The 13th North American Caribou Workshop
Winnipeg, Manitoba, Canada
25–28 October, 2010

# Towards a Manitoba Hydro boreal woodland caribou strategy: Outcomes from Manitoba Hydro boreal woodland caribou workshop

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*Abstract:* Manitoba Hydro is responsible for the continued supply of energy to meet the needs of the province and is committed to protecting the environment when planning the construction and operation of its facilities. Corporate policy dictates ongoing improvement of Environmental Management Systems (EMS) in order to meet or surpass regulatory requirements. Environmental objectives are reviewed annually and programs are modified when necessary to address improvements in environmental performance. Manitoba Hydro plans and constructs major transmission projects throughout northern Manitoba which includes areas occupied by boreal woodland caribou. In recognition of the potential issues associated with hydro transmission construction in boreal caribou range, Manitoba Hydro hosted an expert workshop on May 8, 2007 to provide objective advice in the development of a draft corporate strategy that effectively directs targeted monitoring and research for environmental assessment and mitigation. The workshop focused on assessing the potential threats to boreal woodland caribou from a transmission line construction and operation perspective, and identifying appropriate approaches in site selection and environmental assessment (SSEA) and long-term monitoring and research. A total of nine threat categories were reviewed to determine the degree and magnitude of potential effects that may result from transmission construction and operation; and of the original nine, five final threat categories were delineated. The main elements of the workshop provided strategic approaches for proactive pre-construction monitoring, research on recruitment and mortality for local populations impacted by ROWs and control areas, and various habitat monitoring, management, and mitigation techniques. Research and monitoring priorities have been identified and continued collaboration with Manitoba Conservation and other land users were also identified.

**Key words:** boreal woodland caribou; Delphi; Manitoba Hydro; threats; transmission line right-of-ways.

**Rangifer**, Special Issue No. 20: 115–124

## Introduction

Boreal woodland caribou (*Rangifer tarandus caribou*) are a valued ecosystem component of Manitoba's boreal forest, and have been designated as a threatened species under Canada's Species at Risk Act (COSEWIC, 2010) and the Manitoba Endangered Species Act (Manitoba Conservation, 2010a). In Manitoba, boreal caribou and their habitat are impacted by both natural and anthropogenic disturbance. Wildfire constitutes the majority of disturbance on boreal caribou ranges in Manitoba; however, human activities such as logging, right-of-way (ROW) development (including seasonal and all-weather roads), and hydro-electric transmission can potentially affect

the conservation status of local boreal woodland caribou populations (Manitoba Conservation, 2010b). Manitoba Hydro recognizes the need to address the potential impacts of ROW construction and operation on local boreal woodland caribou populations and collaborates with Manitoba Conservation on collaring and tracking studies and other monitoring required for both planning and long-term monitoring of effects. Data from these studies are being utilized in assessing the effects of previously constructed ROWs on boreal caribou range use and movement as well as in the routing of new transmission ROWs in order to mitigate negative effects, to the extent possible, by avoiding core use areas and critical habitat. These data provide opportunities to enhance the existing knowledge on the potential effects on local caribou populations due to transmission lines and other linear features. These data are also providing direction on future research and monitoring by identifying data gaps and additional information needs.

In order to enhance and refine the collaborative research and monitoring efforts, Manitoba Hydro undertook a threat-based assessment using Delphi methods and outside boreal caribou experts. The Delphi process involved workshops and discussions with the goal of reaching agreeable conclusions on the specific topic, with the premise that: 1) opinions of experts are justified as inputs to decision making where absolute answers are unknown; and 2) a consensus of experts will provide a more accurate response to a question than a single expert (Crance, 1987). The Delphi exercise has been adapted to develop expert-opinion–based suitability indexes for wildlife habitat (Crance, 1987) and was utilized in conducting the threat-based assessment of hydro transmission ROWs on boreal woodland caribou to guide Manitoba Hydro's Site Selection and Environmental Assessment (SSEA) process. Five threat assessment categories were identified based on literature supporting potential issues as a result of transmission ROW development. These included forage, habitat, predation, pathogens, and human interactions (i.e., hunting). The following is a summary of the main threat categories used in the threat assessment.

*Forage and habitat*

Boreal woodland caribou utilize large tracts of functioning habitat that contain adequate space for foraging, predator avoidance, and reproduction. They are generally associated with mature coniferous forests and fen/bog complexes, though this can vary from one location to the next (James & Stuart-Smith, 2000; Hins *et al.,* 2009). The presence of boreal caribou is a function of the ecosystem state at a regional or landscape scale. Fragmentation is generally understood to have negative effects on caribou as this species is associated with contiguous forest.

Effective habitat loss resulting from avoidance behaviours can be a consequence of the construction and operation of a transmission line ROW. James & Stuart-Smith (2000) found that individual caribou differ in their response to linear corridors, but on average caribou avoided corridors. The type and density of linear development within a local caribou range combined with the terrain conditions may or may not reduce the amount of available habitat as linear corridors represent a small fraction of habitat required for sustaining local populations. Studies have indicated that the avoidance of human developments increases as the level of activity increases (Dyer *et al.,* 2001); however, low levels of human activity, such as those most commonly associated with transmission line ROWs, have also been found to cause avoidance of developments by caribou. Reduction in abundance of caribou in the vicinity of various human developments has been reported to range from 1 to 5 kilometers (Weir *et al.,* 2007). Movement and habitat use response of caribou to all-weather logging road development across core winter range have been observed with the effect dissipating as distance to the disturbance increases, resulting in a potential loss of functional habitat up to 1 kilometre (Schindler *et al.,* 2006). Linear corridors specifically may also be avoided by caribou as a means to reduce risk of predation. James & Stuart-Smith (2000) found that caribou mortality attributed to wolf predation was closer to linear corridors than live caribou locations and wolf predation sites were found to be 55 meters closer to corridors than random points.

*Predation*

In Canada, the impact of wolf predation on caribou is considered a factor limiting the size of certain caribou herds (Hayes & Gunson, 1995). Caribou and wolves have been found to typically occupy different habitat types, creating a spatial and temporal separation between prey and predators, thereby reducing predation (James *et al.,* 2004; Courbin *et al.,* 2009). However, fragmentation of the boreal forest and avoidance of disturbances has the potential to concentrate caribou into progressively smaller areas of remaining habitat, which can make caribou vulnerable to predation (Dyer *et al*., 2001; Courbin *et al*., 2009). Boreal caribou exist at low densities compared to other boreal forest ungulates, thereby reducing predation risk as low caribou densities will not support predators in the absence of alternative prey (Thomas, 1995; Dyer *et al*., 2001). Habitat conditions strongly influence the

interaction between prey and predator (Peek, 1986), and spatial separation from other ungulates and conspecifics have been hypothesized as an anti-predation strategy of caribou (Thomas, 1995; James *et al.,* 2004; Courbin *et al.,* 2009). Finally, it has been previously found that linear corridor development in remote regions can increase wolf access and mobility in formerly inaccessible caribou habitat, thus increasing wolf–prey contacts and interactions (Thomas, 1995; James & Stuart-Smith, 2000; Courbin *et al*., 2009).

*Disease and parasites*

In the southern portion of Manitoba where boreal caribou range may overlap with white-tailed deer (*Odocoileus virginianus*), there may be potential for linear development to have a cumulative effect on the infection rates of caribou by meningeal worm (*Parelaphostrongylus tenuis)*. This parasite is common throughout deciduous mixed-hardwood forests of eastern North America, and has been reported as far west as Manitoba (Wasel *et al.,* 2003). While the intermediate host (white-tailed deer) can tolerate the parasite, it is fatal to caribou and may be a contributing factor in declining caribou populations (Thomas, 1995). Human disturbances or fragmentation of forests which facilitate the migration of deer onto caribou range can lead to disease spread within caribou populations. There is little information to support linear development as a mechanism for increased transmission of meningeal worm to caribou in Manitoba.

*Human interactions*

The creation of transmission line ROWs can increase public access to remote areas and potentially lead to increased human recreational activity in caribou habitat. Such recreational activities may include snowmobiling, all-terrain vehicles (ATVs), hiking, and hunting. Harassment by humans may displace cow–calf pairs, and cause caribou to avoid the disturbance stimuli, leave optimal forage areas, alter periods of activity, alter home ranges, and increase energy expenditure. Such stresses can result in death from malnutrition or predation (Seip, 1995).

## Methods

Manitoba Hydro, on May 8, 2007, hosted an expert—or Delphi (Crance, 1987) workshop on boreal caribou focusing on electrical transmission planning, construction, and operation. The workshop goal was to provide advice to Manitoba Hydro in the development of monitoring, research, and mitigation opportunities that would form the basis of a draft corporate boreal caribou strategy. Participants included Manitoba Hydro staff, Manitoba Hydro consultants, and outside authorities known for expertise in boreal caribou research, conservation, and recovery.

The opinions expressed and discussed at the expert workshop were summarized and classified according to the guidelines developed by Environment Canada (Environment Canada, 2007) entitled *Species at Risk Guidance: Guidelines on Identifying and Mitigating Threats to Species at Risk*. These guidelines were intended to aid in the identification and management of threats to species at risk by providing nationally consistent and evidence-based practices, therefore contributing to assessment of the conservation status of species, as well as to recovery planning and implementation. This document defines separate designations of threats to a species at risk. *Threat Categories* were defined as broad categories which indicate the type of threat, and include such categories as Habitat Loss or Degradation, Accidental Mortality, and Disturbance or Harm (Environment Canada, 2007). *General Threats* were defined as the general activity causing the specific threat, and *Specific Threats* were defined as the specific factor or stimulus causing stress to the population (Environment Canada, 2007). *Stress* from an identified threat was defined as an impairment of a demographic attribute of a population, or a physiological or behavioural attribute of an individual in response to an identified or unidentified threat that results in a reduction of its viability (Environment Canada, 2007). Indicators that a population of a certain species at risk is stressed include reduced population size or reduced population viability, small population size, or poor reproductive success (Environment Canada, 2007).

Threat attributes define how a threat acts upon a species, and provides an indication of where measures may be used to manage or mitigate the threat (Environment Canada, 2007). The *Extent* of a threat was defined as indicating whether the threat was widespread, localized, or unknown across the species range. The *Occurrence* of a threat was defined as the indication of whether the threat was historic, current, imminent, anticipated, or unknown (Environment Canada, 2007). *Threat Frequency* was defined as whether the threat was a one-time occurrence, seasonal, continuous, recurrent, or unknown (Environment Canada, 2007). *Causal Certainty* of a threat was defined as indication of whether the best available knowledge about the threat and its impact on population viability was high, medium, or low, and should be a general reflection of the degree of evidence that was known for the threat, which in turn provides information on the risk that the threat has been mis-

diagnosed (Environment Canada, 2007). The *Severity* of a threat was defined as indication of whether the level of severity of the threat is high, medium, low, or unknown (Environment Canada, 2007). The *Level of Concern* of a threat was defined as indication of whether managing the threat was an overall high, medium, or low concern for recovery of the species, taking into account all of the above factors, and may take into account the ability to mitigate or eliminate the threat (Environment Canada, 2007). The Occurrence of a threat, Threat Frequency, Causal Certainty of a threat, and the Severity of a threat can also indicate whether the threat attribute differs between 'local' populations (a specific site or narrow portion of the range of the species), or if the threat attribute applies to the full 'range-wide' distribution (applicability to the whole distribution or large portion of the range of the species) (Environment Canada, 2007).

Nine threat categories were reviewed at the expert workshop to determine the degree and magnitude of potential effects that may result from transmission construction and operation. These specific threat categories were reviewed and in some cases amalgamated or revised based on the expert discussion. A threat classification table (Environment Canada, 2007) was used to organize information on each threat to prioritize and allow action to be taken to manage the identified threats to boreal caribou from the construction and operation of a transmission line and ROW.

## Results and discussion

*Loss of forage during construction and long-term vegetation management*

Forage availability is typically not a limiting factor for sustaining boreal woodland populations (Bergerud, 1996). Although the direct effects of construction and ongoing vegetation management in high quality boreal caribou range could potentially result in a loss or degradation of caribou forage on the transmission line ROW, the magnitude of this impact is small within the context of the overall range requirements for security and forage for boreal caribou (Table 1).

It was found via the workshop that activities associated with ROW clearing and vegetation management could result in a change from conifer/lichen associations to shrub/herb–rich habitat. As lichens are shade intolerant and are known to respond to increased sunlight conditions, there may be opportunities to maintain or enhance caribou forage along transmission lines in high quality range. Vegetation management practices that promote lichen reproduction could be enhanced and incorporated into vegetation management planning.

*Loss of functional habitat and range fragmentation during construction and operation*

The extent of avoidance of transmission lines by boreal caribou during construction or operation is not well understood. There are complex ecological and human-caused interactions that could influence the

Table 1. Implications of threat categories for Site Selection and Environmental Assessment determined during Manitoba Hydro Boreal Woodland Caribou Workshop addressing destruction/degradation of boreal woodland caribou forage (lichens) located along transmission line right-of-ways.

| Construction | | Threat Information | |
|---|---|---|---|
| **Threat Category** | Forage loss and degradation | **Extent** | Local |
| **General Threat** | Right-of-way clearing/ Access Roads: Destruction of lichen-rich habitat during construction and operation | **Occurrence** | Current |
| | | **Frequency** | One Time (Construction) Periodic (Veg. Management) |
| **Specific Threat** | Direct loss of forage resulting in reduced resource availability, increased energetics, decreased health and reduced recruitment | **Causal Certainty** | Low |
| | | **Severity** | Low |
| **Stress** | Decreased fitness and reproductive success, decreased population size | **Level of Concern** | Low |

extent of animal or herd avoidance of transmission line ROWs. These include disturbance from human activity (i.e., primary and secondary access), increased predation by wolves and bears, and other ecological influences directly or indirectly related to human activities in proximity to right-of-ways (e.g., forestry, mining, outdoor recreation,).

It was generally agreed through the workshop that potential effects of ROWs include reduction in forage availability as a result of sensory avoidance and displacement of animals away from high quality habitat into less suitable and less secure habitat away from the ROWs (Table 2). The effects of right-of-ways on individual animal movement compared to the population/range response may be significantly different in that population response is more critical than an individual animal response. Although individual animals may illustrate a movement response to a linear corridor (such as faster movement rates near the corridor) but still cross and utilize their original range, illustrates no effect at the range scale. It was therefore determined that measuring the gradient effect of linear density to determine at what point there is range fragmentation as a result of transmission lines would be an appropriate goal in a Manitoba Hydro strategy. It was also agreed that this may be very difficult to define as a population effect based on thresholds of linear density and effect is dependent upon the types (roads versus ROWs) combined with local terrain conditions (bog versus rock or mineral soil). The natural range of variability of animal movement and range occupation through time and space also needs to be addressed. The effects of natural barriers such as predator-rich riparian areas associated with large rivers and lakes (during summer) may play a greater role in the natural fragmentation of range and needs to be studied.

Manitoba Hydro has acquired significant volumes of boreal woodland caribou location and movement data through both collaborative and corporate-led research and monitoring. Detailed animal-borne GPS data have been gathered in the east, northwest, and

Table 2. Implications of threat categories for Site Selection and Environmental Assessment determined during Manitoba Hydro Boreal Woodland Caribou Workshop addressing boreal woodland caribou reduced use of habitat (less forage availability) away from right-of-ways due to sensory disturbance (human and ecological interactions).

| **Construction** | | **Threat Information** | |
|---|---|---|---|
| **Threat Category** | Range Fragmentation | **Extent** | Local |
| **General Threat** | Right-of-way clearing/ access: Reduced use of high quality habitat from construction and ongoing human activity. | **Occurrence** | Current |
| | | **Frequency** | One time (construction) Continuous (Veg. Management) |
| **Specific Threat** | Avoidance of T-Line and displacement of animals. Loss of functional habitat and foraging opportunities due to sensory disturbance resulting in range isolation, reduced resource availability, increased energetics, decreased health, reduced recruitment | **Causal Certainty** | Low (expected) |
| | | **Severity** | Intuitively thought to be low, however where secondary use exists (i.e., provide access to other areas from the T-Line) there may be long-term chronic effects. Overall severity and extent is unknown (gap in research knowledge) |
| **Stress** | Decreased fitness and reproductive success, decreased population size | **Level of Concern** | Intuitively thought to be low Unknown severity and extent (gap in research knowledge) |

northeast regions in Manitoba. These data continue to be assessed in examining animal movement and population response to transmission lines. These data have also been synthesised into a Manitoba Hydro corporate database for analysis relative to the threats identified.

Prior to conducting analysis of transmission line avoidance at both the individual animal and range population scales, the data must be evaluated to determine its utility for various scientific and management questions. It was found through the workshop that sample size and replication issues could include the number of collared animals, number of years collared, proximity of animals to transmission lines and other linear features (e.g., rail ways, roads), and availability of other disturbance information. Opportunities for region- or province-wide comparisons (i.e., general trends in animal movement) should be assessed. Habitat evaluation/comparisons will also need to be incorporated into any analysis.

The response of experts regarding the effect of activities associated with transmission line construction and operation suggests it will be extremely challenging to associate effects from these activities alone on boreal caribou, or on a specific subset of larger cumulative landscape effects. There is a need for long-term strategic research and monitoring to assess the effects of ROWs through boreal caribou range. It is likely that overshadowing anthropogenic and natural events and processes (i.e., fire, wind, insects, forestry, roads, wolves, alternate prey, etc.) have a much greater effect on boreal woodland caribou than transmission line construction and operation alone. The time lag response of caribou population decline to these natural and cumulative human-caused disturbances can take years or decades to detect and/or quantify, and documenting an effect and conclusively attributing the cause to transmission line activities will require a significant corporate commitment. Avoidance of a transmission line may restrict an individual animal's choice at the local level while not restricting a population's access to its overall range. Based on the current information, the notion of establishing a "threshold" measure of disturbance that equates to when population decline commences is not feasible at this time. Describing and managing an acceptable "gradient" of disturbance may be a more appropriate goal in mitigating potential negative impacts of transmission lines.

Transmission lines constructed in areas occupied by boreal caribou are generally in areas where access is limited, particularly during the post-construction and operation period. As such, it was found by the experts that human access–related direct sensory effects are expected to be less than those associated with all-weather or winter roads. When new transmission lines parallel existing linear development, there would be little to no additive effect expected, however comparisons between multiple linear features has not been objectively assessed. 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. Research on sensory disturbance and ecological effects has been undertaken in Alberta, Labrador, and Manitoba (Frid & Dill, 2002; Schindler *et al.,* 2006; Weir *et al.,* 2007) and it will be important to assess these affects relative to transmission line ROWs and the cumulative effect that may result in areas already fragmented by other anthropogenic disturbance. The cumulative effects of transmission line construction and operation as a factor responsible for a decline are not clearly understood, but are expected to be minor in most cases.

*Increased predation*

Boreal caribou populations are maintained when long-term recruitment trends compensate for ongoing annual mortality (Seip, 1995; Harris *et al*., 2008). Survival of productive adult females is critical to the conservation and recovery of this species. Boreal caribou are sensitive to even small reductions in reproductive potential, such as reduced number of breeding females in the population. In some populations, the additional loss of a few adult females annually (<5) over a period of a few years could lead to local population decline. High wolf densities do not necessarily imply reduction of caribou populations in a given range, however relocation of predators from adjacent areas to linear corridors may increase prey–predator interactions.

The experts found that these interactions could potentially result in increased mortality or displacement away from transmission line ROWs to avoid predators (Table 3). Boreal woodland caribou have an inherent predator avoidance strategy that may result in avoidance of linear features used by predators or humans (Thomas, 1995; James & Stuart-Smith, 2000). Depending on habitat suitability within the range, displacement away from the transmission line ROWs may be a relatively minor issue from a forage perspective (gradient effect issue). Also, if there is no real effect on caribou populations (range-wide), increased predator travel along transmission lines may not be a limiting factor.

It is generally accepted that there is increased probability of caribou mortality with increased use of transmission lines by wolves (Thomas, 1995; James

Table 3. Implications of threat categories for Site Selection and Environmental Assessment determined during Manitoba Hydro Boreal Woodland Caribou Workshop addressing boreal woodland caribou predator movement along right-of-ways due to access and habitat change leading to increased mortality.

| Construction or Operation | | Threat Information | |
|---|---|---|---|
| **Threat Category** | Predation | **Extent** | Local or Range-Wide |
| **General Threat** | Mortality from wolves | **Occurrence** | Current |
| | | **Frequency** | Continuous |
| **Specific Threat** | Increased predation by wolves and bears using transmission corridors (linked to increased mortality from displacement into predator-rich habitat and human effects) | **Causal Certainty** | High |
| | | **Severity** | Intuitively thought to be low<br>Unknown severity and extent (gap in research knowledge)<br>Potential for concern in some areas or circumstances |
| **Stress** | Loss of breeding females, decreased population size | **Level of Concern** | Medium–High |

Table 4. Implications of threat categories for Site Selection and Environmental Assessment determined during Manitoba Hydro Boreal Woodland Caribou Workshop addressing expansion of deer range due to increased forb and shrub habitat along transmission line right-of-ways and possible transmission of brainworm to boreal woodland caribou.

| Construction or Operation | | Threat Information | |
|---|---|---|---|
| **Threat Category** | Natural Process or Activities | **Extent** | Local or Range-Wide |
| **General Threat** | Disease and Parasites:<br>Deer movement northward from T-line development. | **Occurrence** | Current–Future (Climate Change) |
| | | **Frequency** | Continuous |
| **Specific Threat** | T-lines as corridors for deer movement and transmission of *P. tenuis* or other pathogens | **Causal Certainty** | Intuitively thought to be low<br>Unknown severity and extent (gap in research knowledge)<br>Potential concern in some areas or circumstances |
| | | **Severity** | Unknown |
| **Stress** | Decreased population size | **Level of Concern** | Unknown |

& Stuart-Smith, 2000; Courbin *et al*., 2009); however, more research is required on predator density and use of linear development in Manitoba. Comparisons of predator activity for different linear features in the Manitoba context (such as roads and snowmobile trails) are specifically recommended. Differences in animal movement and population range characteristics between industrial developed areas versus remote

areas should be researched to allow for objective comparison to determine potential impacts. Clear monitoring and research objectives will also need to be developed.

*Deer movement and increased occurrence of Parelaphostrongylus tenuis and other pathogens*

Boreal caribou are susceptible to various pathogens, of which the meningeal worm is a significant threat if infected deer invade boreal woodland caribou range (Table 4) (Thomas, 1995). It was found through the workshop that transmission lines may have some effect on the distribution of deer in the boreal forest. Other pathogens, such as Chronic Wasting Disease (CWD), may also be a factor. Monitoring the spread of wildlife disease relative to transmission line ROWs will require collaboration with Manitoba Conservation.

*Hunting by humans*

The susceptibility of boreal woodland caribou populations to decline from loss of breeding females is potentially significant (Table 5). Manitoba Conservation is responsible for determining appropriate protection of boreal woodland caribou and does not permit recreational hunting. First Nations subsistence hunting is a mortality factor, but the extent and significance is not well documented. Stewardship approaches for boreal caribou must consider and respond to the level and distribution of subsistence harvest. It was found by the experts that Manitoba Hydro should cooperate with Manitoba Conservation on appropriate stewardship initiatives. Access management, as part of Manitoba Hydro's construction and operation of new transmission lines, is an important mitigation tool and should be used in boreal caribou range in Manitoba where appropriate and in consultation with communities and Manitoba Conservation.

## Recommendations

The following research/monitoring programs have been recommended to Manitoba Hydro based on results of the May 2007 Boreal Woodland Caribou Workshop:

- Most issues related to construction and vegetation management can be mitigated through site selection and routing processes. Locating transmission lines in areas providing least risk would be a constructive and positive mitigation measure. Conduct pre-project collaring and monitoring of boreal caribou to determine critical local range components including calving and calf-rearing areas and winter core use areas.
- Conduct long-term monitoring of recruitment and mortality in local ranges where transmission line ROWs and other linear development exists. Assess differences in lambda among varying disturbance and linear density regimes and compare with control populations in areas where there is little or no anthropogenic disturbance.
- Specific research is required regarding interactions between transmission lines and the behaviour/density of predators and their impacts on boreal woodland caribou. Key elements to consider include monitoring of select wolf populations, examination of how snowpacks influence the movement and behaviour of wolves, and study of the winter frequency/distribution of wolves through track surveys along transmission lines in comparison to natural areas, other

Table 5. Implications of threat categories for Site Selection and Environmental Assessment determined during Manitoba Hydro Boreal Woodland Caribou Workshop addressing hunting of boreal woodland caribou.

| Construction or Operation | | Threat Information | |
|---|---|---|---|
| **Threat Category** | Direct Mortality from Humans | **Extent** | Local or Range-Wide |
| **General Threat** | Hunting/ Recreation | **Occurrence** | Current |
| | | **Frequency** | Periodic |
| **Specific Threat** | Poaching, subsistence hunting | **Causal Certainty** | High |
| | | **Severity** | Unknown |
| **Stress** | Loss of breeding females, decreased population size | **Level of Concern** | Unknown |

linear features (i.e., rivers, snowmobile trails), and access points to transmission lines. Monitoring should also include the use of trail cameras to document transmission line use by predators, ATVs, and snowmobiles.

- Utilize existing data to demonstrate and document the effects of transmission line ROWs on caribou habitat use and range fragmentation. This will require assessment of movement patterns and habitat use of individuals, and assessment of the overall population response at the landscape level. Elements of consideration include habitat assessment, other linear features, comparisons of areas with transmission lines to areas with no transmission lines, assessment of temporal and spatial variability in use, assessment of possible gradient effects, and DNA evidence of possible range fragmentation.
- Monitoring the presence of primary prey species (deer/moose) of predators is required as part of the environmental monitoring of transmission line ROWs in boreal woodland caribou range. This includes long-term monitoring to assess trends related to the presence and abundance of deer.
- Future monitoring of transmission line use by humans in boreal woodland caribou range must include long-term studies and documentation of all users of the area (e.g., trappers, hunters). Documentation must also include vehicle use along lines and the broader footprint of these lines (e.g., forestry trails leading on to transmission line right-of-ways) to assess and quantify effects of transmission line construction and operation.
- Monitor and document caribou use/activity, season and timing, population demographics and habitat use of primary prey (moose/deer) within and adjacent to transmission line ROWs. This must also incorporate traditional and local knowledge.
- Conduct post-construction monitoring such as aerial transect surveys, standard VHF and GPS telemetry collaring.
- Mitigation strategies should be investigated for assessing mode of access for vegetation management to minimize potential increased use by predators as a result of snowpack. Timing of maintenance during the frost-free period could also be considered. The human access effect or analysis of "spin-off" access to and from transmission lines should be considered in future siting of transmission lines.
- Examination of the effects of transmission lines on black bear populations, particularly near potential and existing caribou calving areas, is required to determine if transmission ROWs in calving complexes contribute to calf mortality.
- Integration of lichen monitoring into proposed long-term vegetation monitoring programs on transmission line right-of-ways to determine the extent of change in conifer/lichen associations into shrub/herb habitats.
- Development and implementation of a vegetation management strategy which encourages lichen production in high quality boreal caribou range.
- Conducting pre-construction surveys to identify lichen-rich habitat in high-quality boreal caribou range.
- Examination of gastropod distribution in Manitoba and varying habitat types to assess the potential risk to caribou populations is required. This includes deer pellet analysis for *P. tenuis*.

## Conclusions

The cumulative effects of transmission lines need to be put in context with other natural and anthropogenic disturbance events. Collaboration with Manitoba Conservation, other land users and stakeholders on population monitoring is important to Manitoba Hydro. Due to the multiple vectors of decline and the time lag response of boreal caribou populations to disturbance, it is essential that long-term monitoring of populations through recruitment and mortality studies be undertaken to understand the cumulative effects of linear development on boreal caribou recruitment and mortality. The long-term goal of such research is to determine if there is a gradient effect of transmission line ROWs relative to range occupation and recruitment and if there is a negative response as a result of ROW development. This is a critical component and ties the proposed monitoring and research to an end effect, and will also contribute to determining if and where the effects of transmission lines are significant or additive to an existing linear disturbance density effect.

Comprehensive review of historical distribution of boreal caribou, fire history, and habitat and human disturbance in the form of a retrospective analysis will demonstrate the dynamic nature of caribou distribution through time and space. This will assist in identifying and rationalizing major transmission line routing options in some cases by avoiding future intact habitat complexes or paralleling existing linear infrastructure. Reviews of historical data should also include analysis of forest succession and use of habitat by boreal caribou through time and space.

The difference in environments and how populations use habitat must also be investigated (e.g., bog versus forest populations).

Integrated collaborative research and monitoring efforts need to be established in the context of overall provincial boreal caribou recovery activities where Manitoba Hydro should be a partner. Manitoba Hydro is assessing the recommendations and has incorporated many of the major components into an internal draft corporate boreal woodland caribou strategy. Collaborative projects are being undertaken with Manitoba Conservation and university graduate studies are underway. Manitoba Hydro will continue to participate in collaborative research and monitoring initiatives with Manitoba Conservation towards the collective goal of achieving self sustaining boreal caribou populations in Manitoba, while ensuring a safe, reliable and environmentally friendly source of energy vital to the economy of Manitoba.

## Acknowledgements

Rob Berger, Rachel Boone, Stan Boutin, Elisebeth Hicks, Shane Mahoney, Wade Munro, Jim Rettie, Gerry Racey, Art Rodgers, and Jim Schaefer.

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