on the sustainability of boreal caribou populations through slight decreases in Lambda (λ), with the primary cause being predation (Schaefer, 2003; Vors et al., 2007). The response of boreal caribou to separate or "space away" from predators and their primary prey on the landscape is thought to be influenced by habitat alteration and linear development (James, 1999; Dyer et al., 2001). It is also hypothesized that linear development and the anthropogenic use of linear features (such as creating snow-packed trails) increases the mobility of predators into previously remote caribou habitat (James, 1999). Again, Manitoba Hydro and their collaborative research initiatives have focused on assessing these impacts.

The main issues relate to anthropogenic landscape disturbance that promote and sustain various limiting factors that contribute to population decline. It is thought that human development and use of landscapes from activities such as large scale forestry, linear development (including all-weather and seasonal access roads), hydro electric transmission, and mining activities, collectively contribute to boreal woodland caribou population decline (Bergerud, 1974; Dyer et al., 2001; McLoughlin et al., 2003). Depending on the nature of the development and the associated disturbances, the mechanisms include short and long term habitat alteration, fragmentation, ecological changes in food web, changes in predator/prey relationships, introduction of pathogens and human disturbance (Bergerud and Mercer, 1989; Cumming, 1992; McLoughlin et al., 2003; James et al., 2004; Wittmer et al., 2007).

1.5 A Strategic Approach

Within the Project Study Area, there were a number of collaborative monitoring and research initiatives that were undertaken prior to the Project SSEA. These data have been made available to Manitoba Hydro for the SSEA and are of high utility in the understanding the historical context of boreal woodland caribou distribution relative to current knowledge.

As part of a larger province-wide strategic effort, Manitoba Hydro has developed a draft internal corporate strategy that directs research and monitoring activities to address issues on the potential effects of transmission development on boreal woodland caribou. The main elements of the strategy were based on an identification and evaluation of potential threats to boreal woodland caribou conservation. The approach undertaken was based on Environment Canada's threat assessment process used in recovery planning for species at risk. The Manitoba Hydro boreal woodland caribou threat assessment was the result of an external expert workshop, which provided an objective assessment of the various potential effects associated with the construction and operation of transmission lines on boreal woodland caribou (Scurrah and Schindler, 2011 In Press). The draft strategy developed from this threat assessment provided a critical path for targeted monitoring and research activities aimed at mitigating the potential impacts of transmission line construction and operation.

The main elements of this strategy focused on the planning and routing of transmission lines that avoid calving and calf-rearing areas, core winter use areas, and/or other potential critical habitat. The routing of major transmission lines such as the Project includes emphasis on pre-Project monitoring of specific caribou ranges to identify “critical habitat”. This provides opportunities to mitigate impacts through selecting a preferred route that avoids critical habitat and sensitive areas. Specific issues addressed in this strategy include loss of forage (both direct and functional loss due to sensory disturbance), range fragmentation, increased predation, northward encroachment of white-tailed deer, and increased mortality (hunting).

The results of the SSEA process resulted in the selection of the Preliminary Preferred Route (PPR) from a number of alternative routes. The identification of alternative routes was established through a multi-disciplinary constraints and opportunities approach, of which boreal woodland caribou were included as a major constraining factor. Alternative routes were based on both biophysical and socioeconomic constraints and opportunities. Routes were selected on the basis of terrain and construction constraints, avoidance of areas with high social and economic importance, and avoidance of known areas of high value relative to various biophysical VECs. Both historical and newly acquired data derived from the Project’s specific caribou monitoring initiatives were utilized in the integrated evaluation and selection of the FPR. This process resulted in a PPR that avoided the majority of core winter areas and important calving and calf-rearing habitats for boreal woodland caribou ranges found across the Project Study Area. The PPR was the preferred alternative for reducing overall fragmentation across the larger landscape; following, where possible, the existing linear development and disturbed areas, thus mitigating and reducing much of the potential impact. The FPR was adjusted from the PPR in the Wabowden area due to issues associated with the Thompson Nickel Belt and mining concerns. In this case, the FPR was located through core winter and summer range. Mitigating the residual effects of FPR is dealt with in Section 6.0.

In the northern portion of the Project Study Area, the frequency and distribution of coastal and barren-ground caribou within the Project Study Area is a function of variable migration patterns that are not spatially or temporally consistent on an annual basis. Furthermore, there is a geographic narrowing of the Project Study Area near the proposed Conawapa converter station resulting in less distance between alternative routes. The massive home ranges of these populations relative to the close proximity of alternative routes did not influence the selection of the FPR.

An environmental assessment (EA) was then conducted on the FPR and was refined based on public consultation processes described in the overall Project Environmental Impact Assessment (EIS).

2.0 STUDY AREA

The Project Study Area (see Glossary) for SSEA included all alternate route options that were evaluated and then ranked in sections by all disciplines of the EA process. The Local Study Area consisted of a three mile planning corridor with the final route consisting of a 66 m ROW (see Glossary). The resulting preferred route selected is approximately 1,380 km long and transects five distinct ecozones: Hudson Plains Ecozone, Taiga Shield Ecozone, Boreal Shield Ecozone, Boreal Plains, and Prairie Ecozone. In composition, these ecozones represent 3%, 3%, 37%, 35%, and 23% of the Project Study Area respectively (Map 4). Although the Project Study Area encompasses both the Boreal Plains and Prairie Ecozones, no caribou range overlaps either ecozone.

2.1 Study Area Ecozones

2.1.1 Hudson Plains

The Hudson Plains Ecozone in Manitoba is found in the northeast corner of the province along the southern edge of Hudson Bay. Peatlands and marshes dominate this poorly drained ecozone. Trees that do exist in this transitional area between the Arctic tundra and boreal forest are

typically sparse, scattered, and stunted. Such tree species include black spruce (*Picea mariana*), white spruce (*Picea glauca*), and tamarack (*Larix laricina*) along drier ridges, and balsam poplar (*Populus balsamifera*), white spruce, and paper birch (*Betula papyrifera*) in sheltered areas along watercourses (Smith et al., 1998; Natural Resources Canada, 2007). Common mammals of the Hudson Plains Ecozone include American marten (*Martes americana*), arctic fox (*Alopex lagopus*), black bear, coastal caribou, barren-ground caribou, grey wolf, lynx (*Lynx canadensis*), moose, and muskrat (*Ondatra zibethica*). Polar bears (*Ursus maritimus*) are common along the coast of the Hudson Bay (Smith et al., 1998; Natural Resources Canada, 2007).

2.1.2 Taiga Shield

The northwestern area of Manitoba is characterized by the features of the Taiga Shield Ecozone: rolling upland hills, lowland bog and fen peatlands, rocky outcrops, and glacial till forming eskers and kettle lakes. Stands of jack pine (*Pinus banksiana*), black spruce, and tamarack cover the southern portion of this ecozone and transition to the treeless Southern Arctic Ecozone in the north. White spruce, balsam poplar, and paper birch are found along protected areas lining waterways (Smith et al., 1998). Common mammals found in the Taiga Shield Ecozone include arctic fox, barren-ground caribou, black bear, brown lemming (*Lemmus sibiricus*), grey wolf, moose, polar bear, and weasel (*Mustela nivalis*) (Smith et al., 1998).

2.1.3 Boreal Shield

The Boreal Shield Ecozone stretches across most of north-central and eastern Manitoba and is dominated by the metamorphic gneiss bedrock of the Canadian Shield, broad expanses of coniferous dominated boreal forest, and numerous lakes. Soils in this ecozone are typically thin, cool, acidic, and have low nutrient availability. Wet, oxygen poor, organic soils underlying wetland areas (Smith et al., 1998). Dominant vegetation cover includes closed stands of conifers, mostly white and black spruce, jack pine, and tamarack. Broadleaf species including white (paper) birch, trembling aspen (*Populus tremuloides)*, and balsam poplar are more abundant towards the south (Zoladeski et al., 1995). Common mammals found in this ecozone include American marten, beaver (*Castor canadensis*), black bear, fisher (*Martes pennanti*), grey wolf, lynx, mink (*Mustela vison*), moose, muskrat, snowshoe hare (*Lepus americanus*), striped skunk

(*Mephitis mephitis*), white-tailed deer, and woodland caribou (Smith et al., 1998; Environment Canada, 2000).

2.2 Project Structures in the Study Area

The proposed Project northern converter station (Keewatinoow) and associated infrastructure including ground electrodes and lines, site access roads, and borrow sites for the Project is projected to lie within the Hudson Plain Ecozone and the southern converter station (Riel) in the Prairies Ecozone. The proposed HVdc transmission line runs between these two converter stations as described above, passing through the Hudson Plain, Taiga Shield, Boreal Shield, Boreal Plains, and the Prairies Ecozones.

3.0 METHODOLOGIES

Methodologies for field studies and data analysis for caribou were designed to evaluate alternate routes and compare the degree and magnitude of potential effects between alternative routes as part of the SSEA process. The results of field studies and data analysis also provided a basis for assessing the environmental effects of the FPR on caribou for the final EIS. In the early stages of the SSEA, it was recognized that the existing available data were not adequate to effectively develop and evaluate alternative routes or select a preferred alternative. In consideration of the potential regulatory and ecological constraining factors, the lack of current baseline data may have excluded several routing options due to the precautionary principle of management and conservation of boreal woodland caribou in Manitoba. In order to better understand range distribution and critical habitat requirements, Manitoba Hydro and Manitoba Conservation collaborated in the development of a significant telemetry program in a number of strategic ranges across the Project Study Area. These telemetry studies were based in part on the needs of the Project as well as strategic long-term research needs identified by Manitoba Hydro in understanding the impacts of transmission line development in boreal woodland caribou range.

The associated collecting and synthesis of telemetry data provided facilitated and improved understanding of the location of core winter and summer range and identifying calving patches and calving habitat. Data was also used for the development of habitat-based models to assist in

the overall evaluation of alternative routes and the FPR. A number of predictive habitat models were derived from the data and provided further utility to the telemetry data.

Aerial distribution surveys, summer recruitment surveys, winter range counts, and monitoring primary prey species such as moose and predators of caribou including grey wolf and black bear, augmented the quantitative assessment of risk to boreal woodland caribou populations from the cumulative effects associated with linear development. Ancillary field studies included the collaring of grey wolves to assess potential range overlap and potential impacts of increased linear development on caribou predation. Trail camera studies attempted to gather information on black bear abundance within calving areas.

The following sections provide a detailed description of the methods used in assessing impacts and residual effects for the caribou portion of the Project EIS.

3.1 Site Selection And Environmental Assessment Process

Manitoba Hydro Licensing and Environmental Assessment Branch (LEA) undertake Site Selection and Environmental Assessment (SSEA) processes for all major transmission projects. The SSEA is a broadly-based assessment of all biophysical and socio-economic values that exist in the Project Study Area. It is the first component in the development of the EIS that has been submitted to Manitoba Environment for licensing of the Project. The SSEA provides rationale for evaluating alternatives and the selection of a preferred and final route and associated infrastructure. The SSEA considers input from potentially impacted First Nations, communities, municipalities, land and resource users, and the public at large.

Through Project Study Area characterization, the locations of sensitive biophysical, socio-economic, and cultural features, as well as technical (engineering) and cost considerations for transmission line routing were identified. The SSEA process utilized data from existing published sources and was supplemented by field studies and feedback from various consultation processes. Through the SSEA process, three alternative route corridors were identified. The alternative routes selected, avoided significant sensitivities where possible and sought to minimize potential effects where avoidance was not possible or practical. A route selection matrix was developed to facilitate the evaluation of alternative routes on a segment-by-segment basis. The alternate routes were separated into 13 segments and evaluated and compared, by segment, considering geographic features, potential opportunities, technical considerations, and professional judgment. During the course of the route selection process, several adjustments were made to the original alternative route segments based on additional input provided by the EA study team and various stakeholders (e.g., mining and agricultural interests).

A total of 28 factors were identified to evaluate the alternative routes and included a full range of biophysical, socio-economic, land use, technical, and stakeholder considerations of which caribou were one. Evaluation criteria were identified for each factor that would facilitate three-tier (high, medium, and low) ranking. Biophysical, socio-economic, and land use rankings were based on the degree to which the factor is affected. Technical rankings were based on the degree to which the factor is a constraint, while stakeholder rankings were based on the nature and degree of response. A four-tier ranking (very high, high, medium, and low) was used for several biophysical factors including caribou, where potentially significant implications on protected species and habitats were identified.

Stakeholder factors were applied to the segment rankings after the ratings were determined. Stakeholder response criteria were based on both a numeric count and a general expert assessment of the negative or positive commentary provided for certain segments. General commentary provided (e.g. diagonal routes are not preferred) was considered in the evaluation of relevant segments. The objective of the stakeholder evaluation was to select route segments with the lowest level of concerns or most favoured as expressed by Aboriginal groups, municipal governments, stakeholder groups, and the general public. A three-tiered ranking system (fair, good, or poor) was based on numeric counts of comments provided plus expert assessment of feedback from all sources.

Aboriginal Traditional Knowledge (ATK) was considered separately under the various applicable biophysical, socio-economic, land use, and stakeholder factors. Where ATK confirmed a scientific finding, no change in ranking was made, but a note to that effect was included for that particular segment. Where ATK provided additional information about any of the 28 factors, it resulted in a higher ranking than what was determined previously.

The EIS is linked to the SSEA and is undertaken to assess the potential adverse effects of the Project, identify the residual impacts, and to identify appropriate mitigation measures that manage the residual effects of the proposed Project on the environment. The EIS also includes a Cumulative Effects Assessment (CEA) and is one step in the process of determining the significance of an environmental effect on caribou and their habitats for the Project. The CEA (2004) states that every screening or comprehensive study of a Project and every mediation or assessment by a review panel, shall include consideration of the following:

(A) *"the environmental effects for the project, including…any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;"* and

(B) *"the significance of effects referred to in paragraph (A)."*

Cumulative effects assessment is defined in the Cumulative Effects Practitioner's Guide (Hegmann et al*.*, 1999) as:

"…changes to the environment that are caused by an action in combination with other past, present and future human action."

where...

"Actions" are defined as "projects and activities."

Cumulative effects assessment considers the spatial and temporal boundaries of the Projects related issues and their overlap with other projects and activities that have, are presently, or will occur.

3.2 Desktop Studies

3.2.1 Development of Habitat Cover Categories

In assessing potential routing options and residual effects of the FPR, it was necessary to adopt a habitat-based assessment tool that would provide relatively up-to-date imagery and land cover information over the entire Project Study Area. Due to the large geographic extent of the Project Study Area, several spatial habitat datasets were assessed to determine their utility in evaluating and modeling specific components of caribou habitat. The Manitoba FRI has been used in the development of Habitat Suitability Index Models (HSI) for boreal woodland caribou in eastern Manitoba (Schindler and Lidgett, 2002). However, as the FRI was produced over several eras of data collection and processing, many of the FRI datasets were both outdated and did not have attribute data that matched between datasets. In some instances, critical attributes such as landscape age was not available and forest fire history was not consistent through all datasets.

For the purpose of the Project, a spatial ecological Geographic Information System (GIS) layer was specifically developed for Manitoba Hydro (Landcover Classification of Canada, Enhanced for Bipole - LCCEB) as part of the Project SSEA. This layer is based upon the Landcover Classification for Canada (LCC) developed by the Canadian Forest Service (Wulder and Nelson, 2003). The LCC layer is a national vector database mapping layer that has been harmonized across the major Federal Departments involved in land management or land change detection (Agriculture and Agri-Foods Canada - AAFC, Canadian Forest Service - CFS, and Canadian Centre for Remote Sensing (CCRS). Existing forest classifications and inventories are based primarily on aerial photography, whereas development of the LCC was done using remotely sensed imagery (Landsat data) as part of the Earth Observation for Sustainable Development of Forests (EOSD) program. The EOSD program utilized a hybrid supervised-unsupervised classification methodology (Wulder and Nelson, 2003). This approach identified unique signatures using an automated algorithm (unsupervised spectral classification) that were subsequently linked to National Forest Inventory (NFI) equivalent classes (supervised classification).

The enhanced version includes a further harmonization/integration of the National Stratification Working Group ecological framework database (Smith et al., 1998) to the ecodistrict scale and the addition of wetland features, Manitoba forest harvest layers, and forest fire layers. This provides attribute data that defines the landform and soil conditions as well as fire and harvest records for the Project Study Area. The following list describes data layers spatially joined to the LCC database in ArcMap (ESRI©, 2011).

1. A comprehensive fire layer including fire data obtained from Manitoba Land Initiative (MLI) and Manitoba Conservation. Data were collected between 1926 and 2010 and as such have variable spatial resolution and reporting scale.
2. A 1:1 million-scale Manitoba Wetlands layer identifying wetland information for the Province.

3. The Canadian Ecological Land Classification System, a 1:1 Million-scale national layer based on the National Stratification Working Group's Ecological Land Classification for Canada, which divides Canada's natural landscapes into 15 terrestrial ecozones which are sub-divided into 53 ecoprovinces, 194 ecoregions, and 1,021 ecodistricts. For the Manitoba classification, ecodistricts are differentiated primarily on the basis of enduring features criteria such as landform composition, land-surface shape, textural group, soil development, and distribution of permafrost. Satellite data and Advanced Very High Resolution Radiometer (AVHRR) was also used to assist in identifying vegetation composition of the polygons. By utilizing enduring features as primary elements of the classification, the ecological stratification hierarchy is less subject to change over time thus the classifications are more persistent. Unlike administrative divisions (e.g. Forest Management Units (FMU)), the polygons of the national framework have associated ecological functions, share similar soils and hydrology, and growing conditions for forest productivity. These are the fundamental reporting units for the LCCEB.
4. A combined layer that provides linework for forest harvest areas in the Project Study Area. This layer combines harvest data provided by Lousiana-Pacific Inc., Tolko Industries Ltd., and Manitoba Conservation. Scale and reporting over time varies with the earliest records dating to the 1960's for softwood harvest. Scale is assumed to be equivalent to digitized line work from aerial photography (1:15,000)
5. A FMU layer providing boundaries for the LCCEB, obtained from the Manitoba FRI database.

The primary attribute of the LCCEB is the land cover category associated with a particular polygon. These landcover types identify the primary ecological cover condition of an area. The land cover classes developed were based on those used in the National Forest Inventory (NFI) and were endorsed by the Canadian Forest Inventory Committee (CFIC).

All of the habitat analysis and modeling in the Project Study Area for mammals was done using LCCEB categories. The LCCEB cover classes were merged in ArcMap (ESRI©, 2011) to produce a simplified land cover classification, which more appropriately reflected the landscape-scale habitat selection exhibited by woodland caribou (Chowns, 2003; Manitoba Conservation, 2006). The simplified cover types included water (1), barren/exposed ground (2), shrublands (3), wetlands (4), coniferous forest (5), broadleaf forest (6), and mixedwood forest (7) (Table 2). Models were developed for caribou calving and caribou wintering areas by characterizing land cover category area and habitat patch metrics for data associated with known calving locations based on real time satellite telemetry collars on female caribou as described below.

Table 18: LCCEB codes utilized to produce a simplified land cover classification for use in caribou habitat modeling

Cover Type Category Name	Cover Type Category Number	LCCEB Codes Represented
Water	1	20
Barren/Exposed Ground	2	30, 31, 32, 33, 34, 35, 36, 37, 40
Shrublands	3	50, 51, 52, 53
Wetlands	4	80, 81, 82, 83
Coniferous Forest	5	210, 211, 212, 213
Broadleaf Forest	6	220, 221, 222, 223
Mixedwood Forest	7	230, 231, 232, 233

3.3 Caribou Telemetry Studies

Telemetry data provided a significant source of information on historical and current distribution of caribou in the Project Study Area. Telemetry studies have been undertaken within the Project Study Area for several decades and have involved various technologies and methods. As part of the long-standing collaborative research and monitoring partnership between Manitoba Hydro and Manitoba Conservation, Manitoba Hydro participated as a member of the Northwest and Northeast caribou committees. Much of the past monitoring has been supported and funded by Manitoba Hydro for the purpose of gaining knowledge about caribou distribution in areas where information was lacking, in part to provide valuable data in advance of future transmission line development across boreal woodland caribou range. Other telemetry studies have focused on examining the effects of the Wuskwatim Transmission Line, which is currently being constructed. These data have had a great deal of utility in the SSEA process and have added to existing knowledge being used in the planning and construction of transmission lines in this region of Manitoba.

Use of telemetry (collars) allows for two advantages to wildlife research which cannot be provided through other research techniques: 1) it can identify individual animals; and 2) it can locate each animal when desired (Moen et al., 1997). These telemetry studies have included a combination of standard very high frequency (VHF) collars to the current state of the art automated animal tracking systems using real time global positioning system (GPS) technology. These data have enabled the characterization of the historical distribution for some caribou ranges in the Project Study Area including the Naosap, Wabowden, and Reed Lake ranges. The historical VHF telemetry data were compiled to provide a historical distribution reference compared to more recent satellite collaring and aerial survey data. Data sources included observation records from: the Reed Lake area from 1969 to 1978, amounting to 100 locations; radio telemetry in the Naosap range from 1996 to 2006, with 1,918 locations, including telemetry from GPS collared animals starting in 2002; and radio telemetry conducted in the Wabowden area from 1995-2000, comprising 602 locations (Map Series 100).

More current data include collaring studies undertaken in the Wimapedi and Wabowden ranges. These included earlier deployments of 24 Ultra High Frequency (UHF) downloadable collars between 2007 and 2011. To augment historical knowledge and fill in critical information gaps, a significant collaring program was conducted by Manitoba Conservation as part of a broader research and monitoring initiative on boreal woodland caribou. In conjunction with Manitoba Conservation, Manitoba Hydro, and ongoing graduate research work, collaring objectives were developed based on the collective needs of all agencies. The overall objectives of the collaring program were as follows:

1. Conduct telemetry studies in areas where detailed range use and distribution are lacking or non-existent.
2. Maintain a minimum sample size of adult female caribou to provide sufficient data for ongoing research of recruitment and mortality.

These studies also utilized ancillary data from a Manitoba Conservation led telemetry study on the coastal caribou populations. This involved the collaring of Cape Churchill and Pen Island caribou during the winters of 2010 and 2011. These data were used to assess movements of coastal caribou in and out of the Project Study Area.

Information from other ancillary studies such as aerial survey data for DNA fecal pick up provided valuable information and identified gaps and telemetry needs. A collaring program was then developed in collaboration among the partners and conducted by Manitoba Conservation. Collaring of boreal woodland caribou was undertaken in a number of ranges in the Project Study Area commencing with the Bog in 2006. The Bog was first identified as a significant range that would be traversed by the Project regardless of any route selection process due to the geographical narrowing of the Project Study Area in this region. Several other herd ranges were also identified in the Project Study Area. As a result, six adult female caribou were radio-collared in 2009, followed by comprehensive collaring efforts for all known herds in the Project Study Area in 2010 and 2011.

The more current telemetry studies on boreal woodland caribou were conducted using Iridium Track3D satellite tracking collars (Lotek Wireless Inc.) that are designed to provide location data for up to three years. Seventy-eight collars were deployed in 2010 and were supplemented by an additional 70 collars in winter 2011. These collars supplement earlier deployments of 24 UHF downloadable collars between 2007 and 2009, nine additional collars deployed in summer 2009, as well as historical data collected from 1969-2006. Additional collaring is planned for the winter of 2012 as part of ongoing monitoring.

Boreal woodland caribou were captured and collared using contracted helicopter net-gun capture techniques by Heli-Horizons Inc. under the authority and direction of Manitoba Conservation. Staff from Manitoba Hydro and Joro Consultants Inc. were involved in collar initialization and testing, reconnaissance flights to locate target animals and groups, field logistics, and data management. Pre-capture flights were conducted using existing collared animals as potential target sources for additional captures as well as to locate un-collared groups of animals near the Project. Once animal groupings were located, the capture crew was directed in and target animals identified. Animals were gently hazed under the supervision of Manitoba Conservation into suitable open areas for capture. After a short intensive pursuit animals were netted and restrained with hobbles and blindfold. No immobilization drugs were used during any capture operations. After non chemical immobilization, measurements and samples were taken (blood, feces, and hair) and collars were fastened. Once the collars were secured and biological samples were collected, the animal was released (Figures 1-2). Data began to transmit immediately post-release. Collars used GPS satellite technology to triangulate the position of the caribou every 3

hours and transmit data every 1.5 days via the Iridium satellite network. Data was stored by Joubeh Technologies Inc. and forwarded via email to Joro Consultants Inc. Each caribou was located up to eight times per day, providing a yearly dataset of up to 2,880 locations per caribou per year (279,360 per year total). Caribou movement patterns were monitored and data was processed in ArcMap 9.3 (ESRI©).

The collaring conducted in 2007 and 2009 utilized “store onboard” technology, where the collar logged all GPS locations with the capability of transmitting to a remote command unit that was operated from an aircraft once the animal was located using standard VHF telemetry techniques. Collars deployed in 2010 and 2011 are more advanced and utilize Iridium satellite technology and provide “real time” location data transmitted to the end user, eliminating the need to fly and find animals. This has greatly improved research and monitoring capabilities and allowing researchers to acquire current and up to date GPS location data of all collared animals. For the purpose of monitoring caribou and wolves within the Project Study Area, GPS telemetry data provided a significant source of information on both the historical and current distribution of caribou in the Project Study Area.

Figure 12: Capture caribou restrained for collaring, measuring and examining by crew

Figure 13: Release of captured caribou after being examined and collared, winter 2010

Caribou range delineations were modified from those currently identified in the Provincial Caribou Strategy using current telemetry data to generate Minimum Convex Polygons (MCPs). Minimum Convex Polygons are generated by drawing lines between outermost location points where no internal angles are greater than 180° and all locations are contained within the polygon (Mohr and Stumpf, 1966). Ranges were determined utilizing total annual and seasonal movements calculated for each animal and then merged for all animals in each range (Map 5).

Location data were also used to calculate path trajectories and volume-based density kernels. Assorted location data were used for movement, distribution, calving, and habitat modeling analyses. These data were of high utility in the assessment of alternative routes and contributed to the data required in selecting a PPR that had the least impact on existing boreal woodland caribou range and were used in determining the annual modified range delineations discussed.

3.4 Aerial Surveys

Multispecies aerial transect distribution surveys were conducted across a number of boreal woodland caribou ranges (Map 6). Aerial surveys were designed to provide estimates of caribou winter density based on observations of animals and tracks. Aerial surveys were conducted either using a helicopter with a crew chief and two observers or using slow-flying fixed wing Super

Cub aircraft. The Super Cub surveys were conducted by Gerry Lee and Harley McMahon survey services who are well known, experienced, and respected wildlife survey pilots from Alaska.

Data from aerial transect surveys conducted prior to the commencement of the Project included boreal woodland caribou survey data from 2004, 2005, 2008, 2009, 2010, and 2011. These surveys were conducted as part of a larger research initiative to collect feces and estimate the distribution of boreal woodland caribou from fecal DNA.

Surveys were flown using 2 to 3 km transects within various ranges, respectively based on previous methodologies utilized by Manitoba Conservation to determine the general distribution of boreal woodland caribou in Manitoba. Tracks and observations of caribou, moose, wolves, and other animals were recorded into a GPS and all data were transferred into ArcGIS (ESRI©, 2011) allowing for the creation of a surface density layer in GIS. For all surveys conducted specifically for the Project, observations of moose and grey wolf (tracks and sightings) were recorded to assess species overlap or separation which could provide information relative to the overall risk of some populations to access, predator movement, and mortality.

Winter caribou distribution surveys were conducted within the Project Study Area north of the boreal woodland caribou management area to detect the presence of Pen Island, Cape Churchill, and barren-ground caribou. Surveys were conducted in suitable habitat near Stephens Lake and Keeyask Lake as defined by the LCCEB habitat model (Section 3.1, Table 2). Transects were spaced at 5 km intervals and any sign of caribou activity was investigated by following caribou tracks to determine presence or absence of caribou and approximate numbers of animals. The surveys were conducted on December 14 to 16 in 2009 and December 2 to 5 in 2010. The 2011 survey was designed to document the arrival of the Cape Churchill population into the core of the northern Project Study Area and to validate the extent of dispersion of Cape Churchill animals throughout the Project Study Area. A significant number of animals were subsequently harvested by hunters in the area over a very short period of time near proposed Project infrastructure associated with the Keewatinow converter station. As such, a secondary objective of the survey was to document and validate the estimated 100 plus animals that were harvested in the area along and near the Conawapa access road.

3.5 Core Area Delineation

Areas where wildlife utilize habitat at significantly higher rates within home ranges can be described as core areas (Semlitsch and Jensen, 2001). Delineating core areas within a home range better captures changing patterns of resource utilization and more precisely identifies important habitat components than statistics derived from total range area (Harris et al., 1990). However, determination of core areas within a range requires the construction of density functions with sufficient location information to provide robust estimates of use. The use of GPS in automated telemetry has been thoroughly studied to determine the appropriateness of conducting animal movement research (Rodgers and Anson, 1994; Moen et al., 1996; Rodgers et al., 1996; Moen et al., 1997; Dussault et al., 2001; Pépin et al., 2004; and Coulombe et al., 2006). GPS and satellite collars are capable of collecting multiple daily fixes over an extended time and provide an unbiased and precise estimate of animal locations. The spatial and temporal resolution of GPS data allows researchers to study interactions of animals and their habitat at an unprecedented level of detail (Rempel et al,. 1995; Rempel and Rodgers, 1997).

During winter, boreal woodland caribou are aggregated and more susceptible to disturbance and effects. Delineating high value caribou habitat and core use areas based on telemetry data and aerial surveys facilitated the SSEA process in identifying constraints and opportunities for routing that had the least impact on caribou. The telemetry data provided a basis for assessing habitat use and characterizing high-quality habitat for modeling purposes.

Boreal woodland caribou core use areas in the Project Study Area were generated from data collected from GPS collars used to monitor caribou from March 1, 2002 to March 15, 2011 as described in Section 3.5. This dataset contains approximately 217,000 locations representing the movement patterns for 196 caribou. These data were used to generate volume-based density kernels to map the core use areas of caribou during winter and summer.

The collaborative collaring of boreal woodland caribou between 2002 and 2011 involved several types and makes of collars. Fix acquisition rates were variable requiring normalization of data to ensure each animal data set were represented equally. Individual animal data were normalized to a three and four-hour fix rate and GPS data were pooled and stratified into separate monthly datasets for all individual animals to reduce the effects of autocorrelation (Schindler, 2006).

Herd ranges were analyzed separately as ecological units. All normalized GPS data were then pooled and stratified into separate monthly datasets for each individual animal. The adaptive kernel estimate derived with GIS tools of monthly home range for all animals generated separate kernels at 10% intervals, producing core use areas containing all ranges used by each individual animal. Winter (December to March) and summer (July and August) months were amalgamated and dissolved by percent volumes, resulting in overall winter utilization distribution (UD) isopleths generated at 10% volume intervals. The 90% kernel area for each range was then merged to form the overall caribou core use area (Schindler, 2006) (Map 7).

The core area analysis was used as a constraint in the SSEA process in selecting a preferred route that intersected the least amount of core area. The PPR was assessed in terms of what percentage of the core area was intercepted by PPR ROW. This is further described in Section 4.4.

3.6 Modeling

3.6.1 Habitat Modeling Analysis and Constraints

The use of expert knowledge in developing predictive habitat models generally produces useful results for identifying and managing wildlife habitat (Edwards et al., 1996; Clevenger et al., 2002). However, this approach often requires fine-tuning following validation based on data collected in the field and statistical analyses (Stoms et al,. 1992; Block et al., 1994; Wintle et al., 2005). The identification of limiting habitat types for selected VEC species within the Local Study Area was an important component in evaluating alternative routes and in the assessment of impacts for the FPR. The use of GIS-based habitat models developed from expert knowledge of species habitat requirements can be used to identify critical habitats (Edwards et al., 1996; Clevenger et al., 2002) and can produce results that are valuable in assessing and monitoring impacts on sensitive species.

3.6.2 Boreal Woodland Caribou Habitat Modeling

Habitat models were developed to identify calving habitat and high quality winter range across the Project Study Area. Habitat models provide an assessment of habitat in absence of high quality telemetry data. Both models utilized the land cover classes found in the LCCEB (Section 3.1). To reflect the ecological requirements of boreal woodland caribou, the assessments of

landscape metrics were based on the patch characteristics of wetlands and coniferous forest. The spatial arrangement of these two major landforms represents the two major eco-typical forms of boreal woodland caribou found in the Project Study Area. This is consistent with other areas of the province, including eastern Manitoba, where boreal woodland caribou can be associated with mainly bog ecosystems or coniferous forest environments (Schindler, 2006). As discussed, the LCCEB provided the most appropriate and available habitat data as other available data such as the FRI were not considered to be up to date and appropriate for all portions of the Project Study Area. As such, the juxtaposition of landform patches such as wetlands and forest were considered to provide a basis model developed by assessing telemetry associations relative to the LCCEB.

3.6.3 Calving Patch Identification and Modeling

Both woodland and barren-ground caribou have been noted to have seasonal fidelity to calving grounds (Gunn and Miller, 1986; Shaefer et al., 2000; Ferguson and Elkie, 2004). Although boreal woodland caribou form aggregations during the winter, they disperse over broad areas in spring which is hypothesized to be a survival strategy to avoid predators (Bergerud and Page, 1987; Rettie and Messier, 2001). This spacing strategy is often observed in conjunction with the use of islands (both those in lakes or 'bog islands'), which Bergerud et al. (1990) determined to be driven by predator avoidance, rather than habitat preference or avoidance of insects. Unlike barren-ground caribou, which remain grouped on calving grounds to avoid predation, this strategy is important to boreal woodland caribou in the persistence of local and range-wide meta-populations (Carr et al., 2007).

The identification of potential calving habitat and known calving areas was an important consideration in the assessment of alternate routes due to the potential for increased access to calving areas by predators. Identifying and minimizing disturbance in known calving areas and/or potential habitat required the development of specific models to characterize known calving habitat and to predict potentially important calving habitat in areas where no telemetry data exists. Characterizing and identifying caribou calving habitat involved the synthesis and analysis of both historical and current telemetry data. Data for a number of boreal woodland caribou ranges were analyzed to assess animal movement during the calving season in order to identify and characterize calving habitat.

The method developed for identifying potential caribou calving areas is based, in part, on observed behaviours from examined literature to determine the patch of habitat most likely to contain the calving site. Schaefer et al. (2000) monitored caribou over a five year period in northern Quebec and Labrador and noted that the calving period reached its peak from May 29 to June 1. Ferguson and Elkie (2004) used residual distance traveled between two or seven day intervals to delineate seasons based on inflection points. The study defined the calving season for woodland caribou in Ontario as being from May 17 to July 14, with a peak of probable activity around June 1, with no visual observations due to the use of UHF (satellite) tracking. Ferguson and Elkie (2004) also observed a “brief sedentary period” of movement rates below 0.2 km/day, for approximately three days in a row. Tracking caribou in Saskatchewan using satellite telemetry, Rettie and Messier (2001) identified the calving period based on visual observations of calves to be from May 5 – May 25. Shoesmith and Storey (1977) conducted observations of woodland caribou in the Reed Lake area of Manitoba between 1974 and 1976. Calves were first spotted between May 17 and May 31 and cows with calves frequently used island calving sites and remained on islands for several weeks (Shoesmith and Storey, 1977). Bergerud (1978) identified the calving period as being the latter half of May. Average calving dates for caribou in Canada range from late May to early June, with calving dates starting later in the east than in the west (Canadian Wildlife Service, 2005).

In order to analyze the current and historic GPS telemetry data that exists for the Project Study Area, it was necessary to determine the time frame by which to conduct the spatial and temporal analysis to define and characterize a likely calving site. Therefore, the following criteria, based on the results of the above studies, were used:

1. Calving likely occurs during the latter half of May.
2. Calving occurs in a very small area, usually preceded by a large movement.
3. Sedentary behaviour is observed immediately following the event, with duration of at least three days.

The characterized patches were used to identify the probable calving location. Rettie and Messier (2001) estimated birth date by identifying the lowest movement interval during the calving period. A GIS analysis of all GPS telemetry data available for the potential spring calving period was undertaken by assessing individual movement based on a three day average of the largest dimension of a daily MCP (rather than movement intervals). This was done for each animal within the calving patch to determine an approximate estimate of the day of calving. We used the MCP approach as it characterized the movement behaviour appropriately relative to a particular patch. Conversion of each daily MCP into its longest dimension was performed in ArcView 3.3 (ESRI©). Three day moving averages were charted for the entire season and the days within the selected patch were compared to find the lowest value. The date of the lowest value indicates the average values of the day and the previous two days, and represents the most sedentary period, indicating the probable calving date as a function of no movement. Three days were subtracted from this date to approximate the calving date. A manual visual assessment on maps using the telemetry data for that period was then undertaken by assessing daily MCPs in GIS to determine how long the animal remained in that specific area or patch.

As boreal woodland caribou fecundity is known to be very high, it is expected that adult cows likely dropped their calves in the location as determined through this analysis. A MCP was created from these points to define the approximate calving patch and estimate patch size. Mean patch sizes were estimated, ranging from <0.1 ha to 200 ha. An average value of 40 ha was selected to be representative of a large proportion of calving areas (~75%).

The modeling conducted for this analysis adopted a 200-ha hexagon sampling grid, encompassing the portions of the Project Study Area in the Boreal Shield, Boreal Plain, Hudson Plain, and Taiga Shield Ecozones. Modeling was carried out in fall 2009, as the Project Study Area was subsequently expanded in the Thompson Nickel Belt region where modeled habitat data did not currently exist. The grid of 200-ha was chosen because it represents the maximum observed calving patch size (Section 4.5.1) and was considered more appropriate than the average calving patch size of 40 ha, based on the assumption that many LCCEB cover type patches have an area greater than 40 ha. Thus, a grid of 40-ha hexagons would likely be too

small-scale to detect were calculated by hexagon regions, using the Patch Analyst extension in ArcMap (ESRI©, 2011).

To identify patch metrics relevant to boreal woodland caribou habitat selection, 60 calving patch centroids derived from the calving patch characterization conducted for 39 collared caribou between 2002 and 2009 were plotted on the Project Study Area hexagon grid (Figure 3). All hexagons that intersected a calving patch centroid were assumed to represent calving patch habitat types. Metric values for these calving patch hexagons were compared with metric values for a random sample of 1,000 hexagons that did not intersect the calving patch centroids. Mean habitat patch metric values for calving hexagons were then compared with those of the randomly selected non-calving hexagons. Metrics that were significantly different (defined as showing more than 40% difference in mean value) between the two groups were identified as possible metrics to be used in defining and modeling woodland caribou calving habitat. A 20% range of values (10% above and below the mean metric values) was calculated for both calving and non-calving hexagons. Where calving centroid mean metric values were higher than non-calving values, all hexagons having metric values greater than the lower end of the range (i.e. 10% less than the calving patch mean metric value) were classified as having a qualifying caribou habitat metric. Where calving centroid mean metric values were lower, the upper end of the calving centroid 20% range was used as the maximum value representing a qualifying habitat metric. Each of these potential qualifying metrics was then plotted with the known calving centroids and visually assessed to determine whether its distribution was similar to that of actual calving patches (Map 8).

The qualifying metrics selected in this manner included number of patches (NumP), patch size coefficient of variance (PSCoV) for coniferous cover types, mean patch size (MPS), median patch size (MedPS), patch size standard deviation (PSSD), total edge (TE), and mean patch edge (MPE) for wetland cover types (Table 3). The selected metrics had mean calving patch values at least 40% or greater than the equivalent non-calving patch values (Table 20; Table 21).

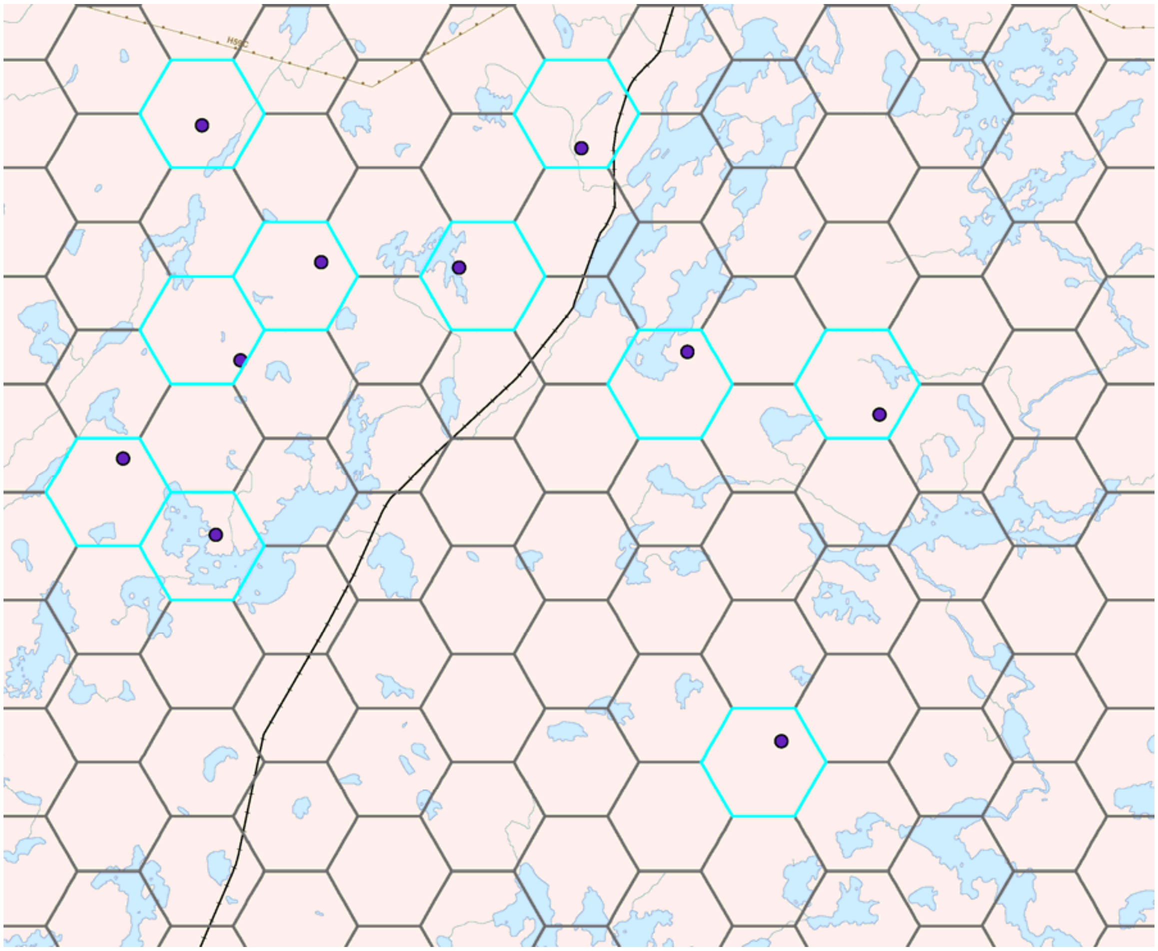


Figure 14: An example of calving patch centroids in the Harding Lake region overlaid on the 200 ha hexagon grid. All hexagons intersected by calving patch centroids (highlighted in turquoise) were selected to characterize calving patch habitat values

Table 19: Abbreviations for metric descriptions used in models

Metric Description	Abbreviation
Mean Patch Edge (m)	MPE
Mean Patch Size (m)	MPS
Median Patch Size (m)	MedPS
Number of Patches	NumP
Patch Size Standard Deviation	PSSD
Patch Size Coefficient of Variance	PSCoV
Total Edge (m)	TE

Table 20: Metrics and values used to develop the predictive threshold model for caribou calving habitat in coniferous habitat types

Metric	Non-Calving Patch Mean Metric Value	Qualifying Metric Values
NumP	3.4	> 3.8
PSCoV	71.7	> 81.3

Table 21: Metrics and values used to develop the predictive threshold model for caribou calving habitat in wetland habitat types

Metric	Non-Calving Patch Mean Metric Value	Qualifying Metric Values
MPS	113131.0	>151856.6
MedPS	85962.8	>99328.3
PSSD	79150.2	>120671.4
TE	6217.0	>8285.2
MPE	1896.2	>2361.4

To ensure that the full range of suitable caribou habitat would be represented in the model, mean metric values and percent of total area were compared among the Naosap, Wimapedi, Wabowden, and Wapisu caribou range calving patches. The Naosap range was found to exploit significantly less wetland habitat and more coniferous habitat than the other herds. Naosap calving patches contained 38.4% coniferous cover types and 25.1% wetland cover types, while calving patches used by the other range consisted of 26.7% coniferous habitat and 62.8% wetlands. This result is expected given there are typically two "ecotypes" of boreal woodland caribou in Manitoba, bog-dwelling and forest-dwelling (Schindler, 2006). To reflect this variation in habitat use, the more moderate (i.e. closest to non-core mean metric values) of the two means was used as the minimum value for a qualifying metric. Consequently, mean metric values for Naosap were used as the minimum qualifying values for wetland metrics, while combined mean metric values for the other populations were used as minimum qualifiers for coniferous metrics. All hexagons having four or more of the seven possible qualifying metrics were merged. These totals were mapped to display the distribution of available woodland caribou calving habitat in the Project Study Area.

3.6.4 Winter Habitat Model

As with the calving patch analysis, patch metrics for wetland and coniferous forest cover types were calculated with Patch Analyst, using a grid of 17,000-ha hexagon regions. This hexagon area was based on the mean winter range area for the Naosap, Wimapedi, Wapisu, and Wabowden caribou ranges through adaptive kernel analysis and identified as the 70% isopleth based on telemetry data (Section 4.4). The 90% isopleth was considered to represent the extent of actual core use areas based on the findings of Schindler (2006). However, to ensure high quality habitat, rather than more marginal habitat on the periphery of the core that was being sampled for model development; the 70% isopleth was used. To account for geographic and landscape variability, this means an area of 17,000 ha represents approximately 1/5 the size of an average core winter use area for all caribou ranges in the Project Study Area based on the 70% isopleths. This facilitated the identification of areas of contiguous high quality winter habitat that could potentially represent a "core area". It also allowed for the delineation of irregular sized habitat patches with a more relevant ecological boundary.

Winter core area metric values were compared with metrics for a random sample of 40 hexagons in non-core areas. As in the calving patch analysis, a 20% range for core and non-core mean metric values was calculated, with the upper limit being 10% greater and the lower limit 10% less than the winter core mean. Where winter core mean metric values were higher than non-core values, the lower end of the mean core 20% range was used as the minimum value representing a qualifying caribou habitat metric. Where winter core mean metric values were lower than non-core means, all hexagons having metric values less than the upper end of the mean core 20% range were classified as having a qualifying habitat metric. As in the calving patch analysis, the distribution of qualifying values for each potential metric was mapped with the winter cores and representative metrics being visually identified (Map 9). The metrics selected to assess winter habitat suitability included MedPS and TE for coniferous cover types, and MPS, MedPS, PSSD, and MPE for wetlands (Table 22;

Table 23). Please see

Table 19: Abbreviations for metric descriptions used in models above for the abbreviations used for metric descriptions. The selected metrics had mean winter core values at least 40% greater than the equivalent non-core values, with exception of coniferous MedPS, which had a mean winter core value 53% lower than the non-core mean.

Table 22: Metrics and values used to develop the predictive threshold model for caribou winter habitat in coniferous habitat types

Metric	Non-Habitat Patch Mean Metric Value	Qualifying Metric Values
MedPS	54442.3	<32241.0
TE	372206.3	>587715.6

Table 23: Metrics and values used to develop the predictive threshold model for caribou winter habitat in wetland habitat types

Metric	Non-Habitat Patch Mean Metric Value	Qualifying Metric Values
MPS	151310.2	>614931.0
MedPS	24121.3	>28258.8
PSSD	991909.5	>3818886.2
MPE	2172.1	>4419.6

The differences in cover type composition between Naosap and the other ranges were less marked for winter habitat than for calving patches. Naosap winter cores were composed of 36.6% coniferous forest and 34.4% wetland, while the averaged Wimapedi, Wapisu, and Wabowden cores contained 42.8 % coniferous habitat and 40.7% wetland. To represent the variation in suitable winter habitat, mean core metric values for Naosap were separated from the averaged mean core metrics for Wimapedi, Wabowden, and Wapisu. The more moderate (i.e. closest to non-core mean metric values) of the two means was used as the minimum value for a qualifying metric. This process resulted in Naosap mean metric values being used for wetland MPS, MedPS and PSSD, and coniferous MedPS. The combination of Wimapedi, Wapowden, and Wapisu metric means were used for wetland MPE and coniferous TE.

The total number of metrics per hexagon that met or exceeded the minimum qualifying requirements were mapped. As Naosap winter cores were underrepresented despite the separation of mean core metric values, the two coniferous metrics (MedPS and TE) were assigned a weight of two for each qualifying metric. This resulted in a total of eight possible qualifying metrics per hexagon. All hexagons having four or more qualifying metrics were merged and mapped to display suitable winter range habitat (Figure 4).

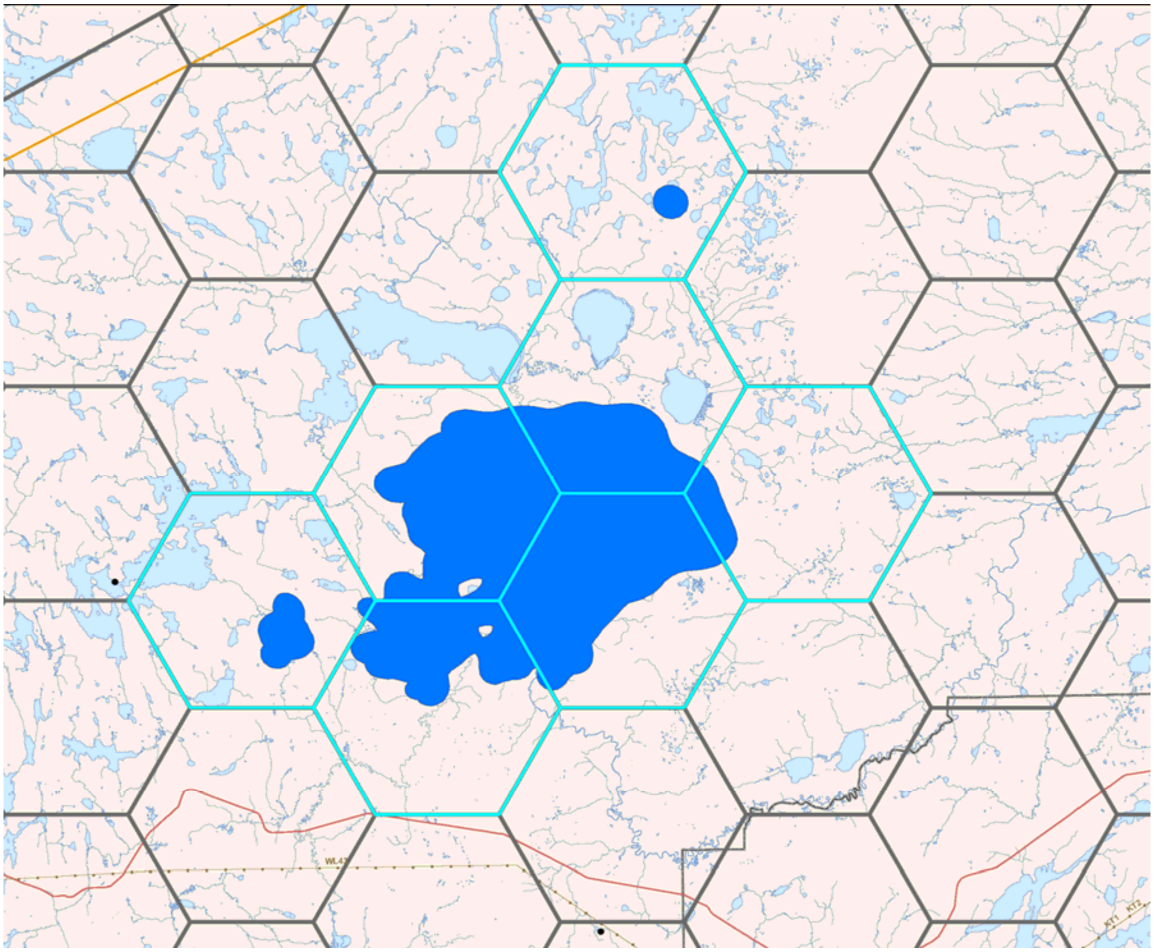


Figure 15: An example of winter core areas in the Harding Lake region overlaid on the 17,000 ha hexagon grid. All hexagons intersected by core areas (highlighted in turquoise) were selected to characterize winter habitat patch values

3.7 Lichen Surveys

Boreal woodland caribou are morphologically and behaviourally adapted to forage and subsist on a diet consisting mainly of terrestrial lichens (*Cladina spp.*) during winter periods (Edwards and Ritcey, 1960; Ahti and Hepburn, 1967; DesMeules and Heyland, 1969; Stardom, 1975; Darby, 1979; Miller, 1982; Darby and Pruitt, 1984; Bergerud and Mercer, 1989; Godwin, 1990; Schaefer and Pruitt, 1991). They are adapted for digging or cratering through deep snow for terrestrial lichens which is an energetically efficient foraging characteristic (Boudreau and Payette, 2004). DesMeules and Heyland (1969) assembled a ranked list of lichen species preferred by caribou and found that *Cladina alpestris*, *Cladina mitis*, *Cladina rangiferina*, and

Cladonia uncialis were preferred forage followed by the arboreal lichens *Usnea* spp., *Evernia mesomophia*, and *Alectoria* spp. Other lichens providing forage include *Cetraria islandica* and *Stereocaulon* spp. Feeding preferences vary depending on the locations where observations were made. As such, the importance of minimizing impact on lichen communities is a consideration in the mitigation of effects on caribou and to ensure maintenance of high quality lichen habitat when being traversed by the Project.

To provide a basis for assessing the potential impacts of the Project on lichens and lichen habitat, aerial and ground surveys were conducted along the FPR with the objective of identifying lichen-rich areas that may require specific protection or mitigation prescriptions during construction and/or operation of the Project. The overall intent of the surveys was to provide a map-based product of lichen-rich sites along the PPR in order to assess the residual effects and appropriate mitigation measures.

Aerial surveys and estimates of lichen ground cover were mapped from the air during late fall of 2010 after 100% leaf fall had occurred and immediately prior to snow fall (Map Series 200). Lichen cover was estimated for intervals of low, medium, and high density of terrestrial lichens and arboreal lichens. Lichen density was described in terms of abundance as being trace (low density, 10 - 20 % ground cover), moderate (medium density, 20 - 50 % ground cover), or abundant (high density, ≥ 50 % ground cover). The most common lichens that can be mapped by the air are considered the most important for caribou and include the common “reindeer lichens” such as *Cladina mitis*, *Cladina rangiferina*, and *Cladina stellaris.* Other common and notable lichens in the Project Study Area included wood coral (*Stereocaulon tomentosum)* and spike lichens (*Cladonia uncialis*). A list of lichen code names can be found in Appendix C1. The extent of lichen mass as a percentage of ground cover was further validated through ground sampling of six medium and high density sites based on the aerial ocular estimate (Map Series 300).

Ground vegetation sampling was conducted using a modified line intercept method (Daubenmier, 1959). Presence and abundance of lichen, moss, herbaceous, and shrubby ground cover was measured using a 100 m measuring tape held straight between two field staff (Figures 5 and 6, Appendix C2).

Figure 16: Photograph depicting fieldworker holding 100 m transect tape in a forest typical of sampling areas

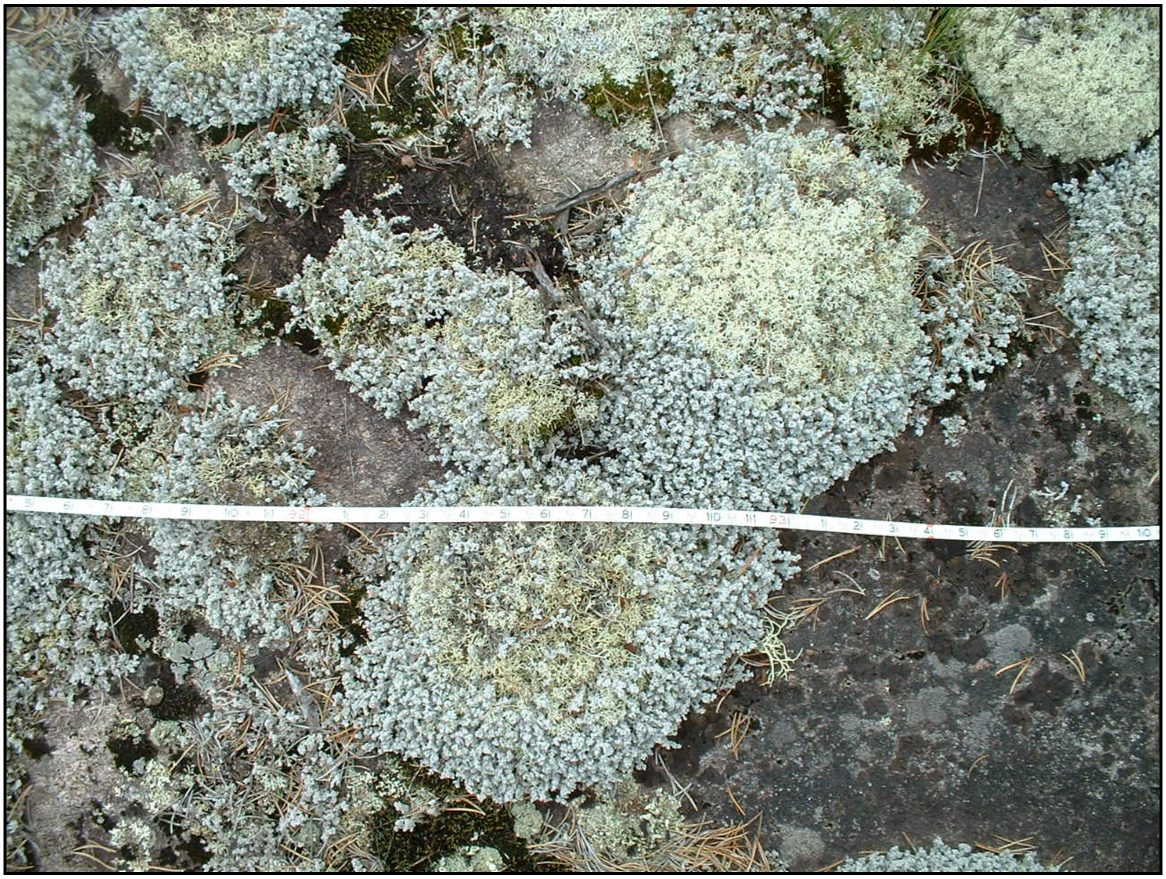


Figure 17: Sampling subsection from transect, showing typical lichen species

The location of both the beginning and end of each 100 m transect segment was recorded using a hand held GPS unit along with an accompanying digital photo. The linear distance that a species intersected the tape was estimated using decimetre graduations. Single species or distinct combinations of species (groups) were considered "present" along the transect if their leaves, stems, or thalli intersected the transect line. One field staff measured the species and the distance of intersect and the other acted as recorder. Distinct patches of lichen and moss were carefully classified while herbaceous plants were classed more broadly. Other ground cover types classified include bare rock and leaf/needle litter. If two or more species were found growing together in a patch, the most dominant species in the combination was recorded first on the data sheet followed by the second-most dominant species and so forth. The total length (m) of each species was summed for each study site (Table 24). Where two or more species were found growing together, the total length for all species was divided by the number of species present and each species was summed separately. Using this rationale, the following nine broad classifications of vegetation were developed based on the results of field sampling.

1. All classifications where *Cladina mitis* and/or *Cladina rangiferina* were the only species present. These were pure runs of lichen.
2. All classifications that included the lichen species *Cladina stellaris*.
3. All classifications that included the lichen genus *Cladonia*, except those that included *Cladonia uncialis*.
4. All classifications that included the lichen species *Cladonia uncialis*.
5. All classifications that included members of the lichen genus *Stereocaulon*.
6. All classifications that included any type of moss, except *Sphagnum*.
7. All classifications where *Sphagnum* was the primary or secondary variable.
8. All classifications where shrubs were the primary species and lichen were secondary species.
9. All classifications where shrubs and mosses were the primary and secondary variables.

Table 24: Total length (m) of selected lichen species and other vegetation and ground cover types along 100 m transects at each site. Data were collected during ground surveys conducted in November 2010

Site Number	Total line intersect length (m) for selected lichens species and other ground cover categories										
	Cladina stellaris	*C. mitis*	*C. rangiferina*	Feather Moss	*Sphagnum spp.*	Bear Berry	Juniper	Grass	Sedge	Leaf Litter	Bare Rock
1	18.7	16.7	12.1	41.5	0.0	0.0	0.0	0.0	0.0	4.7	5.0
2	0.0	22.0	4.7	15.5	55.5	0.0	0.0	0.0	0.0	0.0	2.9
3	16.4	40.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.8	44.3
4	0.0	19.6	7.1	0.0	57.6	0.0	0.0	14.0	0.0	1.8	0.0
5	0.6	43.6	25.1	8.4	0.0	3.6	7.8	0.0	0.0	3.1	6.4
6	3.3	11.4	3.2	74.5	0.0	0.0	0.0	0.0	5.5	0.0	0.0

The classifications allowed for analysis of multiple plant community types by including all species present within a category. For example, the classification 'cmit/crang' would have been included in both the *Cladina mitis* and *Rangiferina* categories. Though overlap between types was minimal it allowed for the quantification of aerial ocular estimates and was necessary to assist in determining presence of lichens and mosses relative to the different stand types.

3.8 Wolf Telemetry And Predation Monitoring

It is hypothesized that grey wolves take advantage of linear development for hunting and travel creating a potential effect on increased predation of caribou. To enhance the evaluation of these potential effects, 18 wolves were captured and equipped with Argos satellite tracking collars (Lotek Wireless Inc.) in locations throughout the Project Study Area during the winter of 2010 (Map 10; Table 9). Two of the initial collars remained active as of March 15, 2011, while eight were recovered in 2010. The remaining eight were lost and not recovered. Thirty-three additional collars were deployed in winter 2011 (Table 9). Eight recovered collars from the previous season were redeployed, along with 25 new Lotek Argos collars.

Capture and collaring of wolves were undertaken by Manitoba Conservation through the services of a custom capture company. Wolves were captured using aerial net gunning from helicopter (Figure 7) without the use of chemical immobilization. Once captured, basic measurements (length, neck girth, sex, and coloration), and biological samples (hair and feces) were taken (Figure 8). Argos tracking collars were placed on the animals and then were released. Argos tracking collars use a VHF beacon to allow for relocation using standard radio telemetry methods. GPS locations are acquired every four to six hours and data are transmitted every nine days via the Argos satellite system and made available for the client through a web-based server (Telnet) or email from CLS America Inc. Wolf movements were monitored and home range and movement data processed in ArcMap software (ESRI©, 2011).

Figure 18: Wolf captured via aerial net gunning from helicopter by Heli Horizons Inc. winter 2010

Figure 19: Capture wolf being restrained for collaring and examination by crew members

Aerial surveys were conducted to complete a wolf census in the Wimapedi-Wapisu and Harding Lake ranges. These surveys were flown in telemetry equipped fixed-wing aircraft. A total count of wolves in the survey block was conducted, as well as identifying and enumerating packs. Telemetry equipment was used to associate radio-collared wolves with packs (Figure 9). Pack ranges were defined by the MCP of radio-collared pack members.

Figure 20: Aerial picture of wolf pack taken during capture work, winter 2010

Table 25: Wolf collar deployed in January of 2010 and January of 2011 in various boreal caribou ranges

Range	2010	2011	Active Collars
Harding Lake	4	11	12
The Bog	0	4	4
Wabowden	4	4	5
Wimapedi-Wapisu	5	10	10
Wheadon	5	0	0
Reed Lake	0	4	4
Total	**18**	**33**	**35**

3.9 Trail Camera Studies

The utilization of trail cameras allows for the identification of caribou movement as well as assessing the presence of ungulates (moose and caribou) relative to predators (grey wolf and black bear) in or near the Project. They also provided ancillary data to support mammal studies; see- *Bipole III- Mammals Technical Report* (Joro Consultants Inc. and WRCS, 2011). Camera studies also contributed to assessing presence of black bear and grey wolf in proximity to important caribou calving areas. Twenty-seven locations were identified for camera clusters based on game trails, all-terrain vehicle (ATV) trails, scat, tracks, and other mammal tracking data collected from the 2010 summer mammal tracking program. Each cluster contained three cameras (one cluster contained two cameras) and a centroid waypoint which was established for each cluster. One camera was placed at the centroid point while the other two cameras were placed approximately 100 m from either side of the centre camera on suitable trails or openings facing north to eliminate the chance of events triggered by the heat of the sun. In addition to the camera clusters, select cameras were deployed on an individual basis to monitor for mammal activity.

In the northern portion of the Project Study Area, a total of 91 RECONYX™ remote monitoring cameras were set up for variable durations from December 2009 to February 2011. Of these, 75 were Silent Image Professionals (PM35C31 and PM35M1) and 16 were rapid-fire models (PM75). Varying number of cameras were distributed across eight general locations, as follows: Hargrave Lake (10 cameras), Harding Lake (10 cameras), McLarty Lake (10 cameras), Reed Lake (11 cameras), The Bog (22 cameras), Wimapedi area (9 cameras), Wabowden area (10 cameras), and Wuskwatim line (9 cameras). In the southern portion of the Project Study Area, a total of 80 RECONYX™ remote monitoring trail cameras were set up between The Pas and Gladstone, Manitoba in the Boreal Plain and southern Boreal Forest Ecozones from September 20 to October 2, 2010 (Figure 10). Seventy-six of the 80 cameras were retrieved between December 7 and December 20, 2010. Four cameras were lost as a result of theft. Trail cameras remained on station for an average period of 74 days. Of these, 31 were Silent Image Professionals (Series PM35C31) and 49 were Hyperfire Professionals (Series PC800).

Figure 21: Set up of trail camera

Cameras were set to set on "aggressive", taking five pictures of the area per movement trigger (two pictures per second). The “no quiet time” option was selected rearming the cameras immediately after an event was triggered to provide a continuous series of photos (Figure 11).

Discretion was used in the event that a camera location was deemed unsuitable for monitoring large mammal activity. Seven camera clusters were moved to new locations in the same general habitat as the original waypoints and that were surveyed during the first tracking interval. Trail cameras were deployed by helicopter on game trails and in open spaces where landing was possible. Cameras were recessed into the trees to make them less obvious to people and wildlife.

Each camera location was given a unique site identification code (i.e. wim01) and was labeled as per the boreal caribou local population range or area in which they were deployed in. When deployed the geographic coordinates were recorded as utilizing a handheld GPS as well as camera number and date. These were entered into the master trail camera database. When cameras were retrieved or memory cards replaced the dates were also recorded. All trail camera photos have been downloaded from the sd/cf cards utilizing the RECONYX MapView Professional Version 3.0. Photos were then organized as per site and range. When analyzing the photos, the source of the photo was defined as the animal or environmental event that triggered the photo activity. If an animal triggered the camera but disappeared at any time during the five-photo burst, the source remained the same for each photo. The number of individuals was defined as the number of animals that appeared in each photo and were tallied according to events. A wildlife event began when a camera was triggered and continued for five photos whether or not the animal remained, left, or reappeared. In order to estimate the total number of individuals, animals were assumed to be the same individual during an event unless they could be differentiated based on traits such as age, sex, colour, presence and characteristics of antlers, or any other visible features. Where possible, unique identifiers were given to moose and elk based on distinguishable characteristics such as scarring, coloured patches, or antlers.

Photographed animals were classified as either adult or juvenile where picture quality allowed the qualitative assessment of physiological features, including size, when picture quality allowed the qualitative assessment of physiological features. For ungulates, the presence/size of antlers and size of animal was used to determine age (either adult or juvenile) and sex (Cooperrider et al., 1986; Høymork and Reimers, 2002). For moose, the colour of the face and the presence of a vulva patch were also used to differentiate females from males.

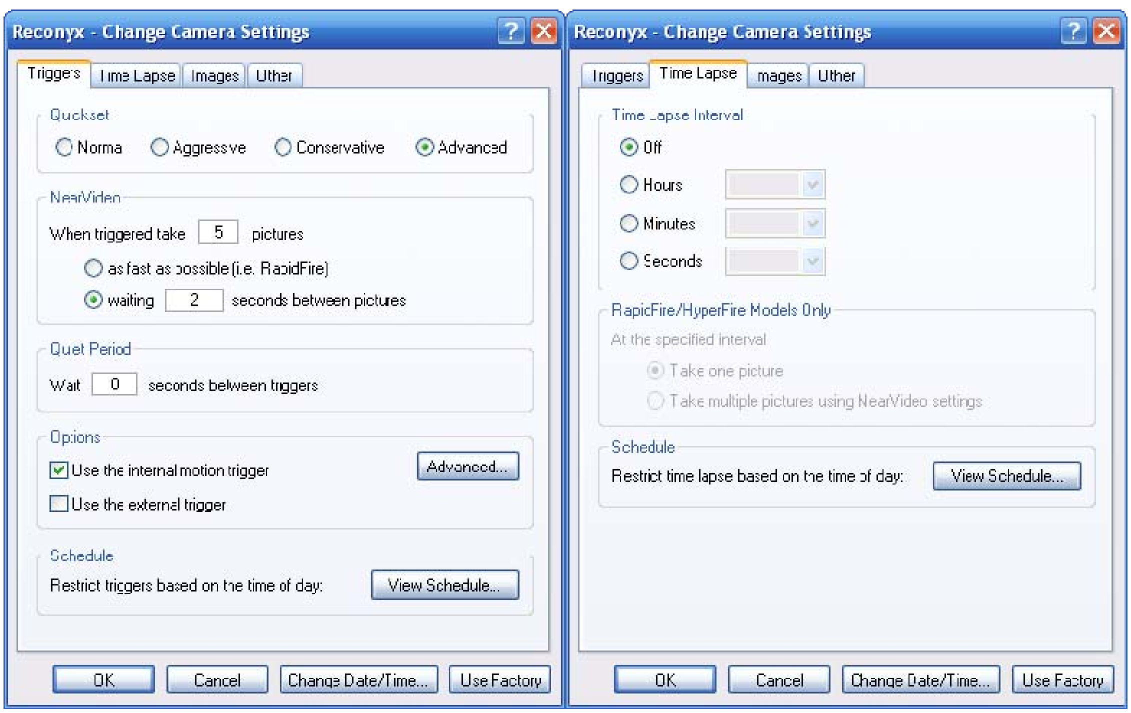


Figure11: RECONYX™ camera settings

Once all photos were key-worded, the software exported all picture data into CSV table format. From this table, all data was sorted into the trail camera picture database, allowing it to be queried by range, site or assigned keyword. Lat/long and UTM coordinates are also included in the key-words which provides the ability to map any of the photos within the data base.

The data provided for an opportunity to subjectively validate the presence of predators and primary prey (moose) within various habitat types. The data from this study is being incorporated into long-term monitoring of presence/absence and abundance of moose, wolves, and bears within caribou calving areas and other important habitats.

3.10 Calf Recruitment Surveys

The sustainability of boreal woodland caribou across their range is a function of several factors, of which calf recruitment is likely the most variable component affecting population growth. It is theorized that anthropogenic disturbance is an indirect pathway of decline through the alteration of habitat and predator/prey relationships, resulting in increased predation (Manitoba Conservation, 2006). This is mainly due to the fact that boreal woodland caribou have the lowest fecundity rates of North American ungulates (Banfield, 1974). An understanding of the entire reproductive cycle includes breeding, which is coincidental with the rut and occurs mid-September through mid-October (Shoesmith and Story, 1977). Females will participate in the rut and begin breeding at age 2.5 (Fuller and Keith, 1981; Darby and Pruitt, 1984), though they can breed successfully at 1.5 years (Rettie and Messier, 1998). Males will attempt to breed at 1.5 years of age; however, the social structure of the rut often prevents successful breeding until age 3.5 to 4.5 years (Kelsall, 1984). Calves are born in May through June after a 7.5 month gestation period (Fuller and Keith, 1981). In the Project Study Area, the mean calving date based on analysis of high resolution GPS tracking collars on female caribou is May 25. Although pregnancy rates for woodland caribou can average 86%, unlike other ungulates, they rarely produce twins and successful recruitment of calves into the population is very low (Bergerud and Elliot, 1986) and can vary considerably among years and among populations (Rettie and Messier, 1998; Wittmer et al., 2005). As boreal woodland caribou populations are small compared to other ungulate populations, slight declines in calf recruitment can have detrimental effects on overall population trends.

To establish baseline conditions and to assess the current status of caribou populations in the Project Study Area, calf recruitment studies were initiated to: 1) assess if there are differences in recruitment among boreal woodland caribou populations in the Project Study Area; and 2) detect if the level of anthropogenic disturbance and amount of linear development affects recruitment rates. These surveys were conducted in the spring, summer, and early fall of 2010 in several boreal woodland caribou ranges within the Project Study Area. A minimum sample of 20 collared adult females was completed where possible to ensure statistical validity. Collaring was undertaken in The Bog, Wimapedi, Wapisu, Wheadon, and Wabowden ranges. There is significant overlap between the range distributions of Wimapedi and Wapisu. Wapisu also includes a northern sub-population that is geographically separate from its southern counterpart. Thus, for the purposes of recruitment studies, Wimapedi and Wapisu south were considered as one range, known as Wimapedi-Wapisu, while the northern sub-population of Wapisu was considered separately and designated Harding Lake for the purpose of this study. Each range is characterized by a different disturbance regime with varying amounts of anthropogenic disturbance, allowing for comparison of recruitment among different ranges. All female caribou that have been tracked in these ranges were collared using Iridium real time satellite tracking collars as well as standard VHF and store on-board GPS collars.

Using the Iridium downloading protocol, locations of calving females were mapped and downloaded into a hand held GPS prior to recruitment flights in order to minimize the amount of time required to locate and document presence/absence of calves. For VHF and store-onboard GPS collars, more extensive flights were required to locate collared females. Surveys were conducted on a monthly basis throughout the summer starting in May and ending in September. The overall objective was to track a representative number of adult female caribou in each population to obtain a statistically valid estimation of calf survival through to the fall.

The recruitment flights entailed the use of standard VHF telemetry as all collars including Iridium have VHF tracking capability. Care was taken to minimize the amount of search time as to reduce any potential stress caused by attempting to obtain a visual account of the female. Observations of “calf or no calf” were documented, along with an estimate of cover, visibility, and intensive search time. If a calf was present, it was either recorded as present or at heel in such cases. If no calf was observed, this individual was recorded as such. To minimize observation error, a random sample of females without calves were re-sampled throughout the summer to obtain a measure of observation error (if detected) and increase the confidence of summer recruitment estimates.

Mortality investigations were also conducted for adult females and calves to assess the effects of predation on overall recruitment. Adult female mortality was assessed through the documentation of mortalities among all collared animals. Mortalities were mapped based on last known location for store-onboard collars and actual mortality location for Iridium-collared animals. Where possible, mortality collars were located in the field during the course of monthly recruitment surveys and cause of mortality was determined. Mortality sites were also mapped in relation to GPS Argos spatial data collected for collared wolves in each range area. Since no calves were collared, the causes of calf mortality could not be directly determined. However, the results of trail camera studies were used to assess predator activity in relation to calf mortalities. In particular, bear occurrences observed through trail camera footage were mapped with the last known locations of mortality calves.

3.11 Disturbance Regime Assessment

Anthropogenic disturbance associated with linear feature development and maintenance has the potential to negatively affect caribou populations through the combined effects of habitat loss and fragmentation. Transmission line ROWs may also act as corridors for increased predator movements (James, 1999; James and Stuart-Smith, 2000; Dyer et al., 2001; McLoughin et al., 2003; Cameron et al. 2005). Disturbance regime was assessed for The Bog, Wabowden, Wimapedi-Wapisu, Wheadon, Reed Lake, Naosap, and Harding Lake caribou ranges, to evaluate the effects of linear features on calf recruitment. The area of assessment for each range was the MCP for all collared caribou points within the range collected between February 2002 and March 2011 (Map 5).

Disturbance regime assessment incorporated two components: habitat fragmentation metrics and linear feature metrics. To evaluate habitat fragmentation, LCCEB wetland and forest cover types were merged in a GIS environment to produce single layers for wetlands and forests within the ranges. The LCCEB wetland and forest layers were intersected with a merged linear features layer that included highways, major roads, closed or abandoned roads, access roads, in block (forestry) roads, unclassified roads, rail lines, and transmission lines (Figure 12 and 13). The datasets for the merged linear features layer were produced by Manitoba Hydro and Tolko Industries Ltd. The intersected layers delineated contiguous wetland and forest habitat patches within the caribou ranges. Patch size metrics, including mean, minimum, and maximum patch size, and patch size standard deviation and variance were calculated for contiguous wetland and forest for each range MCP.

Linear feature metrics, including linear feature length, linear feature density, and number of linear features were calculated for each range for all linear feature types in the merged linear features shapefile.

Total disturbance was assessed for all ranges utilizing Principle Component Analysis (PCA) (Legendre and Legendre, 1998) to identify metrics that typified habitat fragmentation and to characterize the extent to which each range was affected by disturbance. A total of 41 metrics were used to describe disturbance (Table 26**: Metrics utilized in the principle component analysis to characterize regime by caribou range minimum convex polygon, including linear feature length, density and number by feature type, and patch size metrics for contiguous wetland and forest habitats**). The results of the analysis were summarized in graph format in Section 4.10.

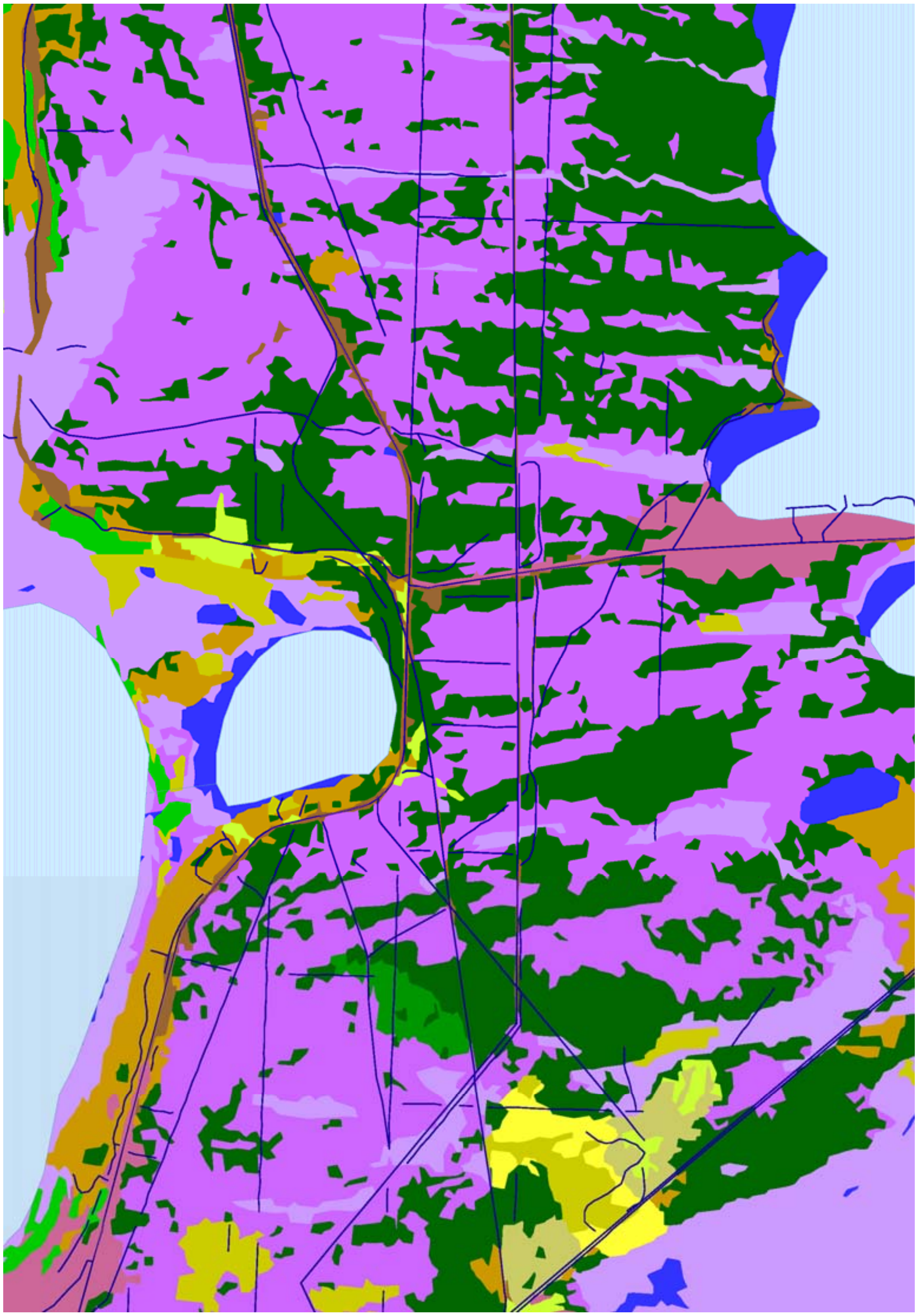


Figure 222: Example of fragmented habitat

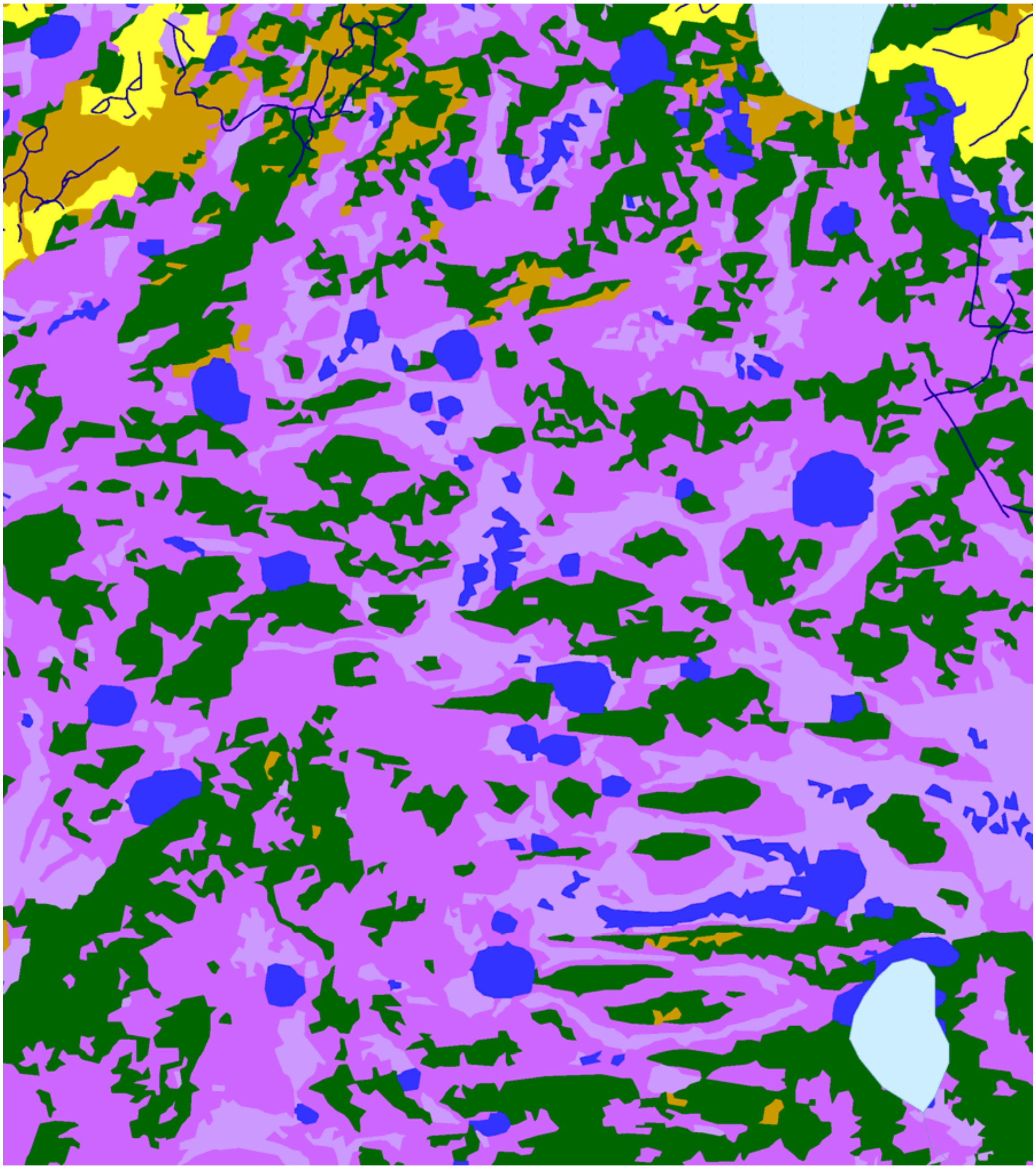


Figure 233: Example of unfragmented contiguous wetland and forest habitats

Table 26: Metrics utilized in the principle component analysis to characterize regime by caribou range minimum convex polygon, including linear feature length, density and number by feature type, and patch size metrics for contiguous wetland and forest habitats

Metrics	Harding Lake	Naosap	Reed Lake	The Bog	Wabowden	Wheadon	Wimapedi-Wapisu
Total Range Area (km^2)	3190	4542	4112	4820	5562	6770	11765
Total Linear Feature Length (km)	409	1298	939	838	1813	552	923
Total Linear Feature Density (m/km^2)	128	286	228	174	326	81	78
Total Length of Access Roads (km)	0	20	20	0	13	27	21
Total Length of Closed/Abandoned Roads (km)	113	353	105	48	295	74	157
Total Length of Highways (km)	37	55	72	147	154	0	72
Total Length of In-Block Roads (km)	0	152	102	22	37	46	27
Total Length of Major Roads (km)	0	228	157	84	106	73	30
Total Length of Railroads (km)	0	51	33	31	66	0	37
Total Length of Transmission Lines (km)	55	81	59	127	329	202	393
Total Length of Unclassified Roads	204	358	390	379	813	129	186

Metrics	Harding Lake	Naosap	Reed Lake	The Bog	Wabowden	Wheadon	Wimapedi-Wapisu
(km)							
Total Density of Access Roads (m/km^2)	0	4	5	0	2	4	2
Total Density of Closed/Abandoned Roads (m/km^2)	35	78	25	10	53	11	13
Total Density of Highways (m/km^2)	12	12	18	31	28	0	6
Total Density of In-Block Roads (m/km^2)	0	33	25	5	7	7	2
Total Density of Major Roads (m/km^2)	0	50	38	17	19	11	3
Total Density of Railroads (m/km^2)	0	11	8	6	12	0	3
Total Density of Transmission Lines (m/km^2)	17	18	14	26	59	30	33
Total Density of Unclassified Roads (m/km^2)	64	79	95	79	146	19	16
Number of Access Roads	0	1	2	0	2	3	3
Number of Closed/Abandoned Roads	117	607	111	43	541	212	269

Metrics	Harding Lake	Naosap	Reed Lake	The Bog	Wabowden	Wheadon	Wimapedi-Wapisu
Number of Highways	1	9	13	20	20	0	17
Number of In-Block Roads	0	429	302	40	69	105	72
Number of Major Roads	0	56	36	25	31	12	13
Number of Railroads	0	1	2	1	10	0	2
Number of Transmission Lines	2	2	2	3	6	4	10
Number of Unclassified Roads	216	551	468	451	974	277	244
Number of Contiguous Forest Patches	2711	5535	4370	5320	5573	4279	11480
Minimum Contiguous Forest Patch Size (m^2)	0.1	0.0	0.0	0.4	0.0	0.1	0.0
Maximum Contiguous Forest Patch Size (m^2)	442920731	121219863	155712167	114156358	244785402	847452309	955066503
Mean Contiguous Forest Patch Size (m^2)	609095	321243	345502	236279	316295	758434	461434
Contiguous Forest Patch Size Standard Deviation (m^2)	11221426	3201341	3917047	2043086	4322749	14257227	10890499
Contiguous Forest Patch Size Variance (m2)	12592040529	1024858413	1534325816	417420226	1868615994	20326851360	11860297333

Metrics	Harding Lake	Naosap	Reed Lake	The Bog	Wabowden	Wheadon	Wimapedi-Wapisu
Total Forest Area (m^2)	1651255352	1778078554	1509844381	1257002720	1762714312	3245341211	5297262994
Number of Contiguous Wetland Patches	6315	5383	3851	1300	4301	8187	14038
Minimum Contiguous Wetland Patch Size (m^2)	0.7	0.0	0.0	1.3	0.0	0.1	0.1
Maximum Contiguous Wetland Patch Size (m^2)	88882628	437196073	437196073	2346079287	1277447078	221858532	1226812346
Mean Contiguous Wetland Patch Size (m^2)	128809	239202	380818	3060787	717019	190050	302325
Contiguous Wetland Patch Size Standard Deviation (m^2)	1569209	6073067	8950706	69713758	22018827	3458346	11014565
Contiguous Wetland Patch Size Variance (m^2)	246241650	3688214373	8011513951	486000802504	48482873202	1196016042	12132063648
Total Wetland Area (m^2)	**813429356**	**1287622369**	**1466530508**	**3979023414**	**3083897302**	**1555940695**	**4244045043**

3.12 Effects Monitoring

Linear features have been observed to influence caribou movement, distribution, and survival (James and Stuart-Smith, 2000). Caribou response to linear features was assessed through a number of GIS analyzes to better understand the potential effects to both individual and range animal movements. The data used in this assessment were comprised of GPS caribou collar data collected from summer 2007 (June 15th to September 15th) to winter 2010-2011 (November 1st to March 15th). The distribution of caribou location data at successive distances to existing linear features were measured using a point density analysis. The effect of the recently constructed Wuskwatim Transmission Line was assessed using caribou location data collected prior to and following completion. Data collected from 2002-2006 in the Naosap range was used to supplement Iridium and UHF data spanning from 2007 to the present. The following GIS techniques were utilized in this process.

3.12.1 Point Density Calculations

A set of GIS procedures was established to measure and quantify the effects that linear features have on caribou movement and habitat usages. A series of sections of the newly constructed Wuskwatim Transmission Line, between Wuskwatim Lake and Snow Lake and surrounding linear features, including roads and railways, were selected to perform the point density analysis (Map 11). Buffer interval distances of 500 m were chosen based on expert opinion and previous accurate caribou density studies (Schindler et al., 2007). The 500 m polygon closest to the linear feature encompassed the linear feature. Using ten buffer distances at 500 m intervals yields a 5 km buffer zone on either side of the disturbance (Figure 14). Each 500 m wide buffer polygon was doughnut-shaped, excluding the area of the smaller buffer polygon found within it. Buffered areas of linear features, when selected as a subset of a larger linear feature, have flat ends (not rounded ends) to represent the selected linear feature as accurately as possible. Each buffered area has an area measurement value in km^2.

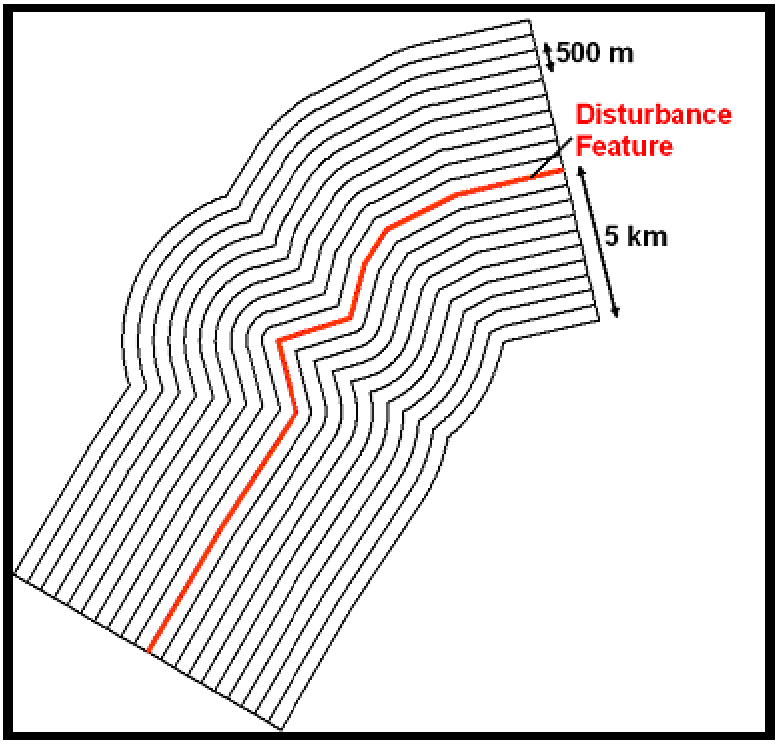


Figure 244: The disturbance feature (red line) is surrounded by a series of 10 buffered areas (black polygons) at a distance of 500 m totalling 5 km for the Project Study Area

GPS point density clustering was used to identify the number of caribou in a given area at any given time. Hawth's Analysis Tools (Version 3.27), "Count Points in Polygon" function in ArcGIS 9.3 (ESRI©, 2011), was used to identify the number of GPS points contained within each buffered polygon. For each buffered area, the count of GPS points was normalized as a percentage of all GPS collar points captured by the ten buffered polygons. This was achieved by dividing the count by the sum of all ten counts. The area of the polygon was then normalized by dividing each area value by the sum of the ten total polygon areas. A ratio of GPS collar points per buffered area was calculated by dividing percentage of normalized GPS collar points by normalized area. The resulting information provides an indication of caribou movement in relation to such linear features as roads, railways, or transmission lines. Point densities for multi-year and multi-season investigations were conducted. Comparisons consisted of pre- and post-Wuskwatim transmission construction. Telemetry data is available from 2007 to present for the Wuskwatim Transmission Line which was constructed in winter 2008-09. The effect the transmission line is having on caribou movement patterns in that area was identified and analysed (Figure 15).

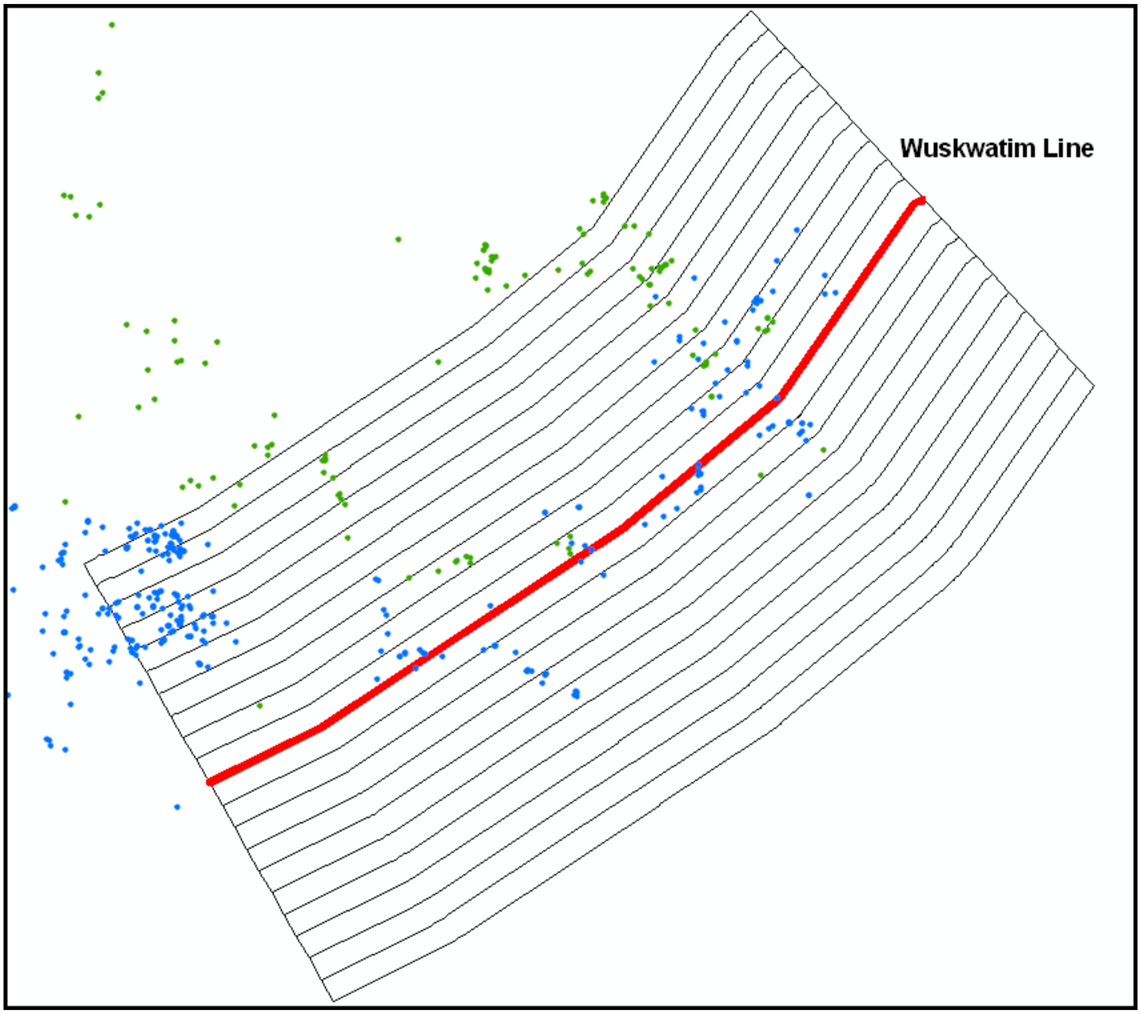


Figure 255: **Wuskwatim Transmission Line (red) and surrounding 500 m buffered areas (black polygons) with pre-construction of Wuskwatim Transmission Line caribou locations (blue points) and post construction of Wuskwatim Transmission Line caribou locations (green points) overlaid**

3.12.2 Path Trajectory

Caribou crossing analysis was used primarily on existing linear features such as power line corridors, roads, and railways. Caribou location data was converted into path trajectories for use in linear response analysis. Using Hawth's Analysis Tools (Version 3.27), “Convert Points to

Lines” function in ArcGIS 9.3 (ESRI©, 2011), each individual caribou location was connected chronologically to form a linear movement path for each animal. The order of points is predetermined by using the GPS time stamp information found within the telemetry data stream. Once a series of line features is created for each individual animal, a length calculation (in metres) is performed for each line segment, transforming GPS points to trajectory tracking information (Figure 16).

Attributes of Iridium_OCT_30_10

FID	Shape	Id	COLLAR_ID	Length
0	Polyline	0	2537	616.581366
1	Polyline	0	2537	28.879949
2	Polyline	0	2537	359.73723
3	Polyline	0	2537	619.357477
4	Polyline	0	2537	79.951094
5	Polyline	0	2537	202.02508
6	Polyline	0	2537	264.305531
7	Polyline	0	2537	343.671809
8	Polyline	0	2537	844.121616
9	Polyline	0	2537	171.199055
10	Polyline	0	2537	354.194311
11	Polyline	0	2537	466.5394
12	Polyline	0	2537	18.850116
13	Polyline	0	2537	2.994698
14	Polyline	0	2537	344.258759
15	Polyline	0	2537	746.103438
16	Polyline	0	2537	359.645022
17	Polyline	0	2537	213.086401
18	Polyline	0	2537	137.054486
19	Polyline	0	2537	356.193058
20	Polyline	0	2537	82.2079
21	Polyline	0	2537	71.41122
22	Polyline	0	2537	450.315074
23	Polyline	0	2537	691.224993
24	Polyline	0	2537	1026.18391
25	Polyline	0	2537	119.307117

Record: 0 Show: All Selected Records (0 out of 38314 Selected) Options

Figure 266: The attribute table of a line file generated from global positioning system point file for the caribou with the COLLAR_ID 2537 with length in metres (blue column) for each individual line segment in order by time

GPS data is converted from point features to line features by ‘connecting the dots’ through linking point A to point B (Figure 17).

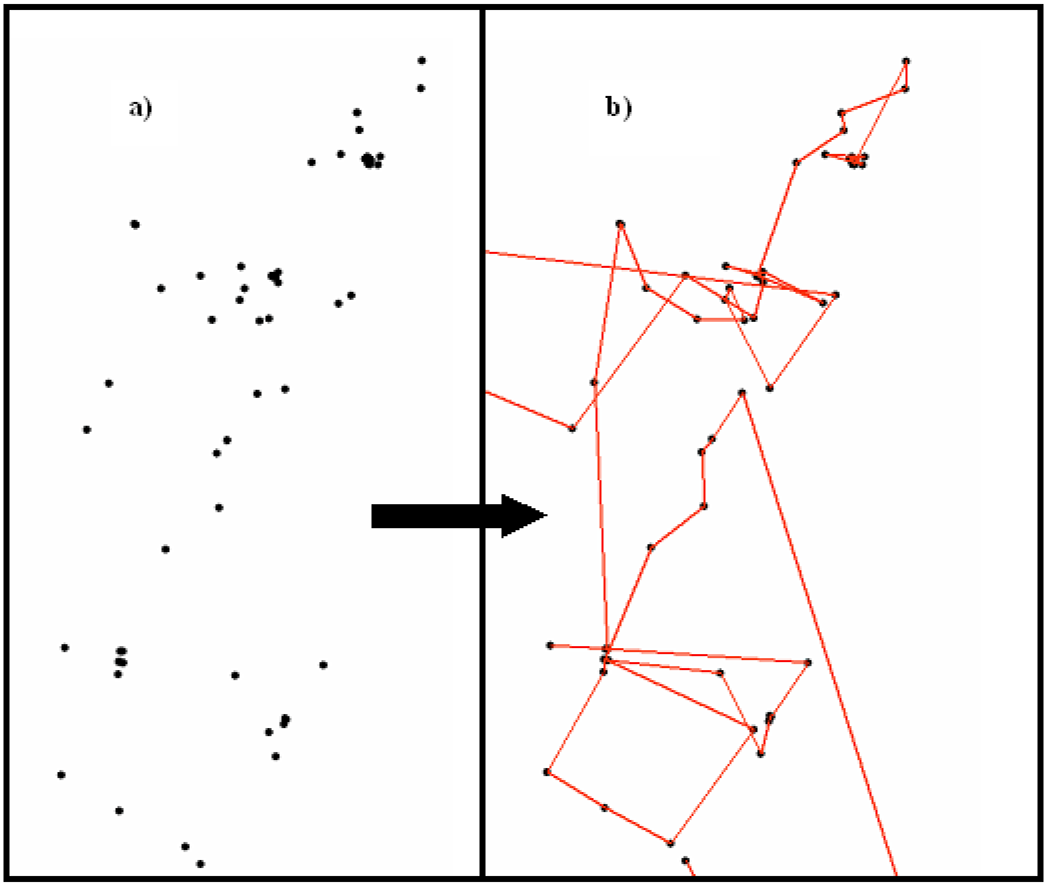


Figure 277: a) Example depicts a global positioning system point file consisting of X and Y locations. b) Illustrates the conversion of a global positioning system point file to a line file (red line) by linking sequential points by time

The trajectory files can be overlaid with linear feature information to determine if a spatial disturbance is limiting caribou movement and if so, in what spatial context (Figure 18).

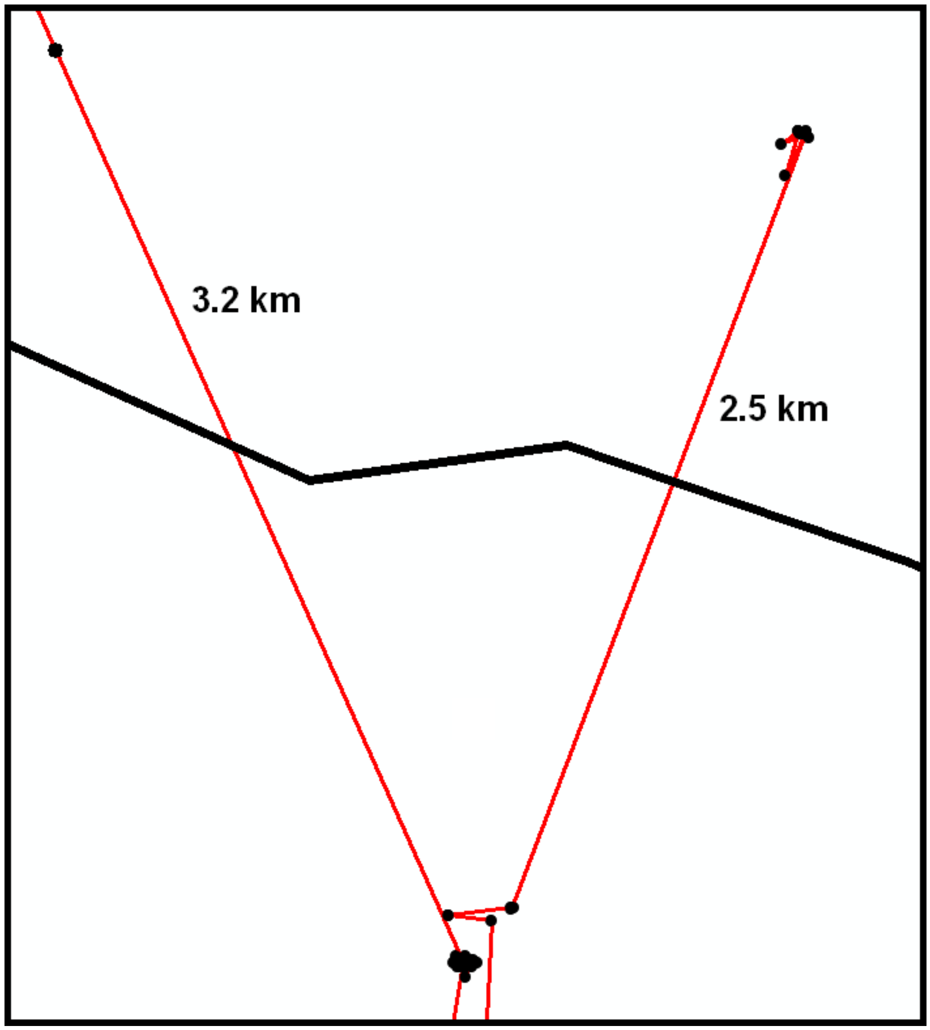


Figure 288: Example of a caribou trajectory path (red lines) generated from caribou global positioning system locations (block dots) indicate caribou move very quickly across a disturbance linear feature (black line)

The length of trajectory analysis determines the rate or speed at which caribou are crossing the linear feature verses the rate of speed they typically move at in the same area. Based on seasonality and movement patterns, critical calving locations and mortalities sites are identified. Standard Query Language (SQL) queries are made to the trajectory file database. For example, if 20 consecutive records in the ‘length’ column have occurred with a distance below 250 m from a single animal and if the season is fall and the animal moves on after a few days this may be a caribou calving area. If the animal does not move on, this may be a mortality site. A team can be deployed to confirm the animal in question. If mortality is confirmed, the team can recover the collar for new deployment.

3.12.3 Case Study: Before and After Wuskwatim

Using location data collected between 2007 and 2010, selected areas of caribou activity along the Wuskwatim Transmission Line were analyzed to compare distribution and behaviour prior to and following construction of the feature. Construction of the transmission line between Wuskwatim Lake and Snow Lake began with route clearing in winter 2008 and was completed in 2009. UHF data collected prior to construction (up to end of March 2008) was compared with GPS data following completion of the line (beginning in January 2010). Using path trajectory data, the movement rates of caribou when crossing the line were measured for each caribou (Figure 19).

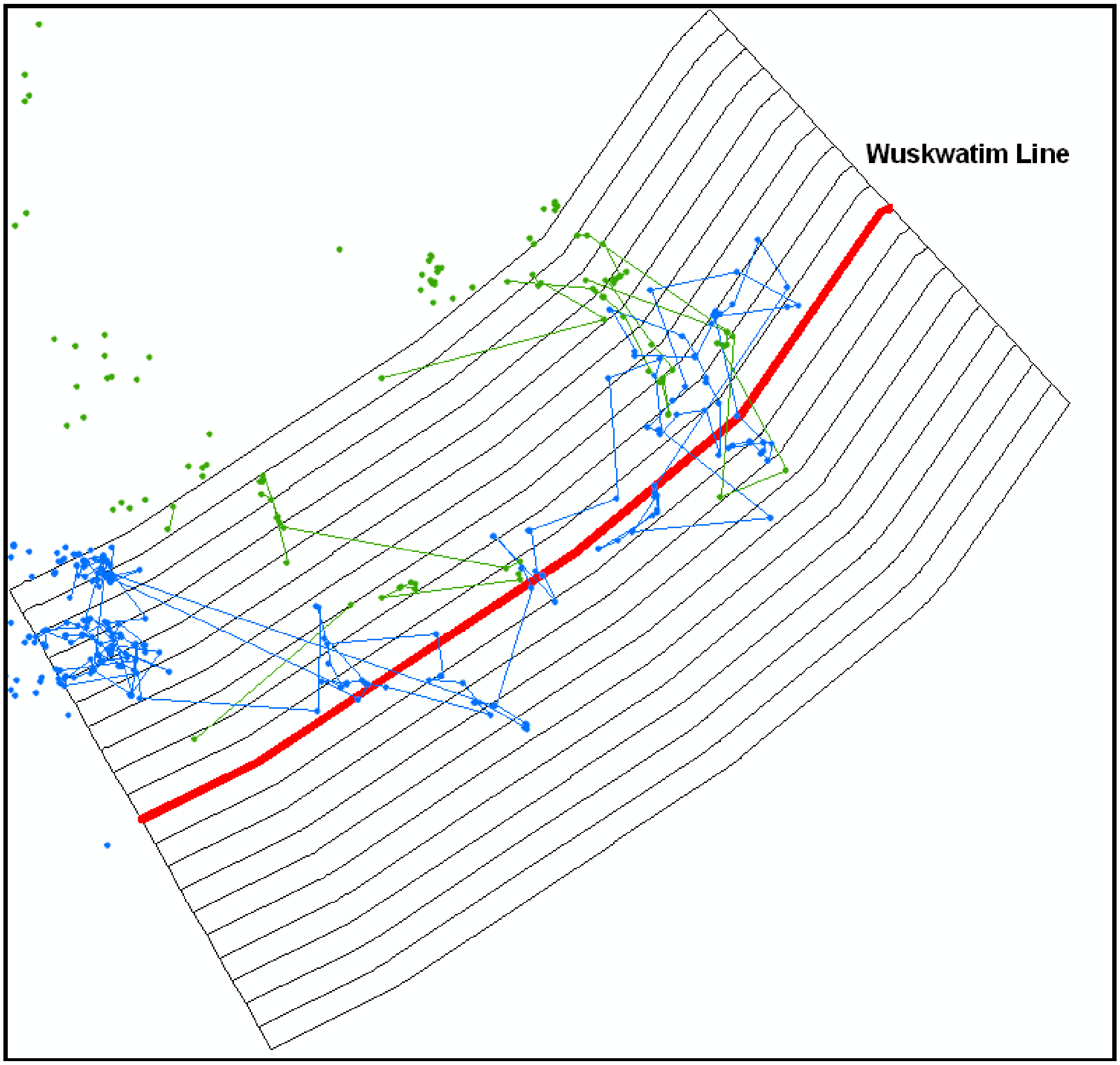


Figure 19: Wuskwatim Transmission Line (red) and surrounding 500 m buffered areas (black polygons) with pre-construction of Wuskwatim Transmission Line caribou path trajectories (blue lines) and post construction of Wuskwatim Transmission Line caribou path trajectories (green lines) overlaid. All trajectories outside the 5 km buffered area were excluded

3.13 Project Infrastructure-Core Area Intercept Analysis

The six boreal woodland caribou ranges entirely or partially contained in the Project Study Area include The Bog, Naosap, Wheadon, Harding Lake, Wabowden, and the combined Wimapedi-Wapisu range. These boreal woodland caribou evaluation ranges were assessed to determine the degree to which individual caribou populations will be affected by the Project infrastructure. Overlap between each range and the Project infrastructure Local Study Area was calculated in relation to total range area for boreal woodland caribou populations. Final preferred route length and its effects on total linear feature length within the area of overlap were evaluated. Intersection of range core areas, intact forest, and wetland patches were also assessed.

Winter core areas based on all available GPS telemetry data (collected from VHF, UHF, Iridium, and ATS collars between 2002 and 2011) were used to define range area (Map 7). Overlap with the Project infrastructure Study Area was expressed in km^2 and as a percentage of the total winter core area contained in the Project Local Study Area.

For all ranges found to have winter core areas overlapping with the Project Local Study Area, the length of existing linear features within the corridor and the length of intercepting the Project infrastructure (including the FPR centreline; no other Project infrastructure components were found to intersect boreal woodland caribou range cores) were calculated. Linear feature density within the Local Study Area based on existing linear features obtained from Manitoba Hydro and Tolko Industries Ltd. linear feature datasets was determined. Post-Project linear feature density, utilizing existing linear features and the FPR, were computed separately to evaluate the increase in linear feature density and range fragmentation resulting from transmission line construction.

In addition, the effects of the Project infrastructure on intact habitat patches were assessed for each of the affected range core areas. Wetland and forest (including broadleaf, mixedwood, and coniferous) LCCEB cover types were dissolved in a GIS environment. All intact patches contained in or intercepted by the range core areas were intersected with existing linear features obtained from Manitoba Hydro and Tolko Industries Ltd. datasets. The number and area of habitat patches intersected by Project infrastructure were computed for each range. The length of intercepting infrastructure was also calculated for each habitat patch by range.

3.14 Aboriginal Traditional Knowledge

Aboriginal Traditional Knowledge (ATK) materials, including literature, data, and maps, were obtained from the following communities and reviewed (MMM Group Ltd., 2011):

- Fox Lake Cree Nation
- Dakota Plains
- Dakota Tipi
- Duck Bay
- Camperville
- Pine Creek
- Waywayseecappo
- Dawson Bay
- Herb Lake
- Barrows
- Pelican Rapids
- Cormorant
- Thicket Portage
- Pikwitonei
- Chemawawin
- Westgate
- National Mills
- Baden
- Powell
- Red Deer Lake

In addition, ATK regarding caribou in the Bipole III study area was obtained from six First Nation Communities (Opaskwayak Cree Nation [OCN], Fox Lake Cree Nation [FLCN], Tataskweyak Cree Nation [TCN], Long Plain First Nation [LPFN], Wuskwi Sipihk First Nation [WSFN], and Swan Lake First Nation [SLFN]), as well as the Manitoba Metis Federation (MMF). Though information from these First Nations was used in this report (see Section 5.1.14 – Caribou ATK), names of interviewees and First Nations providing specific ATK were withheld this report for their confidentially purposes.

Once collected, the ATK survey data were reviewed for caribou location information and important features pertaining to the caribou. The locations of important sites, caribou habitats, and hunting of caribou were also noted, especially in relation to the Project Study Area.

Key personal interviews were conducted in October 2010 across various locations within the proposed Project route. The interview process was recorded by a tape recorder, notes were taken, and maps provided by MMM Group Ltd. were used. In addition to ATK, TEK was collected via non-aboriginal resource user interviews and was provided to Joro Consultants Inc. for use in this report. Results of interviews were synthesized, summarized, and added to Section 4.0 (*Existing Environment*) and Section 5.3 (*Environmentally Sensitive Areas/Sites*).

3.15 Residual Effects and Significance Evaluation

For the purpose of this report, a residual environmental effect is defined as the resultant change in the environment after the application of mitigation measures (Hegmann et al., 1999). In discussing significance of environmental and residual effects, the Bipole III Transmission Line III Scoping Document specifies that "the significance of the residual environmental effects of the proposed Project will be evaluated based on best and current practices, and will use a pre-determined significance evaluation framework…" Significance of possible residual effects on VEC species was determined through the use of eight factors evaluating each effect: Direction or nature of effect, magnitude, geographic extent, duration, frequency, reversibility, ecological and importance societal importance. Based on these eight factors, significance ratings were assigned to each potential affect as being either 1) Not significant, Insignificant or Negligible, 2) Potentially Significant or 3) Significant. See Section 4.2.10 of the Bipole III EIS – Residual Effects Significance Evaluation for a detailed description of the factors and criteria use.

4.0 EXISTING ENVIRONMENT

The following section provides a description of the existing environment based on the results of desktop investigations and field studies. The results of modeling, assessing existing information, and data derived from field studies provided the basis for assessing alternative routes and the FPR.

4.1 Development of Habitat Cover Categories

The LCCEB was produced for the entire Project Study Area in shapefile format for use in habitat and land cover-related analyses and map displays (Map 12). The dataset was also generated in tiled format for all National Topographic System (NTS) map sheet tiles intersecting Project Study Area boundary.

4.2 Caribou Telemetry Studies

In 2010, there were a total of 76 Iridium Track3D collars manufactured by Lotek Wireless Inc. from Newmarket, Ont. Each collar provided a GPS location every three hours for the duration of the battery life of three years (Map 13). The 76 collars supplemented previous 24 UHF and Iridium collars deployed in 2009 to maintain a sample size of 20 collars per range. Historical data was also used from collars deployed from 1969 to 2006. The Iridium GPS collars attempts to record eight locations per day, at three hour intervals. Data is transmitted via the Iridium satellite network after every twelve locations are recorded, approximately 36 hours. Data is received by Joubeh Inc. (Dartmouth, NS) and stored on their server and is downloaded by Joro Consultants Inc. on a bi-weekly schedule. Further processing is required utilizing specialized software from Lotek Wireless Inc. while mapping and analysis was completed in ArcGIS (ESRI©, 2011). The following is a summary of collar data used in the Project (

Table 27;

Table 28).

Table 27: Boreal woodland caribou collar deployments 2002-2011 and active collars as of March 15, 2011

Caribou Range	Type	Deployments			Active Collars
		2002-2009	2010	2011	
Wabowden	UHF	10	0	0	9
Wimapedi	UHF	14	0	0	0
The Bog	Iridium	0	16	8	22
Wimapedi	Iridium	0	7	8	16
Wabowden	Iridium	0	10	5	12
Reed Lake	Iridium	3	3	5	10
Wheadon	Iridium	0	20	8	22
Harding Lake	GPS/Irid	3	8	14	19
Wapisu	GPS/Irid	3	12	0	11
The Bog	VHF	6	0	0	3
Naosap	GPS/Irid	15	0	22	22
Total		**54**	**76**	**70**	**146**

Table 28: Coastal caribou collar deployments 2010-2011 and active collars as of March 15, 2011

Range	Type	Deployments		Active Collars
		2010	2011	
Cape Churchill	Iridium GPS	10	0	8
Pen Island	Iridium GPS	9	13	18

4.3 Aerial Surveys

Multispecies surveys were flown in 2011 in The Bog, Wabowden, Wimapedi, and Wheadon ranges. For each range, track and sightings were recorded for caribou, as well as moose and wolf (Map Series 400). The relative distributions of each species were mapped using volume based kernel methods to identify concentrations of each species within the range (Map Series 600 for caribou, 700 for moose, and 800 for wolf). Tables 13 to 15 indicate species observations within each survey block.

Table 13: Results for 2011 caribou aerial surveys across in various ranges within the Project Study Area

Range Surveyed	Adults	Calves	Total
The Bog	41	4	45
Wimapedi- Wapisu	12	1	13
Wabowden	24	0	24
Wheadon	20	0	20

Table 14: Results for 2011 moose aerial surveys across in various ranges within the Project Study Area

Range Surveyed	Adults	Calves	Total
The Bog	35	5	40
Wimapedi-Wapisu	11	2	13
Wabowden	5	0	5
Wheadon	30	4	34

Table 15: Results for 2011 wolf aerial surveys across in various ranges within the Project Study Area

Range Surveyed	Adults
The Bog	10
Wimapedi-Wapisu	1
Wabowden	1
Wheadon	11

In 2009-2010, surveys were conducted in the Wimapedi-Wapisu, Wheadon, Naosap, Wabowden, and The Bog ranges. Caribou surveys were conducted in the Gillam area in 2009 and 2010. Results of 2009-2010 aerial surveys are summarized by species in Tables 16-18 (Map Series 500).

Table 296: Summary of 2009-2010 results for caribou aerial surveys conducted within the Project Study Area

Range	Year	Number of Track Observations	Number of Observed Individuals
Bog	2009	267	13
Gillam	2009	8	11
Bog	2010	187	26
Naosap	2010	193	70
Wheadon-Wimapedi-Wapisu	2010	220	156
Keeyask	2010	17	30
Wabowden	2010	54	0

Table 307: Summary of 2009-2010 results for moose aerial surveys conducted within the Project Study Area

Range	Year	Number of Track Observations	Number of Observed Individuals
Bog	2009	132	25
Gillam	2009	20	4
Bog	2010	0*	31
Naosap	2010	72	48
Wheadon-Wimapedi- Wapisu	2010	28	12
Keeyask	2010	0	4
Wabowden	2010	30	11

*Track observations were not recorded, however tracks might have been present.

Table 318: Summary of 2009-2010 results for wolf aerial surveys conducted within the Project Study Area

Range	Year	Number of Track Observations	Number of Observed Individuals
The Bog	2009	23	10
Gillam	2009	13	0
The Bog	2010	36	0
Naosap	2010	51	24
Wheadon-Wimapedi-Wapisu	2010	96	27
Keeyask	2010	0	0
Wabowden	2010	16	0

Prior to 2010, helicopter surveys were conducted for caribou in similar survey blocks, including The Bog range, the Loonhead block (Wheadon range), Wekusko block (Wimapedi Range), Swan-Pelican range, and Naosap range. These surveys were conducted irregularly between 2004 and 2009 (Table 19: Summary of 2004-2009 results for caribou aerial surveys conducted within the Project Study Area19). There were no confirmed caribou observations in the Swan-Pelican area and subsequent flights in 2010 and 2011 did not locate any caribou (Table 20: Summary of 2007-2011 results for caribou surveys conducted in the Swan-Pelican range.

Point density surfaces were generated with surveys from 2004-2010 for these ranges to provide supplementary distribution data for the core areas produced from GPS data where necessary (Map 14).

Table 19: Summary of 2004-2009 results for caribou aerial surveys conducted within the Project Study Area

Range/Block	Year(s)	Number of Track Observations	Number of Observed Individuals
Naosap	2006	76	8
Loonhead	2008-09	184	90
The Bog	2004-07	543	65
Wekusko	2007	163	26

Table 20: Summary of 2007-2011 results for caribou surveys conducted in the Swan-Pelican range

Year	Count
2007	0*
2009	0
2010	0*
2011	0

*Track observations were not recorded

4.4 Core Area Analysis

The core area analysis utilized GPS data to delineate major wintering grounds of boreal woodland caribou ranges supplemented by aerial survey data. The 90% contour of the volume-based kernel was chosen to identify continuous core areas for each range area. The total area covered in all ranges was 12,091 km^2, Table 21 summarizes the ranges, indicating the number and size of core areas. Map 7 shows the distribution of core areas in relation to the FPR. The FPR intersects winter core areas in three ranges, for a total of 62 km, as shown in Table 21: Number and size of core areas by range1.

Table 21: Number and size of core areas by range

Range	Number of Cores	Mean Area (km^2)	Total Area (km^2)
Harding Lake	3	113.7	341
Naosap	2	931.0	1,862
Reed	3	679.3	2,038
The Bog	3	638.3	1,915
Wabowden	4	414.5	1,658
Wheadon	2	499.5	999
Wimapedi-Wapisu	7	468.3	3,278

4.5 Boreal Woodland Caribou Habitat Modeling

4.5.1 Calving Patch Identification and Modeling

The predictive calving habitat model was initially developed for use in the Project Alternative Routes Evaluation. As such, it was generated for the northern portion of the Project Study Area, including the ecoregions contained in the Hudson Plain, Boreal Plain, and Boreal Shield Ecozones (Map 15).

Caribou calving habitat, as identified by the LCCEB-based predictive habitat model, occurred in the Hudson Plain, Boreal Plain, and Boreal Shield Ecozones and in five of the six Ecoregions (Interlake Plain, Mid-Boreal Lowland, Churchill River Upland, Hayes River Upland, and Hudson Bay Lowland) intersected by the Project Study Area (Table 22; Table 23). The exclusion of the Selwyn Lake Upland Ecoregion was a result of its minimal area of overlap with the corridor, rather than absence of predicted calving habitat (Map 15). The corridor contained a total of 145,413 ha of calving habitat (Table 22). Calving habitat within the corridor was concentrated in the Boreal Plain Ecozone, with 48% of all habitat overlapping the corridor being contained in the Mid-Boreal Lowland Ecoregion.

Modeled calving habitat patches were intersected by all northern Project components, including the Keewatinoow-Construction Power Site line (KN36 - 60 m ROW), the northern electrode line (50 m ROW), the AC collector Henday-Long Spruce (L61K - 60 m ROW), the combined AC collector lines (310 m ROW), the construction power camp and construction power site footprints, the Keewaatinoow converter station footprint, and the proposed and alternative northern electrode sites (NES6 and NES7) (Table 22-24). The total length of intersection between predicted calving habitat and Project infrastructure was 299 km, the majority (93%) of intersecting infrastructure being composed of the FPR (Table 23).

Despite the considerable number of intersecting Project components, the total area of potential calving habitat within the Project footprints represented only approximately 0.5% of available habitat in the corridor, all of which was contained in the Hudson Bay Lowland Ecoregion.

Table 22: Area (ha) of overlap between Project infrastructure component footprints and predicted caribou calving habitat by ecozone and ecoregion, and percentage of total overlapping infrastructure area for each component

Ecozone	Ecoregion	Area (ha) of Calving Habitat within the Project Local Study Area	% of Total Habitat within the Project Local Study Area	Area (ha) of Calving Habitat within the AC Collector 310m ROW	% of Calving Habitat within the AC Collector 310m ROW	Area (ha) of Calving Habitat within the Construction Power Camp Footprint	% of Total Calving Habitat within the Construction Power Camp Footprint	Area (ha) of Calving Habitat within the Construction Power Station Footprint	% of Total Calving Habitat within the Construction Power Station Footprint	Area (ha) of Calving Habitat within the Keewaatinoow CS Footprint	% of Total Calving Habitat within the Keewaatinoow CS Footprint	Area (ha) of Calving Habitat within the Northern Electrode Site NES6	% of Total Calving Habitat within the Northern Electrode Site NES6	Area (ha) of Calving Habitat within the Northern Electrode Site NES7	% of Total Calving Habitat within the Northern Electrode Site NES7
Boreal Plain		97,503.0	67.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Interlake Plain	27,105.3	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mid-Boreal Lowland	70,397.7	48.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Shield		24,862.7	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Churchill River Upland	10,441.1	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hayes River Upland	14,421.6	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hudson Plain		23,047.2	15.9	359.9	0.3	27.6	0.0	2.3	0.0	0.0	0.0	187.6	0.1	175.5	0.1
	Hudson Bay Lowland	23,047.2	15.9	359.9	0.3	27.6	0.0	2.3	0.0	0.0	0.0	187.6	0.1	175.5	0.1
Total		**145,412.9**	**100.0**	**359.9**	**0.3**	**27.6**	**0.0**	**2.3**	**0.0**	**0.0**	**0.0**	**187.6**	**0.1**	**175.5**	**0.1**

Table 23: Length (km) of intersection between linear Project infrastructure components and predicted caribou calving habitat by ecozone and ecoregion, and percentage of total infrastructure length for each component

Ecozone	Ecoregion	Length (km) of Intersection with Project Infrastructure	Length (km) of Intersection with FPR	% of Total Intersection with FPR	Length (km) of Intersection with KN36	% of Total Intersection with KN36	Length (km) of Intersection with L61K	% of Total Intersection with L61K	Length (km) of Intersection with Northern Electrode Line	% of Total Intersection with Northern Electrode Line
Boreal Plain		214.0	214.0	71.6	0.0	0.0	0.0	0.0	0.0	0.0
	Interlake Plain	56.1	56.1	18.8	0.0	0.0	0.0	0.0	0.0	0.0
	Mid-Boreal Lowland	157.9	157.9	52.8	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Shield		49.2	49.2	16.5	0.0	0.0	0.0	0.0	0.0	0.0
	Churchill River Upland	16.6	16.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0
	Hayes River Upland	32.6	32.6	10.9	0.0	0.0	0.0	0.0	0.0	0.0
Hudson Plain		35.7	13.8	4.6	4.1	1.4	16.3	5.5	1.5	0.5
	Hudson Bay Lowland	35.7	13.8	4.6	4.1	1.4	16.3	5.5	1.5	0.5
Total		**298.9**	**277.0**	**92.7**	**4.1**	**1.4**	**16.3**	**5.5**	**1.5**	**0.5**

Table 24: The Project infrastructure components and associated identification codes used in environmental assessment analyses

Infrastructure Component	ID Code	ROW Width
Final Preferred Route	FPR	66 m
AC Collector Lines and Construction Power Line (Henday - Keewatinoow)	L61K, K61H, K62H, K63H, K64H, KN36	310 m
Construction Power (Keewatinoow to Construction Power Station)	KN36	60m
AC Collector (Long Spruce - Henday)	L61K	60 m
Preferred Northern Electrode Site	NES6	N/A
Alternate Northern Electrode Site	NES7	N/A
Preferred Southern Electrode Site	SES1c	N/A
Alternate Southern Electrode Site	SES3	N/A
Northern electrode line	N/A	50 m

4.5.2 Winter Habitat Model

Like the calving model, the predictive caribou winter habitat model was generated for the northern portion of the Project Study Area for use in the Project Alternative Routes Evaluation (Map 16).

Predicted winter caribou habitat was distributed amongst the Hudson Plain, Boreal Plain, and Boreal Shield Ecozones in all Project Local Study Area intersected ecoregions, excepting the Selwyn Lake Lowland Ecoregion (

25; Table 26). The corridor contained a total of 167,419 ha of winter habitat. Winter habitat within the corridor was distributed similarly to predicted calving habitat, though, at 58%, the concentration of habitat in the Mid-Boreal Lowland Ecoregion was even more pronounced.

Winter habitat patches were intersected the Keewatinoow-Construction Power Site line (KN36 - 60 m ROW), the northern electrode line (50 m ROW), the combined AC collector lines (310 m ROW), and the proposed and alternative northern electrode sites (NES6 and NES7) (Table 25; Table 26). The total length of intersection with all components was 335 km, with the FPR comprising greater than 99% of the intercept length (Table 26).

At 0.46% of the total predicted habitat area in the corridor, the proportion of predicted winter habitat within the Proejct infrastructure footprints was similar to that observed for the calving habitat model (Table 25).

Table 25: Area (ha) of overlap between the Project infrastructure component footprints and predicted caribou winter habitat by ecozone and ecoregion, and percentage of total overlapping infrastructure area for each component

Ecozone	Ecoregion	Area (ha) of Winter Habitat within the Project Local Study Area	% of Total Habitat within the Project Local Study Area	Area (ha) of Winter Habitat within the AC Collector 310m ROW	% of Winter Habitat within the AC Collector 310m ROW	Area (ha) of Winter Habitat within the Northern Electrode Site NES6	% of Total Winter Habitat within the Northern Electrode Site NES6	Area (ha) of Winter Habitat within the Northern Electrode Site NES7	% of Total Winter Habitat within the Northern Electrode Site NES7
Boreal Shield		43,018.1	25.7	0.0	0.0	0.0	0.0	0.0	0.0
	Churchill River Upland	13,133.3	7.8	0.0	0.0	0.0	0.0	0.0	0.0
	Hayes River Upland	29,884.8	17.9	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Plain		103,716.7	62.0	0.0	0.0	0.0	0.0	0.0	0.0
	Interlake Plain	6,681.6	4.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mid-Boreal Lowland	97,035.1	58.0	0.0	0.0	0.0	0.0	0.0	0.0
Hudson Plain		20,684.2	12.4	742.7	0.4	9.5	0.0	12.8	0.0
	Hudson Bay Lowland	20,684.2	12.4	742.7	0.4	9.5	0.0	12.8	0.0
Total		**167,419.0**	**100.0**	**742.7**	**0.4**	**9.5**	**0.0**	**12.8**	**0.0**

Table 26: Length (km) of intersection between the linear Project infrastructure components and predicted caribou winter habitat by ecozone and ecoregion, and percentage of total infrastructure length for each component

Ecozone	Ecoregion	Length (km) of Intersection with Project Infrastructure	Length (km) of Intersection with FPR	% of Total Intersection with FPR	Length (km) of Intersection with KN36	% of Total Intersection with KN36	Length (km) of Intersection with Northern Electrode Line	% of Total Intersection with Northern Electrode Line
Boreal Shield		87.9	87.9	26.2	0.0	0.0	0.0	0.0
	Churchill River Upland	30.8	30.8	9.2	0.0	0.0	0.0	0.0
	Hayes River Upland	57.0	57.0	17.0	0.0	0.0	0.0	0.0
Boreal Plain		220.3	220.3	65.7	0.0	0.0	0.0	0.0
	Interlake Plain	17.5	17.5	5.2	0.0	0.0	0.0	0.0
	Mid-Boreal Lowland	202.8	202.8	60.5	0.0	0.0	0.0	0.0
Hudson Plain		27.0	24.2	7.2	0.8	0.2	1.9	0.6
	Hudson Bay Lowland	27.0	24.2	7.2	0.8	0.2	1.9	0.6
Total		**335.1**	**332.4**	**99.2**	**0.8**	**0.2**	**1.9**	**0.6**

4.6 Lichen Surveys

The abundance of terrestrial and arboreal lichens as determined from the aerial and ground surveys conducted in November 2010 was mapped along the FPR (Map Series 300). The map provides a visual measure lichen abundance, which operates as an indicator of caribou habitat quality. It will be used in the Environmental Protection planning process to assess the need for mitigation measures relative to the FPR and surrounding area.

4.7 Wolf Telemetry And Predation Monitoring

In winter 2010 and 2011, a total of 51 wolves were equipped with satellite telemetry collars across ten study ranges (Table 27). Thirty-five collars remained active as of March 15, 2011.

Table 27: Wolf collar deployment by caribou range and active collars as of March 15, 2011

Range	2010	2011	Active Collars
Harding Lake	4	11	12
The Bog	0	4	4
Wabowden	4	4	5
Wapisu	3	0	0
Wheadon	5	0	0
Wimapedi	2	10	10
Wuskwatim	0	4	4
Total	**18**	**33**	**35**

Wolf census data from aerial surveys was combined with telemetry data to identify pack sizes and home ranges where collared animals were observed with a pack. Pack sizes and number of collared animals are shown in Table . In the census area (17,000 km^2), 83 wolves were observed amongst 20 packs or lone animals. An approximate density of 5 wolves per 1,000 km^2 was estimated. Twenty-seven collared wolves were observed among eight of these packs during aerial surveys conducted in January 2011 (Map 17) and pack associations were determined for the collared animals based on these results. Wolf pack home ranges were delineated for these

eight packs by mapping the total MCPs for the collars associated with each pack (Map 18). Pack size ranged from 2 to 12, with as many as 5 collared wolves in a single pack.

Table 28: Pack size and number of collars deployed for wolf packs surveyed in the Project Study Area

Pack Name	Pack Size	Collars
Muskego Lake	5	3
Odei River	6	3
Ridge Lake	8	4
Crowduck Bay	2	2
Riel Lake	12	5
William	1	
Smith	2	
Saw Lake	9	5
McNeal Lake	8	3
Pakwa Lake	2	
Fish Lake	2	
North Setting Lake	2	
Wabowden Dump	2	
Rosenberry Lake	2	
Egg Lake	3	
Tullibee Lake	2	
Threepoint Lake	1	
Bison Lake	5	
Burr Lake	1	
Reed Lake	8	2
Total	**83**	**27**

4.8 Trail Camera Studies

From the 91 cameras to date, a collection of approximately 130,000 pictures have been captured. Keywords were applied to pictures captured up to the end of 2010 (Appendix C3). Species identified on the cameras included caribou (Figure 20), moose (Figure 21), black bear (Figure 22), wolf (Figure 23), wolverine, lynx, other furbearers, and bird species (Appendix C4). The distributions of observations are displayed in Map Series 900 for caribou and Map Series 1000 for wolf and black bear. A comprehensive database that contributes to long-term monitoring of

species diversity in caribou range will include GPS camera locations and species occurrence and is currently being coordinated by Manitoba Hydro Licensing and Environmental Assessment (LEA).

Figure 20: Trail camera picture of boreal woodland caribou from the Bog range, fall 2010

Figure 21: Trail camera picture of a bull moose from the Harding Lake area, December 2010

Figure 22: Trail camera picture of bear and cubs from the Bog area, summer 2010

Figure 23: Trail camera picture of wolves from the Bog area, December 2010

4.9 Calf Recruitment Surveys

Initial calf recruitment among collared animals varied widely between ranges in 2010 (Map Series 1100). A total of 80 collared females were tracked over the course of the summer and a total of 20 calves observed during the initial surveys conducted, representing 25% overall initial recruitment for all observed collared caribou in the spring in the Project Study Area (Figure 24).

Initial recruitment (calves actually observed during the first surveys) was found to be variable among populations. At the range level, 20% initial recruitment was observed for collared females in the Wabowden and The Bog ranges. The lowest recruitment rate was found in the Wimapedi-Wapisu range area, with only 10% of observed females having calves. The highest initial rates of recruitment were seen in the most remote and undisturbed ranges Harding Lake (43%) and Wheadon (48%). Recruitment in the Wheadon range was primarily concentrated in the Highrock Lake region and animals with calves were frequently observed on islands.

While initial recruitment was highly variable among ranges, calf survival through the summer and into the fall was poor across the Project Study Area. Only three surviving calves were observed in the Bog in September and 100% mortality occurred in the other ranges, resulting in a mean recruitment rate of less than 4% (Table 29).

Table 32: Minimum natality and September calf:cow ratios by range for all collared caribou observed in tracking surveys conducted monthly between May and September 2010

Range	Number of Collared Caribou Observed	Number of Calves Observed	Minimum Natality Rate	Number of Calves Surviving in September	September calves:100 cows
Harding Lake	7	3	42.9	0	0.0
The Bog	20	4	20.0	3	15.0
Wabowden	15	3	20.0	0	0.0
Wheadon	17	8	47.1	0	0.0
Wimapedi-Wapisu	21	2	9.5	0	0.0
Total	**80**	**20**	**25.0**	**3**	**3.8**

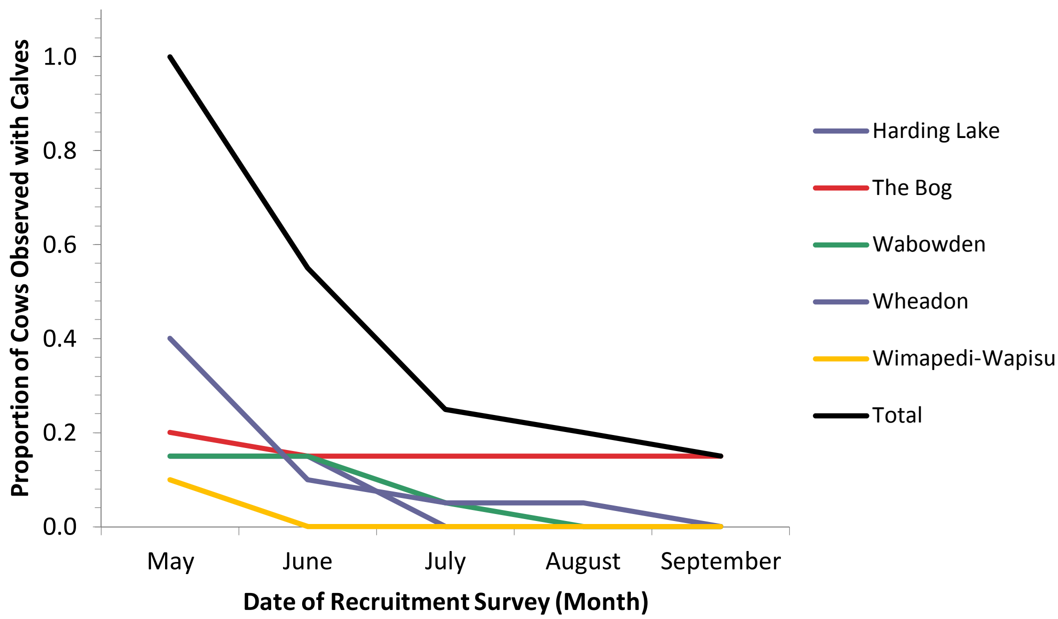


Figure 24: Proportion of tracked collared female caribou by range observed with calves, based on very high frequency tracking surveys conducted monthly between May and September 2010

Mortality among collared female caribou was relatively low for all ranges between February 2009 and December 2010 (Figure 25). All confirmed female mortalities were wolf kills and were spatially correlated with GPS Argos point locations (Map Series 1200). The highest mortality rates were observed in the most remote and unfragmented range areas: Harding Lake (25%) and Wheadon (20%) (Section 4.9). Wimapedi-Wapisu and The Bog, with moderate levels of habitat disturbance, had lower mortality rates of 13% and 10%, respectively. The lowest rate of wolf predation on collared females (5%) was observed in the Wabowden range, which is characterized by the greatest degree of habitat fragmentation and anthropogenic disturbance.

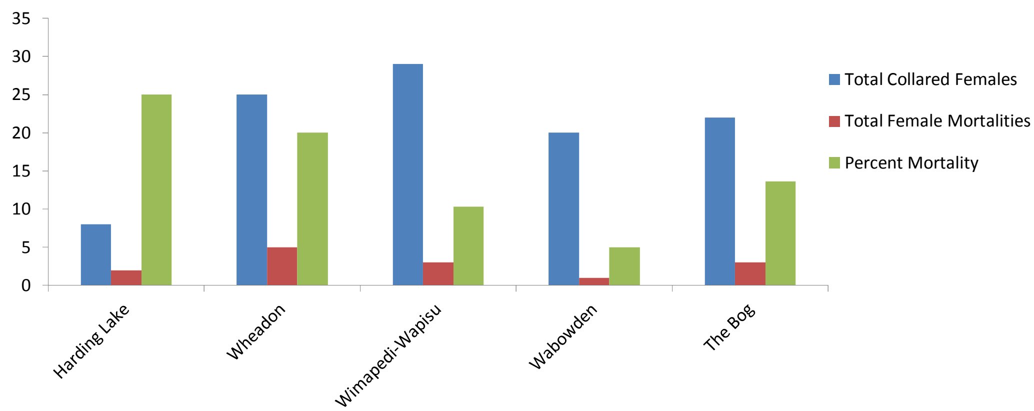


Figure 25: Total and percent female mortality for all collared boreal woodland caribou by range between February 2009 and December 2010

Trail camera results showed some correspondence between bear sightings and calf distribution (Map Series 1300); however, results are preliminary and more data collection must occur before conclusions can be drawn regarding the relative impact of bears on calf survival.

4.10 Disturbance Regime Assessment

The disturbance trends for each caribou range are displayed in Figure 26. The X-axis was characterized primarily by the overall disturbance trend, with the amount of disturbance increasing to the right of the graph. Secondly, it was typified by habitat type, with more forested habitats falling at the top of the graph and the proportion of wetland-dominated habitat increasing toward the base of the graph. The Y-axis was characterized primarily by linear feature type. The trend percentages along the axes indicated that 68% of the variation in the disturbance metrics was explained by the two axes depicted in the graph.

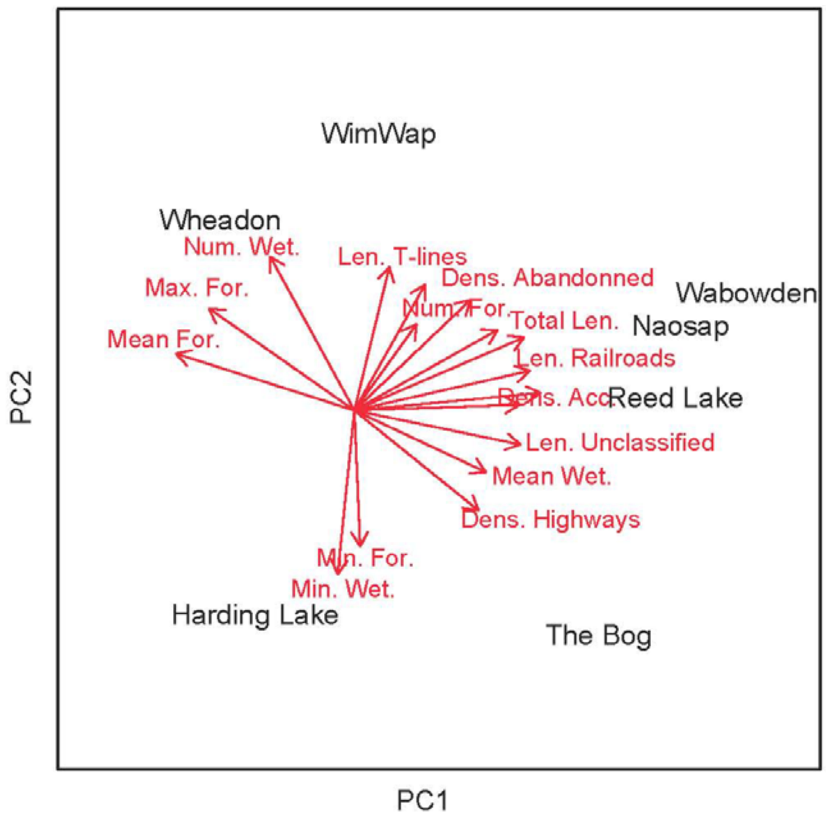


Figure 26: Graphical biplot presentation of the principle component analysis used to assess disturbance regime in The Bog, Wabowden, Wimapedi-Wapisu (= WimWap), and Harding Lake Ranges (Legend: For.=forest, Wet.=wetland, Acc.=access, Len.=length, Dens.=density, Num.=number, Max.=maximum, Min.=minimum, T-line=transmission line). Note: Only selected variables are displayed

Metrics for the number and length of features were usually strongly correlated, except for transmission lines and forestry roads, for which length was a better indicator than number of roads. This trend reflected the fact that transmission lines are characterized by a few very long segments, while forestry roads are composed of a large number of short segments; thus, number of roads tended to exaggerate the disturbance effects of forestry roads, while minimizing those of transmission lines.

Roads in general trend strongly with overall trends for fragmentation, with higher values for number and length of roads being correlated with more fragmented (less contiguous) habitat. Conversely, rail lines were unremarkable as an indicator of disturbance.

As defined by the PCA, The Bog had a moderately high overall level of disturbance, being characterized by large contiguous wetland patches and a large minimum patch size, but also a high density of highways. Based on this analysis, The Bog range illustrates a high degree of disturbance; however, virtually all access is concentrated in the eastern portion of the range, leaving the western portion relatively undisturbed.

Harding Lake and Wheadon were the least affected by fragmentation, an expected result as they are the most remote ranges. Both were characterized by larger numbers of contiguous patches and larger minimum patch sizes. Both also had a high proportion of forested habitat in relation to wetland habitat.

Wabowden, Naosap, and Reed Lake were characterized primarily by the presence of railroads. Reed Lake was relatively normal to slightly impacted, due to the railroad and several abandoned roads and access routes. Wabowden and Naosap showed a similar pattern to Reed Lake with much larger values for access and roads. These sites were considered impacted, being the most affected by fragmentation as result of the high density of roads.

Wimapedi-Wapisu was typified by a large number of access roads and a large number of contiguous forest and wetland habitat patches. Fragmentation values for this range tended to be more normal than the other ranges; however, the Wimapedi-Wapisu range MCP is much larger than the other range MCPs. Thus, a much broader range of habitat conditions were present and had the effect of diluting trends that may have been identifiable in a smaller area.

4.11 Effects Monitoring

The following section provides a brief overview of a preliminary analysis of caribou movement near anthropogenic linear features such as roads and transmission line ROWs. The information presented is preliminary and based on limited data up to March, 2011. Data from collared animals continues to be acquired and additional analysis is currently being undertaken. The results of a comprehensive analysis will be presented as a supplemental report for additional evidence in the Project environmental licensing process.

4.11.1 Point Density

There were seven linear features selected to perform caribou point density calculations on caribou telemetry dated back to 2007 to 2010 and was broken down by summer and winter. The seven line segments were based on existing linear features including sections of the Wuskwatim Transmission Line, the Provincial Trunk Highway 6, a railway, and existing 230 kV transmission lines (Wuskwatim to Herblet Lake, Herblet Lake to Rall's Island, and Grand Rapids to Ponton). Summer consisted of dates ranging from June 15 to September 15 while winter dates ranged from November 1 to March 15. In total, eight seasons were examined for caribou point density (Figure 26).

Figure 26 shows 11.4% caribou are found within 500 m on either side of the linear features for a 5 km buffered area. Caribou tend to congregate in the 500 to 1,500 m range of the linear features and dissipate beyond 2,500 m of the linear features (Figure 27).

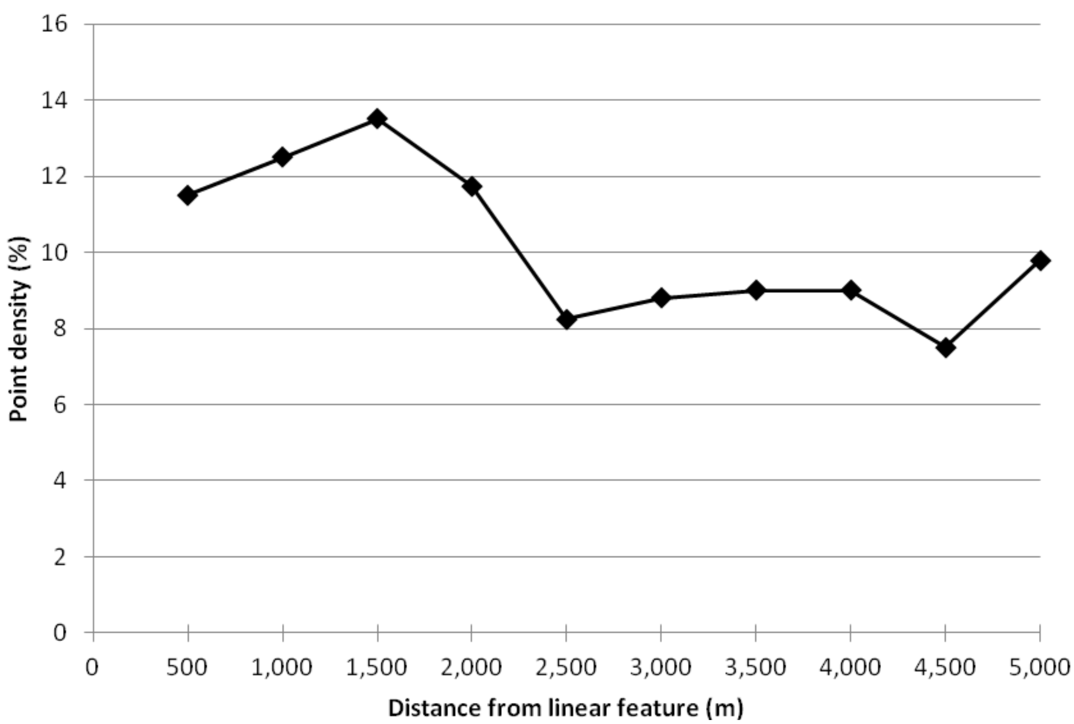


Figure 27: Caribou point density in percentage for all linear features and for all seasons in buffered areas

4.11.2 Path Trajectory

The same seven linear features as were used in the point density calculations (Section 4.11.1) were selected to perform caribou path trajectory calculations on. Caribou telemetry was taken every three hours using June 2007 to December 2010 data. These were separated by summer and winter seasons for each year. Summer movement analysis consisted of dates ranging from June 15 to September 15, while winter dates ranged from November 1 to March 15. In total, eight seasons were examined for caribou path trajectory (Table 30).

Table 30: Caribou path trajectories that did and did not cross the seven linear features within 5 km

Season	Crossed Count	Crossed Average (m)	Non-Crossed Count	Non-Crossed Average (m)
Summer 2007	43	2,136.1	502	541.5
Winter 2007-08	20	2,319.2	412	621.4
Summer 2008	21	1,830.7	321	517.5
Winter 2008-09	25	2,751.9	3,314	348.4
Summer 2009	125	1,569.1	2,696	454.2
Winter 2009-10	190	2,122.1	9,384	484.9
Summer 2010	248	1,601.9	5,945	421.5
Winter 2010	69	2,820.9	1,129	589.1

For each season, the average length of caribou path trajectory crossing linear features was three to four times longer than the non-crossed trajectory for all seven linear features. This pattern is apparent when examining caribou trajectories by season, namely all summer trajectories versus all winter trajectories and all trajectories combined (Table 31).

Table 31: **All caribou summer trajectories verses all caribou winter trajectories and all trajectories combined**

	Crossed Count	Crossed Average (m)	Non-Crossed Count	Non-Crossed Average (m)
All Summer	437	1,656.1	9464	440.4
All Winter	304	2,345.5	14,239	465.3
All Seasons	741	1,938.9	23,703	455.4

This trend is exaggerated when multiple linear features such as roads, railways, and transmission lines are combined. Map 19 shows the Project Study Area where Provincial Highway 6 and a 230 kV transmission line are examined for crossing and non-crossing caribou path trajectories (Table 32).

Table 32: Caribou crossing and no-crossing trajectories for multiple features (highway and transmission line)

	Crossed Count	Crossed Average (m)	Non-Crossed Count	Non-Crossed Average (m)
All Seasons	41	4,055.6	4,595	471.6

Caribou crossings over multiple linear features such as PTH 6 paralleled by HVdc ROWs are rare. In four years of telemetry data, only 41 of 4,595 trajectories (or less than 1 % in the 5 km Project Study Area) recorded caribou crossing these multiple features. The trajectory distances for crossed trajectories are nearly ten times longer than non-crossed trajectories.

The results of this preliminary analysis are consistent with the findings from other studies. Avoidance of linear features is apparent, however the effect is limited in distance to approximately 1 km. There are significant differences in path trajectory distances between types of linear feature and the effect of multiple and paralleled linear development is greater than single ROWs with no all-weather access. Although movement rates are greater near linear features, the majority of overall range movement is not affected. Areas such as PTH 6 being paralleled with multiple linear features may result in avoidance and possible range fragmentation. Further analysis of telemetry data is being conducted and will be developed as a supplemental report.

4.11.3 Case Study: Before and After Wuskwatim

The data for pre-Wuskwatim line construction consisted of telemetry collected from June 2007 to September 2008. Post-construction data was collected from November 2009 to December 2010. Three subsets along the transmission line were selected for their high caribou density properties (Map 20).

Pre-construction caribou density values spike at the 500 m buffer distance with other values fluctuating throughout the 5 km Project Study Area (Figure 28). The post-construction caribou density values coincide with the trend identified when comparing all caribou telemetry to the seven linear features. Caribou are found within 1,500 m of the linear feature (highest density at

1,500 m, 39.4%) with decreasing values at the 3,500 m distance. The major difference between pre- and post- density values occurs directly on the transmission line itself with a decrease (14.6%) in density after construction. The density values are nearly identical in the 1,000 m buffered area for pre (26.6%) and post (27.4%) construction telemetry. Density values are also very similar for the 1,500 m, 2,000 m, and 2,500 m buffered distances.

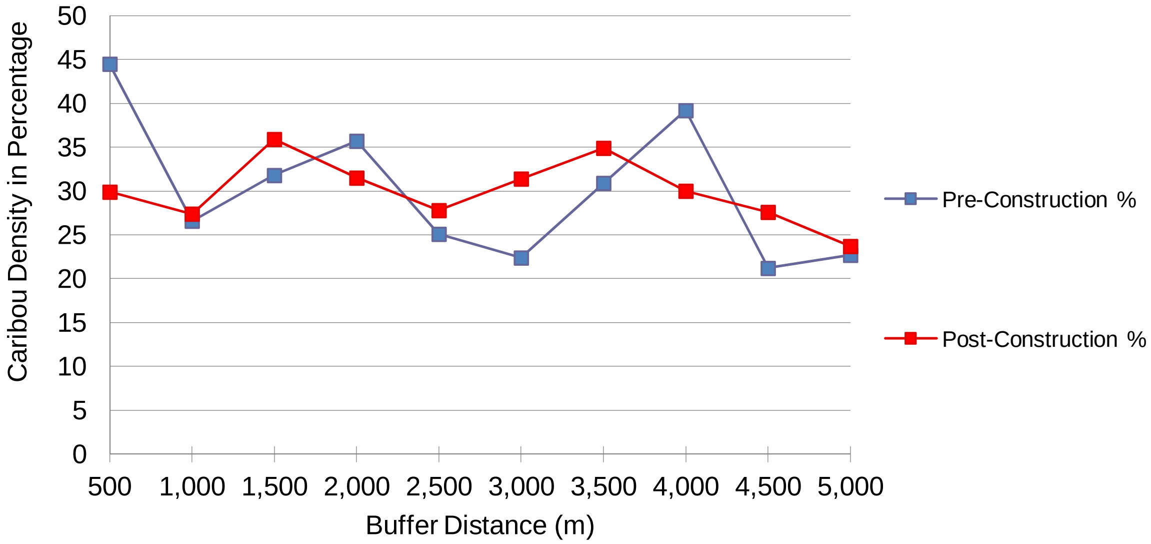


Figure 28: Comparing caribou density prior to and after the Wuskwatim Transmission Line construction

4.12 Project Infrastructure-Core Area Intercept Analysis

Of the six caribou ranges considered, only three were intercepted by the Project Local Study Area. These included The Bog, Reed Lake, and Wabowden. The degree of overlap varied (Table 33). Reed Lake had the smallest value of 3% overlap, while Wabowden, with 10% of its winter core use area contained in the Project corridor, had the highest value. While the total core area for Wabowden was smaller than the other two ranges, it had the largest absolute area contained in the corridor. Core areas for Reed Lake and The Bog were similar; however, the absolute core area contained in the corridor for The Bog was close to twice that found in Reed Lake core.

Table 33: Core use area values for woodland caribou ranges potentially affected by the Project

	Harding Lake	Naosap	Reed	The Bog	Wabowden	Wheadon	Wimapedi -Wapisu
Total Winter Core Area (km^2)	340	1,861	1,974	1,915	1,657	999	3,278
Area (km^2) of Winter Core in Project Study Area	0	0	68	120	165	0	0
Percentage of Winter Core in Study Area	0	0	3	6	10	0	0

Existing linear feature density within the Project Local Study Area overlap zone was variable for the three affected ranges (Table 34). Existing linear feature density was similar for The Bog and Wabowden ranges (0.5 and 0.6 km/km^2, respectively), while density in the Reed Lake core within the corridor was much lower at 0.2 km/km^2. Inclusion of the FPR in the linear feature density calculation resulted in a 25-30% increase in feature density for The Bog and Wabowden and a 100% increase for the Reed Lake within the corridor.

Table 34: Existing linear feature length and density and predicted post-construction linear feature length and density by range core area within the Project Local Study Area

	Reed	The Bog	Wabowden
Length(km) of Existing Linear Features	15	63	97
Density(km/km^2) of Existing Linear Features	0.2	0.5	0.6
Length(km) of Intersection with FPR	14	27	34
Density(km/km^2) of Existing Linear Features and FPR Centre line	0.4	0.8	0.8

Habitat patches intersected by the FPR were dominantly wetland for all three ranges. However, while wetland made up 93% and 84% of the intersected habitat patches for The Bog and Wabowden ranges, respectively, a larger proportion of intersected habitat patches (40%) were forested habitat types for Reed Lake. Similarly, the Reed Lake core area was characterized by a

larger number of intersections with small wetland patches and a lesser number of intersections with larger forested habitat patches. The opposite pattern was evident in The Bog and Wabowden, with many small forest patches and fewer, large wetland patches being intersected. These trends reflect differences in habitat composition between the ranges, rather than degree of habitat fragmentation.

While The Bog was found to have the greatest length of intersection between contiguous habitat patches and the FPR (152 km for wetland and forested habitat patches combined), it had proportionally fewer patch intersections, with only seven wetland patches being intersected. This reflects the large area of undisturbed wetland that typifies The Bog range. A single wetland patch, having an area in excess of 260,000 ha comprised 55% of the total area of The Bog MCP and exceeded the total area of The Bog winter core area (Table 35).

Wabowden was found to have the smallest minimum, maximum and mean patch sizes for both contiguous wetland and forest habitat, indicating a greater degree of habitat fragmentation existing prior to the Project than exists in the Reed Lake and The Bog ranges.

Table 35: Patch size metrics and intersections with the final preferred route centre line for wetland and forest habitat types by range core area within the Project Local Study Area

	Reed Lake	The Bog	Wabowden
Total Area (ha) of Wetland Patches	226,207	997,106	502,314
Number of Wetland Patches	10	7	19
Minimum Wetland Patch Size (ha)	1.7	1.4	1.2
Maximum Wetland Patch Size (ha)	96,421	269,875	33,754
Median Wetland Patch Size (ha)	6	94,073	21
Mean Wetland Patch Size (ha)	9,688	116,367	3,690
Wetland Patch Size Standard Deviation	28,911	101,651	10,315
Length (km) FPR in Wetland Patches	12	145	33
Total Area (ha) of Forest Patches	149,263	76,520	95,395
Number of Forest Patches	6	20	29
Minimum Forest Patch Size (ha)	2.2	2.4	0.5
Maximum Forest Patch Size (ha)	6,729	1,295	1,224
Median Forest Patch Size (ha)	313	18	34
Mean Forest Patch Size (ha)	2,368	221	219
Forest Patch Size Standard Deviation	3,087	437	334
Length (km) FPR in Forest Patches	15	7	17

Based on percentage of core overlap with the corridor and total linear feature density including the FPR, Reed Lake remained the least affected range, while Wabowden was the most impacted. The Bog had intermediate range overlap values and similar linear feature density values to Wabowden; however, the majority of disturbance in the Bog core occurred in the eastern portion of the range, while the western portion remained relatively unaffected (Map Series 1400). Conversely, Wabowden was intersected closer to the core of its range area and displayed a greater degree of existing habitat fragmentation (Map Series 1500). Thus, Wabowden is at greater risk of suffering negative effects as a result of Project construction and operation.

5.0 ENVIRONMENTAL EFFECTS ASSESSMENT

5.1 Environmental Effects Identification From Literature

Boreal woodland caribou (*Rangifer tarandus caribou*) in Canada have been designated as a threatened species under Canada's *Species at Risk Act* since 2000 (COSEWIC, 2010).

Populations of woodland caribou have declined throughout most of their range in Canada (COSEWIC, 2010). Since June 2006, boreal woodland caribou have been designated as a threatened species under the Manitoba *Endangered Species Act* (Manitoba Conservation, 2010a). The number of woodland caribou in Manitoba is currently estimated to range between 1,800 to 3,150 individuals (Manitoba Conservation, 2010b). Caribou habitat in Manitoba is impacted by human activities such as logging, right-of-ways (ROWs) development, and recreational activities, and by natural disturbances such as wildfire (Manitoba Conservation, 2010b). Anthropogenic activities in the boreal forest, including the construction and operation of hydroelectric transmission line ROWs, can negatively affect populations of woodland caribou.

Based on their conservation status and their overall value to humans, woodland caribou were identified as a VEC warranting the investigation of the potential effects the construction and operation of the Project may have on the species. Habitat fragmentation is a potential impact resulting from the construction and operation of a transmission line ROW which may contribute to subsequent changes in predator-prey dynamics and human disturbance of caribou. These impacts are explored in detail throughout this report. Though much of the literature pertaining to the potential impacts of disturbance are broadly based, the context of this report will specifically reference transmission line ROWs and the possible effects of their construction and operation.

Predictions regarding effects on caribou are partly based on relevant literature that was reviewed and evaluated. However, the acquisition of large volumes of current telemetry data was invaluable in assessing the potential effects of the Project on the various caribou ranges. The selection of the FPR based partly on avoidance of core winter range, critical calving areas, and high quality un-fragmented habitat provided for the most important coarse filter in mitigating the potential effects of the Project. Site specific effects of the FPR have been reduced and in some areas eliminated through effective routing.

5.1.1 Habitat

Woodland caribou are generally associated with mature coniferous forests and fen/bog complexes, though this can vary from one location to the next (James and Stuart-Smith, 2000; James et al., 2004; Hins et al., 2009). In Alberta, caribou have been found to prefer fen/bog complexes or large peatland areas and avoid well-drained areas (James and Stuart-Smith, 2000). Boreal woodland caribou tend to prefer spruce swamps in summer and early winter and in late winter, move to mature, dry, jack pine sites which support mosses, arboreal lichens, and ground lichens (EnvironmentEnvironment Canada, 2008). Since caribou feed on lichens in the winter, they generally live in areas where other ungulates are unable to, creating spatial separation from other ungulate species, reducing the likelihood of wolf predation and transmission of parasites and diseases (Thomas, 1995).

5.1.2 Diet

Caribou are morphologically and behaviourally adapted to winter subsistence on lichen diets, with terrestrial lichens (*Cladina* spp.) being the primary forage during winter periods (Edwards and Ritcey, 1960; Ahti and Hepburn, 1967; DesMeules and Heyland, 1969; Stardom, 1975; Darby, 1979; Miller, 1982; Darby and Pruitt, 1984; Bergerud and Mercer, 1989; Godwin, 1990; Schaefer and Pruitt, 1991). Woodland caribou are known for digging or cratering through snow in search of terrestrial lichens which is an energetically efficient foraging characteristic (Boudreau and Payette, 2004). DesMeules and Heyland (1969) assembled a ranked list of lichen species preferred by caribou. Their research found that the most preferred terrestrial lichens included *Cladina alpestris*, *Cladina mitis*, *Cladina rangiferina,* and *Cladonia uncialis* followed by the arboreal lichens *Usnea* spp., *Evernia mesomophia,* and *Alectoria* spp. Secondary to these species were *Centrariz islandica* and *Stereocaulon* spp. Caribou feeding preferences vary depending on the locations where observations were made. In the Project Study Area, lichen habitat is not limiting and assessments of habitat alteration among those ecodistricts where caribou are found, illustrates minute to un-measurable effects.

5.1.3 Fragmentation and Habitat Loss

Habitat loss is implicated as one of the leading causes contributing to the decline of woodland caribou populations (Dyer et al., 2001). Habitat loss and fragmentation generally poses a large problem for those working on the protection and rehabilitation of the species. Habitat fragmentation is the change in configuration of habitat as habitat cover decreases (Grossman et al., 2008). Effects of fragmentation include increased forest edge, reduced forest interior habitat, and increased isolation of forest patches. Since caribou are a species associated with contiguous forest, fragmentation is generally understood to have negative effects on their populations. Additionally, forest fragmentation can affect predator-prey interactions, making it essential to understand the direct and indirect impacts habitat fragmentation may have on woodland caribou as well as the predators with which caribou may interact. One of the largest causes of caribou habitat loss in the boreal forest is fragmentation due to forest harvesting (Courbin et al., 2009). During the last century, the southern limit of semi-continuous caribou distribution has retracted northward in Canada. This northward recession of caribou distribution follows the advancing forest harvest front producing an overrepresentation of early successional stands on the landscape thereby decreasing the amount of suitable habitat available for caribou (Thomas, 1995; Courbin et al., 2009).

5.1.4 Avoidance of Human Disturbance Stimuli

Research data on disturbance regimes has begun to support the theory, which was originally proposed by Walther in 1969, that non-lethal disturbance stimuli caused by humans is analogous to predation risk (Frid and Dill, 2002). Behavioural responses to predation risk and disturbance stimuli both divert time and energy from other fitness-enhancing activities such as feeding, parental care, and mating (Frid and Dill, 2002). Disturbance stimuli are human related, that is, disturbance created by human presence, objects, or sounds. A disturbance is a deviation in an animal's behaviour from those patterns occurring in the absence of human influences (Frid and Dill, 2002). The most common response of woodland caribou to disturbance stimuli is avoidance of the disturbance itself. Caribou avoid disturbance by shifting their distribution away from the disturbance stimuli.

Developments in the boreal forest, such as the construction and operation of transmission lines, are generally believed to cause avoidance behaviours in woodland caribou. Reduction in the abundance of caribou in the vicinity of disturbed areas has been reported in numerous studies to range between 1 to 5 km (Weir et al., 2007), although reactions to disturbance vary across individuals. Some members of a caribou herd have been found to be more sensitive than others to the disturbances from human activities. Females with calves, as an example, have been found to be less tolerant and more likely to avoid disturbances than other individual caribou in the herd (Weir et al., 2007). Many studies have indicated that caribou avoidance of human developments increases as the level of disturbance activity increases (e.g. Dyer et al., 2001); however, even low levels of human activity, such as those associated along transmission lines, have been found to cause avoidance behaviours by caribou. Research conducted in Norway found calving semi-domesticated reindeer had a 73% lower density in areas within 4 km of a power line, despite the high proportion of preferred habitat found within this zone (Vistnes and Nellemann, 2001). Studies investigating avoidance behaviour exhibited by ungulates towards human developments typically show that the strongest avoidance effect is found in closest proximity to the disturbance, with the avoidance effect dissipating as distance away from the disturbance increases. For example, areas within 1 km of a logging road in southeast Manitoba were found to be underutilized by caribou when compared to other zones of habitat located further from the road (Schindler et al., 2006).

Given that caribou avoid habitats associated with high levels of perceived risk and areas that do not meet their basic life needs, the creation of potential avoidance zones can further reduce the amount of suitable habitat that is available to caribou. Therefore, while the physical footprint of a development may be insignificant when compared to functional habitat loss, the overall fragmentation of the boreal forest resulting from that physical footprint has the greatest potential to concentrate caribou into progressively smaller areas of remaining habitat. Caribou are consequently more vulnerable to predation and human hunting (Dyer et al., 2001; Courbin et al., 2009). Avoidance of developments and disturbance stimuli can result in caribou displacement into less favourable habitats (Thomas, 1995). Similar spatial displacement observed in other ungulate species resulted in declines in productivity, overgrazing as a result of crowding, smaller animals, and lower pregnancy rates for yearlings (Dyer et al., 2001). Habitat loss associated with human development and caribou avoidance behaviour may impede the ability of caribou to move across the landscape. Energy expenditure may also be increased as caribou are forced to travel through less desirable landscapes in search of more favourable habitat.

Habitat loss resulting from caribou avoidance behaviours is a potential consequence resulting from the construction and operation of a transmission line and its associated ROW. James and

Stuart-Smith (2000) found that individual caribou differ in their response to linear corridors, however, on average, caribou avoided corridors altogether. The large amount of linear features that are currently found in some areas of the boreal forest combined with slight levels of avoidance behaviours observed by caribou have effectively reduced the amount of suitable habitat that is available to them. Research conducted over a 20,000 km² project study area in north eastern Alberta illustrated the relationship between linear features and habitat loss. The study revealed that 26,850 km of linear features could result in 2,846 km² of potential habitat loss for caribou as a result of their avoidance behaviours (James and Stuart-Smith, 2000). Individual differences in response to linear features may be attributed to a variety of factors, including increased forage available along corridors or the potential use of corridors as easy travel routes in areas where encounter rates with predators and people are low (James and Stuart-Smith, 2000).

5.1.5 Predators

Predators of woodland caribou include grey wolf, wolverine (*Gulo gulo*), lynx (*Lynx canadensis*), golden eagle (*Aquila chrysaetos*), and ravens (*Corvus corax*) with the main predator being wolves (Kelsal, 1968). In the boreal forest, wolves depend mainly on moose as a primary prey species and other prey including caribou as a secondary food source (Seip, 1992). When woodland caribou numbers are at normal or expected densities, they will co-exist with normal wolf populations. When woodland caribou densities are low, normal wolf densities (1 wolf/65-130 km^2) will limit caribou populations (Bergerud, 1983). When a biological system contains two or more prey species with a common predator, changes in predator/prey dynamics can lead to the extinction of the secondary prey (apparent competition), even in absence of resource competition (Wittmer et al., 2005). Changes in forest age and structure may force woodland caribou to occupy habitats that contain higher numbers of moose (Rempel, 1997) and the subsequent increase in wolf densities can result in increased mortality, even though they are a secondary prey species (Bergerud and Elliot, 1986; Seip, 1992). Predation of caribou is highest during summer when range overlaps with the primary prey species and predators (Seip, 1992).

5.1.6 Hunting by Wolves along Linear Corridors

Caribou may avoid linear corridors to reduce their risk of predation. Studies have shown an individual's risk of predation is greater when they are located in closer proximity to linear corridors (James and Stuart-Smith, 2000). Linear corridor development in remote regions may allow for increased predator access into previously remote caribou habitat. Corridors encourage the movement of wolves into prime caribou habitat and offer routes supporting increased rates of travel. Corridors, therefore, may influence wolf travel routes, their distribution, and wolf-prey contact and interaction (Thomas, 1995; James and Stuart-Smith, 2000; Courbin et al., 2009). Corridors increase wolf search rate, restrict caribou migration and movement, improve wolf predation efficiency, increase the number of other ungulate species, alters thermal regimes, and increase harassment of caribou (Thomas, 1995; James and Stuart-Smith, 2000). James and Stuart-Smith (2000) found wolf locations within caribou habitat were 134 m closer to corridors than random points and wolf telemetry locations. Their research findings identified caribou mortalities attributed to wolf predation were found closer to linear corridors than live caribou locations. Furthermore, wolf predation sites were found to be 55 m closer to corridors than random points. Research also suggests increased levels of human activity along linear corridors can influence the use of these features by wolves. Corridors with low levels of human activity, such as remote transmission ROWs, are used more frequently by wolves as easy travel routes.

5.1.7 Human Use of Linear Corridors

Linear corridors provide increased levels of human access into remote forested areas and prime caribou habitat. Enhanced levels of accessibility into these areas by human hunters may result in intensified hunting pressure on caribou populations and the potential subsequent decline in caribou populations (James and Stuart-Smith, 2000).

5.1.8 Alterations in Predator-Prey Relationships

Habitat conditions strongly influence the interactions between prey and predator (Peek, 1986). It has been hypothesized, that the spatial separation of caribou on the landscape from other ungulates is an anti-predation strategy of the species (James et al., 2004; Courbin et al., 2009). Spatial separation is achieved in part by difference in habitat selection observed between moose, deer, and caribou. Mature climax forests preferred by caribou are not as attractive to moose and deer as young stands are. Caribou tend to avoid the mixed and deciduous stands preferred by moose and deer, therefore, leading to a spatial separation from these species on the landscape (Courbin et al., 2009). Caribou also distance themselves from conspecifics, isolating themselves to reduce predation risk, as low caribou densities will not support wolves in the absence of alternative prey (Thomas, 1995; Dyer et al., 2001). Niches characterized by absence or scarcity of other prey, and therefore predators, allow woodland caribou to persist at low densities (Thomas, 1995).

5.1.9 Disruption of Spatial Separation of Caribou

Natural and anthropogenic forest disturbances produce extensive vegetation regeneration and browse production. Forest fires create increased browse availability which is advantageous for moose and white-tailed deer. The large amount of boreal and transitional forest areas burned in Canada since 1969 has allowed these species to expand their range northward (Thomas, 1995). Similarly, forest harvest opens up old growth forest areas, traditionally used by caribou, creating early successional stages of vegetation growth and producing conditions supporting understory colonization by deciduous species, enhancing habitat suitability for moose and white-tailed deer (Passmore, 1989; Hins et al., 2009). Forests in early successional stages following forest fires or logging activity typically show increasing moose and deer populations due to the quantity and quality of regenerating browse (James et al., 2004; Weir et al., 2007).

Various telemetry studies conducted on caribou and wolves reveal that these species typically occupy different habitat types throughout most of the year, suggesting they are characteristically spatially and temporally separated on the landscape (James et al., 2004; Courbin et al., 2009). Wolves have been found to select habitat areas with a high proportion of regenerating cuts, as preferential selection of mixed and deciduous stands by wolves increases the likelihood of encountering prey (Courbin et al., 2009). Conversely, caribou avoid recent and regenerating cutblocks (Courbin et al., 2009).

5.1.10 Increased Predation on Caribou

When disturbances occur in the boreal forest which support the incursion of other ungulates into caribou habitat, wolves may follow these prey. This may result in higher caribou mortality attributed to wolf predation. Given that caribou generally exist at low densities, the influx of higher densities of moose and deer within previously characterised caribou habitat may increase total prey density sufficient enough to support resident wolves. Caribou would be presumably consumed in proportion to their availability (James et al., 2004). Such increases in predation on caribou could result in large reductions in their population (Passmore, 1989; Weir et al., 2007). It is believed that caribou populations decline in areas where the biomass of prey allows wolf populations to increase to, or be maintained at, high levels. Elevated wolf densities may lead to incidental predation on caribou by wolves (James et al., 2004). This incidental predation can impair caribou population viability (Thomas, 1995) and elevated levels of predation could prompt the extirpation of caribou from a certain area (James et al., 2004). For example, wolves in southern British Columbia may eliminate some caribou herds because moose sustain the wolf population while the caribou population declines (Seip, 1995). Population doubling of moose between 1948 and the early 1980's and their range expansion during the 1970's, potentially contributed substantial prey to the wolf-caribou system. Research has identified that growing moose populations in Ontario and Quebec has led to increased predation on caribou (Thomas, 1995). In Canada, the impact of wolf predation on caribou is a common problem for those tasked with dealing with wolf and ungulate management and wolves are thought to be a significant factor currently limiting the size of certain caribou herds in all provinces and territories (Hayes and Gunson, 1995). Due to the increasing amount of corridors found in the boreal forest, which substantially erode the effectiveness of refuge habitat areas for caribou, herds may diminish under the increased levels of predation (James et al., 2004).

5.1.11 Vulnerability of Caribou to Predation

In a multi-ungulate system, caribou are particularly a vulnerable prey species given their large mass and the low potential risk of injury they pose to wolves given that they seem not to use their feet for defence (Dale et al. 1995; Thomas, 1995). Individual caribou within a population differ in their vulnerability to a wolf attack. In a study conducted in Denali National Park in Alaska, caribou were found to be more vulnerable to predation by wolves when they were young, old, and in poor condition (Mech et al., 1995). The nutritional status of caribou affects their vulnerability to wolves. Caribou, in a poor nutritional state, are weaker and therefore more vulnerable to predation. Nutritional condition was one of the most common variables in predisposing moose and caribou in Denali National Park to predation (Mech et al., 1995). Poor nutritional conditions in ungulate populations are usually associated with lower body condition of individuals, lower pregnancy rates, and lower recruitment (Mech et al., 1995).

Snow conditions also greatly affect the vulnerability of caribou to predation. Deep, soft snow favours caribou mobility while compacted or crusted snow gives wolves the advantage (Thomas, 1995). One study has found an indirect effect of snow depth on caribou calves in utero who were predisposed to wolf predation during the next summer and winter (Mech et al., 1995). Human activities which alter snow depth and packing in the winter could therefore predispose caribou to increased predation both during the winter and in the following year.

Given that caribou have low fecundity and productivity they cannot sustain high levels of mortality from predators or humans (Thomas, 1995). Their low fecundity and productivity contribute to their vulnerability to even slight changes in their environment (Thomas, 1995). Caribou experience high levels of mortality due to other limiting factors, and therefore, will be less able to sustain viable population levels under increased wolf predation (Seip, 1995). Research into the wolf-moose and wolf-caribou relationships in several locations have found that wolves can exert substantial control over moose and caribou populations, which can prevent efforts to maintain high populations of these prey species (Peek, 1986).

5.1.12 Disease and Parasites

Another consequence resulting from the northward range expansion of other ungulate species into traditional caribou habitat is the potential for the spread of disease and parasites. *Parelaphostrongylus tenuis* is a parasite that threatens caribou populations. *P. tenuis*, commonly referred to as meningeal worm, is a common parasitic nematode of white-tailed deer (Anderson, 1972). This parasite is widespread throughout the deciduous mixed-hardwood forests of eastern

North America and may be expanding its range westward through the Aspen Parkland Ecoregion (Wasel et al., 2003). *P. tenuis* has been reported as far west in Canada as Manitoba, though Wasel et al. (2003) reported finding an infected white-tailed deer in Saskatchewan about 60 km from the Manitoba border.

White-tailed deer have greatly expanded their range northward and westward during the twentieth century as a result of human activities (logging, burning, agriculture, winter feeding of livestock, reduction of competition, restrictions on hunting, etc.) which have broken up the mature mixedwood forest and adjacent coniferous forests (Anderson, 1972; Passmore, 1989). *P. tenuis* is spread from deer to woodland caribou, when caribou feed on vegetation containing a gastropod, the parasite's intermediate host (Anderson, 1972). Though white-tailed deer can tolerate this parasite, it has proven to be fatal to caribou and may be another contributing factor to declines in the number of woodland caribou (Thomas, 1995). In caribou, signs of *P. tenuis* infection include listlessness, ataxia, abnormalities in the eyes and in the position of the head, lumbar paralysis, and death (Anderson, 1972). Caribou debilitated by the meningeal worm also become more vulnerable to predation (Thomas, 1995). Attempts to reintroduce reindeer from Norway to an island in Georgian Bay, Ontario, failed due to infection by *P. tenuis* spread by white-tailed deer which was historically absent from the island but which was subsequently introduced (Anderson, 1972). Conditions which correlate with the highest presence of *P. tenuis* were found to be periods of summer and fall precipitation, low winter and spring temperatures, areas where forest cover occurred between 50 and 75%, and areas with high deer density (Wasel et al., 2003). Human disturbances or fragmentation of the forest which promote the co-occurrence of deer and caribou could lead to disease spread.

5.1.13 Human Disturbance of Caribou

The effects of human disturbance on habitat at multiple scales can also influence predation rates on woodland caribou. As stated, wolves are known to utilize linear corridors more than interior forest resulting in increased mortality to caribou in proximity to roads and seismic lines (James and Stuart-Smith, 2000). Forestry operations in woodland caribou range results in early successional habitat favourable to moose and deer, resulting in increased predator and prey densities and increased incidental mortality to woodland caribou (Cumming, 1992). Woodland caribou decline along the southern limits of Ontario's boreal forest has been attributed to the northerly development of forestry and associated anthropogenic effects on habitat and mortality (Schaefer, 2003).

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).

Coupled with this, recreational human activities can affect caribou. The creation of a transmission line ROW may increase human recreational activity in prime caribou habitat. Snowmobile use may result in avoidance behaviour in caribou and increased energetic expenditure (Webster, 1997). Snow compacted from snowmobiles has been found to increase the energy required to dig for lichens and reduce the ability of caribou to be able to smell lichen under crusted snow (Webster, 1997). Snowmobile trails provide increased access into caribou habitat which can be used by predators for easier travel. Similarly, ROWs increase access for all terrain vehicles (ATVs) and increase potential human hunting pressure by enlarging the area hunters can search. Human activity may destroy terrestrial lichens caribou rely on during the winter (Webster, 1997). The destruction of terrestrial lichens can be very devastating as the lichen species preferred by caribou require 40 to 150 years to recover following a fire (Thomas, 1995). Human pedestrians walking in the forest have also been shown in various studies to be more disturbing to ungulates than some mechanical stimuli, as they have a relatively silent approach and can appear suddenly (Webster, 1997). Subtle noises caribou cannot pinpoint are more likely to be associated with predators than a steady state noise from mechanical stimuli (Webster, 1997).

The alteration in behaviour of caribou disturbed by human harassment could potentially increase energy expenditure or risk of injury. Harassment by humans may stress caribou potentially causing them to leave optimal cover or forage, change normal periods of activity, alter their home range, increase energy expenditure, and displace of cow/calf pairs (Webster, 1997). Stress and increased energy expenditures can lead to physical exhaustion and eventual death from malnutrition or predation as caribou become progressively weaker. Winter survival, reproduction, and calf survival can all be negatively affected by human harassment.

5.1.14 Caribou Aboriginal Traditional Knowledge

The majority of aboriginal communities interviewed within the Project Study Area reported sightings of either barren-ground, coastal, or boreal woodland caribou populations in the area. Response from interviewees and information on the different caribou types varied based on location of community. The following sections describe information on barren-ground, coastal, and boreal woodland caribou movement observations, calving areas, and hunting activities by community members interviewed for the Project.

5.1.14.1 Caribou Area Use

It has been reported that barren-ground caribou are often seen during the summer east of Stephens Lake, on the north side of the Nelson River. Interviewees stated that barren-ground caribou often migrate from the northwest near the Lac Brochet area. According to one interviewee, caribou also migrate through the Owl and Weir Rivers. During the fall migration, barren-ground caribou often congregate near Conawapa Rapids and Bird until the winter freeze-up, when they can cross the Kichi Sipi and continue southwest towards Ilford and Oxford House.

Pen island coastal caribou often migrate from the northeast, around the Fort Severn area and then travel south towards the Shamattawa First Nation. Upon their arrival at the Kichi Sipi, they circle around the southeast portion of the river until it becomes frozen. One interviewee also stated: “Pen Island caribou here swim all over the place. They swim to any island and then they come north and they turn back. They start from Angling Lake and come all the way this way to Goose Creek, they cross here (near Conawapa)”. From Shamattawa, caribou are known to travel through the Angling Lake and Angling River area and cross the Kichi Sipi at lower Limestone and Flathead Rapids. Pen Island caribou also follow the Limestone River and sometimes mix with the barren-ground variety whose northern range includes Churchill, Manitoba.

Fox Lake community members stated that caribou movements have shifted, particularly after the construction of the Conawapa road and that the proposed location for the Keewatinoow Converter Station overlaps with migration routes for Pen Island and barren-ground caribou herds. This area has also been cited by community members as being habitat for boreal woodland caribou. Community members also stated that caribou also cross the Kichi Sipi Horseshoe Bay and near what is now a boat launch associated with Manitoba Hydro's Conawapa Camp.

The majority of aboriginal communities interviewed within the Project Study Area reported sightings of woodland caribou populations in their area, to varying degrees. In addition, it was stated by some interviewees that woodland caribou often use winter habitat in the Grand Rapids area.

5.1.14.2 Caribou Calving Areas

Caribou are known to calve from late May to the second week of June. Interviewees stated that woodland caribou calving areas include the areas of Swift Creek, Beaver Creek, Goose Creek, and Moondance Creek, as well as Spider and Deer Islands and the areas surrounding Cormorant. These areas all have an abundance of vegetation that serves as food and shelter for caribou.

5.1.14.3 Caribou Hunting

Many of the interviewees reported harvesting barren-ground and boreal woodland caribou within the Project Study Area. It was noted that interviewees traditionally used caribou as a source of food in their area. Interviewees in the northern portion of the Project Study Area noted that they hunt all three varieties of caribou – woodland, barren-ground, and Pen Island coastal – mostly during the late fall and winter.

Regarding specific location of hunting, it was noted that barren-ground caribou are frequently harvested around the Gilliam area. One interviewee stated that they hunted caribou within the Keewatinoow Local Study Area in the fall of 2009 and 2010. In addition, interviewees stated that

Pen Island caribou migrate north through the Bipole III Study Area from Shamattawa. One interviewee also stated that caribou migrate along the "old Canadian National bed" near the Conawapa Road. This interviewee also stated that they witnessed two packs of wolves (one with nine wolves) following a herd of caribou.

5.1.15 Summary

Boreal woodland caribou are sedentary in nature and are found throughout the Project Study Area. They occupy ranges that are typically constrained, apparently as an artefact of generational fidelity. Unlike the barren-ground caribou (migratory herds), woodland caribou have evolved at very low densities across the northern boreal taiga with population densities averaging 0.02 animals per km^2 (Rock, 1982). Both migratory and sedentary populations are well known for their fidelity to calving, mating, and wintering forage areas within their home range at different scales (Schaefer et al., 2000). Woodland caribou in eastern Manitoba are very gregarious during winter periods and solitary during spring and summer (Darby, 1979).

Population fluctuations in caribou are caused by complex interactions between multiple regulating factors (Klein, 1991). Depending on the herd under study, population increases or declines may be an effect of a single or combination of factors specific to that herd, however it is difficult to pin point the limiting or shaping factors due to the complexity of the caribou-ecosystem relationship (Klein, 1991; Whitten, 1994; Gunn, 2001). As an example, it has been suggested that the primary factors causing population fluctuations in the George River caribou herd are a combination of habitat destruction, overharvesting, predations, disease, and climate changes (Crête & Payette, 1990). Therefore, deciphering the root causes of caribou population fluctuations may prove to be unachievable.

Potential threats related to industrial development include habitat loss, fragmentation, and disturbance (Manitoba Conservation, 2006). Direct mortality factors in the boreal forest include over hunting and predation. Mortality from indirect causes include the introduction of parasites such as the nematode parasite or brainworm from white-tailed deer through increased contact between deer and caribou due to habitat modification favourable to deer (Pitt and Jordan, 1994). The responses of alternate prey species and parasites to anthropogenic activities such as forestry and recreational development can potentially contribute to decline of caribou (Dzus, 2001; Manitoba Conservation, 2006). Direct mortality to woodland caribou can be attributed to predation and humans.

5.2 Environmental Effects Identification from Study Results

Manitoba Hydro's SSEA process resulted in the selection of the FPR which avoided the majority of high risk ranges and other local population core winter and summer habitat for a number of important boreal woodland caribou ranges found in the Project Study Area. In addition, the majority of the FPR is routed in proximity to existing linear features (roads, rail lines, and transmission lines), which reduces the overall effects of additional habitat fragmentation as a result of the Project. Due to social and biophysical values identified in the SSEA, it was not possible to avoid all known core ranges within the Project Study Area. As a result three of eleven occurring boreal woodland caribou ranges identified by Manitoba Conservation (Manitoba Conservation, 2006) are potentially impacted by the FPR. These include the Bog Range, the Reed Lake Range (paralleling the existing Wuskwatim Transmission Line), and the Wabowden Range. In the area south of the Pas, the FPR intersects core winter and summer habitat, again paralleling an existing transmission corridor. However, due to competing interests in the Wabowden area, it was not possible to avoid the fragmentation of existing core winter and summer habitat for the Wabowden range. In addition, the northern portion of the Project Study Area contains habitat that is occasionally occupied by coastal and barren-ground caribou.

Opportunities to mitigate effects through routing are not necessarily effective due to the spatial and temporal variability of occurrence of these populations in the Project Study Area. This combined with the small proportion of Project Study Area within their respective ranges, does not provide a basis for rationalizing alternative routes that minimize effects. The location and foot print of the Keewatinow Converter Station also represents an insignificant proportion of the overall range of coastal and barren-ground populations. The construction of the ground electrodes and lines will be felt short-term and represents an insignificant proportion of the range of coastal and barren-ground caribou. Site access roads overlapping with the coastal and barren-ground caribou and boreal woodland caribou ranges may enhance avoidance of disturbance on a short-term scale.

The degree and magnitude of environmental effects on caribou vary among the three boreal woodland caribou ranges; however, the overall description of the effects is similar. This is due to the differences in the amount of caribou core use area intersected by the FPR within the Local Study Area[3]. The degree of existing fragmentation was also assessed for each evaluation range in order to qualify the potential for cumulative effects associated with a new ROW in caribou range.The following sections describe the potential effects for coastal, barren-ground, and boreal woodland caribou ranges that intersect the FPR. Due to differences among caribou ranges including existing disturbance regimes, location of the FPR relative to core use areas, and habitat quality, the potential effects are not consistent among ranges and need to be described separately. For each caribou Ecotype and range, the various project components are evaluated against a number of specific threats that include:

- Direct loss of habitat – actual clearing of high quality habitat;
  - o Effects expected during construction, maintenance, and operation.
- Loss of functional habitat – reduction in forage availability due to disturbance and edge effects from the cleared ROW;
  - o Effects expected during construction, maintenance, and operation of transmission line and ROW.
- Increased predation – predator movement along ROW and increased hunting opportunity by wolves;
  - o Effects expected during operation of transmission line and ROW.
- Increased edge effects and habitat favourable to bears near calving areas;

[3] A 3 mile corridor was utilized in the evaluation of the FPR due to the potential sensory effects of the HVdc transmission line on caribou range use and movement.

  - o Effects expected during operation of transmission line and ROW.
- Introduction of disease and other pathogens – deer movement along ROW;
  - o Effects expected during operation of transmission line and ROW.
- Increased mortality from hunting and poaching – access into core areas or previously remote un-fragmented habitat;
  - o Effects expected during construction, maintenance, and operation of transmission line and ROW.

Section 7.0 - Residual Effects provides a detailed description of the effects of both construction and operation of the Project components for both coastal and barren-ground caribou as well as boreal woodland caribou.

5.2.1 Site Preparation and Construction

Loss of habitat is not considered to be a factor for any caribou range intersecting the FPR as habitat is not limiting in the Project Study Area. Sensory disturbance due to clearing and ongoing access of the ROW by construction crews as the line is assembled may result in short-term avoidance of a relatively small area by caribou. Effects will likely be in the immediate vicinity of construction activity. The degree of avoidance will depend on the frequency of vehicular traffic and is expected to vary as site preparation activity proceeds along the route. Caribou may be temporarily displaced due to disturbance and access.

There is also potential for increased movement of grey wolves along ROWs following construction. Particularly, ROW clearing and tower erection schedules may result in long lengths of low use, snow packed ROW behind or following the intensive clearing and construction activities, providing opportunity for enhanced predator movement.

Improved access to the area via access roads and trails may increase the mortality of caribou in core winter areas due to hunting. If coastal or barren-ground caribou migrate into the area during construction, the associated access may result in increased mortality from hunting. Based on past events, access to much of the area by snowmobile and existing hunting near the Conawapa

access road can result in excessive harvest in a short period of time. Although boreal woodland caribou are technically protected from hunting, there is risk to uncontrolled hunting and poaching of animals when clearing and construction occurs during winter in core ranges.

Habitat will be permanently altered, as vegetation will be maintained at an early successional stage along the ROW. Habitat availability throughout the various ecoregions is not limiting to any subspecies of caribou which prefer mature forest, bogs, and open lichen rich tundra.

5.2.2 Operation

No additional habitat will be lost during operations; however, fragmentation may remain an issue or may increase the potential for fragmentation in all ranges intersected by the FPR. Fragmentation is not an issue for coastal and barren-ground populations. Based on telemetry data, the FPR traverses the easterly edge of core winter range, paralleling the existing Wuskwatim Transmission Line. Similarly, the FPR parallels an existing transmission ROW in The Bog. Fragmentation effects in the Wabowden range may impact caribou movement; however, the long-terms effects are largely unknown.

In general, the maintenance of vegetation at an early successional stage may benefit other species such as moose and deer by providing browsing opportunities which may attract predators such as grey wolf into closer proximity to caribou. Linear corridors may provide improved access for wolves, especially during winter on maintained ROWs. The continual presence of the ROW and the presence of towers and conductors are expected to have a small, long-term effect on caribou range utilization based on historical and current caribou movement analysis of collar data near linear corridors.

Annual ground-based inspections of the line, typically in winter, and/or aerial methods by helicopter two to three times per year, plus sporadic maintenance-related access and activity are expected to result in sensory disturbance. This disturbance will be short-term and local, and is expected to have a negligible effect on caribou in the area.

After construction is complete and disturbance has ceased, the ROW will provide a movement corridor for predators such as coyote, red fox, and grey wolf for ease of travel and more efficient hunting. While this may benefit predators, mortality of prey species such as caribou could increase.

5.2.3 Decommissioning

It is anticipated that all components of the proposed Project, with the application of decommissioning mitigation (removal of equipment and foundations, re-vegetation, etc.), are fully reversible. Over time, the biophysical disruptions due to the Project should be outweighed by ongoing naturally occurring variation (e.g., succession, wildfire) or by human activity (e.g., agriculture).

5.3 Environmentally Sensitive Sites

There are a number of environmentally sensitive sites (ESS) that have been identified for caribou along the FPR. These include areas where the FPR intersects core winter and summer range in the Wabowden, Reed Lake, and The Bog ranges as well as high quality lichen habitat, where there are opportunities to maintain and mitigate habitat loss near the FPR. There is also a known potential calving site for an individual Pen Island collared female that has a documented summer use area located directly in a burned area on the FPR in the Little Limestone Lake area.

Mitigation activities include access and vegetation management activities that significantly reduce the potential effects of human and predator movement into core areas. These are described in following sections. ESSs are illustrated in Map 21.

6.0 MITIGATION MEASURES

Manitoba Hydro's standard practices for environmental protection during the construction of transmission lines will generally reduce many of the effects of human activity, such as handling of hazardous and non-hazardous material, hazardous and non-hazardous waste disposal, and regulations for personnel (e.g., no harvesting of area resources by work crews). Mitigation measures for minimizing or avoiding Project component (HVdc transmission lines and AC collector lines, Keewatinoow Converter Station, ground electrodes, site access roads, and borrow and excavation sites) effects during construction and operation on caribou are as follows (Table 36):

6.1 Construction

6.1.1 Coastal and barren-ground caribou

- Use along the ROW and within the Project site will be limited to reduce sensory disturbances and minimize functional habitat loss during caribou migration events which are infrequent and unpredictable.
- Existing satellite collared animals from the Cape Churchill and Pen Island herds will be monitored during construction. Aerial surveys will be conducted to verify numbers and concentrations of animals that may or may not migrate into construction areas. Manitoba Hydro will maintain access control onto the ROW and Project site and cooperate with Manitoba Conservation in measures that will protect excessive harvest in the area including signage and no hunting areas during construction to protect both workers and migrating caribou. Manitoba Hydro will work cooperatively on with Manitoba Conservation include access control through joint access management plan, hunting closures (Health Safety and Workplace Act) and hunter education or information initiatives with Manitoba Conservation to reduce the effects of overharvest and wastage.
- Hunting by project personnel will be prohibited and firearms restricted in work camps and associated areas to minimize caribou mortality.
- Aerial and ground surveys will be conducted and satellite collared caribou will be monitored in advance of construction activities to ascertain the location and movement of Cape Churchill or barren-ground caribou into the construction area.

6.1.2 Boreal woodland caribou

- Timing of construction (winter) will mitigate sensory disturbance on females during calving and calf rearing in calving areas.
- Natural low tree cover will be maintained in core winter areas and known and potential calving areas to maintain natural functional structure to encourage ongoing use by boreal woodland caribou. Boreal woodland caribou in the Wabowden area have demonstrated high levels of movement north and south throughout the areas being traversed by the

FPR. Wildlife corridors will be facilitated by maintaining the naturally low occurring vegetation such as black spruce and tamarack.

- Maintenance of natural low tree cover and wildlife corridors will also minimize predator flow through these critical habitats. Emphasis will be placed on the Wabowden range in core use areas where a new ROW will increase the level of fragmentation for this range compared to Reed and The Bog where existing linear features are being paralleled; Wildlife corridors to facilitate boreal woodland caribou movement will also be implemented in the Bog range.
- In the Wabowden range, robust and effective access control to the ROW from PTH 6 will be applied near core use areas. These will be based on site specific conditions and methods that halt or limit ATV and snowmobile traffic. Methods include gates (during construction) and the spreading of debris, ditching and trenching (post construction). Natural vegetation will be encouraged and where necessary planting of trees will occur to discourage future snowmobile and ATV access into core winter and summer use areas.
- Future maintenance of ROW will involve helicopter access and minimize snow packing in the Wabowden Range. In other areas development of Manitoba Hydro snowpack trails will be limited in core winter areas to minimize potential predator effects into core areas and potential illegal hunting activities.
- Limiting recreational use and travel by ATVs and snowmobiles along the ROW in the core winter area and known potential calving areas will be encouraged to reduce sensory disturbances and minimize functional habitat loss.
- Ancillary access and other project footprints (staging areas) will be minimized to reduce potential disturbance, functional habitat loss, and temporary range fragmentation.
- Organic material will be removed from temporarily cleared areas for Project construction and re-distributed to encourage re-growth of native vegetation to facilitate a quick recovery to natural low growing vegetation that will provide security cover to encourage animal movement across the ROW in future.

- Hunting by Project personnel will be prohibited and firearms use restricted in work camps and areas will minimize mortality.
- Long term monitoring of the boreal caribou ranges intersected by the Project will continue and include population monitoring, and assessment of recruitment and mortality. Data will be gathered through satellite collaring and assessments will be conducted on sensory disturbance and avoidance of the ROW and overall range fragmentation.
- Monitoring of wolves will be conducted in all boreal woodland caribou ranges intersecting the Project using aerial surveys and satellite tracking studies to determine use of the ROW and increased predation.
- Studies will be initiated on the effects of black bears and the potential effects of the ROW on bear activity and predation in calving areas near the ROW in the Wabowden range.

Table 36: Valued environmental component (caribou) summary – Environmental effects and mitigation

Component	Environmental Indicator	Measurable Parameter	Environmental Effect	Mitigation Measures	Residual Environmental Effect
Boreal Woodland Caribou, Coastal, and Barren-Ground Caribou	Core winter range	Amount of core habitat intersected by FPR	Loss of winter forage, functional loss of winter range, higher energetics due to fragmentation, sensory disturbance, increased predation and mortality, mortality from hunting and poaching.	Avoidance through routing. Minimize winter travel /patrolling Limit access at key points Maintain low vegetation	Small functional loss of habitat. Potential small increase in mortality.
	Calving areas and core summer range	Amount of known and potential calving habitat intersected	Sensory disturbance and displacement from calving habitat into higher risk habitats. Increased predation and access by bears and wolves. Increased transmission of pathogens – disease from white-tailed deer. Higher calf mortality	Avoidance through routing. Minimize access. Maintain low vegetation	Small functional loss of habitat Potential small increase in mortality
	Reduced Lambda	Adult female mortality Calf recruitment	Decreased range population	Monitor wolves, bears and primary prey species (moose)	Small decrease in Lambda…requires monitoring to determine extent of residual effect and population response.

6.2 Operation

6.2.1 Coastal and barren-ground caribou

- Use within the ROW and Project site will be limited to reduce sensory disturbances and minimize functional habitat loss during caribou migration events which are infrequent and unpredictable;
- Aerial surveys will be conducted to verify numbers and concentrations of animals that may or may not migrate into operation areas. Manitoba Hydro will maintain access control in the ROW and Project site and cooperate with Manitoba Conservation in measures that will protect excessive harvest in the area including signage and no hunting areas during operation and maintenance to protect both workers and migrating caribou. Manitoba Hydro will work cooperatively on with Manitoba Conservation include access control through joint access management plan, hunting closures (Health Safety and Workplace Act) and hunter education or information initiatives with Manitoba Conservation to reduce the effects of overharvest and wastage;
- Hunting by project personnel will be prohibited and firearms restricted in work camps and associated areas to minimize caribou mortality.

6.2.2 Boreal woodland caribou

- Wildlife corridors will be facilitated by maintaining the naturally low occurring vegetations such as black spruce and tamarack.
- This will also minimize predator flow through these critical habitats. Emphasis will be placed on the Wabowden range in core use areas where a new ROW will increase the level of fragmentation for this range compared to Reed and The Bog where existing linear features are being paralleled; Wildlife corridors to facilitate boreal woodland caribou movement will also be implemented in the Bog range.
- In the Wabowden range, robust and effective access control to the ROW from PTH 6 will be applied near core use areas. These will be based on site specific conditions and methods that halt or limit ATV and snowmobile traffic. Methods include gates (during

construction) and the spreading of debris, ditching and trenching (post construction). Natural vegetation will be encouraged and where necessary planting of trees will occur to discourage future snowmobile and ATV access into core winter and summer use areas.

- Maintenance of ROW will involve helicopter access and minimize snow packing in the Wabowden Range. In other areas development of Manitoba Hydro snowpack trails will be limited in core winter areas to minimize potential predator effects into core areas and potential illegal hunting activities.
- Limiting recreational use and travel by ATVs and snowmobiles along the ROW in the core winter area and known potential calving areas will be encouraged to reduce sensory disturbances and minimize functional habitat loss.
- Ancillary access and other project footprints (staging areas) will be minimized to reduce potential disturbance, functional habitat loss, and temporary range fragmentation.
- Hunting by Project personnel will be prohibited and firearms use restricted in work camps and areas will minimize mortality.
- Long term monitoring of the boreal caribou ranges intersected by the Project will continue and include population monitoring, and assessment of recruitment and mortality. Data will be gathered through satellite collaring and assessments will be conducted on sensory disturbance and avoidance of the ROW and overall range fragmentation.
- Monitoring of wolves will be conducted in all boreal woodland caribou ranges intersecting the Project using aerial surveys and satellite tracking studies to determine use of the ROW and increased predation.
- Studies will be initiated on the effects of black bears and the potential effects of the ROW on bear activity and predation in calving areas near the ROW in the Wabowden range.

6.3 Decommissioning

It is anticipated that all components of the proposed Project, with the application of decommissioning mitigation (removal of equipment and foundations, re-vegetation, etc.), are

fully reversible. Over time, the biophysical disruptions due to the Project should be outweighed by ongoing naturally occurring variation (e.g., succession, wildfire) or by human activity (e.g., agriculture).

7.0 RESIDUAL EFFECTS

For the purpose of this report, a residual environmental effect is defined as the resultant change in the environment after the application of mitigation measures (Hegmann et al., 1999). The Project is not anticipated to have significant adverse residual effects based on the criteria and factors described in Chapter 4.2.10 of the Bipole III EIS after the successful implementation of the recommended mitigation as outlined in Section 6 and summarized in Section 7.3 However, the extent of potential long term residual effects is also linked to the cumulative effect of other anthropogenic disturbance that may occur in the respective ranges after the development of the Bipole III Project.

Boreal woodland caribou occupy large home ranges and exist at very low densities. Their status as a Threatened species is the result of a number of biological and ecological pathways of decline that are spatially and temporally influenced by anthropogenic disturbance including transmission line ROWs. From a landscape perspective, the amount of area occupied by transmission lines in Manitoba's boreal woodland caribou ranges are small in comparison to other anthropogenic activities and natural disturbance events. Foraging habitat is typically not a limiting factor for local populations and access-related sensory effects from the HVdc are expected to be less than those associated with all weather or winter roads occurring in boreal woodland caribou range. Access created by the HVdc ROW has the potential to increase the risk of predation by wolves and illegal hunting or poaching during winter. ROW maintenance near calving areas may attract black bears due to increased forage and potentially increase bear/caribou interaction and predation risk to calves during spring. Indirect ecological impacts from transmission lines are generally thought to be minor compared to those associated with other human caused or natural landscape disturbances such as large scale forestry. The cumulative effects of transmission line construction and operation as a pathway of decline are not clearly understood, but are expected to be minor in most cases.

7.1 Coastal and barren-ground caribou

Coastal and barren-ground caribou occurrence during winter is associated with occasional migration events. The Pen Island caribou are occasionally observed to cross the Nelson River.

The Cape Churchill caribou are known to migrate more frequently into the FPR ROW area. Barren-ground caribou have not been observed in the Project Study Area for several years. There are no impacts on habitat and the functional loss of habitat due to the effects of paralleling the existing ROW are minor (Table 37). Potential residual effects such as increased predation and human hunting are not expected to increase or affect these populations.

Residual effects are expected to be negligible with no detectable or measurable change in the status of any of the Cape Churchill, Pen Island, or Quaminiruak caribou. The ecological and social importance of these caribou populations are moderate due to their infrequent occupation of the study area. The magnitude of the residual effects of the Project on these populations is small, even in light of the 2010 high harvest of Cape Churchill animals that occurred along the Conawapa access road. Any residual effects could be reversed over time through adaptive management efforts such as access management, maintenance of residual vegetation, and limiting maintenance during seasons.

Based on the mitigation measures described, the residual effects expected include potential excessive harvest of animals on and along the new ROW, Keewatinoow converter station, during construction of the ground electrodes, along the site access roads, and within the borrow areas as a result of improved local access, when and if significant migration events occur. Sensory disturbance during construction and operation of all Project components will also result in some avoidance behaviour. Due to the creation of linear features and habitat removal, predator access will be improved resulting in higher predation on caribou. These residual effects for coastal and barren-ground caribou are characterized as negative in direction, low to medium in ecological importance, low to medium in societal importance, small in magnitude, Project site/footprint to local study assessment area in geographic extent, short to medium term in duration, sporadic/intermittent in frequency, and reversible, and therefore considered not significant.

7.2 Boreal Woodland Caribou

Residual environmental effects after all mitigation is carried out are similar for The Bog, Reed Lake and Wabowden ranges based on the mitigation described in Section 7.3 A summary of the factors and criteria that residual effects are found in Chapter 4.2.10 of the Bipole III EIS and summarized in Table 38.

The ecological and social importance of these boreal woodland caribou ranges is high due to their status and potential fragility to cumulative effects associated with all resource development including mining, access development and forestry. The potential residual effects due to both the construction and operation of the HVdc Transmission Line as well as the site access roads include; sensory disturbance causing avoidance or displacement, overharvesting by hunters or poachers due to increased access into the ranges, habitat fragmentation, and increased predation due to the construction and maintenance of the HVdc ROW. Increase in succulent biomass due to clearing and establishment of early seral vegetation may attract moose which in turn attract wolves and bears which would increase the risk to boreal woodland caribou and their calves.

Direct loss of habitat is not considered to be a factor for The Reed Lake Range. It is anticipated that approximately 68 km^2 of 1,974 km^2 (3% of the total) of total core winter habitat are contained in the 3 mile FPR evaluation corridor (Local Study Area). This section of the HVdc Bipole parallels the existing Wuskwatim Transmission Line and is at the extreme eastern edge of the known Reed Lake winter range and does not bisect any major core use area and avoids all known calving areas. The potential negative effects associated with increased predation and hunting is not anticipated to be a cumulative factor. Long term monitoring of the effects of the Wuskwatim transmission Line on boreal woodland caribou is being undertaken in this area and is expected to continue.

Similar to Reed Lake, direct loss of habitat for the Bog range is not a factor. It is anticipated that approximately 120 km^2 of 1,915 km^2 (6% of the total) of core winter habitat is contained within the Local Study Area (3 mile evaluation corridor). The ROW will be constructed in parallel and in proximity to the existing transmission line corridor and the potential effects associated with predation, disturbance and fragmentation are expected to not be cumulative. There is also a groomed snowmobile trail, maintained by Snoman Inc. (Snowmobilers Association of Manitoba) on the existing transmission ROW and it is unlikely that the new HVdc will experience similar snow pack and snowmobile activity.

Of all boreal woodland caribou evaluation ranges, the Wabowden Range has the highest degree of existing fragmentation due to existing highway and railroad infrastructure and past anthropogenic disturbance. There is potential for increased predation and mortality as the ROW bisects intact known core winter and summer use areas including known calving areas. Direct loss of habitat is not considered to be a factor for the Wabowden range as habitat is not limiting. It is anticipated that approximately 165 km^2 of 1,657 km^2 (10% of the total) of core habitat in this range occurs within the 3 mile FPR evaluation area. Some level of sensory disturbance is expected and fragmentation effects in the Wabowden range are expected to be minimal based on a preliminary assessment of individual caribou movement and range use from the Project and Wuskwatim caribou monitoring. Concerns relate to increased predator access and possible mortality from hunting along the new ROW through core winter use areas. However the mitigation suggested in Section 7.3 are expected to minimize these effects. The results of aerial surveys and camera studies indicate that there are few white-tailed deer occupying the area, with habitat conditions not necessarily conducive to large scale deer or moose expansion in the area due to habitat alteration as a result of the ROW clearing and maintenance. Human use of the ROW during winter is expected to be low as existing snow mobile trails exist near and along existing linear features away from the FPR.

The areas being traversed by the FPR in core use areas are predominantly bog and wetland habitats that will require much less frequent clearing of vegetation, thus is it expected that the effect of the Project on the Wabowden range will be small in magnitude if mitigation is successful based on monitoring and adaptive management over the geographic extent of the Project Study Area. The majority of effects will occur during construction of the HVdc line as well as site access roads and may be realized during periodic maintenance

7.3 Summary of effects

Sensory disturbance due to clearing and ongoing access of the ROW by construction crews as the line is assembled may result in short-term avoidance and displacement for all three ranges. Possible effects of disturbance via construction will likely be focused to the immediate vicinity of construction activity. The degree of avoidance will depend on the frequency of vehicular

traffic and is expected to vary as site preparation activity proceeds along the route. Boreal woodland caribou may be temporarily displaced due to disturbance and access if they are present during construction.

The nature of the terrain in all three ranges (i.e. open and sparsely treed bogs) is more accessible by snowmobile than more dense coniferous habitats occupied by boreal woodland caribou in other ranges making them more susceptible to illegal hunting and poaching. Although boreal woodland caribou are technically protected from hunting, there remains risk to hunting and poaching of animals during winter in their core use areas.

There is also potential for increased movement of grey wolves along the ROW following construction for all three ranges. Particularly, as ROW clearing and tower erection schedules may result in long lengths of low use snow packed ROW behind or following the intensive clearing and construction activities, providing opportunity for enhanced predator movement.

In order to address the various Project effects that could not be managed by routing, there are a number of mitigation measures that have been identified. Of particular importance are measures that will mitigate against predator movement, while maintaining connected and non-fragmented landscapes, particularly in critical core winter use and calving areas. The use of wildlife corridors and buffers in selected areas can provide for landscape connectivity, facilitating natural and un-restricted movement wildlife (Tischendorf and Fahrig, 2000; Bennett and Mulongoy, 2006; Chetkiewicz and Boyce, 2009; Barrows et al., 2011). The use of wildlife corridors and buffers are also recommended in the Forest Management Guidelines for Wildlife in Manitoba (1989). The maintenance of natural low tree cover within selected areas in the ROW as corridors to maintain landscape function facilitating the natural movement of boreal woodland caribou within core areas will be applied.

The specific mitigation activities that are recommended to address the residual effects are summarized as follows;

- Timing of construction (winter) will mitigate sensory disturbance on females during calving and calf rearing in calving areas.

- Natural low tree cover will be maintained in core winter areas and known and potential calving areas to maintain natural functional structure to encourage ongoing use by boreal woodland caribou. Boreal woodland caribou in the Wabowden area have demonstrated high levels of movement north and south throughout the specific area. Wildlife corridors will be facilitated by strategic tower placement on rock outcrops to increase the conductor to ground height, enabling the maintenance of naturally low occurring vegetation such as black spruce and tamarack. This will also minimize predator flow through these critical habitats. Emphasis will be placed on the Wabowden range in core use areas where a new ROW will increase the level of fragmentation for this range compared to Reed and The Bog where existing linear features are being paralleled; Wildlife corridors to facilitate boreal woodland caribou movement will also be implemented in The Bog range.

- In the Wabowden range, robust and effective access control to the ROW from PTH 6 will be applied near core use areas. These will be based on site specific conditions and methods that halt or limit ATV and snowmobile traffic. Methods include gates (during construction) and the spreading of debris, ditching and trenching (post construction). Natural vegetation will be encouraged and where necessary planting of trees will occur to discourage future snowmobile and ATV access into core winter and summer use areas.

- Future maintenance of ROW will involve helicopter access and minimize snow packing in the Wabowden Range. In other areas development of Manitoba Hydro snowpack trails will be limited in core winter areas to minimize potential predator effects into core areas and potential illegal hunting activities;

- Limiting recreational use and travel by ATVs and snowmobiles along the ROW in the core winter area and known potential calving areas will be encouraged to reduce sensory disturbances and minimize functional habitat loss;

- Ancillary access and other project footprints (staging areas) will be minimized to reduce potential disturbance, functional habitat loss and temporary range fragmentation;

- Organic material will be removed from temporarily cleared areas for Project construction and re-distributed to encourage re-growth of native vegetation to facilitate a quick recovery to natural low growing vegetation that will provide security cover to encourage animal movement across the ROW in future;
- Hunting by Project personnel will be prohibited and firearms use restricted in work camps and areas will minimize mortality.
- Long term monitoring of the boreal caribou ranges intersected by The Project will continue and include population monitoring, and assessment of recruitment and mortality. Data will be gathered through satellite collaring and assessments will be conducted on sensory disturbance and avoidance of the ROW and overall range fragmentation.
- Monitoring of wolves will be conducted in all boreal woodland caribou ranges intersecting The Project using aerial surveys, trail camera studies and satellite collar tracking studies to determine use of the ROW and increased predation.
- Studies will be initiated on the effects of black bears and the potential effects of the ROW on bear activity and predation in calving areas near the ROW in the Wabowden and The Bog ranges.

Subject to the successful implementation of the mitigation measures outlined above, the residual effects of the HVdc transmission line on boreal woodland caribou are sensory disturbance due to clearing and ongoing access, short-term avoidance and displacement during construction, the risk of an increase in illegal hunting due to additional access, the risk of an increase in the presence of wolves due to additional access, and increased presence of bears due to an increase in succulent biomass.

The residual effects of the HVdc transmission line on boreal woodland caribou in the Wabowden, Reed Lake and Bog ranges after successful implementation of the mitigation measures outlined above are expected to be negative in direction, small in magnitude, Project Study Area in geographic extent, short term (construction) and medium term (operation) in duration, regular to continuous in frequency, reversible after Project decommissioning, and

therefore not significant. This assessment is subject to scientific uncertainty and concern, particularly with regard to boreal woodland caribou in the Wabowden range, based on the following considerations:

- There is uncertainty regarding the location of this range and the present size of its population, some of which uncertainty may be resolved in 2012 when the province publishes its revised assessments on these topics.
- There is concern that there is a risk of unsustainable losses in the population of the range from the incremental effects of the Project due to the risk of increased predation, increased hunting and increased presence of bears.
- The probability of there being unsustainable effects due to the Project is indeterminable in part because there is currently no known disturbance threshold for boreal woodland caribou sustainability in general, let alone specifically for boreal woodland caribou in the Wabowden range. Further, there has not been an adaptive management strategy implemented to date for this range and, accordingly, there is no basis today to conclude that such strategy would be 100 percent effective in maintaining the population(s), with or without the Project.
- Both the provincial and the federal governments will be publishing new recovery strategies for boreal woodland caribou in 2012; specialists are currently reviewing drafts of these strategies and are trying to reach consensus on the subject of disturbance thresholds.

Current intensive monitoring is helping to reduce the uncertainty in predicting effects on these boreal woodland caribou ranges through the gathering of more data on the size of the range and current recruitment and mortality. Ongoing monitoring will be required with respect to all three ranges to provide early warning of potential population effects, in which cases early responsiveness with an adaptive management plan will be required to ensure that residual effects remain insignificant. Adaptive management actions will be particularly important and required in the Wabowden range, and potentially in the Bog and/or Reed Lake ranges, to further mitigate

effects if identified through monitoring. Overall monitoring and adaptive management plans in each range will need to be reviewed and updated as required when the new federal and provincial recovery strategies and provincial assessments for each range are released in 2012.

Integrated management solutions involving Manitoba Conservation will also be important in sustaining these local populations through enforcement of regulations protecting boreal woodland caribou from hunting, access management and the regulation of other resource use activities that may increase the cumulative effects.

Table 37: Bipole III residual environmental effect assessment summary table for coastal and barren-ground caribou

1. Residual Environmental Effect	2. Direction	3. Ecological Importance	4. Societal Importance	5. Magnitude	6. Geographic Extent	7. Duration	8. Frequency	9. Reversibility	10. Significance	Comments
Direct and functional loss of habitat	Negative	Moderate	Moderate	Small	Project Sites	Short term	Regular	Reversible	Not significant	Habitat is not limiting.
Range Fragmentation	Negative	Moderate	Moderate	Small	Local Study Area	Long term	Regular	Reversible	Not significant	No effects
Increased predation	Negative	High	High	Small	Local Study Area	Long term	Regular	Reversible	Not significant	Monitoring required apply adaptive management
Mortality due to hunting	Negative	High	High	Small	Local Study Area	Long term	Regular	Reversible	Not significant	Boreal woodland caribou protected.
Introduction of pathogens and disease	Negative	High	High	Small	Project Study Area	Long term	Regular	Reversible	Not significant	Range habitat not suitable for deer

Table 38: Bipole III residual environmental effect assessment summary table for boreal woodland caribou

1. Residual Environmental Effect	2. Direction	3. Ecological Importance	4. Societal Importance	5. Magnitude	6. Geographic Extent	7. Duration	8. Frequency	9. Reversibility	10. Significance	Comments
Direct and functional loss of habitat	Negative	High	High	Small	Project Sites	Medium Term	Regular	Reversible	Not significant	Habitat is not limiting
Range Fragmentation	Negative	High	High	Small	Project Study Area	Medium Term	Regular	Reversible	Not significant	Possible short term effects
Increased predation	Negative	High	High	Small	Project Study Area	Medium Term	Regular	Reversible	Not significant	Monitoring required apply adaptive management
Mortality due to hunting	Negative	High	High	Small	Project Study Area	Medium Term	Regular	Reversible	Not significant	Boreal woodland caribou protected.
Introduction of pathogens and disease	Negative	High	High	Small	Project Study Area	Medium Term	Regular	Reversible	Not significant	Range habitat not suitable for deer

8.0 CUMULATIVE EFFECTS

Cumulative effects assessment is an important step in determining the impact of anthropogenic and environmental factors on the long-term viability of the environment and its function as an ecosystem (Hegmann et al., 1999). The *Cumulative Effects Assessment Practitioners Guide* (Hegmann et al 1999) defines cumulative effects as "changes to the environment that are caused by an action in combination with other past, present and future human actions." For the purpose of this report, cumulative effects will be examined in reference to spatial and temporal effects of past, current, and future projects/developments on boreal woodland, coastal, and barren-ground caribou, on the landscape.

Cumulative effects associated with the Project transmission line structures are anticipated to include electrical effects (EMF), visual disturbance, loss of wildlife habitat, forest resources, and increased access (Wuskwatim Transmission EIS, 2003). Some of the effects identified (e.g., EMF and visual disturbance) are effectively limited to the immediate environs of the ROWs and sites (Wuskwatim Transmission EIS, 2003). Cumulative effects identified as more significant, occurring at a boarder, regional scale, such as wildlife habitat loss and increased access. Such effects are discussed here.

As discussed in this technical report, there is a consensus among the scientific community that boreal woodland caribou decline is a population response to the cumulative effects of disturbance regimes that contribute to various pathways of decline. Anthropogenic disturbance such as linear development in combination with other land-based activities including forestry, mining, recreation and, access development may lead to a cumulative effect response that could influence the population growth rate (Lambda (λ)) and possibly lead to a decline in local or regional populations (Dyer et al., 2001; McLoughlin et al., 2004). Linear development as a cumulative pathway of decline is not clearly understood and it is difficult to measure the response of any one activity on the persistence of a population. These effects include the possibility of changing the natural distribution of primary prey into critical boreal woodland caribou habitat. These changes in predator distribution may result in increased interaction between high level carnivores (in search of primary prey such as moose etc.) and boreal woodland caribou (James et al., 2004). The potential for increased incidental predation on boreal woodland caribou can have significant implications on the sustainability of boreal woodland caribou populations through slight decreases in Lambda (λ) with the primary cause being predation (Schaefer, 2003; Vors et al., 2007).

The complex nature of boreal woodland caribou "spacing" themselves away from predators and their alternate prey on the landscape are well documented and are hypothesized to be influenced by habitat alteration and linear development (James, 1999; Dyer et al., 2001). It is also hypothesized that linear development and the anthropogenic use of linear features (such as creating snow-packed trails) increases the mobility of predators into previously remote caribou habitat (James, 1999). Under most conditions, these phenomena can be expected to contribute to the decline of regional or local caribou, although the cumulative relationships and pathways of decline are not consistent among meta-populations (Klein, 1991) and there is even greater variability between local populations (Environment Canada, 2009). Population decline is dependent upon the amount and distribution of anthropogenic activity and industrial development that can indirectly influence primary prey habitat and predator distribution relative to boreal woodland caribou critical habitat (Vistnes and Nellemann, 2007).

Dating back as far as 1958, there are various activities that have been undertaken within the Project Study area which may contribute to cumulative effects of the Project. These endeavors include forestry activities conducted by *Tolko Industries Ltd.* and *Louisiana-Pacific Canada Ltd.,* mining activities conducted by Crowflight Minerals Inc., HudBay Minerals Inc., San Gold Corporation, Tantalum Mining Corporation of Canada, Ltd., and Vale and the Wuskwatim Transmission Project conducted by Manitoba Hydro. It is anticipated that some, if not all, of these activities will continue to occur on the landscape, thus contributing to the potential cumulative effects on caribou. Given their intensive nature, these activities are also used as the spatial components for cumulative effects.

8.1 Other Projects In/Around the Project Study Area

Several projects may have the potential to contribute to cumulative effects in the Project Study Area. A summary of potential cumulative effects identified for wildlife populations existing in and surrounding the Project Study Area are indicated below:

8.1.1 Tolko Industries Ltd.

Manitoba first entered into Forest Management License (FML) Agreement 2 with Repap Manitoba Inc. in 1989. Forest Management License Agreement 2 and associated operations were transferred to Tolko in 1996. Tolko’s forest management license (FML) area overlaps with the Churchill River Upland, Hayes River Upland, and Mid-Boreal Lowlands Ecoregions. Forest management activities have been known to have trans-boundary effects on wildlife, most notably wide-ranging species such as migrant birds and woodland caribou. Tolko Industries Ltd. have stated that its forestry practices may result in mammal avoidance of areas of disturbance and clear-cut areas (Tolko Industries Ltd. Forest Management, 2011). Forestry operations within or near boreal woodland caribou ranges commonly alter or change predator/prey dynamics through landscape changes in successional forest, creating younger more succulent forage for species such as moose, and attracting higher numbers of wolves which may increase the interaction between caribou and wolves, leading to increased mortality of caribou. Similarly, landscape changes to early seral forest communities can increase biomass to the benefit of bears who may also impact survivorship of caribou calves. Adherence to the practices and strategies defined for these above mentioned species may mitigate the potential impacts.

8.1.2 Louisiana-Pacific Canada Ltd.

Louisiana-Pacific (LP) entered into FML Agreement # 3 with the province of Manitoba in 1994, with LP beginning its operations in FML area 3 in 1996. Louisiana-Pacific’s (FML) area overlaps with the a number of ecoregions, including the Mid-Boreal Uplands, Mid-Boreal Lowlands, Interlake Plain, and Lake Manitoba Plain Ecoregions. Louisiana-Pacific Canada Ltd. has stated that it forestry practices are anticipated to have a negative effects on wildlife populations within its forest management license areas (FML) (Louisiana-Pacific Canada Ltd. Forest Management Plan, 2010). Wildlife species, such as woodland caribou, which require old

growth or late-seral stage forest, may experience a reduction in available habitat. Minor forest fragmentation may result in a reduction of some wildlife species populations. The results of studies and surveys in the Swan-Pelican area indicate there is likely an un-sustainable boreal woodland caribou population or at best a remnant group that has eluded detection for some years. The decline of this population may be explained by the long term cumulative effects as described above.

8.1.3 Wuskwatim Transmission Project

It is stated that the Wuskwatim Transmission Project will result in a minor loss of wildlife habitat during the course of ROW construction and fragments/removal of forested areas (Wuskwatim Transmission Project, 2003). The potential residual effects on wildlife habitat are considered to be small within the context of the local area and ecodistrict (Wuskwatim Transmission Project, 2003). These effects are expected to be insignificant given the implementation of mitigation measures and the preparation of an environmental protection plan (Wuskwatim Transmission Project, 2003).

8.1.4 Mining

There are a number of mining operations currently active in Manitoba (Table 39)**Error! Reference source not found.**. Activities occurring within and around the immediate Project Study Area involve prospecting exploration, drilling, exploration, access roads, camps, and the establishment of mine sites. These activities result in the clearing of forested areas for activities/camp/construction sites and creation of access roads. Mining-related activities also create high level of disturbance, causing avoidance of terrestrial and avian species in the area (Weir et al., 2007).

Potential impacts of mining activities within the Project Study Area have been stated to include clearing/disturbance for forested areas, noise disturbance (ventilation fans, generators and human activity), surface vibrations/noise related to underground blasting, waste disposal, and increased public access to previously remote areas (Crowflight Minerals Corp., 2004).

Table 39: List of mining companies currently operating in Manitoba (as of April 2011)

Company	Mine	Location	Date Opened	Major Metals/Minerals Mined
Crowflight Minerals Inc.	Bucko Lake Nickel Mine	Wabowden	2009	nickel
HudBay Minerals Inc.	Trout Lake Mine;	Flin Flon	1982	copper, zinc
	Chisel North Mine;	Snow Lake	1998	copper, zinc
	777 Mine	Flin Flon	2000	copper, zinc
San Gold Corporation	Rice Lake Gold Mine;	Bissett	2006	gold
	Hinge Mine	Bissett	2009	gold
Tantalum Mining Corporation of Canada, Ltd.	Tanco Mine	Lac du Bonnet	1969	spodumene, pollucite
Vale	Thompson mine T1 & T3;	Thompson	1958	nickel, copper
	Birchtree Mine	Thompson	1968	nickel, copper

Note: Table from the Government of Manitoba's Innovation, Energy and Mines website. Accessed April 2011 (http://www.gov.mb.ca/stem/mrd/min-ed/minfacts/index.html)

Note: Table from the Government of Manitoba's Innovation, Energy and Mines website. Accessed April 2011 (http://www.gov.mb.ca/stem/mrd/min-ed/minfacts/index.html)

The objectives of the initiatives described below are generally to protect landscape-scale habitat, inter-connecting wildlife corridors, and reduce the magnitude of cumulative effects caused through human activities (Hegmann et al., 1999). Mitigating a local effect as much as possible is the best way to reduce cumulative effects; however, to be most effective, mitigation and monitoring must be long term and regionally based (Hegmann et al., 1999).

The effects of transmission facilities and converter stations themselves are likely to be minor in relation to forestry activities or new road development (including those associated with prospective forestry activity). As alluded to above, the majority of large-scale resource related activities would likely result in caribou avoidance over time due to more intensive landscape and habitat change be it removal of forest, construction, or increase in public access. As a result of habitat removal, habitat fragmentation is anticipated to affect species which have large home ranges such as caribou. Activities involving clear-cutting and creation of roads (e.g. forestry and mining operations) are anticipated to strongly contribute to these effects. A small but long-term cumulative effect from fragmentation is expected in the Project Study Area.

From a landscape perspective, the amount of area occupied by transmission lines in Manitoba's boreal woodland caribou range is small in comparison to other human activities. Boreal woodland caribou also occupy extremely large home ranges and exist at very low densities making risk of ROWs impacting forage availability extremely low. Access related sensory effects from transmission lines are expected to be less than those associated with all weather or winter roads. Indirect ecological impacts from transmission lines are also expected to be minor compared to those associated with other human caused or natural landscape disturbances. Access management and provincial harvest management strategies that regulate hunting are also expected to play an important role in conserving boreal woodland caribou and coastal caribou.

Increased public access is strong and negative cumulative effects are expected with the Project in relation to other projects in and surrounding the Project Study Area. Cumulative effects include sensory disturbance increase via snowmobiles, ATVs, campers, hikers, trappers, and hunters, gaining access to wilderness areas previously difficult to access. The anticipated result of this effect contributes to sensory disturbance and possible higher levels of mortality through hunting in previously remote areas. Access management and provincial harvest management strategies that regulate hunting will play an important role in conserving boreal woodland caribou and coastal caribou.

Climate change conditions including wetter spring seasons and drier, hotter summer seasons could negatively impact caribou through ecosystem level changes in the food web and the availability of forage items. However, the extent to which climate change will contribute to boreal woodland caribou in the more northerly latitudes is unknown.

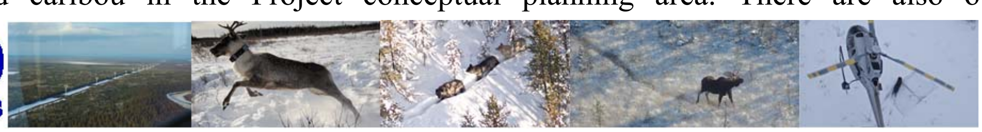
In order to aid in the prevention of the spread of disease and parasites, such as bovine tuberculosis and chronic wasting disease, sampling and monitoring of ungulate species should be undertaken. Limiting ungulate movement in areas found to contain such diseases could be used as a method of prevention of further spread infection.

Grey wolf use of linear corridors for predation has been well documented by numerous authors. Linear corridors allow wolves to travel more quickly and also potentially influence their travel routes, the distribution of wolves, and wolf-prey contacts and interactions (Thomas, 1995; James and Stuart-Smith, 2000; Courbin et al., 2009). Linear corridor development in remote regions allows for increased access into formerly remote habitat, thus increasing predation efficiency. Habitat alteration which provides predators access to previously safe places for caribou, reduces wolf search rates and increases the variety of other ungulate prey species for predation (Thomas, 1995; James and Stuart-Smith, 2000). Taking this into account, the development of new linear corridors, be it through clearing cutting for forestry operations, development of access roads for prospect mining, or the development of the ROW for the Project may contribute to the increase in wolf movement and predation rate on caribou within the Wabowden, Reed Lake, and The Bog ranges.

9.0 FOLLOW-UP/MONITORING

The purpose of follow-up is to verify the accuracy of EAs and determine the effectiveness of mitigation measures (Hegmann et al., 1999). Follow-up, in practice, is normally recognized as monitoring and the establishment of environmental management measures (Hegmann et al., 1999). The situations which require follow-up monitoring are generally understood to be situations where there is uncertainty about the effectiveness of the mitigation measures for cumulative effects or situations where a cumulative effects assessment is based on a new/innovative approach (Hegmann et al., 1999).

Manitoba Hydro and Manitoba Conservation have been working cooperatively on boreal woodland caribou and grey wolf collaring and data collection within the Project Study Area. Manitoba Hydro has also previously supported a significant body of research and monitoring of boreal woodland caribou in the Project conceptual planning area. There are also other



collaborative research projects that have been undertaken or are currently underway that have provided significant data on boreal woodland caribou distribution and relative numbers. These data include animal borne GPS collar data from several local populations and aerial survey data. These data have provided a baseline for the identification of core wintering and summer calving areas for some populations with additional monitoring and research work currently underway as part of the SSEA process and Ph.D. research which is currently being undertaken.

Specific to Manitoba Hydro, the interest in supporting this research is based on a draft corporate strategy on boreal woodland caribou that is guiding the following routing constraints and potential impacts being evaluated in the Project SSEA process. Manitoba Conservation supports this monitoring to reduce the potential impacts that the Project may bring to boreal woodland caribou in the ranges traversed by this Project.

In particular, the amount and spatial distribution of habitat disturbance that boreal woodland caribou can withstand to maintain or increase Lambda (λ) on local ranges is described. Research is intended to contribute to new knowledge on the dynamic cumulative effects of various resource developments in boreal woodland caribou populations. The National Science Review has illustrated the need for further research in many different areas relative to the long-term recovery of boreal woodland caribou in Canada. The linkages and relationships between the potential pathways of decline are not well understood. Specifically, the following hypotheses are being tested as part of ongoing Ph.D. research and Manitoba Hydro's long-term monitoring program.

Range Fragmentation Hypothesis

The range fragmentation hypothesis predicts that boreal woodland caribou range utilization will be lost due to various anthropogenic developments and this loss of functional range is the result of cumulative effects associated with each type of anthropogenic and natural disturbance. Schindler (2006) conducted the only linear analysis effects study in Manitoba on boreal woodland caribou and found that there are individual animal responses to an all-weather forestry road and there is a measurable loss of functional habitat; however, there was no overall fragmentation of winter range. Differences in amount of activity, linear development, snow-packed versus not snow packed linear features relative to winter distribution and summer distribution will all contribute to the extent and response of individuals and populations to linear development.

Reduced Lambda Hypothesis

The reduced Lambda hypothesis predicts that reduced recruitment and increased mortality is a direct function of the spatial arrangement and numbers of primary prey, predators, and anthropogenic disturbance (type and magnitude). The mosaic of anthropogenic disturbance in association with natural features, distribution of primary prey, predators and human activity (e.g. snow-packed linear corridors and forestry areas) may have an impact on the distribution and effectiveness of predators. Linkages to habitat distribution (i.e. maintenance of large, non-fragmented tracts of suitable habitat will be studied). Factors include prey escape and the ability for boreal woodland caribou to have adequate habitat to space themselves away from predators, disturbance effects such as avoidance of high quality habitat resulting in increased energetic outlay and reduced fecundity, and the direct relationship of these to the cumulative environmental factors (anthropogenic and natural) that exist on the landscape.

A comparison of recruitment and mortality over a three to five year period of a number of different caribou ranges with varying levels of linear development and other anthropogenic disturbance will be studied. The collaring objective is to maintain a minimum sample of 20 collared adult females in each test population throughout the course of the study. In order to detect a decline in Lambda, it is estimated through power analysis that it will require an approximate change of 10% in Lambda to detect any significant change. As collar data are being acquired, the extent and delineation of some ranges are being discussed with Manitoba Conservation. At this time, for the purpose of this study, the following range units are being considered.

- Harding Lake (Wapisu north)
- Wapisu and Wimapedi
- Wheadon

- Wabowden
- Naosap
- The Bog
- Charron Lake – Note: Charron Lake is a remote population with little anthropogenic disturbance and may be used as a control population to compare recruitment and mortality to.

Boreal Woodland Caribou Recruitment

The sustainability of boreal woodland caribou across their range is a function of several factors, of which calf recruitment is likely the most significant component of maintaining populations. It is theorized that anthropogenic disturbance is an indirect vector of decline through the alteration of habitat and predator/prey relationships resulting in increased predation (Manitoba Conservation, 2006). This is mainly due to the fact that boreal woodland caribou have the lowest fecundity rates of North American ungulates (Banfield, 1974). An understanding of the entire reproductive cycle includes breeding, which is coincidental with the rut and occurs mid-September through mid-October (Shoesmith and Story, 1977). Females will participate in the rut and begin breeding at age 1.5 to 2.5 (Fuller and Keith, 1981; Darby and Pruitt, 1984; Rettie and Messier, 1998). Males will attempt to breed at 1.5 years of age however the social structure of the rut prevents successful breeding until age 3.5 to 4.5 years (Kelsall, 1984). Calves are born in May through June after a seven and a half month gestation period (Fuller and Keith, 1981). In the Project Study Area, the mean calving date based on analysis of high resolution GPS tracking collars on female caribou, is May 25. Although pregnancy rates for woodland caribou can average 86%, unlike other ungulates, they rarely produce twins and successful recruitment of calves into the population is very low (Bergerud and Elliot, 1986). As boreal woodland caribou populations are small compared to other ungulate populations, slight declines in calf recruitment can have detrimental effects on overall population trends.

To establish base line conditions and to assess current status of populations in the Project Study Areas, calf recruitment studies will be conducted to: 1) assess if there are differences in

recruitment among boreal woodland caribou populations with different fragmentation and anthropogenic disturbance regimes, and 2) detect if the level of anthropogenic disturbance and amount of linear development affects recruitment rates. These surveys will be conducted in the spring, summer, and early fall. A minimum sample of 20 adult females is required to ensure a minimum sample for statistical validity. Late winter surveys provide better visibility, larger group sizes, and the best measure of recruitment as calves are nearing independence. Twenty collared animals can lead you to 50 or 60 adult females giving an excellent sample size to assess recruitment.

Using the Iridium downloading protocol, locations of calving females will be mapped and downloaded into a hand held GPS prior to recruitment flights in order to minimize the amount of time required to locate and document presence/absence of calves. For VHF and GPS store-onboard, more extensive flights will be required to locate collared females. Surveys will be conducted on a monthly basis throughout the summer starting in June and ending in September for a minimum of three years from 2011, maintaining collars in order to collect sufficient data and sample size until 2014. The overall objective is to track a representative number of adult female caribou in each population to obtain a statistically valid estimation of calf survival through to the fall. Minimum samples of 20 female caribou will be tracked in each population where possible.

Trail Camera Studies

The research also involves monitoring the distribution and abundance of primary prey species and predators in relation to boreal woodland caribou habitat and core winter and summer range through aerial surveys and trail camera studies. Trail camera studies will be undertaken to assess black bear and wolf activity near calving areas and core winter range as well as along linear corridors (transmission lines). RECONYX™ Silent Image Professional trail cameras (PM35C31 and PM35M1) rapid fire models will be used. Camera clusters will be distributed across several caribou ranges to assess predator abundance and distribution. Photo analysis will be conducted using the RECONYX™ software and incorporated into an integrated GIS layer for spatial analysis. (Note: This will be expanded).

Monitoring Local Populations – Range Definition

The study is being conducted in the Northwest, Northeast, and Eastern regions of Manitoba. There are currently eight or nine ranges of boreal woodland caribou that are being monitored through collaborative works involving Manitoba Conservation and Manitoba Hydro as described above. As data are being acquired, a better understanding of range extent may result in new range delineations. These boreal woodland caribou ranges are also being monitored as part of broader monitoring requirements associated with past and current transmission line development. The overall objective of the collaring and tracking portion of the study is to ensure a minimum sample of 20 adult females in each test range. Each range will have distinct habitat and anthropogenic disturbance regimes. Collars will be deployed and will function for a 3-year period and will be automatically "dropped off" using timed release mechanisms. Iridium collars allow for daily acquisition of animal position and will allow the user to detect mortality events in real time, allowing the researcher to quickly investigate the mortality event to determine cause of death. Standard VHF and downloadable store-onboard GPS do not facilitate this type of data acquisition and also require significant amounts of flying to track and find animals.

Landscape Habitat Analysis

A habitat-based inventory will be developed and used to model and evaluate landscape vegetation and habitat characteristics to determine the extent and type of natural features that exist across the boreal woodland caribou landscape. Detailed habitat and landscape metrics will be calculated for critical use areas such as core wintering areas, calving sites, and calf-rearing areas. Baseline habitat data may involve several data sources depending on the scale of analysis and location of data. Preliminary investigations suggest that landscape modelling can be facilitated using Earth Observation data for Sustainable Development (EOSD). This federal database has been refined using EOSD satellite data and incorporated into a vector-based habitat mapping imagery. These data will be updated with historical and current fire history data as well as wetland classification data. A new habitat map will be developed that incorporates critical vegetation components, underlain soil and moisture regimes as well as relative age of origin. These data will be used to establish a predictive model to determine areas of potential critical habitat based on an analysis of boreal woodland caribou telemetry data. It will be possible to determine landscape habitat and vegetation metrics that have specific significance to boreal woodland caribou habitat selection and distribution. Telemetry data will be used to identify and characterize various habitat components, such as size and number of habitat patches, distance between patches, and edge density of patches for a number of key habitat types. A hexagonal habitat modeling approach will be conducted using Patch Analyst or Patch Grid. A model will be developed to spatially evaluate the locations of high quality winter range as well as calving and calf-rearing areas. This model will form a backdrop for critical caribou habitat and provide for additional evaluation of the juxtaposition of various habitat and vegetation types relative to primary prey distribution and habitat as well as predator abundance and foraging behaviour. Spatial analysis will include interspersion analysis of primary prey observation and habitat modelling as well as distribution survey data from aerial moose and wolf surveys. Analysis will include nearest neighbour and contagion analysis (degree to which things attract or cluster) and joint dispersion (assessment of patterns of interspersion).

Determine Primary Prey and Predator Distribution.

Aerial surveys and monitoring of both predators (wolves and bears) and prey (primarily moose) will be conducted in each of the test populations. Wolf surveys will be conducted as minimum counts in various ranges. These surveys will be conducted annually for 3 years to determine minimum wolf populations and general distribution as well as collecting data on movement and predation activities. Pack movement distances will be documented as well as travel by packs along rivers and snow-packed linear features or other anthropogenic features through satellite tracking and collaring of wolves. Locations of moose concentrations will also be surveyed and mapped. Telemetry data for wolves will also be incorporated into the spatial analysis described above. GPS telemetry data will augment aerial survey data and be incorporated into the overall interspersion analysis.

Population Viability Analysis (PVA)

A landscape meta-population modeling analysis will utilize the spatial data gathered above to assess the sustainability of the test populations under various risk scenarios. The PVA will

combine the spatial data on the landscape with the habitat requirements of boreal woodland caribou and will be used to model various simulations that will quantify the sustainability of the various populations. Critical information will include fecundity rates (using spring calving surveys), mortality rates and causes (such as the use of the mortality sensors on all collars), predator use and distribution (from aerial surveys, ancillary studies and trail cameras), and primary prey distribution and abundance (from annual distribution surveys and habitat modeling).

Other Monitoring

Detailed examination of all telemetry data will be undertaken to assess the differences in caribou movement in relation to linear development and other anthropogenic disturbance. Monitoring areas experiencing heavy vehicle traffic for incidences of wildlife-vehicle collisions, particularly involving large game species (such as moose, elk, deer, caribou, bear, wolves, or coyotes) should be used for adaptive management and regulation of highway use. Adaptive measures could include reduction of speed limits or restriction of access road use to the public through the use of gates (Jalkotzy et al., 1997).

For all of these monitoring and follow-up options, management and coordination between regional planning authorities will be essential to maintain mammal populations within their natural range of variability. Additionally, coordination and communication with the public regarding monitoring programs and the potential effects of the Project on mammal populations should be used wherever feasible. Use of public consultation sessions, email-out questionnaires, and individual consultations with key resource users (such as trappers, hunters, campers, etc.) will provide valuable feedback and monitoring of mammal movement and response to the Project development. Furthermore, consultation with First Nations should be ongoing. First Nations trappers and hunters could be consulted via personal interview and/or email-out/mail-out survey for ATK with regard to mammal populations in the area to include this information in adaptive management measures.

10.0 CONCLUSIONS

10.1 Valued Environmental Components

Woodland caribou were identified as a VEC warranting the investigation of the possible and actual effects the construction and operation of the Project. Habitat fragmentation is a potential impact resulting from the construction and operation of a transmission line ROW which may contribute to subsequent changes in predator-prey dynamics and human disturbance of caribou. Habitat loss and fragmentation generally poses a large problem for protection and rehabilitation of woodland caribou. Caribou may are generally understood to avoid linear corridors to reduce their risk of predation. The effects of human disturbances and recreational activities on caribou habitat is also thought to also influence predation rates and increase disturbance (respectively) to woodland caribou.

Given their influence to woodland caribou ecology and movement to this Project, wolves were considered a VEC linkage species for this Project. When disturbances occur in the boreal forest which support the incursion of other ungulates into caribou habitat, wolves may follow these prey. This results in higher caribou mortality attributed to wolf predation. Linear corridor developments in remote regions allow for increased predator access into formally remote caribou habitat. Due to the increasing amount of corridors found in the boreal forest, which decreases the effectiveness of refuge caribou habitat areas caribou herds may diminish under the increased levels of predation (James et al., 2004). Caribou are understood to be most vulnerable to predation by wolves when they were young, old, and in poor condition (Mech et al., 1995).

10.2 Environmental Effects/Mitigation Measures

There are expected environmental effects on populations of woodland caribou by the Project. Core winter range may be directly affected through the loss of forage and functional loss of winter range due to animal displacement. Secondary effects include higher energy expenditures of caribou due to increased movement as a result of forest fragmentation, increased predation and mortality from changing predator-prey interactions, and mortality due to hunting and poaching facilitated by increased access into caribou habitat. To mitigate these effects, it is recommended that core habitat be avoided by careful routing of the transmission line. It is also

recommended that winter travel/patrolling be minimized. Human access to the development and associated roads should be limited at key locations. Additionally, when tree cutting is being performed, shrubs and other low vegetation species should be maintained to provide cover for the animals. After mitigation is completed, residual effects are expected to include a small functional loss of habitat as well as a potential small increase in animal mortality.

Calving habitat and core summer range may be impacted by the Project. This could cause sensory disturbance and displacement of animals from calving habitat and core habitat into higher risk habitats, subsequently leading to increased predation by bears and wolves. Access of predators into the area may also be facilitated by the Project development. If caribou are displaced into white-tailed deer territory, or white-tailed deer access is facilitated into caribou territory, there is potential for increased transmission of pathogens and disease from white-tailed deer to caribou populations. Suggested mitigation measures include avoiding calving habitat and core summer habitats through careful routing of the Project, minimizing access to the area, and maintaining shrubs and other vegetation that will provide cover when cutting overstory trees. After mitigation is completed, residual effects are expected to include a small functional loss of habitat as well as a potential small increase in animal mortality.

Effects from the Project may result in decreased recruitment in caribou populations as a result of changing predator-prey interactions leading to an increase in the mortality of adult females and calves. This may have the consequence of decreasing population range and size. No specific mitigation techniques are recommended, however ongoing monitoring of wolves, bears, and moose population levels and range in the area should be undertaken. There may be a residual effect of a small decrease in recruitment, which will require monitoring to determine the extent of the effect and population response.

Manitoba Hydro’s standard practices for environmental protection during the construction of transmission lines will generally reduce many of the effects of human activity, such as handling of hazardous and non-hazardous material, hazardous and non-hazardous waste disposal, and regulations for personnel (e.g., no harvesting of area resources by work crews). General mitigation recommendations to avoid harm to caribou include clearing the ROW and other projects in winter, and not leaving snow piles or piles of stored vegetation. To reduce mortality, prohibitions of hunting by Project personnel are recommended, as well as enforcing speed limits on access roads, and warning signs in animal activity areas. During operation, destroyed habitats should be restored post-construction and line inspection to be completed aerially as much as possible. Temporary trails should be decommissioned to limit access. It is anticipated that all components of the proposed Project, with the application of decommissioning mitigation (removal of equipment and foundations, re-vegetation, etc.), are fully reversible.

Expected residual effects on caribou are not anticipated to be significantly adverse, however, the extent of these is relatively unknown and is linked to cumulative effects of other developments and disturbances in the region. Effects are expected to be less than those associated with all weather or winter roads. Indirect ecological impacts from transmission lines are also intuitively thought to be minor compared to those associated with other human caused or natural landscape disturbances. The cumulative effects of transmission line construction and operation as a pathway of decline are not clearly understood, but are expected to be minor in most cases. Understanding the predator/prey relationships within the northern Project Study Area are considered essential in the evaluation of population viability for species such as the boreal woodland caribou, which are extremely sensitive to increases in predation. Slightly different effects are expected for the different populations in the Project Study Area, as detailed in Section 7.0, with effects more likely to be observed in boreal woodland caribou populations than coastal and barren-ground caribou.

10.3 Environmentally Sensitive Sites

Environmentally sensitive sites for woodland caribou were determined to be calving complexes and core winter ranges. Mitigation and protection measures for these sites involve limiting activities during specific calving times, limiting activities when caribou are present in core winter ranges within/near to construction areas, use of 3 km buffers around calving complexes, use of 5 km buffers around core winter ranges, continually monitoring caribou during active construction periods, and limiting clearing and construction schedules when in the vicinity of caribou populations.

10.4 Follow-up/Monitoring

The situations requiring follow-up monitoring are generally understood to be situations where there is uncertainty about the effectiveness of the mitigation measures for cumulative effects. There several cumulative effects anticipated to occur within the Project Study Area. Manitoba Hydro and Manitoba Conservation have been working cooperatively on boreal woodland caribou and grey wolf collaring and data collection within the Project area. Research Projects in the area are currently underway and are expected to continue. Ongoing studies will be carried out to evaluate the effects of habitat fragmentation by studying the response of individuals and populations to linear development. To study the effects of the Project on population recruitment, mortality over a three to five year period of a number of different caribou ranges with varying levels of linear development and other anthropogenic disturbance will be studied. Calf recruitment studies will be carried out to assess if there are differences in recruitment among boreal woodland caribou populations with different fragmentation and anthropogenic disturbance regimes, and detect if the level of anthropogenic disturbance and amount of linear development affects recruitment rates.

Trail camera studies will be undertaken to assess animal activity near calving areas and core winter range as well as along linear corridors in order to monitor the distribution and abundance of predators and predators in relation to boreal woodland caribou habitat. In the Northwest, Northeast, and Eastern regions of Manitoba, ranges of boreal woodland caribou are being monitored to achieve a better understanding of range extent that may result in new range delineations. A habitat-based inventory will be developed and used to model and evaluate landscape vegetation and habitat characteristics to determine the extent and type of natural features that exist across the boreal woodland caribou landscape. Detailed habitat and landscape metrics will be calculated for critical use areas such as core wintering areas, calving sites and calf-rearing areas. To gauge impacts on predator-prey interactions, aerial surveys and monitoring of both predators (wolves and bears) and prey (primarily moose) will be conducted. A landscape meta-population modeling analysis will utilize all spatial data gathered to assess the sustainability of the caribou populations under various risk scenarios. The population viability analysis (PVA) will combine the spatial data on the landscape with the habitat requirements of boreal woodland caribou and will be used to model various simulations that will quantify the sustainability of the various populations.

Additionally, monitoring areas experiencing heavy vehicle traffic for incidences of wildlife-vehicle collisions, particularly involving large game species (such as moose, elk, deer, caribou, bear, wolves, or coyotes) should be used for adaptive management and regulation of highway use. For all of these monitoring and follow-up options, management and coordination between regional planning authorities will be essential to maintain caribou populations within their natural range of variability. Coordination and communication with the public regarding monitoring programs and the potential effects of the Project on mammal populations should be used wherever feasible.

10.5 Data Sources/Limitations

Due to the geographical expanse of the Project Study Area and the inherent lack and variability of both habitat based and species specific data, there are limitations to much of the data used in this EIS. Spatial data are limited in some areas (north) and in some cases, non-existent. The LCCEB was seen as an appropriate and consistent data set for evaluating habitat. Use of the FRI augmented the LCCEB in most cases where data were available. Species specific data acquired from government and non-government sources were also used, however these data were also not consistent across the Project Study Area. Field studies were conducted to supplement and in some cases, provide the only base line data available. The approach to modeling VEC habitat validated through field studies is considered to be acceptable for the assessment undertaken for the Project EIS.

10.6 Outstanding Information Requirements

There are a number of outstanding sources of information regarding caribou in the Project Study Area. Firstly, some sections of the FPR were identified only after the caribou studies had been conducted. This is particularly significant in the Thompson Nickel Belt region, where a portion of the FPR intersecting the Wabowden core area is not contained in the FPR where several studies were conducted. The lack of data at these new locations for a portion of the route has resulted in gaps for the caribou assessment in these areas. Affected studies included lichen surveys conducted along the FPR in November 2010 and calving and winter habitat models, which were generated within the extent of the original Project Study Area.

In addition, methodologies for some preliminary analyses are currently being refined based on initial results and the accumulating bank of telemetry and survey data. These include the calving and winter habitat models and linear analyses conducted for effects monitoring (Section 4.5). Habitat models were generated using data collected between 2002 and 2009 and are currently being validated and refined based on additional calving collected in 2010 and 2011. Linear features analyses were preliminary and will be modified with the telemetry results now being collected for caribou ranges in the Project Study Area which were not available prior to collar deployments in January 2011. Both of these analyses will be developed further in conjunction with long-term monitoring studies.

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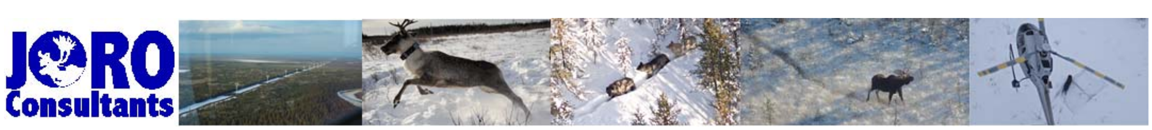

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GLOSSARY

Environmentally Sensitive Areas/Sites: habitat features that are particularly important in the maintenance of species' life functions and where these features may be highly susceptible to transmission line construction and operation activities.

Footprint: Area covered by the project components, such as transmission lines, electrode lines, ROWs, converter station sites, ground electrodes or construction power stations.

Indicator Species: A species that defines a trait or characteristic of the environment (Farr, 2002).

Keystone Species: A species that is critical in maintaining the structure of an ecological community and whose impact on a community is larger than would be expected based on its relative abundance (Paine, 1995).

Local Study Area: Term used to describe the 3-mile wide corridor for the Project transmission line and the area surrounding the project components including AC collector transmission line ROW, converter stations, and ground electrodes.

Linkage Species: A species featuring for whom environmental effects are considered only as they relate to a valued ecosystem component with which the linkage species has significant interactions.

Population Viability: The ability of a population to persist and to avoid extinction. Most regularly associated with rates of population birthrates and death rates.

Project Study Area: Defines the broadest area used to provide spatial context and comparison to the Project components.

Recruitment: The survival of a juvenile to a point where it is added to the population.

Right-of-Way (ROW): The project footprint for transmission lines, electrode lines, and cleared areas associated with these project structures.

Rutting: The mating season of ungulate mammals such as deer, elk, sheep, moose, and caribou.

Succession: The progressive replacement of one dominant type of species or community by another in an ecosystem until a stable climax community is established.

Umbrella Species: A species selected for making conservation-related decisions that indirectly protects many other species within the ecological community (Roberge et al., 2004).

APPENDIX A: IDENTIFICATION OF VALUED ENVIRONMENTAL COMPONENTS AND CONSTRAINTS

Risks of potential effects on the environment were measured in part by using a VEC[4] approach and a constraints identification process. VECs were selected to measure important mammal species values. A total of seven mammal species were selected as VECs and included:

- Beaver (*Castor canadensis*)
- American Marten (*Martes americana*)
- Wolverine (*Gulo gulo*)
- Moose (*Alces alces*)
- Elk (*Cervus canadensis*)
- Woodland Caribou (*Rangifer tarandus caribou*)
- Barren-Ground Caribou (*Rangifer tarandus groenlandicus*)
- ***Grey wolves were also considered as a VEC Linkage Species, due to the potential predation effects of new linear development. Understanding the predator/prey relationships within the northern study are considered essential in the evaluation of Population Viability for species such as the boreal woodland caribou, who are extremely sensitive to increases in predation.

Selection criteria comprised several factors that included:

Importance to people – Species important for hunting and trapping activities, as well as culturally significant species.

Regulatory Requirements – Federal and provincial legislation regulate both hunting activities and protect critical habitats for rare and endangered species.

[4] The Canadian Environmental Assessment Agency (2009) identifies VECs as "any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern."

Keystone Species – A species that is critical in maintaining the structure of an ecological community and whose impact on a community is larger than would be expected based on its relative abundance (Paine, 1995).

Umbrella Species – A species selected for making conservation related decisions that indirectly protects many other species within the ecological community (Roberge and Angelstam, 2004).

Indicator Species – A species that defines a trait or characteristic of the environment (Farr, 2002).

Model Applications – Data for a given species is present and available to construct and validate (if required) simple models.

Habitat Requirements – The various habitats required by each species for critical life stages such as food, cover, migration, overwintering, calving, etc.

Risk Potential – The assessment criteria accounts for population effects due to concentrations of a species, population decline or rarity of a species, fragmentation related potential affects, wire-collision mortality, potential changes to the landscape, loss of food and cover, and increases in food and cover.

The approach to the assessment for each species was also analyzed and was determined if the following approaches could be used:

Simple LCCEB derived model;

Simple LCCEB derived model with other data enhancement;

Simple CLI derived model;

Fragmentation and/or core habitat analysis for sensitive species;

Habitat total by route segment;

Habitat total by ecodistrict; and

Proportion of habitat intersected verses availability.

Once the assessment method(s) were selected, a categorical risk ranking by segment of high, moderate or low was completed.

Mammals

Justification:

Several of the species listed are of particular importance (economic, traditional use, food source) for humans;

All mammal species are provincially protected under the Manitoba *Wildlife Act*;

Some species are declining globally, are considered rare, and are currently listed by SARA either as of 'Special Concern' or 'Threatened' (i.e. woodland caribou);

At least one of the species selected is considered a Keystone Species, which is a species that is critical in maintaining the structure of an ecological community and whose impact on a community is larger than would be expected based on its relative abundance (i.e. beaver);

Three of the species selected are considered an umbrella species, which is a species that when protected indirectly protects many other species within the ecological community (i.e. moose, elk, and beaver);

All of the species selected are considered indicator species, which is a species that defines a trait or characteristic of the environment;

Information regarding woodland caribou, barren-ground caribou, moose, pine marten, wolverine, elk, and beaver exists and is available to construct a simple model of habitat preference and distribution;

Mammals were selected as indicator species because of their relationship to certain habitat types, including mature coniferous forest, early successional habitats, certain wetland types, grasslands, shrublands, deciduous forests, mixedwood forests, coniferous forests, and open coniferous wetland forests;

These species are found in several or all of the ecozones present in the Project Study Area, including the Prairie, Boreal Plain, Boreal Shield, Taiga Shield, and Hudson Plain.

Issues:

A variety of issues surround the mammal species selected as VECs, which include:

Increased risk of negative population effects because of concentrations;

Increased risk of negative population effects because of access and fragmentation-related potential effects from increased predation, harvest, parasitism, and disease transmission;

Increased risk of negative habitat effects with potential changes at the landscape level; and

Positive habitat effects related to potential increases of food, cover, or edge.

Analysis:

The following approaches were used to assess Project effects on the mammal species selected as VECs:

Development and use of a simple LCCEB derived model that identified the location of high quality habitat for each of the species (i.e., semi-open forest and natural edge adjacent to wetlands) relative to each Project Study Area segment;

Fragmentation and/or core habitat analyses for the sensitive species;

Calculation of total habitat by segment;

Calculation of habitat totals by ecodistrict;

Proportion of habitat intersected verses availability;

Maximum coverage included the distribution of the species in the Project Study Area; and,

Context was derived by comparing potentially affected areas to availability within an ecodistrict.

Spot Analysis:

A Spot Analysis was completed on Government and Non-government Designated Areas - Multiple wildlife values including important populations and habitats, potential legislative concerns, and biodiversity concerns.

Several rare and endangered mammal species potentially occur in the Project Study Area and include the 38 species and/or subspecies. The definitions for the COSEWIC, Endangered Species Act (ESA) - Manitoba and SARA listings are as follows:

COSEWIC

Extinct	A species that no longer exists
Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere
Endangered	A species facing imminent extirpation or extinction
Threatened	A species likely to become endangered if limiting factors are not reversed
Special Concern	A species that is particularly sensitive to human activities or natural events but is not an endangered or threatened species
Data Deficient	A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction
Not At Risk	A species that has been evaluated and found to be not at risk

MESA

Extinct	Any species extirpated throughout its entire range
Extirpated	Any species once native to Manitoba that has disappeared through all of its Manitoba range. Extirpated species may still be found elsewhere in their range, or in captivity
Endangered	Any native Manitoba species threatened to disappear through all or most of its Manitoba range
Threatened	Any native Manitoba species likely to become endangered or at risk due to low or declining numbers in Manitoba if the factors affecting it don't improve
Vulnerable	Species not regulated under the Endangered Species Act but which could eventually be considered Endangered or Threatened if the factors affecting them do not improve

SARA

Extinct	A species that no longer exists
Extirpated	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere
Endangered	A wildlife species that is facing imminent extirpation or extinction
Threatened	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction
Special Concern	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats

Appendix B: Factors and Criteria when considering residual Environmental effects (i.e. after mitigation)

1. Direction of the Effect (Direction describes the difference or trend compared with existing conditions (i.e., pre-project).

Positive:

- Beneficial or desirable change in the environment.

Negligible:

- No measurable change in the environment.

Negative:

- Adverse or undesirable change in the environment.

2. Ecological Importance (Ecological importance includes rarity and uniqueness, fragility, importance within ecosystems, and importance to scientific studies).

High:

- Protected species or habitat (e.g., listed under the Species At Risk Act (Federal) and/or The Endangered Species Act (Provincial)

- Fragile area, ecosystem or habitat.

- Important ecological function or relationships.

- Important to scientific investigation (i.e., ongoing research/study).

Medium:

- Moderately rare, unique or fragile.

- Moderately/seasonally fragile environmental component.

- Somewhat important to ecosystem function or relationships.

- Some importance to scientific investigations.

Low:

- Not rare or unique (i.e., common).

- Resilient environmental component.

- Minor ecosystem importance.

- Limited scientific importance (i.e., no research/study).

3. Societal Importance (Societal importance includes the value that individuals/communities place on components of the affected socio-economic and/or biophysical environments that are necessary for economic, social and cultural well-being).

High Value:

- Designated areas (e.g., parks), infrastructure or heritage resources that are protected internationally, nationally or provincially.

- Areas, activities, infrastructure and services or other components of the socio-economic/biophysical environment that have been identified as being important to sustaining the economic, social and cultural well-being of communities through the EA public consultation/ATK processes or EA regulatory guidance.

Medium Value:

- Designated areas, infrastructure or heritage resources that are protected regionally/ locally.

- Areas, activities, infrastructure and services or other components of the socio-economic/biophysical environment that have been identified as being somewhat important to sustaining the economic, social and cultural well-being of individuals (e.g., domestic resource use) through the EA public consultation/ATK processes or EA regulatory guidance.

Low Value:

- Areas or infrastructure that has no formal designation.

- Areas, activities, infrastructure and services or other components of the socio-economic/biophysical environment that the public has not identified through the EA consultation/ATK processes or EA regulatory guidance as important for individuals' overall well-being.

4. Magnitude (Degree of disturbance the effect has on a component of the biophysical or socio-economic environment).

Large:

- Effect on a population in sufficient magnitude to cause a decline in abundance and/or change in distribution lasting several generations.

- For socio-economics, effect on an entire community.

- Effect on the physical environment exceeds regulated limits, standards or guidelines.

- Effect can be easily observed, measured and described.

Medium:

- Effect on part of a population that result in a short-term change in abundance and/or distribution over one or more generations.

- For socio-economics, effect on part of a community.

- Effect on the physical environment meets and may occasionally exceed regulated limits, standards or guidelines.

- Effect can be measured with a well-designed monitoring program.

Small:

- Effect on a group of individuals within a population or stock over one generation or less; similar to random changes in the population.

- For socio-economics, effect on individuals.

- Effect on the physical environment does not exceed regulated limits, standards or guidelines.

- No measurable effect on a population as a whole.

5. Geographic Extent (The spatial boundaries where the effect would occur).

Regional Assessment Area:

- Effect extends into regional study area, including surrounding communities.

- Area where indirect or cumulative effects may occur.

Local Assessment Area:

- Effect extends beyond the project footprint into the surrounding areas, including potentially affected communities within a 5.0 km (3 mile) wide corridor of the route (i.e., 2.5 km) on either side of the RoW and around other project components.

- Area where direct and indirect effects may occur.

Project Site/Footprint:

- Effect confined to the footprint for all project components (transmission line RoW 66 m).

- Area where direct effects would occur.

6. Duration (How long would the effect last).

Long-term:

- Effect is greater than 50 years.

Medium-term:

- Effect extends throughout the construction and into the operation phase of the project (i.e., up to 50 years).

Short-term:

- Effect occurs during the construction phase of the project (i.e., 0 to 5 years).

7. Frequency (How often would the effect occur).

Regular/continuous:

- Effect occurs continuously or periodically during the life of the project.

Sporadic/intermittent:

- Effect occurs without any predictable pattern during the life of the project (e.g., wildlife-vehicle collisions, bird strikes with transmission lines).

Once :

- Effect occurs only once during the life of the project (e.g., initial clearing of the right-of-way).

8. Reversibility (What is the potential for recovery from an adverse effect)

Irreversible/Permanent:

- A long-term effect that is permanent (i.e., remains indefinite as a residual effect, even after project decommissioning).

Reversible:

- Effect is reversible either during the life of the project or upon project decommissioning.

APPENDIX C: TABLES

Appendix C1: Field codes used to record the total length of selected lichen species and other vegetation types and ground cover in ground surveys conducted in November 2010

Species/Ground Cover Type	Field Code
C. stellaris	ST
C. rangiferina	R
C. mitis	M
Bearberry (*Arctostaphylos uva-ursi*)	BB
Sedge	SE
Juniper	J
Sphagnum	SP
Feather Moss	FM
Shrubs	SH
Grass	G
Bare Rock	BR
Leaf Litter	LL

Appendix C2: Length (m) of intersect for individual occurrences of selected lichen species and other vegetation types and ground cover by sample site in ground surveys conducted in November 2010

Sample Site 1	
Field Code	**Length of Intersect (m)**
ST	1
LL	1.4
M	0.4
ST	0.2
FM	0.8
FM/M/R	1.4
BR	1.8
ST/M	2.5
BR	0.7
ST/M/R	12.6
FM	7.6
M/FM	4.4
FM	22.8
M/R/ST	6.4
FM	4.2
ST	2
LL	1.5
M/ST	2.3
FM	3.4
ST/R/M	4.8
BR	2.5
ST/M/R	8.5
LL	1.8
ST	2.6
R/M	2.4

Sample Site 2	
Field Code	**Length of Intersect (m)**
M/R	9.4
BR	2.9
SP/FM	27.7
SP/FM/M	4.7
M/SP	3.5
SP	2.8
M	3
SP/M	1.4
M	3.8
SP	2.3
M	0.7
SP	1.8
M	0.9
SP	2.4
M	0.6
SP	1.2
M	0.6
SP	1.1
M	1.4
SP	5.9
M	0.2
SP	5
M	2
SP	15

Sample Site 3	
Field Code	**Length of Intersect (m)**
M	1
BR	2.6
M/ST	4.4
BR	3
M	3
BR	2.1
M	0.7
BR	1.4
M	10.9
BR	0.4
M	2.3
BR	7.6
M/ST	6.6
BR	4
M	0.9
BR/ST	1.3
BR	0.8
M/ST	2.7
BR	1.6
M/ST	1.3
BR	1.9
M	2.1
BR	2.4
M/ST	8
BR	3
M/ST	2.7
FM	3.3
M	3
FM	1.7
M/ST	2.4
BR	5.9
M/ST	3.4
BR/LL	1.5

M	1.5
BR	4.3
M	0.7
BR	1.6
M	1.7
BR	0.3

Sample Site 4	
Field Code	**Length of Intersect (m)**
SP	1.4
M	2
SP	1.2
SP/M	3.8
SP	0.6
M	5.6
LL	1.8
R/M	5.2
SP	5.3
R/M	8.9
SP	4.8
M	0.4
SP	2.4
M	0.2
SP	0.7
M	0.2
SP	1.4
SP	5.2
M	0.5
SP	4.7
M	1
SP	6.2
SP/M	1.5
SP	7
G/SP	28

Sample Site 5	
Field Code	**Length of Intersect (m)**
M/R	5
M/FM	1.3
M	1.8
FM	1.2
M/R	1.6
FM/R	1.9
M/R	23.5
FM	4.2
R/M	4.9
FM/M	2.2
M/J	8.1
SH/J	1.2
ST	0.6
M	3.3
BR	0.7
M	2.1
LL	3.1
FM	0.3
M/R	7
BB	0.4
M	4.1
BB	0.8
BB/J/R/M	12.7
BR	0.4
M	1
BR	3.9
M/BR	2.7

Sample Site 6	
Field Code	**Length of Intersect (m)**
FM	3.3
FM/M	2.5
FM	2.1
M/ST	2.1
FM	4.2
M/FM	2.8
SE/FM	10.9
M	3
FM	3.7
M/R	2
FM	8.4
M/FM	1.8
FM	13.8
M/FM	4.4
FM	10.5
M/FM	1.1
FM	7.4
M	1
FM	2
R/ST	2
FM	6
M/R/ST	3.7
FM	1.3

Appendix C3: Trail camera keywords applied to coding images

Species	Sex	# Mature	# Immature	# Juvenilles	# Offspring	Activity	Total Number In Group	Vehicle	Environmental Trigger	Camera Crash	Observant Of Camera	Residual Events
Caribou	Male	0	0	0	None	Walking	Text value	Truck	Wind	Bear	Yes	Extra triggered picture when animal is running
Moose	Female	1	1	1	1	Running		Snowmachine	Sun	Wind	No	
Bear	Unknown	2	2	2	2	Milling		ATV	Deployment	Straps loose		
Deer		3	3	3	3	Feeding		Semi-truck				
Human		4	4	4	4	Bedding		Train				
Wolf						Sparring						
Lynx						Camera curious						
Martin												
Squirrel												
Fox												
Mink												
Groundhog												
Fisher												
Muskrat												
Beaver												
Sandhill crane												

Heron
Crow
Raven
Black bird
Hawk
Song bird
Grouse

Appendix C4: Species located at each trail camera in 2010

RANGE	SITE_ID	SPECIES_1	SPECIES_2	SPECIES_3	SPECIES_4	SPECIES_5	SPECIES_6	SPECIES_7	SPECIES_8	SPECIES_9	SPECIES_10	SPECIES_11
The Bog	BOG_1	caribou	moose	sandhill crane	unknown							
The Bog	BOG_2	caribou	moose	mink								
The Bog	BOG_3	caribou	ruffed grouse									
The Bog	BOG_4	caribou										
The Bog	BOG_5											
The Bog	BOG_6	caribou										
The Bog	BOG_7	beaver	moose	mallard	Canada goose	wolf						
The Bog	BOG_8	caribou	moose	bear	wolf	lynx	sandhill crane	white tailed deer				
The Bog	BOG_9	caribou	moose	bear	wolf	sandhill crane	white tailed deer	rabbit				
The Bog	BOG_10	caribou	moose	bear	wolf	sandhill crane	white tailed deer	lynx	human			
The Bog	BOG_11	bear	coyote	fisher	human	lynx	mink	moose	rabbit	squirrel	white tailed deer	wolf
The Bog	BOG_12	caribou	moose	bear	unknown							
The Bog	BOG_13	caribou	moose	bear	hawk	small bird						
The Bog	BOG_14	caribou	marten	whiskey jack								
The Bog	BOG_15	caribou	sandhill crane									
The Bog	BOG_16	caribou	sandhill crane									
The Bog	BOG_17	marten										
The Bog	BOG_18	caribou	bear	hawk								
The Bog	BOG_19	caribou										

The Bog	BOG_20	caribou	marten	sandhill crane	wolf	unkown		
The Bog	BOG_21	sandhill crane						
The Bog	BOG_22	caribou	sandhill crane	hawk				
McLarty Lake	MCL_1	bear	lynx	rabbit	sandhill crane	white tailed deer	unknown	
McLarty Lake	MCL_2	caribou	bear	cotote	lynx	moose	sandhill crane	wolf
McLarty Lake	MCL_3	moose						
McLarty Lake	MCL_4	caribou						
McLarty Lake	MCL_5	moose	bear	wolf	coyote	human	unknown	
McLarty Lake	MCL_6	caribou	wolf	sandhill crane	lynx	whiskey jack		
McLarty Lake	MCL_7	hawk	sandhill crane	unknown				
McLarty Lake	MCL_8	caribou	bear					
McLarty Lake	MCL_9	caribou	sandhill crane					
McLarty Lake	MCL_10							
Wuskwatim	WUSK_1	sandhill crane	red fox					
Wuskwatim	WUSK_2	sandhill crane	red fox					
Wuskwatim	WUSK_3	caribou	sharptailed grouse					
Wuskwatim	WUSK_4	sharptailed grouse	red fox					
Wuskwatim	WUSK_5	red fox	hawk	unknown	unknown bird			
Wuskwatim	WUSK_6	red fox	sandhill					

			crane					
Wuskwatim	WUSK_7							
Wuskwatim	WUSK_8	caribou	red fox	owl	small bird			
Reed Lake	REED_1	caribou	moose	bear	human	Canada goose		
Reed Lake	REED_2	caribou	moose	bear	human	Canada goose		
Reed Lake	REED_3	caribou	bear	lynx	marten	squirrel	woodchuck	unkown
Reed Lake	REED_4	caribou	bear					
Reed Lake	REED_5	caribou	marten					
Reed Lake	REED_6	caribou						
Reed Lake	REED_7	caribou	bear	moose	marten	unkown		
Reed Lake	REED_8	caribou	white tailed deer					
Reed Lake	REED_9	caribou	marten					
Reed Lake	REED_10	caribou	bear	moose	lynx			
Reed Lake	REED_11	caribou						
Harding Lake	HARD_1	caribou	bear	wolf	grouse	sandhill crane	wolverine	
Harding Lake	HARD_2	caribou	bear	wolf	sandhill crane			
Harding Lake	HARD_3							
Harding Lake	HARD_4	caribou	wolf	lynx				
Harding Lake	HARD_5	caribou	moose	wolf	sandhill crane			
Harding Lake	HARD_6	sandhill crane						
Harding Lake	HARD_7	bear	song bird					
Harding Lake	HARD_8	bear	moose					

Harding Lake	HARD_9	caribou	moose	bear	red fox	marten	grouse	sandhill crane
Harding Lake	HARD_10	caribou	moose	bear	hare			
Wimapedi	WIM_01	caribou	sandhill crane	song bird				
Wimapedi	WIM_02	caribou	sandhill crane					
Wimapedi	WIM_03							
Wimapedi	WIM_04	bear	sandhill crane					
Wimapedi	WIM_05	caribou	sandhill crane					
Wimapedi	WIM_06	caribou	bear					
Wimapedi	WIM_07	sandhill crane						
Wimapedi	WIM_08	moose	hawk					
Wimapedi	WIM_09	caribou						
Wabowden	WAB_01							
Wabowden	WAB_02	caribou	bear	hawk				
Wabowden	WAB_03	caribou	wolf	sandhill crane	hawk			
Wabowden	WAB_04	caribou	owl					
Wabowden	WAB_05	caribou						
Wabowden	WAB_06	sandhill crane	crow					
Wabowden	WAB_07	lynx	wolf	sandhill crane	song bird			
Wabowden	WAB_08	caribou	crow	sandhill crane	song bird			
Wabowden	WAB_09	caribou	hawk	sandhill crane				
Wabowden	WAB_10	moose	hawk					
Hargrave	HGL_01	caribou	hawk	sandhill				

Lake				crane		
Hargrave Lake	HGL_02	sandhill crane				
Hargrave Lake	HGL_03	caribou	hawk	lynx		
Hargrave Lake	HGL_04	caribou	sandhill crane			
Hargrave Lake	HGL_05	caribou	red fox			
Hargrave Lake	HGL_06	sandhill crane	hawk			
Hargrave Lake	HGL_07	moose	wolf	red fox	sandhill crane	hawk
Hargrave Lake	HGL_08	sandhill crane	rabbit			
Hargrave Lake	HGL_09					
Hargrave Lake	HGL_10	sandhill crane	owl