Keeyask Generation Project

Environmental Impact Statement

Supporting Volume

Terrestrial Environment

KEEYASK
Hydropower Limited Partnership

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SECTION 7

MAMMALS

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7.0 MAMMALS

7.1 INTRODUCTION

Wildlife populations are an integral part of the boreal ecosystems in the Keeyask region. Decomposition of dead plant and animal material by **invertebrates** functions to return nutrients to plants, herbivores, and predators. **Trophic** interactions between predators and their prey species create an intricate food web that maintains ecosystem function (*e.g.*, forests, bogs) and the exchange of nutrients, water, and gases between these ecosystems. Linkages, or relationships, between members of food webs and habitat requirements of wildlife species in the Keeyask region make understanding wildlife communities an important element in planning for the development of the Keeyask Generation Project (the Project).

Each mammal species has a role in maintaining the health and balance of the community in which it lives. Some species like moose (*Alces alces*) and mink (*Mustela vison*) contribute to local lifestyles and economies. For many mammal species, construction and operation of the Project would result in changes to habitats and populations. Project-related changes to the physical environment could be observed in wildlife communities through a variety of linkages. For example, a change in water quality in an area could result in a decrease in fish abundance that could result in a corresponding decrease in mink and river otter. Linkages are discussed in more detail in the Habitat and Ecosystems section of the Terrestrial Environment Supporting Volume (TE SV).

Assessment of potential effects on wildlife communities associated with development of the Project was intended to address concerns put forth by: the KCNs and public stakeholders and government agencies within a framework of meeting all provincial and federal requirements for a comprehensive environmental impact assessment. Concerns raised by stakeholders with respect to the potential impact of the Project on mammal populations include human disturbance, water level fluctuations, mercury contamination, habitat loss or habitat alteration, and increased road access. The KCNs are also concerned about changes to predator/prey balance, changes in hunting pressure, and the ability of KCNs Members to rely on wildlife for food and income in the future. These concerns were considered in developing study designs. The main question to be addressed for the environmental assessment is: What are the anticipated effects of the Project construction and operation on mammals and their habitats, and how might these affect the long-term viability of mammal populations?

A number of sources were used in describing the existing environment, including **Aboriginal traditional knowledge** (ATK), **local knowledge**, scientific literature, other studies, and studies designed specifically as part of the environmental impact assessment of the Project. Section 7.2.4 details the sources of information, while Appendix 7A outlines the methodology used to gather field data.

7.2 APPROACH AND METHODOLOGY

7.2.1 Overview to Approach

The following section describes the study approaches for the various wildlife groups inhabiting the Keeyask region. As these groups vary greatly in their habitat usage, home range size, seasonal mobility, and the degree to which they could be affected by Project components, different study approaches were required to survey the different groups.

7.2.2 Priority Mammal Species

As outlined in the Habitat and Ecosystems section of the TE SV*,* the terrestrial assessment focused on the key ecosystem health issues of concern that could experience substantial Project effects and are especially important to maintaining overall ecosystem function and the long-term benefits that these functions provide to present and future generations. Since evaluation of potential Project-related effects on all wildlife species in the Keeyask region was not practical, Valued Environmental Components (VECs) were selected from a list of priority mammal species **(priority species).** Priority mammal species (priority mammals), including VECs, address specific issues of high scientific and/or social concern and collectively indicate how the Project is expected to affect terrestrial ecosystem health. Selection of VECs was made through a detailed screening process (see the Habitat and Ecosystems section of the TE SV) in which wildlife species were evaluated based largely upon their sensitivity to potential effects, their value to humans, and/or their importance to ecosystem function. Three species of mammals (beaver, moose, and caribou) were selected as mammal VECs (Appendix 1A).

Other species were included as priority mammals because they provide a broader picture of Project effects, and establish how important influences on VECs would be affected by the Project. Furthermore, the KCNs do not value one species of wildlife over any other and feel all species should be given equal priority (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*); FLCN Environment Evaluation Report (Draft)). As there are few mammal species in the Keeyask region when compared with the number of plant and bird species, all mammal species that were not selected as VECs were considered other priority mammals. These were grouped according to general characteristics and assessed to a lesser extent than VECs. These groups included small mammals, aquatic furbearers, terrestrial furbearers, large carnivores, ungulates, and rare or regionally rare species. Two ungulate species are found in the Keeyask region. Caribou and moose are both VECs, and are described in Section 7.3.6. Groups were based on general characteristics such as body size and broad habitat requirements, and not on biological **taxonomy**. As such, mammal groupings are not meant to imply similarity in specific characteristics such as diet (*e.g.*, herbivore or carnivore), or particular habitat preferences (*e.g.*, mature forest or recent burns).

Other priority mammals also include rare or regionally rare species. Rare species are those listed as endangered or threatened by the federal *Species at Risk Act* (SARA) or *The Endangered Species Act* of Manitoba (MESA), or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Boreal woodland caribou, listed as threatened by SARA and MESA, is discussed under caribou, a Project

VEC (see Section 7.3.6.3). Wolverine is listed as a species of special concern by COSEWIC. Its range includes the Mammals Regional Study Area, but it is not found in large numbers in Manitoba. Little brown myotis (*Myotis lucifugus*) is not currently listed by SARA or COSEWIC, but it has been recommended that it be listed under Schedule 1 of SARA (COSEWIC 2012). Regionally rare species are rare in the Keeyask region but are common elsewhere in Manitoba. American water shrew, little brown myotis, porcupine, raccoon, striped skunk, and coyote are regionally rare in the Keeyask region.

7.2.3 Study Area

Refer to the Habitat and Ecosystems section of the TE SV for a detailed description of the terrestrial study areas in the Keeyask region.

The need for multiple zones that describe the size of a study area is based in part, on the relative size required to maintain a minimum resident mammal species population in the order of 100 to 500 individuals or greater. Home ranges large enough to maintain mammal populations in a community were considered in the development and selection of study areas. Small mammal population (*e.g.*, red-backed vole) home ranges are in the order of hectares to a few square kilometres. Population home ranges for moderate to large resident mammals including some furbearer species (*e.g.*, American marten, *Martes americana*) range from hundreds to a few thousand square kilometres. Species such as caribou and wolverine require very large home ranges, often extending thousands to tens of thousands of square kilometres. The study area was also large enough to capture the key ecological processes operating at the regional ecosystem level, such as the fire regime (see Habitat and Ecosystems section of the TE SV). The need for further information outside the immediate area of interest was provided as necessary to develop context of broader populations, movements, seasonality or habitat qualities that may not have been provided by the Project effects area or by the regional comparison area.

Mammal surveys were conducted in the Keeyask region, with the majority of sampling concentrated in Zones 3 and 4 (Map 7-1, Table 7-1). When generally discussing all mammals, or a species' presence in the Keeyask region, the Mammals Local and Mammals Regional Study Areas were Zones 3 and 6, respectively. The area that addressed intactness was Zone 5. The area where direct effects will occur (the Project Footprint) was Zone 1. Study areas specific to a VEC or mammal group are identified in the relevant sections below.

Aerial surveys for ungulates were conducted in the Zones 5 and 6, but often extended beyond these boundaries to provide further context, especially for species with very large home ranges. An aerial survey for moose was conducted in the Split Lake Resource Management Area (SLRMA) to address concerns related to the Adverse Effects Agreement (AEA) offsetting programs. Aerial surveys for aquatic furbearers were done primarily in Zone 4. Mammal tracking transects were established near Gull Lake in Zone 3. Transects were also surveyed at Stephens Lake, a **proxy** (comparison) **area** in Zone 4. Similarly, small mammal trapping blocks were established near Gull Lake, in Zone 3, and along shorelines at Stephens Lake, in Zone 4.

Table 7-1: Sizes of Terrestrial Study Areas

Location	Size (km²)
Zone 1	130
Zone 2	187
Zone 3	420
Zone 4	2,215
Zone 5	14,160
Zone 6	30,500

7.2.4 Information Sources

Refer to the Habitat and Ecosystems section of the TE SV for a description of Information Sources.

7.2.4.1 Aboriginal Traditional Knowledge

Aboriginal traditional knowledge (ATK) was used to the extent possible, where information was available. Sources included reviewing existing published documents that contained ATK and information provided by the KCNs, particularly the CNP Keeyask Environmental Evaluation Report, YFFN Evaluation Report (*Kipekiskwaywinan*), FLCN Environment Evaluation Report (Draft), and the Keeyask Traditional Knowledge Report (FLCN 2010 Draft). Other ATK was obtained during interviews with resource harvesters at Project meetings and workshops. Reports of caribou or other species communicated directly or indirectly to the study team in the field were treated as incidental data.

Additional information was collected during the Keeyask Mammals Working Group meetings, which were held between November 2009 and February 2012. The working group was established to address the interest the KCNs communities had in learning more about caribou and other mammal studies as well as to coordinate the process of sharing information on mammal species and dealing with regulators. A number of topics were addressed, including caribou in the Keeyask region, updates of mammal field studies, addressing wildlife disease concerns and questions, the role of resource management boards, potential effects of the Project on mammals, and possible mitigation options. The mandate for the working group was as follows:

- Identify issues with respect to mammals in the terrestrial environment of interest to Manitoba Hydro and the KCNs;
- Develop a common understanding of the issues with input from the environmental assessment study team, the KCNs and their advisors, and Manitoba Hydro;

- Discuss proposed mitigation, monitoring or other strategies through an evaluation process considering magnitude of effect, level of concern to stakeholders, utility of proposed measures, and costs; and
- Develop a means of communicating results of the evaluation process to the KCNs, regulators, and other stakeholders.

Some of the key statements made during the Keeyask Mammals Working Group meetings were as follows:

- Measures should be taken so areas that will become new islands after flooding will not be cleared during reservoir clearing (Meeting # 1, November 25th, 2009);
- Fewer caribou will use the area after construction (Meeting # 1, November 25th, 2009);
- KCNs Members expect to see more hunters along transmission lines associated with the Project (Meeting # 1, November 25th, 2009; Meeting #5, December 9th, 2010);
- Changes to the distribution of aquatic furbearers were noted after the construction of Kettle Generating Station (GS) (Meeting # 1, November 25th, 2009);
- Cadmium and other heavy metals should be monitored in country foods (Meeting #3, April 15th, 2010);
- Summer resident caribou in the area should be treated as if they are boreal woodland caribou (Meeting #3, April 15th, 2010; Meeting #10, January 24th, 2012);
- There is a lack of knowledge about the caribou found in the Keeyask region for a number of reasons, which reinforces the idea of the need for a longer-term cooperative management program (Meeting #3, April 15th, 2010; Meeting #4, Oct 13th, 2010);
- All caribou in the area are important to the KCNs (Meeting #3, April 15th, 2010; Meeting #4, October 13th, 2010);
- Changes in the distribution of a variety of mammals have been observed since the construction of Kettle GS (Meeting #5, December 9th, 2010);
- The landscape has changed as a result of previous hydroelectric projects and will change as a result of the Keeyask GS (Meeting #10, January 24th, 2012);
- There were caribou in the vicinity of Kettle GS, which have only recently started to return (Meeting #10, January 24th, 2012);
- Caribou will be affected by multiple projects and the effects should be discussed at a larger scale than Keeyask alone (Meeting #11, February 28th, 2012); and
- The cost of mitigation measures for calving islands far outweighs the benefits, particularly given the uncertainty (Meeting #11, February 28th, 2012).

7.2.4.2 Existing Published Information

A review of the literature, hunting and trapping data, local knowledge, environmental impact statements for other generating station projects, and ATK was conducted in order to gain a historic perspective on mammals in the Mammals Regional Study Area. However, there was a considerable lack of historic information specific to the Keeyask region, particularly in the scientific literature and unpublished reports.

More recent studies and datasets reviewed include:

- Manitoba Conservation Aerial Survey for Moose in Game Hunting Area (GHA) 3 in 1999/2000 and GHA 9 in 2000/2001;
- Manitoba Conservation caribou data from coastal summer surveys 2008 and 2009;
- Manitoba Conservation trapline data for SLRMA (1961–1984 and 1996–2005) and Fox Lake Resource Management Area (FLRMA) (1996–2005); and
- Caribou data from Parks Canada (Summer 2008).

7.2.5 Environmental Impact Assessment Studies

Ground-based and aerial studies conducted from 2001 to 2006 were designed to characterize sparse to very common wildlife species in the Keeyask region. Studies were conducted in the Mammals Regional Study Area or in proxy or **benchmark areas** beyond this region. Study sites were selected to describe the existing environment and to assess the occurrence, distribution, and abundance of mammal species on the landscape. Mammal habitat descriptions were based directly on the Habitat and Ecosystems section of the TE SV*,* which outlines the terrestrial ecosystem in the Keeyask region.

Wildlife use of exiting habitats, shorelines, and specific habitat features was measured using techniques conforming to accepted professional standards and practices. A variety of methods was used to determine species frequency-per-unit-effort, describe distribution, **relative abundance**, habitat use and seasonality, and provide a baseline for mercury in aquatic furbearers (see the Wildlife and Mercury section of the TE SV). A program is currently underway for establishing a baseline for mercury and other heavy metals in ungulates and other wildlife as a response to concerns arising from the KCNs during the Mammal Working Group meetings. The mammal study team included community members from TCN, WLFN, YFFN, and FLCN. Members were involved in the identification and recording of mammal signs by species and **attributes** such as age and sex of the animal, where possible. In addition, local trappers supplied tissue samples of aquatic furbearers for mercury analysis (see the Wildlife and Mercury section of the TE SV).

A number of technical studies were designed to assess mammal populations in the Mammals Regional Study Area and to provide information for predicting potential Project effects on mammals. These studies included habitat-based mammal sign surveys; aerial surveys for moose, caribou, beaver, and muskrat; small mammal trapping; mercury studies for aquatic furbearers; and ground surveys for muskrat for wetland function validation. Additional efforts were made to design studies and collect sufficient data to construct and validate statistically derived multivariate habitat models for mammal VECs. Detailed methods, including descriptions of factors assessed for each study type, are described in Appendix 7A.

7.2.5.1 Habitat-based Mammal Sign Surveys

In order to classify habitat types in Zones 3 and 4, the Coarse Habitat classifications from habitat typing (see the Habitat and Ecosystems section of the TE SV) were employed to assess the area covered by the study zones. Where tracking transects crossed one or more coarse habitats, these were combined to form a **coarse habitat mosaic**. **Rare habitat mosaics** (habitats) were identified as those that comprise less than or equal to 1% of the available habitat in Zone 4; all other habitats comprising more than 1% of habitat in Zone 4 were characterized as **common habitat mosaics**. For mammal sign surveys, mammal signs were recorded along the length of each transect and included scat, tracks, trails, **browse** and feeding sites, and shelters. See Map 7-2 for all habitat-based transect locations.

Coarse habitat mosaic surveys were conducted on transects near Stephens Lake in Zones 3 and 4. In all, 35 transects were located in six common habitats, and one was established in one rare habitat.

Coarse habitat mosaic surveys were conducted on transects near Gull Lake in Zone 3 in summer and winter (Table 7-2). In summer, 121 transects were located in 10 common habitats, and 10 transects were established in two rare habitats. In winter, 69 transects were located in eight common habitats, and one transect was established in one rare mammal habitat. Riparian shoreline surveys and lake perimeter surveys were also conducted in Zone 3 (Map 7-3), and treated separately from terrestrial upland habitats.

Sixty-seven islands on Stephens Lake were surveyed for caribou activity in Zone 3 during the summer of 2003, and replicated, in part, in the summer of 2005 (Map 7-4). Caribou presence was recorded, and variables such as the size of islands and nearest distance to the mainland were measured. Where possible, the age and sex of individuals was identified. In 2009, 210 treed islands in peatland complexes or **caribou calving and rearing habitat complexes** were sampled in Zone 6 and in a broader comparison area using track and scat detection techniques similar to those used on islands in lakes.

Table 7-2: Mammal Tracking Surveys in the Keeyask Region

Survey Type	Season	Year	Number of Transects	Total Length (km)[1]
Coarse habitat mosaic	Summer	2001 to 2003	167	152,575
Coarse habitat mosaic	Winter	2001 and 2002	72	62,230
Riparian shoreline	Summer	2001 to 2003	54	16,000
Lake perimeter	Summer	2002 and 2003	20	86,520

1. Most transects were surveyed for more than one study year

Studies were also conducted along the north and south access road routes from 2001 to 2004. In 2001 and 2002, the lengths of the proposed access road routes were surveyed for mammal signs. In 2003, 32 transects were surveyed in **upland** habitats along the length of the north access road route. An additional 20 transects were surveyed along the cutline centred on the generally proposed area of the road. In 2004, 10 transects were surveyed in four habitats near the proposed south access road route, and six transects were surveyed at potential stream crossing sites. An additional potential stream crossing site was surveyed on the north access road route. Mammal signs were recorded along the length of each transect and included scat, tracks, trails, browse and feeding sites, and shelters.

7.2.5.2 Aerial Surveys

Aerial surveys for aquatic furbearers (beaver and muskrat) were conducted along watercourses and waterbodies in Zones 3, 4, and 5 in spring 2001, 2003, and 2006 (Map 7-5), and in fall 2001 and 2003 (Map 7-6). The number of beaver lodges and muskrat push-ups along waterbodies of varying sizes was counted, they were classed as either active or inactive, and their positions were marked using a GPS. An aerial survey was conducted in fall 2011 (Map 7-7) to determine the number of active and inactive beaver colonies in Zone 1, which will be directly affected by the Project.

Aerial surveys for ungulates (moose and caribou) were conducted in Zone 5 in winter 2002 to 2006 (Map 7-8). Ungulate counts included observations of individuals as well as signs of their presence (*e.g.*, tracks and feeding craters). Signs of gray wolf were recorded opportunistically.

Aerial surveys for moose were conducted in the SLRMA in March 2009 and January–February 2010 (Map 7-9). Moose counts included observation of individuals, age, and sex as well as signs of their presence (*e.g.*, tracks). Detailed methods can be found in the Moose Harvest Sustainability Plan.

Aerial surveys were conducted in the eastern portion of Zone 5 in the winter of 2011–2012 (Map 7-10) to document recent observations of caribou in the Keeyask region. Observations of other large mammals and their signs were also recorded. These surveys were conducted at the request of the KCNs to improve data collection on the north side of the Nelson River.

7.2.5.3 Small Mammal Trapping

Seventy-eight small mammal trapping blocks were trapped from 2001 to 2004 in Zones 3 and 4 (Map 7-11). Small mammals captured were weighed, measured, and where feasible, identified to species by dental characteristics.

7.2.5.4 Ground Surveys for Muskrat

Thirteen lakes, ponds, and sections of the Bigstone and Fox River shorelines were surveyed for muskrat signs in 2006 to improve understanding of wetland function. Signs of muskrat such as lodges, burrows, runs, clippings, tracks, scat, and feeding or loafing platforms were recorded (Map 7-12).

7.2.5.5 Trail Camera Surveys in Caribou Calving and Rearing Habitat

Between mid-May and early September 2010, 80 RECONYX™ trail cameras were distributed among 45 islands in Stephens and Gull lakes and among 28 caribou calving and rearing habitat complexes adjacent to the north and south access road routes. In all, 47 cameras were set up on Stephens Lake, 5 on Gull Lake, and 15 near each access road route. In 2011, 111 RECONYX™ trail cameras were distributed among 53 islands in Stephens and Gull lakes and among 17 caribou calving and rearing habitat complexes throughout the Caribou Local Study Area. In all, 49 cameras were set up on Stephens Lake, four on Gull Lake, and 48 on calving and rearing complex on the mainland. Occupancy, frequency of occurrence, and the age and sex of individuals were identified where possible. Supplemental information on moose calving and the occurrence of other wildlife was collected at the same time.

7.2.5.6 Bat Survey

Ten stations were monitored for bat activity at small mammal trapping blocks from late June to mid-July 2001. All tributaries, bays, and a variety of shoreline habitats were surveyed along the Nelson River between Birthday and Gull rapids in mid-July. An Anabat™ bat detection system was used. No bats were detected. A bat was detected in the field camp on the north shore of Gull Lake in mid-August, but was not positively identified to species. Attempts at live-trapping bats at the camp using a harp-net were unsuccessful.

7.2.6 Establishment of Benchmarks

7.2.6.1 Physical Habitat Loss

The amount of physical habitat loss was determined by overlaying the Project Footprint (human footprints plus buffers) and species-specific habitat data. The total amount of physical habitat lost (area of physical habitat falling within Zone 1) was calculated. Benchmark values for physical habitat loss indicated a low magnitude adverse effect where habitat loss is less than 1%, a moderate magnitude adverse effect where habitat loss is between 1% and 10% and a high magnitude adverse effect where habitat loss is greater than 10% (Salmo Consulting Inc. *et al.* 2003). This benchmark was used for all VECs.

7.2.6.2 Intactness

Intactness refers to the degree to which a geographic area has not been subdivided into smaller areas by human features, how easy is it for animals and plant **propagules** to move from one area to another and the degree to which other ecological flows such as surface water can follow natural patterns (see the Habitat and Ecosystems section of the TE SV). Critical habitat is used to assess the intactness of caribou habitat, which is defined as “the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species” (Government of Canada 2002). Critical habitat for woodland caribou is not defined for the species as a whole but rather for each individual population and is dependent upon the location, amount, and type of habitat (Environment Canada 2008; Environment Canada 2011). A reasonable estimate for the range determination of the caribou in the Keeyask region may be defined by Zone 5 in Map 7-1. Zone 5 was selected as the Intactness Regional Study Area (see the Habitat and Ecosystems section of the TE SV) based in part on mammals and their habitat requirements. While intactness is primarily discussed in the context of caribou in this section of the TE SV, it is important for non-VEC species such as American marten.

Intactness was calculated by buffering all linear features (*e.g.*, roads, transmission lines, railways, conventional cutlines) by 500 metres (m) to create a footprint of potential loss of **effective habitat** and physical habitat. This polygon was combined with polygons for burned areas younger than 40 years in order to create an overall footprint for disturbed caribou habitat. Water was also removed as habitat. Neither burned areas nor water were buffered. The area in the polygons was then used to determine the total amount of disturbed area. In cases where linear features and burned areas overlapped, care was taken to ensure the disturbed area was not counted twice. The total amount of intactness was the amount of critical habitat available in the identified range that was outside of the disturbed area polygons.

Benchmark values for intactness indicated a low magnitude adverse effect where core area, as a percentage of land area, is greater than 65%, a moderate magnitude adverse effect where core area percentage is between 45% and 65%, and a high magnitude adverse effect where core area percentage is lower than % (Salmo Consulting Inc *et al.* 2003; Athabasca Landscape Team 2009; Dzus *et al.* 2010). Benchmark values for intactness indicated a low magnitude adverse effect where less than 35% of the range is undisturbed, a moderate magnitude adverse effect when 35% to 45% of the range is undisturbed and a high magnitude adverse effect when more than 45% of the range is disturbed (Salmo Consulting Inc *et al.* 2003). This benchmark was only used in the assessment of caribou as recommended in the woodland caribou recovery strategy (Environment Canada 2011).

7.2.6.3 Linear Feature Density

Total linear feature density was measured as the total length of all linear features divided by the total land area. Transportation density was the combined density of roads and railways. The benchmark values for total linear feature density indicated a low magnitude adverse effect on caribou where total linear feature density is below 0.60 km/km^2, a moderate magnitude adverse effect where the density is between 0.60 km/km^2 and 1.2 km/km^2 and a high magnitude adverse effect where the density is more than 1.2 km/km^2 (Salmo Consulting Inc *et al.* 2003 and Athabasca Landscape Team 2009). This benchmark was only used in the assessment of caribou, which are sensitive to habitat fragmentation effects.

7.2.6.4 Gray Wolf Density

Ungulate biomass was used to calculate the density of wolves in the Keeyask region, the details of which are outlined in the Moose Harvest Sustainability Plan. Including other literature (Salmo Consulting Inc *et al.* 2003), the plan indicates that the following benchmarks are most likely to be appropriate for this area. The benchmark values used for gray wolf density indicated a low magnitude adverse effect on ungulates where gray wolf density is below 4 wolves/1,000 km^2, a moderate magnitude adverse effect where gray wolf density is between 4 and 6 wolves/1,000 km^2 and a high magnitude adverse effect where gray wolf density is more than 6 wolves/1,000 km^2 (Moose Harvest Sustainability Plan). This benchmark was used in the assessment of caribou and moose.

7.2.6.5 Harvest

Harvest numbers used in this assessment were derived from the Moose Harvest Sustainability Plan. The plan indicates that the following benchmarks are most likely to be appropriate for this area. Benchmark values used for harvest indicated a low magnitude adverse effect when less than 10% of the population was harvested, a moderate magnitude adverse effect when 11% to 20% of the population is harvested, and a high magnitude adverse effect when more than 20% of the population is harvested. This benchmark was only used in the assessment of moose.

7.2.7 Assessment Methods

The approach to mammal population and habitat assessment varied depending on requirements to support the environmental impact assessment, as follows:

- Local Study Areas were selected and generally described in sufficient detail to allow the habitat types to be determined for mammal community sampling locations in a manner compatible with that applied to more intensively studied areas; and
- Regional Study Areas were selected and generally described in sufficient detail to allow the habitat types to be mapped in detail to permit calculation of pre and post Project habitat areas, in support of models predicting changes in the mammal community.

The Habitat and Ecosystems section of the TE SV provides a detailed description of habitat types in the Keeyask region.

7.3 ENVIRONMENTAL SETTING

7.3.1 Overview

7.3.1.1 Historical Records of Priority Mammals

Up to 40 species of mammals occurred historically or may have occurred as known ranges extended into the Mammals Regional Study Area (Table 7B-1), if grizzly bear and mule deer are included in the total. Species such as grizzly bear have been extirpated, and species such as white-tailed deer and possibly porcupine occur very infrequently and likely do not persist in the area today.

The distributions of mammals in the boreal forest have changed over time, in response to changes in forest structure, age, climate, and natural and human-caused disturbances. As ponds undergo succession and forests burn, the structure and age of a forest can change considerably, creating a new mosaic of habitats for some species while reducing habitat for others. Although limited information is available, historic mammal community conditions may be used to compare and contrast current and future mammal populations and their distributions.

Sixteen furbearing species were identified in trapping records for the SLRMA between 1961 and 1984, including arctic fox, beaver, black bear, coyote, ermine, fisher, gray wolf, lynx, American marten, mink, muskrat, river otter, raccoon, red fox, red squirrel, and wolverine (Table 7B-2). All sixteen species were listed in the 1996–2005 trapping records, with the addition of badger, which was most likely collected outside the SLRMA in southern Manitoba (Table 7B-3). Seventeen furbearers are listed in the trapping records for the FLRMA between 1996 and 2005. These species include arctic fox, beaver, black bear, coyote, ermine, fisher, gray wolf, lynx, American marten, mink, muskrat, river otter, raccoon, red fox, red squirrel, weasel, and wolverine (Table 7B-4).

These records, combined with information in the Split Lake Post-Project Environmental Review (Split Lake Cree 1996a) indicate that trapping success fluctuated over time. However, in the 1970s greater effort and expense was required to produce a reasonable return because of damage to the shorelines of Split Lake and the Nelson River from fluctuating water levels caused by the Lake Winnipeg Regulation-Churchill River Diversion and associated hydroelectric development (Split Lake Cree 1996a). These patterns in trapping do not give a comprehensive measure of species abundance. Factors such as demand, market prices, and trapper effort can affect the data. Instead, trapping data provides presence/absence information for the region, and in some cases, it can provide an understanding of a sustainable harvest level, which may improve the overall understanding of relative population sizes for these furbearers.

7.3.1.2 Current Conditions of Priority Mammals

Mammals are part of an interconnected system where energy and matter are cycled through producers, consumers, and decomposers (Chapin *et al.* 2002). Up to 38 mammal species can currently be found in the Mammals Regional Study Area including small mammals (*e.g.*, red-backed vole), aquatic furbearers (*e.g.*, muskrat), terrestrial furbearers (*e.g.*, American marten), large carnivores (*e.g.*, gray wolf), and ungulates (*e.g.*, moose). Twenty-nine mammal species or groups were found during surveys in the Mammals Regional Study Area (Table 7B-5). At least five species or signs were observed incidentally and outside of formal studies, including woodchuck, northern flying squirrel, ermine, arctic fox, and mule deer. Species such as mule deer are highly unlikely to occur in the Keeyask region; however, one mule deer antler was found near Gull Lake. Although it was confirmed as a mule deer antler by the Manitoba Museum, it may have been transported into the area from elsewhere.

Mammal communities in the Mammals Regional Study Area consist predominantly of resident species, although a few species such as caribou migrate into the region from Ontario and Nunavut. Resident species rely on a wide variety of boreal forest habitats in the Mammals Regional Study Area to support their life functions for breeding, food, and shelter. Mammal community dynamics in the Mammals Regional Study Area are influenced by many factors including fire, weather, disease, insect populations, human development, hunting, and climate change (Fisher and Wilkinson 2005; Murray *et al.* 2006). Most mammal residents such as ungulates have adapted to living in cold northern environments (Telfer and Kelsall 1984).

Species rarity was estimated by considering the abundance (mean frequency) of species sign and the proportion of transects on which each species was detected (Rabinowitz *et al.* 1986). Species distribution was characterized as very widespread, widespread, scattered, or localized (Table 7-3). Species abundance was characterized as very abundant, abundant, sporadic, or scarce. Distribution and abundance were combined to characterize species rarity as very common, common, uncommon, or sparse (Table 7-4).

Table 7-3: Distribution and Abundance of Mammals in the Mammals Study Areas

Abundance	Mean Sign Frequency[1]	Distribution	Proportion of Transects
Very abundant	0.51+	Very widespread	0.51+
Abundant	0.21 - 0.50	Widespread	0.21 - 0.50
Sporadic	0.11 - 0.20	Scattered	0.11 - 0.20
Scarce	<0.01 - 0.10	Localized	<0.01 - 0.10
Absent	0	Absent	0

1. Signs/100 m²

Table 7-4: Scale of Abundance of Mammals in the Mammals Study Areas

Abundance	Distribution	Species Rarity
Very abundant or abundant	Very widespread or widespread	Very common
Sporadic or scarce	Very widespread or widespread	Common
Very abundant or abundant	Scattered or localized	Uncommon
Sporadic or scarce	Scattered or localized	Sparse

7.3.2 Small Mammals

Small mammals include mice, voles, shrews, squirrels, and chipmunks, and are the foundation of carnivore and omnivore food webs. Small mammals captured or observed in the Small Mammals Regional Study Area (Zone 3 in Map 7-1) are listed in Table 7B-6. As the red-backed vole is an important prey species for many birds and mammals, detail has been provided for this species. It also serves to illustrate project linkages for mammals with small home range sizes, and for common and widespread species.

Northern flying squirrels (*Glaucomys sabrinus*) are very widespread throughout their range in Manitoba (NatureServe 2011), which includes the Keeyask region. This species was not detected during formal studies, but several individuals were observed incidentally at Gull Lake camp and elsewhere. Based on known range and habitat use, and professional judgement, it is estimated to be common in the Keeyask region. Winter hibernation and low detection probabilities using traditional tracking and snap-trapping methods both in winter and summer precludes any further evaluation of species rarity.

7.3.2.1 Red-backed Vole

7.3.2.1.1 General Life History

Red-backed voles (*Clethrionomys gapperi*) prefer forest with coarse woody debris (Keinath and Hayward 2003) such as rotten logs, stumps, and brush (Banfield 1987) on which fungi (an important food item) grow. This debris also provides ample protection from predators. Optimal habitat for red-backed voles is characterized as dense, mature, **mesic** coniferous forest with large diameter trees and a predominantly closed overstory or canopy (Allen 1983). Grass cover is unsuitable (Allen 1983). A source of water such as creeks and bogs is required (Banfield 1987), likely to fulfill physiological water requirements (Getz 1968).

Red-backed voles are omnivorous, taking advantage of seasonally abundant foods. Fungi are a common food source, and can comprise up to 80% of the diet in the Canadian north (Martell 1981). Other food items include lichens, berries, seeds, bark, petioles of leaves, and wildflowers (Banfield 1987). Insects are eaten on occasion and cannibalism has been reported (Johnson and Johnson 1982; Banfield 1987). Due to their high physiological need for water, red-backed voles are rarely found more than 60 m from standing water or saturated soils (Allen 1983; Banfield 1987).

Red-backed voles are short-lived, and are often depredated. Common predators of red-backed voles include hawks, owls (Johnson and Johnson 1982), raccoon, mink, American marten and other weasels, red fox, coyote, and striped skunk (Banfield 1987). Bacterial infections and parasites are also sources of mortality (Johnson and Johnson 1982).

7.3.2.1.2 General Abundance and Habitat

Reports of red-backed voles in northern Manitoba date back to the early 1900s. This species was common between Norway House and Hudson Bay, and its distribution reached the Churchill area (Preble 1902).

The red-backed vole is not listed as species of conservation concern by the Manitoba Conservation Data Centre (MBCDC), and is widespread, abundant, and secure throughout Manitoba (NatureServe 2011). This species is abundant downstream of the Long Spruce GS and was found in a variety of habitat types, although it was infrequently trapped along open-canopied tributaries and shorelines (WRCS unpubl. data).

7.3.2.1.3 Regional Abundance and Habitat

Red-backed voles were found on 98% of trapping blocks in the Regional Study Area (see Table 7B-6) and were somewhat more frequently captured in upland than riparian areas. Relative to other small mammal species, red-backed voles were the most frequently captured over four study years. Habitat was assessed for some, but not all, trapping blocks. Where habitat was assessed, red-backed voles were captured on all blocks in all habitats but one, black spruce treed and young regeneration on shallow peatland (Table 7B-7). The frequency of capture was greatest in young regeneration on mineral and thin peatland or shallow peatland habitat and lowest in young regeneration on shallow peatland.

7.3.2.1.4 Local Abundance and Habitat

The Small Mammals Local Study Area was Zone 2 in Map 7-1. Red-backed voles were found on all trapping blocks in the Local Study Area over the four-year study period (Table 7B-8). The frequency of capture was greater in riparian than upland areas in 2001, was greater in upland areas in 2003, and was similar in both areas in 2002 and 2004. Over the four-year study period, capture frequency was slightly greater in riparian areas. Red-backed voles were the most frequently captured small mammal species over the combined study period. With the exception of 2001, red-backed voles were the species most frequently captured in individual study years. Red-backed voles were captured on 96% of blocks for which habitat was assessed over the four-year study period (Table 7B-9). As in the Regional Study Area, capture frequency was greatest in young regeneration on mineral and thin peatland or shallow peatland habitat, and was lowest in young regeneration on shallow peatland. Capture frequency of red-backed voles increased from 2001 to 2002, remained roughly the same in 2003, then declined in 2004 (Figure 7-1). These survey years most likely captured a portion of the vole cycle, which is typically three to four years (Korpimäki and Krebs 1996). Long-term small mammal trapping studies would be required to confirm the periodicity of population cycling in the Local Study Area.

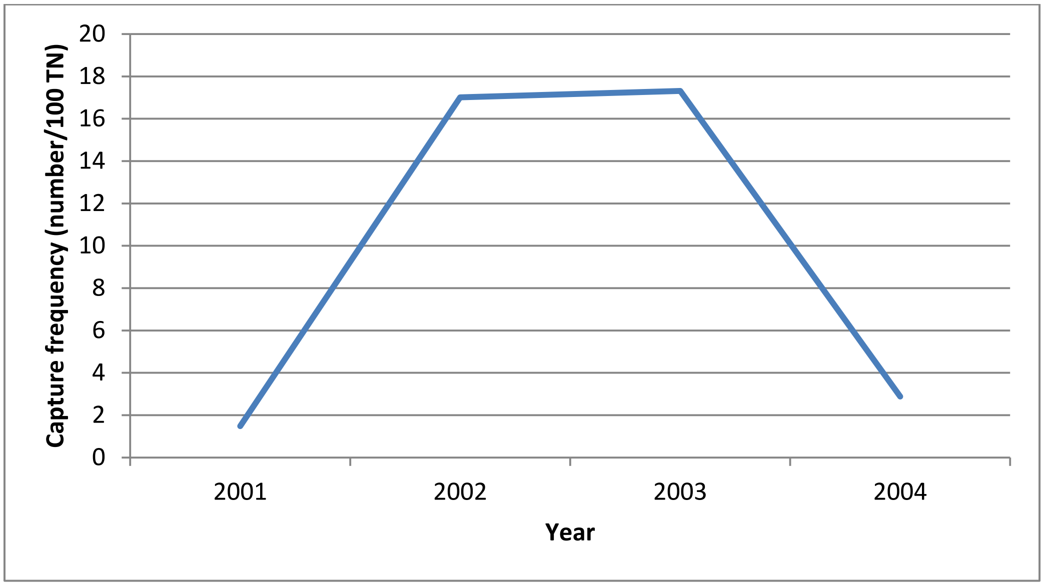

Figure 7-1: **Capture Frequency of Red-backed Voles in the Small Mammals Local Study Area over a Four-year Period**

7.3.2.2 Other Small Mammals

7.3.2.2.1 General Life History

Small mammals such as shrews, mice, voles, squirrels, and chipmunks are generally short-lived and are prolific breeders; most have more than one litter a year (Banfield 1987). Exceptions include pygmy shrew (*Sorex hoyi*), least chipmunk (*Eutamias minimus*), red squirrel (*Tamiasciurus hudsonicus*) in northern Canada, and possibly northern bog lemming (*Synaptomys borealis*) (Banfield 1987). Small mammals occupy a range of habitats, and their diets are varied (Banfield 1987). A primary source of small mammal mortality is predation (Banfield 1987). Small mammal populations cycle with relative regularity (Boonstra *et al.* 1998), which can influence local predator populations (Korpimäki and Krebs 1996).

7.3.2.2.2 General Abundance and Habitat

Small mammal species such as meadow jumping mouse (*Zapus hudsonius*) were common around Oxford House in the early 1900s, and were found as far north as Churchill and York Factory (Preble 1902). Meadow voles (*Microtus pennsylvanicus*) were distributed from Norway House to Hudson Bay in the early 1900s, and were common in suitable habitats (Preble 1902). Masked shrews (*Sorex cinereus*) were distributed through most of Manitoba in the late 1920s, with the exception of the northwestern corner of the province (Jackson 1928). Range expansions of masked shrew and northern bog lemming were reported in the mid-1950s, to include the Churchill region (Quay 1955).

It was suggested that several additional species of small mammals could have been found as far north as Churchill by the early to mid-1950s, including arctic shrew (*Sorex arcticus*), pygmy shrew, deer mouse (*Peromyscus maniculatus*), and least chipmunk, if an effort had been made to demonstrate these species were in the area (Smith and Foster 1957), most likely via trapping studies. In the 1970s, the known range of arctic shrews was expanded to include Churchill (Wrigley *et al.* 1979). Studies conducted near Churchill in 1951 yielded very few voles and lemmings; however their numbers increased dramatically in 1952 and appeared to peak in 1953 (Smith and Foster 1957). The vole population remained high in 1955, while lemming numbers declined (Smith and Foster 1957).

Small mammals are currently abundant and widespread in northern Manitoba (Banfield 1987). They are an important food source for the smaller carnivores in the Keeyask region, including red fox, American marten, fisher, and mink, and to a lesser extent for river otter and lynx.

7.3.2.2.3 Regional Abundance and Habitat

In addition to red-backed vole, nine small mammal species were captured in the Regional Study Area: arctic shrew, deer mouse, heather vole (*Phenacomys intermedius*), masked shrew, meadow vole, meadow jumping mouse, northern bog lemming, pygmy shrew, and American water shrew (see Table 7B-6). Least chipmunk and red squirrel were occasionally captured (four least chipmunks and one red squirrel over a four-year study period), but the small mammal trapping study was not designed for **arboreal** (tree-dwelling) species such as these, and these observations were considered incidental. Signs of activity such as middens and den sites were recorded during tracking studies. These species are more common than indicated by field studies.

The large majority of small mammal species tend to be widespread and abundant in the Regional Study Area. After red-backed voles, heather voles were most frequently captured over the four-year study period (1.88 individuals/100 **trap nights** (TN)). American water shrews were least frequently captured (less than 0.01 individuals/100 TN). Variations in the number of small mammals were observed between riparian and upland areas and by year surveyed. These variations were likely due to natural population cycles of small mammals, habitat availability, and habitat quality (Johnson and Johnson 1982).

7.3.2.2.4 Local Abundance and Habitat

All ten of the small mammal species that were captured in the Regional Study Area were captured in the Local Study Area. Capture frequency of shrew, mouse, and vole species varied over the four-year study period, with peaks generally occurring in 2002 or 2003 (Figure 7-2, Figure 7-3, and Figure 7-4).

After red-backed vole, heather vole abundance was greatest (1.72 individuals/100 TN) over the four-year study period (see Table 7B-8). Of the small mammals identified to species, American water shrew (less than 0.01 individuals/100 TN) and pygmy shrew (0.01 individuals/100 TN) were least frequently captured, followed by arctic shrew (0.03 individuals/100 TN).

The frequency of capture was greater in riparian than terrestrial areas for all but three species over the four-year study period. Deer mouse and heather vole were more frequently captured in terrestrial areas than riparian, and capture frequency of masked shrew was similar in both areas.

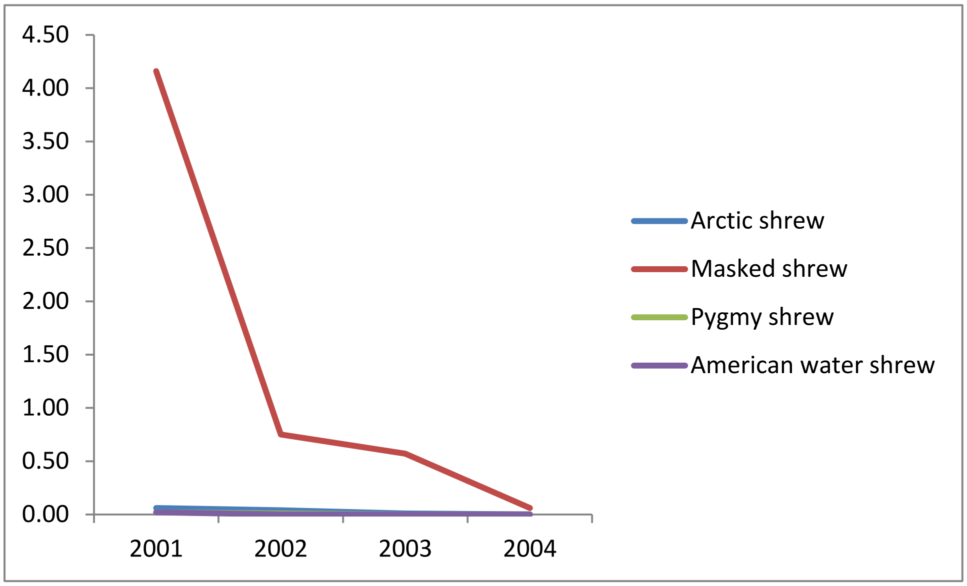

Figure 7-2: Capture Frequency of Four Shrew Species in the Local Study Area over a Four-year Period

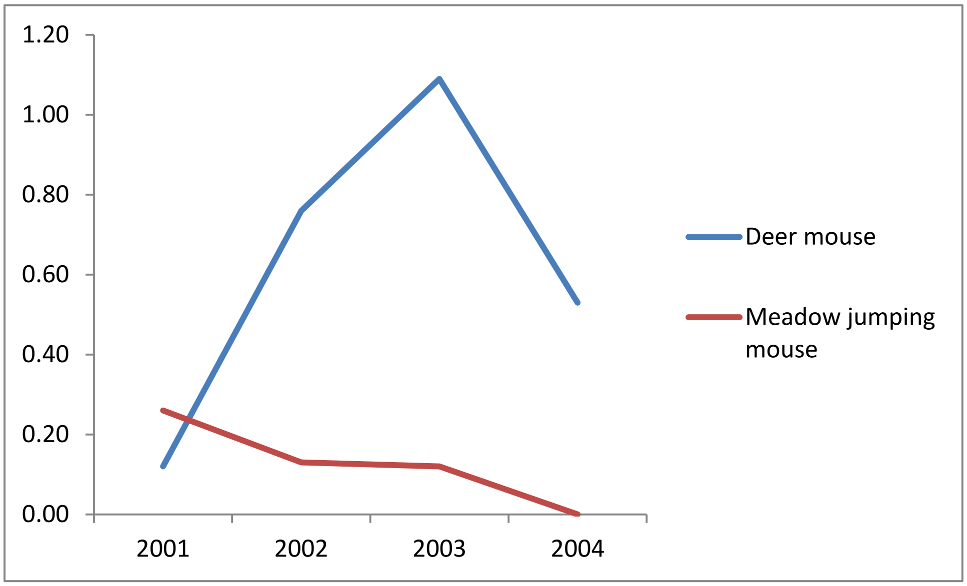

Figure 7-3: **Capture Frequency of Two Mouse Species in the Local Study Area over a Four-year Period**

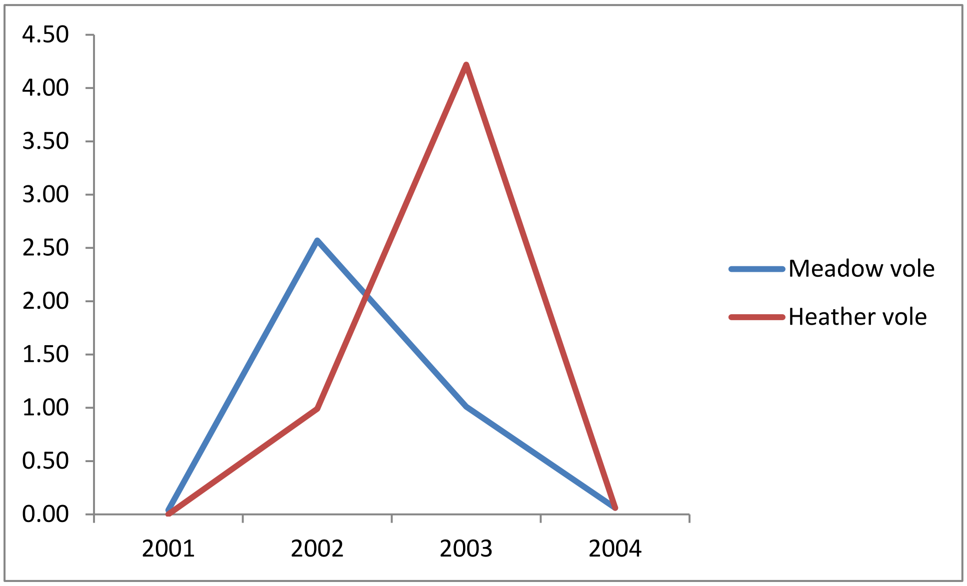

Figure 7-4: **Capture Frequency of Two Vole Species in the Local Study Area over a Four-year Period**

7.3.3 Aquatic Furbearers

Aquatic furbearers are medium-sized mammals that rely on water for a large portion of their food or habitat. They are important to the KCNs for cultural and economic reasons (see the CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report (*Kipekiskwaywinan*), FLCN Environment Evaluation Report (Draft), and the Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume (SE SV). The Furbearers Local Study Area was Zone 3 and the Furbearers Regional Study Area was Zone 4 in Map 7-1. Aquatic furbearers found in the Keeyask region are beaver, muskrat, mink, and river otter. As beaver is a VEC, it is described in Section 7.3.6.2.

7.3.3.1 Muskrat

7.3.3.1.1 General Life History

Muskrat (*Ondatra zibethicus*) require a source of permanent water such as marshes, ponds, lakes, streams, and rivers for habitat (Boutin and Birkenholz 1998). They generally inhabit the edge of **emergent** vegetation zones (Banfield 1987), and are absent from large bodies of open water (Errington 1963), where wave action is greater. In northern climates, muskrat occupy waterbodies that do not freeze to the bottom in winter (Dobbyn 1994).

Along streams, bank burrows are the primary dwelling of muskrat (Banfield 1987). They tend to build lodges in ponds with a relatively constant water level and suitable vegetation for construction (Banfield 1987). At Delta Marsh, Manitoba, muskrat constructed lodges for winter inhabitation, and moved to bank burrows when temperatures increased (MacArthur and Aleksiuk 1979). Lodges are typically made of cattails, bulrushes, pondweeds, and assorted debris, and are constructed prior to the winter freeze (MacArthur and Aleksiuk 1979). **Push-ups**, by contrast, are temporary shelters composed of aquatic vegetation pushed up through holes in ice (Perry 1982), in which feeding occurs (Pattie and Hoffmann 1990).

The typical muskrat diet consists primarily of aquatic vegetation including shoots, roots, bulbs, and leaves (Boutin and Birkenholz 1998). Commonly consumed vegetation includes cattails, rushes, sedges, iris, water lily, and pondweeds (Pattie and Hoffmann 1990). Some animal matter, such as shellfish, frogs, turtles, and salamanders may also be consumed on occasion (Pattie and Hoffmann 1990).

Females are **polyoestrous**, capable of producing more than one litter per year; populations appear to follow a four-year cycle of increases and declines (Perry 1982; Erb *et al.* 2000). Primary sources of muskrat mortality include trapping, disease, parasites, and predation (Perry 1982). Abnormal climatic conditions can cause muskrat population declines, as salinity, pH, water tables, and food plants could be affected (Perry 1982). In addition, during population peaks, vegetation can become decimated over a large area, resulting in an ‘eat-out’, where habitat is rendered unsuitable for muskrat and a population crash occurs (Perry 1982).

7.3.3.1.2 General Abundance and Habitat

The muskrat is not listed by the MBCDC, and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011). Muskrat density at Delta Marsh in southern Manitoba ranged from

0.4 individuals/hectare (ha) to 21.3 individuals/ha in the 1980s, indicating that muskrat population densities vary greatly (Clark and Kroeker 1993). Approximately 23,400 muskrat were trapped in Manitoba in the 2009–2010 season and 9,150 were trapped during the 2010 to February 2012 season (Manitoba Conservation 2011a). The number of muskrat harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged one per trapline per (SE SV).

7.3.3.1.3 Regional Abundance and Habitat

In summer, muskrat in the Regional Study Area consume **submergent** aquatic plants, including pondweeds, water lilies, water arum (*Calla palustris*) and milfoil (*Myriophyllum* spp.), and emergent plants such as horsetail (*Equisetum fluviatile*) and sedges (*Calyx* spp.) (WRCS unpubl. data). Food samples were collected, and their composition was almost equally divided among these species. Muskrat push-ups were almost entirely composed of submergent aquatic vegetation (WRCS unpubl. data). Aquatic mosses were also found in some samples.

A total of 28,105 m of shoreline was sampled during the ground-based surveys for muskrat. Slightly more muskrat signs were observed on lakes visually and broadly categorized as fair to poor habitat than on those presumed good, or with no estimated quality (Table 7-5). Similarly, more active dwellings were encountered on lakes with fair to poor muskrat habitat than on those presumed good (Table 7-6). Plant species identified included pondweed (*Potamogeton zosteriformis, P. praelongus, P. gramineus,* and *P. richardsonii),* bur-reed *(Sparganium* spp.), yellow water lily (*Nuphar microphyllum),* sedges, water arum, water-crowfoot *(Ranunculus aquatilis),* horsetail, and northern milfoil (*Myriophyllum sibricum).* On average, emergent species were collected more often than submergent species.

Table 7-5: All Muskrat Signs Observed Along Water Bodies in the Regional Study Area, 2006

Estimated Lake Quality	Number signs/100 m	Mean signs/100 m
Good	9.90	9.20
Fair to Poor	12.10	11.60
None	5.00	5.10
All	10.60	8.90

Table 7-6: Active Muskrat Dwellings Observed Along Water Bodies in the Regional Study Area, 2006

Estimated Lake Quality	Number Dwellings/100 m	Mean Active Dwellings/100 m
Good	1.90	1.40
Fair to Poor	2.20	2.10
None	1.20	1.00
All	1.70	1.50

The density of muskrat push-ups observed during aerial surveys in spring 2001 was 0.14 push-ups/km (Table 7B-10). Push-up density peaked in 2003 (0.21 push-ups/km) and was similar in 2006 (0.20 push-ups/km). A single push-up was observed in a pond on an island in an unnamed lake over the three-year study period, and none was observed on islands in rivers. Push-up density was greatest in ponds or streams each study year, and was greatest in streams overall (a mean of 0.31 push-ups/km). Push-up density was low in Clark and Stephens lakes and the central Nelson River, which includes Gull Lake, and were absent on the Nelson River downstream of Kettle GS (Map 7-13). For maps of annual muskrat push-up observations, refer to Appendix 7C.

7.3.3.1.4 Local Abundance and Habitat

Muskrat presence was observed near waterbodies throughout the Local Study Area. During aerial surveys, muskrat push-up density was greatest in spring 2003 (0.24 push-ups/km; Table 7B-11) and was similar in 2001 and 2006. As in the Local Study Area, a single push-up was observed in a pond on an island in an unnamed lake over the three-year study period, and none was observed on islands in rivers. Push-up density was greatest in ponds and streams in 2001 (0.29/km), in small lakes in 2003 (0.43/km), and unnamed rivers in 2006 (0.50/km), where a single push-up was observed over the 2 km surveyed. When this single push-up is removed from consideration as being a small sample size outlier, push-up density was greatest in streams (0.25/km) in 2006. Over the three-year period, muskrat density was greatest in streams (0.32/km), lakes, (0.27/km), and ponds (0.23/km). Other than islands in ponds, push-up density was lowest in the central Nelson River, which includes Gull Lake. The muskrat population increased from 2001 to 2003. Muskrat density decreased in streams and unnamed lakes during this period, and again in 2006. In ponds, density increased from 2001 to 2003, then decreased in 2006. A general decline in the muskrat population was observed from 2003 to 2006. Muskrat populations fluctuate over approximately 10 years in northern Canada (Banfield 1987). The low phase of this cycle could have been partly captured during the study period, however further study would be required for confirmation.

Signs of muskrat activity were observed on tracking transects in the Local Study Area, usually associated with water. As the distribution of muskrat signs was very widespread (Table 7-7) and abundance was scarce, muskrat signs were common on lake perimeters in the Local and Regional Study Areas in summer. No lake perimeters were assessed during the winter. Signs of muskrat activity were observed on all 10 lake perimeters in Zone 1. There were more signs of muskrat activity at lakes surveyed south of Gull Lake than north and inside Zone 1 than outside (Table 7B-12). Mean sign frequency was greatest in low vegetation or tall shrub on wet peatland habitat (0.17 signs/100 m²), and no sign of muskrat activity was found in black spruce treed on wet peatland. Muskrat sign abundance was sporadic on the smallest lakes (0.11 signs/100 m²), and scarce on medium-sized and larger lakes (0.02 signs/100 m²).

Table 7-7: Mean Frequency of Muskrat Signs (signs/100 m²) on Transects in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.08	0.03	scarce	0.75	very widespread	common
Coarse habitat mosaics	<0.01	<0.01	scarce	0.03	localized	sparse
Coarse habitat mosaics (winter)	0	0	absent	0	absent	absent
Riparian shorelines	0.06	0.02	scarce	0.17	scattered	sparse

Muskrat signs were sparse on coarse habitat mosaic transects in summer and were absent in winter (Table 7-7). In all, 10 signs were observed over three study years; none were found in 2001 (Table 7B-13). Signs were observed north and south of Gull and Stephens lakes, in riparian and upland areas, and inside and outside Zone 1 over the three-year study period. Muskrat signs were observed in 5 of the 13 habitats surveyed, all in black spruce-dominated habitats. No signs were observed in areas with young regeneration or broadleaf trees. As the mean frequency of muskrat signs was 0.01 signs/100 m² or less for all transect characteristics, no comparisons were made. Tracking transects are less suited to assess muskrat abundance than aerial surveys, as muskrat signs are more difficult to detect on the ground, particularly in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. Signs were more frequently observed on lake perimeter transects, where these aquatic furbearers spend much of their time.

Muskrat signs were sparse on riparian shoreline transects on Gull Lake during the summer (Table 7-7). No riparian shoreline transects were assessed during the winter. In 2001 and 2002, 20 signs were observed and mean sign frequency was greatest in 2002 (0.09 signs/100 m²; Table 7B-14). Over the three-year study period, signs of muskrat activity were most frequent in areas of moderate riparian zone width (0.19 signs/100 m²) and low slopes (0.10 signs/100 m²). Mean sign frequency was similar north and south of Gull Lake. Signs were most frequently observed in black spruce treed on shallow peatland habitat, and were absent from black spruce treed on mineral and thin peatland or shallow peatland, black spruce mixedwood on mineral and thin peatland, and broadleaf treed on all ecosites habitat.

Eight muskrat signs were observed at three stream crossing sites along the north and south access road routes surveyed in summer 2004 (Table 7B-15), two on the south route and one at the single stream crossing surveyed on the north route. No signs were observed during upland surveys of the access roads in 2001, 2002, or 2003. As muskrat are aquatic furbearers that spend the majority of their time in or near water, no activity was anticipated in these upland areas.

Muskrat signs were observed in aquatic habitats in the Local and Regional Study Areas. Based on aerial surveys and signs on lake perimeters, muskrat select smaller waterbodies in the Regional and Local Study Areas, which is consistent with their preference for ponds and slow-flowing rivers and streams (Nadeau *et al.* 1995). Relatively few muskrat appear to make use of the habitat on the shores of Gull Lake. Muskrat were active on lakes and in riparian and upland areas in Zone 1 in summer and winter, suggesting that they inhabit areas to be affected by the Project.

7.3.3.2 Mink

7.3.3.2.1 General Life History

The mink is an economically important furbearer. Mink habitat is associated with water, including stream banks, lakeshores, forest edges, and swamps (Banfield 1987). Mammals are of primary importance in the mink diet year round, with muskrat, small mammals, hares, and rabbits commonly taken (Eagle and Whitman 1998). In summer, waterfowl, marsh-nesting birds, and aquatic invertebrates are consumed while in winter, fish are a more frequent source of food (Eagle and Whitman 1998).

Sources of mortality include predation, diseases and parasites, accidents, and trapping (Lindscombe *et al.* 1982). While owls, lynx, bobcat, foxes, coyote, gray wolf, black bear, and fisher prey on mink, predation does not appear to be a major source of mink mortality (Lindscombe *et al.* 1982; Eagle and Whitman 1998); nor do diseases and parasites (Lindscombe *et al.* 1982). Trapping by humans has the most important impact on the mink population (Eagle and Whitman 1998).

7.3.3.2.2 General Abundance and Habitat

Mink were abundant and widely distributed between Lake Winnipeg and Hudson Bay in the early 1900s, but were less common near Churchill (Preble 1902). Currently, the mink is not listed by the MBCDC, and is widespread, abundant, and secure throughout Manitoba (NatureServe 2011). The average mink harvest in Manitoba has declined from a five-year average of approximately 6,000 individuals from 1994 to 1998 to 1,672 individuals in the 2011 to February 2012 season (Manitoba Conservation 2011a). Average auction values have oscillated since 1994 (Manitoba Conservation 2011a). The number of mink harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged two mink per trapline per year (SE SV).

Mink fecal samples were collected throughout the Keeyask region and downstream of the Long Spruce GS. In the Keeyask region, fecal samples were composed mainly of mammal remains (Figure 7-5). Invertebrates, vegetation, and birds made up a smaller proportion of the samples. No fish remains were found in samples from the Keeyask region. Downstream of the Long Spruce GS, fecal samples were also composed mainly of mammals (Figure 7-6). Remains of red-backed vole, heather vole, meadow vole, and northern bog lemming were identified in some samples. Excluding unknown matter, fish comprised the next-greatest proportion of samples downstream of the Long Spruce GS.

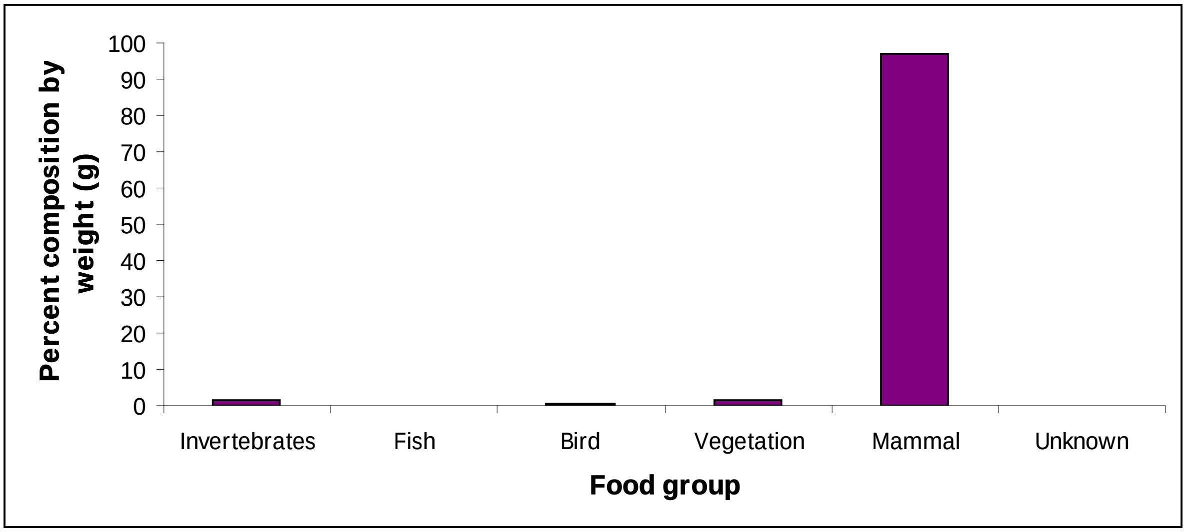

Figure 7-5: **Composition of Mink Scat Samples Collected in the Furbearer Regional Study Area**

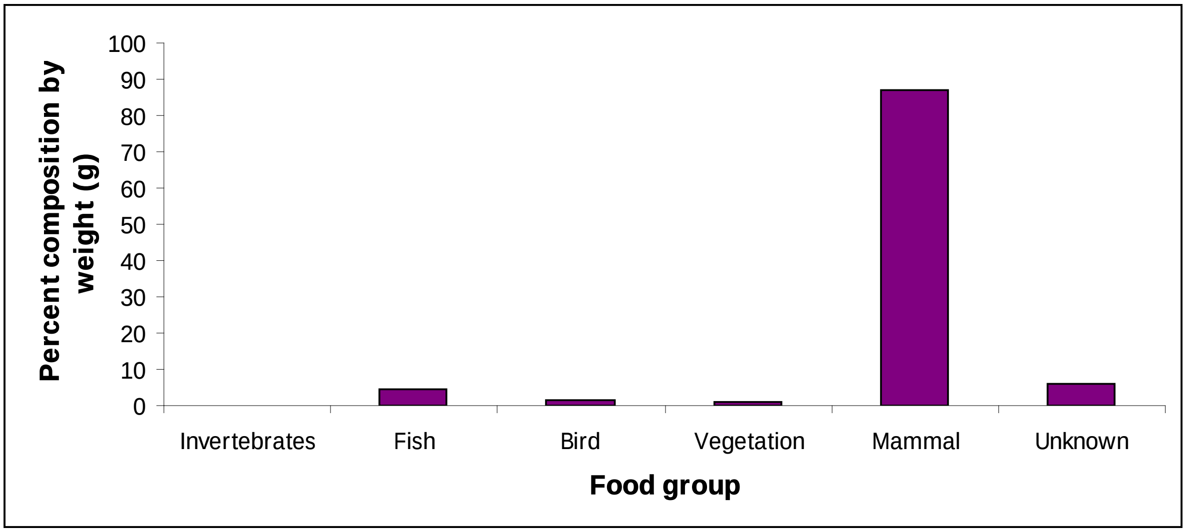

Figure 7-6: **Composition of Mink Scat Samples Collected Downstream of the Long Spruce Generating Station**

7.3.3.2.3 Local Abundance and Habitat

Signs of mink activity were common in the Local Study Area (Table 7-8). Mink signs were common along lake perimeters in the Local and Regional Study Areas during the summer. No lake perimeter transects were assessed in winter. While sign abundance was scarce over the two-year study period, the distribution of signs was very widespread. Mean frequency of mink sign was greater north of Gull Lake than south in 2002 and 2003 (Table 7B-16). Signs of mink activity were greater outside Zone 1 than inside and mink signs were observed at 5 of 10 lakes in Zone 1. No signs were observed in low vegetation or tall shrub on wet peatland habitat. Mean sign frequency ranged from 0.01 signs/100 m² in young regeneration on mineral and thin peatland or shallow peatland to 0.08 signs/100 m² in black spruce treed on mineral and thin peatland or shallow peatland, and black spruce treed on shallow peatland. Mink activity was greatest on small lakes.

Table 7-8: Mean Frequency of Mink Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.05	0.01	scarce	0.65	very widespread	common
Coarse habitat mosaics	0.01	<0.01	scarce	0.10	localized	sparse
Coarse habitat mosaics (winter)	0.01	<0.01	scarce	0.26	widespread	common
Riparian shorelines	0.12	0.03	sporadic	0.39	widespread	common

Signs of mink activity were sparse on coarse habitat mosaic transects surveyed in summer (Table 7-8). Mink signs were scarce and localized. There was no sign of mink activity in 2001 (Table 7B-17). Summer tracking transects are less suited to assess mink abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. Signs were more frequently observed on riparian shoreline and lake perimeter transects, where these aquatic furbearers spend much of their time. Signs were also observed north and south of Gull and Stephens lakes, and in 4 of the 13 habitats surveyed. All of the habitats in which mink signs were observed were dominated by black spruce. Signs such as dens and scat, which are more easily observed than tracks, were most often recorded. Where mink signs were observed, mean sign frequency was 0.01 signs/100 m² or less for all transect characteristics.

Mink signs were common on coarse habitat mosaic transects surveyed in winter 2001 and 2002 (Table 7-8). Twenty-four mink signs were observed (Table 7B-18), for a total mean frequency of 0.01 signs/100 m². While sign abundance was scarce, the distribution of signs was widespread. Mink signs were observed north and south of Gull Lake, in riparian and upland areas and inside and outside Zone 1 in 2001 and 2002. Mink signs were found in six of nine common habitats, and in the rare habitat. No signs were found in black spruce treed on shallow peatland and low vegetation, or tall shrub on wet peatland habitat.

Mink signs were common along riparian shorelines during the summer; no transects were assessed in winter. Abundance of mink signs was sporadic, and the distribution of signs was widespread over the three-year study period (Table 7-8). Signs of mink activity were generally greater north of Gull Lake than south (Table 7B-19). A single sign was observed on islands, in 2003. No mink signs were detected in riparian zones wider than 100 m in 2001, and none were observed in riparian zones 31 to 100 m in width in 2002. The relatively large sign frequency in this category in 2001 and 2003 resulted in the greatest mean sign frequency over the three-year study period. Mink signs were detected in riparian zones 0 to 30 m wide each survey year. No signs of mink activity were observed in black spruce mixedwood on mineral and thin peatland and broadleaf treed on all ecosites habitat. Mink activity was greatest (0.33 signs/100 m^2) in black spruce treed on mineral and thin peatland or shallow peatland habitat.

Mink signs were observed along the access road routes from 2001 to 2004 (Table 7B-20). While signs of mink activity were greatest (0.04 signs/100 m^2) at the potential stream crossing sites surveyed in 2004, signs were sparse on the north and south access road routes during all surveys over four years.

Signs of mink activity were frequently observed in black spruce treed on mineral and thin peatland or shallow peatland habitat. This habitat has an understory dominated by low shrubs (see the Habitat and Ecosystems section of the TE SV) that provide adequate cover for mink (Allen 1984). Mink were active on lakes, the shores of Gull Lake, and in riparian and upland areas in Zone 1 in summer and winter, suggesting that they inhabit areas to be affected by the Project.

7.3.3.3 River Otter

7.3.3.3.1 General Life History

River otter (*Lontra canadensis*) inhabit aquatic environments, including lakes, streams, and other wetlands (Melquist and Dronkert 1998). Good river otter habitat is commonly associated with that produced by beavers (Reid *et al.* 1994a), as dams create favourable conditions for river otter habitation. Consequently, riparian vegetation is a key component of river otter habitat, as it attracts beavers, and an adequate supply of food is important (Melquist and Dronkert 1998). Fish are the main component of the river otter diet, and birds, amphibians, insects, and aquatic invertebrates are opportunistically consumed, particularly in summer (Reid *et al.* 1994b).

Most river otter mortality is caused by human-related factors such as trapping, illegal shooting, road kills, and accidental captures in fish nets or set lines (Melquist and Hornocker 1983). Pollution and habitat degradation also have a large impact on river otter numbers (Toweill and Tabor 1982; Boyle 2006). Accidental deaths may be the result of ice flows (Serfass and Rymon 1985) or shifting rocks (Melquist and Hornocker 1983). Starvation may occur due to excessive tooth damage (Serfass and Rymon 1985). Other sources of river otter mortality include predation, parasites, and disease although these generally do not have a great effect on the population (Toweill and Tabor 1982). Winter habitat and food availability are factors limiting river otter density in the north (Reid *et al.* 1994b). Suitable winter habitat includes shoreline in which to construct underground dens above water level, and access to water under the ice

(Reid *et al.* 1994b). Beaver dams, lodges, and bank burrows may be used as shelter or as resting sites (Melquist and Dronkert 1998).

7.3.3.3.2 General Abundance and Habitat

The river otter is not listed by the MBCDC, and is widespread, abundant, and secure throughout Manitoba (NatureServe 2011). Approximately 880 river otter were trapped in Manitoba in the 2009–2010 season and 1,384 were reported for the 2010 to February 2011 season (Manitoba Conservation 2011a). The number of river otter harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year with an average annual total (SE SV).

River otter fecal samples were collected throughout the Keeyask region and downstream of the Long Spruce GS. In the Keeyask region, fecal samples were composed mainly of fish (Figure 7-7). Invertebrates, vegetation, mammals, and unidentified matter made up a smaller proportion of the samples. Downstream of the Long Spruce GS, fecal sample content was composed of slightly more invertebrates than fish (Figure 7-8). Birds, mammals, and vegetation were also identified. Unidentified matter composed 1.3% of the fecal matter sampled.

Fish scales extracted from fecal samples were identified to species where possible. Unknown fish made up the greatest proportion of scale samples (Table 7B-21). Northern pike scales were most frequently identified. Scales from relatively small fish were more often observed in the fecal samples than scales of large fish.

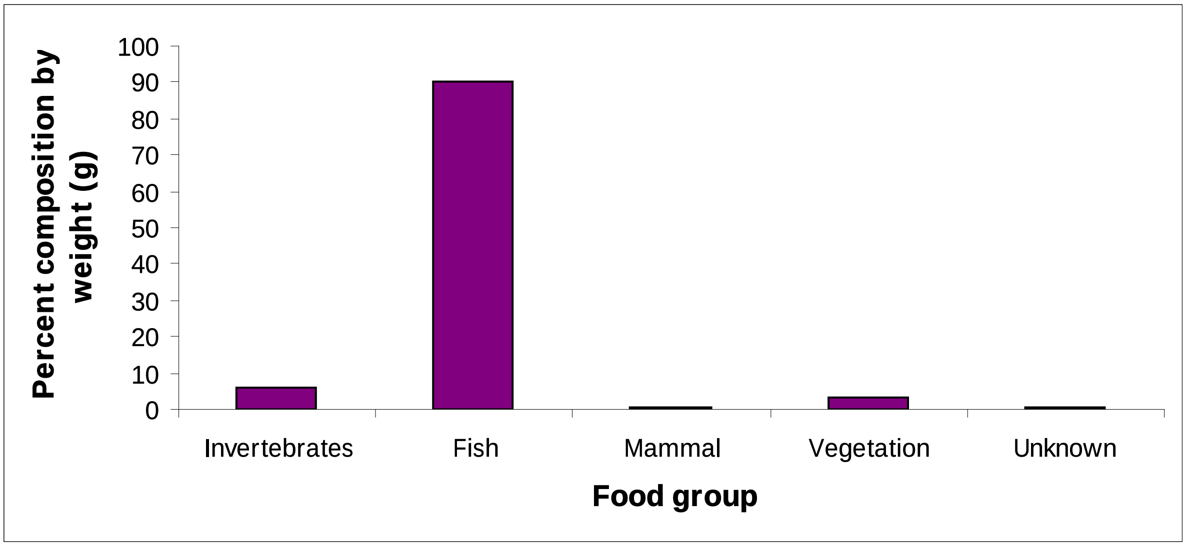

Figure 7-7: Composition of River Otter Scat Samples Collected in the Keeyask Region

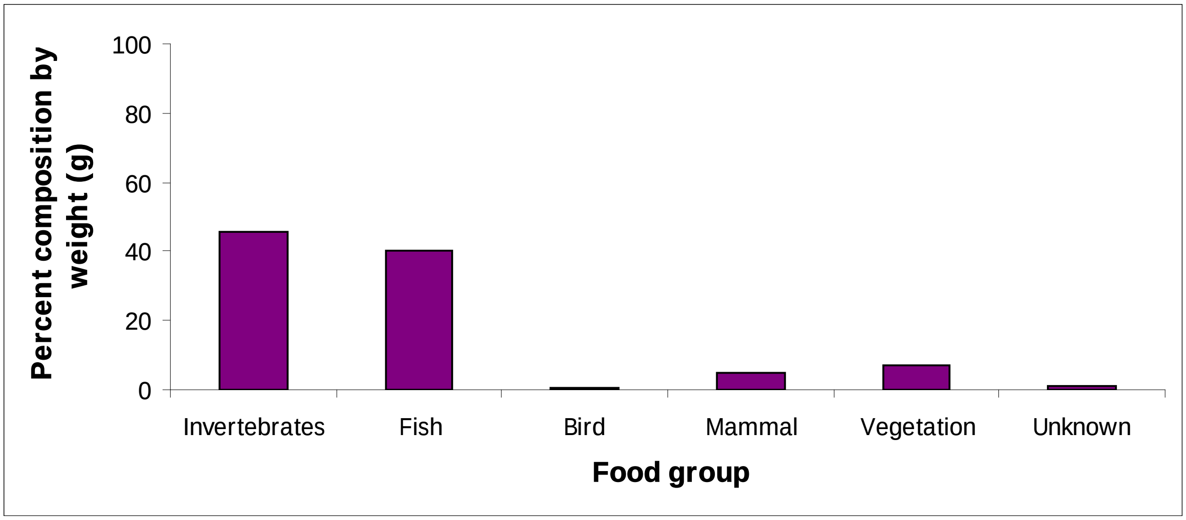

Figure 7-8: Composition of River Otter Scat Samples Collected Downstream of the Long Spruce Generating Station

7.3.3.3.3 Local Abundance and Habitat

River otter signs were very common on lake perimeter transects in the Local and Regional Study Areas (Table 7-9). Signs of river otter activity were very abundant and distribution was very widespread. These observations included 26 den entrances on at least 7 different ponds or lakes. Given the aquatic nature of river otter ecology, a relatively high frequency of river otter occurrence was expected. River otter signs were found at all 10 lakes in Zone 1. Mean sign frequency was greatest on lakes north of Gull Lake each year and overall (Table 7B-22). More signs of river otter activity were observed outside Zone 1 than inside, and activity was greatest on medium-sized lakes. River otter signs were found in all habitat types. Mean sign frequency ranged from 0.21 signs/100 m^2 in black spruce treed on mineral and thin peatland habitat to 1.01 signs/100 m^2 in black spruce treed on wet peatland.

River otter signs were sparse along coarse habitat mosaic transects surveyed in summer (Table 7-9). Summer tracking transects are less suited to assess river otter abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. However, signs were more frequently observed on riparian shoreline and lake perimeter transects, where these aquatic furbearers spend much of their time. Eighty river otter signs were observed along the transects surveyed from 2001 to 2003 (Table 7B-23). River otter signs were scarce and their distribution was scattered (Table 7-9). River otter appeared to utilize the islands in Gull and Stephens lakes, as mean sign frequency was greater on the islands than on the mainland north and south of the lakes over the three-year study period. Signs were only observed in riparian areas, and activity was similar inside and outside Zone 1. Signs of river otter activity were absent from 8 of 13 habitats, most of which were dominated by young regeneration or wet peatland. Where signs were observed, mean frequency ranged from less than 0.01 signs/100 m^2 in black spruce treed on shallow peatland to 0.04 in black spruce treed and young regeneration on shallow peatland. As the mean frequency of river otter signs was 0.01 signs/100 m² or less for all transect characteristics, no comparisons were made.

Table 7-9: Mean Frequency of River Otter Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.55	0.12	very abundant	0.95	very widespread	very common
Coarse habitat mosaics	0.01	0.01	scarce	0.11	scattered	sparse
Coarse habitat mosaics (winter)	0.02	0.01	scarce	0.24	widespread	common
Riparian shorelines	0.30	0.07	abundant	0.61	very widespread	very common

River otter signs were common along the coarse habitat mosaic transects surveyed in the winters of 2001 and 2002. Sign abundance was scarce and distribution was widespread (Table 7-9). Thirty-seven river otter signs were observed (Table 7B-24). River otter signs were observed north and south of Gull Lake and in riparian and upland zones over the two-year study period. Mean sign frequency was similar in all areas (0.02 signs/100 m²). No signs of river otter activity were observed in three of nine habitats. Signs were absent from broadleaf mixedwood on mineral and thin peatland, low vegetation or tall shrub on wet peatland, and black spruce treed on wet peatland habitat. As in summer, river otter appeared to avoid wet peatland, but were found in two habitats dominated by young regeneration. Where signs were observed, mean frequency ranged from 0.01 signs/100 m² in young regeneration on mineral and thin peatland to 0.21 signs/100 m² in black spruce treed on mineral and thin peatland or shallow peatland habitat. While enumeration of sites with scat has commonly been used to determine river otter relative abundance, several otters may use a common site, and individuals could be present without depositing feces (Gallant *et al.* 2007), thus caution should be used in the interpretation of this sign type. Other signs, such as tracks in snow were considered as the primary means to assess abundance.

River otter signs were very common along the riparian shoreline transects on Gull Lake. Ninety-six signs were observed (Table 7B-25). Signs were abundant and very widespread (Table 7-9). No signs of river otter activity were observed on islands over the three-year study period. Mean sign frequency was greater south of Gull Lake than north. Mean frequency of river otter signs was greatest in widest riparian zones and with the steepest slopes. Signs of river otter activity were observed in all habitat types over three years, however, signs were only found in black spruce treed on mineral and thin peatland, and low vegetation or tall shrub on wet peatland habitat in 2001 and 2002. Mean frequency of river otter signs was greatest in black spruce mixedwood on mineral and thin peatland habitat (0.75 signs/100 m²) and lowest in black spruce treed on shallow peatland (0.06 signs/100 m²) over the combined study period.

With the exception of potential stream crossings, the abundance of river otter signs was scarce on the north and south access road routes surveyed from 2001 to 2004 (Table 7B-26). Sign abundance was sporadic (0.11 signs/100 m²) and distribution was scattered (14% of transects) at the potential stream crossing sites surveyed in 2004. No sign of river otter activity was observed on either access road route in 2003.

River otter are not particularly selective of habitat in summer (Reid *et al.* 1994a), indicated by the diversity of habitats in which signs of river otter activity were found in the Local and Regional Study Areas. Signs of river otter activity were limited to riparian areas in summer, particularly shorelines and lake perimeters. Signs of activity were observed in upland areas in winter, which could indicate a wider range of habitat use, or could be attributed to the difficulty in detecting signs in upland areas in summer. River otter were active at lakes, on the shores of Gull Lake, and in riparian and upland areas in Zone 1 in summer and winter, suggesting that they inhabit areas to be affected by the Project.

7.3.4 Terrestrial Furbearers

Terrestrial furbearers spend the majority of their time in and derive most or all of their food from upland habitats. They are medium-sized mammals, and include snowshoe hare, woodchuck, red and arctic fox, American marten, fisher, weasels, and lynx. These species are important to the KCNs for domestic and commercial purposes. The Furbearers Local Study Area was Zone 3 and the Furbearers Regional Study Area was Zone 4 in Map 7-1.

The woodchuck (*Marmota monax*) is widespread throughout its range in Manitoba, which includes the Regional Study Area (NatureServe 2011). This species was not detected during formal studies, and only one individual was observed incidentally along Provincial Road (PR) 280. Based on known range, habitat use and professional judgement, it is estimated to be sparse to uncommon in the Regional Study Area. Winter hibernation and low detection probabilities using traditional tracking methods both in winter and summer precludes any further evaluation of species rarity.

7.3.4.1 Snowshoe Hare

7.3.4.1.1 General Life History

Snowshoe hare (*Lepus americanus*) are found in deciduous, coniferous, and mixedwood forests (Litvaitis *et al.* 1985), with an apparent preference for conifer-dominated habitats (Hoover *et al.* 1999). In winter, snowshoe hare utilize dense understory vegetation for thermal cover and protection from predators (Litvaitis *et al.* 1985). Habitat structure, not species composition, is the primary factor for selection (Ferron and Ouellet 1992). Snowshoe hare may shelter under branches or in short tunnels dug under the snow (Banfield 1987).

In summer, snowshoe hare prefer forests with relatively closed canopies, sufficient herb cover, and a dense understory (Ferron and Ouellet 1992); however open areas with herb and shrub species suitable for browse may be inhabited. Shallow depressions under low branches or beside trees, rocks, or shrubs, called **forms**, or occasionally old dens of other animals are inhabited (Banfield 1987).

Snowshoe hare are somewhat social and several may occupy the same area (Banfield 1987). Females are polyoestrous, capable of producing more than one litter per year (Banfield 1987). Snowshoe hare populations generally follow 9- to 11-year cycles of peaks and crashes in the boreal forests of North America (Krebs *et al.* 1986; Krebs *et al.* 2001), and in northern Canada, may undergo 8- to 11- year cycles of population peaks and lows (Murray 2000). While habitat and food availability are important for snowshoe hare survival, they do not appear to have an effect on the population cycle (Wolff 1980), in which predation plays a major role (Boonstra *et al.* 1982).

7.3.4.1.2 General Abundance and Habitat

Snowshoe hare were distributed throughout the area between Lake Winnipeg and Hudson Bay in the early 1900s (Preble 1902). They were common some years near Churchill, and were not often observed in the York Factory area (Preble 1902).

The snowshoe hare is not listed by the MBCDC, and is widespread and secure throughout its range in Manitoba (NatureServe 2011). This species is common to abundant in the Regional Study Area, and occupies a range of habitats.

7.3.4.1.3 Local Abundance and Habitat

Snowshoe hare signs were very common in the Local Study Area. Summer tracking transects are less suited to assess snowshoe hare abundance than winter transects, as signs other than scat are more difficult to detect in summer and were inconsistently recorded. As snowshoe hare scat is generally scattered along a transect and it cannot be determined how many individuals it came from, summer data should be interpreted with caution.

Snowshoe hare signs were common along lake perimeter transects in the Local and Regional Study Areas in summer (Table 7-10). No lake perimeter transects were assessed during the winter. Snowshoe hare signs were scarce but widely distributed over the two-year survey period. Signs of snowshoe hare activity were observed on 6 of the 10 lake perimeters in Zone 1. Mean sign frequency was somewhat greater at lakes south of Gull Lake than north (Table 7B-27) and inside Zone 1 than outside. Signs were observed in four of the six habitats surveyed. No sign of snowshoe hare activity was observed in young regeneration on mineral and thin peatland or shallow peatland or in black spruce treed on wet peatland habitat. Mean frequency of snowshoe hare signs was greatest on black spruce treed on mineral and thin peatland or shallow peatland habitat (0.11 signs/100 m^2) and was similar in the remaining habitats (0.03 signs/100 m^2). No sign of snowshoe hare activity was observed at lakes 2,000 to 4,000 m in diameter.

Table 7-10: Mean Frequency of Snowshoe Hare Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.03	0.03	scarce	0.45	widespread	common
Coarse habitat mosaics	0.37	0.04	abundant	0.86	very widespread	very common
Coarse habitat mosaics (winter)	0.60	0.07	very abundant	0.94	very widespread	very common
Riparian shorelines	-	-	-	-	-	-

Snowshoe hare signs were very common during the summer coarse habitat mosaic surveys. Signs were abundant and very widespread (Table 7-10). Snowshoe hare activity was observed on transects north and south of Gull and Stephens lakes, and was less abundant on islands over the three-year study period (Table 7B-28). Mean frequency of snowshoe hare signs was greater in riparian than terrestrial areas, and somewhat greater outside Zone 1 than inside. Signs were observed in all but 2 of the 13 habitats surveyed. Where signs were observed, mean sign frequency ranged from 0.03 signs/100 m² in broadleaf treed on all ecosites to 0.93 signs/100 m² on black spruce treed and young regeneration on mineral and thin peatland habitat. No sign of snowshoe hare activity was observed in young regeneration on shallow peatland or low vegetation, or tall shrub on wet peatland habitat.

Signs of snowshoe hare activity were very common during the winter surveys of coarse habitat mosaic transects. Signs were very abundant and very widespread (Table 7-10). Most signs were observed in 2002 (Table 7B-29). Mean frequency of snowshoe hare signs was somewhat greater along transects south of Gull and Stephens lakes, in riparian areas, and outside Zone 1 over the three-year study period. Snowshoe hare were absent from low vegetation or tall shrub on wet peatland habitat, and mean sign frequency was relatively low in young regeneration on mineral and thin peatland (0.07 signs/100 m²) and black spruce treed on wetland (0.10 signs/100 m²) habitat. Mean frequency of snowshoe hare sign was greatest in black spruce treed on mineral and thin peatland habitat (0.78 signs/100 m²).

When compared with the abundance of snowshoe hare signs on other types of transects, relatively few were observed on riparian shoreline transects on Gull Lake. Snowshoe hare data were not collected on riparian shoreline transects on Gull Lake in 2001 or 2002. In 2003, mean frequency of snowshoe hare signs was similar on the north (1.13 signs/100 m²) and south (1.19 signs/100 m²) shores of Gull Lake, and was lower on islands (0.50 signs/100 m²; Table 7B-30). Signs of snowshoe hare activity were observed in riparian zones of all widths and slopes. Signs were observed in two of the seven habitats surveyed. Mean sign frequency was 1.49 signs/100 m^2 in black spruce treed on mineral and thin peatland habitat and 0.67 signs/100 m^2 lowest in black spruce treed on shallow peatland (0.50 signs/100 m^2).

Snowshoe hare signs were observed on transects along the north and south access road routes during all study years (Table 7B-31). Signs were most frequently observed in 2004.

Snowshoe hare appeared to avoid habitats dominated by young regeneration or low vegetation. As these habitats generally have low shrub understories (see the Habitat and Ecosystems section of the TE SV), they provide little cover. Snowshoe hare activity tended to be greatest in black spruce treed on mineral and thin peatland habitat; similar habitats have been described as good for snowshoe hare (Bittner and Rongstad 1982). Snowshoe hare were active at lakes, on the shores of Gull Lake, and in riparian and upland areas in Zone 1 in summer and winter, suggesting that they inhabit areas to be affected by the Project.

7.3.4.2 Red and Arctic Fox

7.3.4.2.1 General Life History

The red fox (*Vulpes vulpes*) prefers diverse habitats including farmland, pasture, hardwood stands, and open areas with edges suitable for hunting. They are rarely found in the core area of boreal forests (Eadie 1943; Cook and Hamilton 1944; Ables 1974; Banfield 1987). Diverse edge habitat is particularly desirable (Ables 1974).

The red fox is a **generalist** predator capable of increasing predation pressure in boreal areas exhibiting human fragmentation (Kurki *et al.* 1998). Although habitat fragmentation can increase populations, studies indicate that red fox avoid areas with high human densities (Randa and Yunger 2006). Sources of red fox mortality include rabies, sarcoptic mange, accidents such as road kill, and trapping (Plummer 1954; Samuel 1981, Manitoba Conservation 2007a). Voigt (1998) reports that more than 80% of tagged foxes were killed by hunting, trapping or road kills in one study, and in another study in southern Ontario, about 25% of the deaths of juveniles resulted from road kills.

The arctic fox (*Alopex lagopus*) is not a resident of the Local Study Area; it is a migrant only seen in winter (see Table 7B-1). During winter, this species is found in the arctic and on the frozen seas of the north (Banfield 1987). In winter, marine mammal carcasses (*e.g.*, seal) killed by polar bears are scavenged on sea ice, particularly in periods of low lemming abundance (Roth 2002). Lemmings are the primary food source in summer (Roth 2002).

7.3.4.2.2 General Abundance and Habitat

Red fox were abundant between Lake Winnipeg and Hudson Bay in the early 1900s (Preble 1902). Arctic fox were observed near Churchill and north of York Factory at that time, and large numbers were reported as far south as Norway House in the winter of 1900-1901 (Preble 1902).

Red fox is not listed by the MBCDC, and is widespread, abundant, and secure throughout Manitoba (NatureServe 2011). The five-year average harvest of red and arctic fox declined from the 1994 to 1998 and 2004 to 2008 seasons, and continued to decline in the 2009–2010 and 2010 to February 2011 seasons (Manitoba Conservation 2011a). However, this harvest usually follows patterns in average auction values

(Manitoba Conservation 2011a), and does not necessarily indicate a decrease in the availability of red or arctic fox. The number of red fox harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one red fox per trapline per year (SE SV).

7.3.4.2.3 Local Abundance and Habitat

Red fox signs were common on lake perimeter transects in the Local and Regional Study Areas during the summer (Table 7-11). Signs were scarce but very widespread and were observed on 7 of 10 lake perimeters in Zone 1. No lake perimeters were assessed in winter. Mean frequency of red fox signs was similar at lakes north and south of Gull Lake (0.02 signs/100 m^2 and 0.04 signs/100 m^2, respectively) over the two-year study period (Table 7B-32). Mean sign frequency was somewhat greater at lakes outside Zone 1 (0.04 signs/100 m^2) than inside (0.03 signs/100 m^2). Mean sign frequency was similar on small and medium-sized lakes (0.04 and 0.03 signs/100 m^2, respectively) and was lower on large lakes (0.01 signs/100 m^2). Signs of red fox activity were observed in all six habitats surveyed over the two-year study period. Mean sign frequency ranged from 0.01 signs/100 m^2 in black spruce treed on mineral and thin peatland and in black spruce treed and young regeneration on mineral and thin peatland habitats to 0.06 signs/100 m^2 in young regeneration on mineral and thin peatland or shallow peatland habitat.

Table 7-11: Mean Frequency of Red Fox Signs (signs/100 m^2) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.03	0.01	scarce	0.70	very widespread	common
Coarse habitat mosaics	0.02	0.01	scarce	0.25	widespread	common
Coarse habitat mosaics (winter)	0.01	<0.01	scarce	0.15	scattered	sparse
Riparian shorelines	0.20	0.04	sporadic	0.48	widespread	common

Signs of red fox activity were common during summer surveys of coarse habitat mosaic transects. Signs were scarce and widespread (Table 7-11). Summer tracking transects are less suited to assess red fox abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. Sixty-two signs were observed over the three-year study period (Table 7B-33). Signs of red fox activity were observed north and south of Gull and Stephens lakes and on islands. Signs were observed in riparian and upland areas, inside and outside Zone 1, and in 8 of the 13 habitats surveyed. No sign of red fox activity was observed in young regeneration on mineral and thin peatland, young regeneration on shallow peatland, broadleaf treed on all ecosites, low vegetation or tall shrub on wet peatland, or black spruce treed on wet peatland habitat. Where red fox signs were observed, mean frequency was less than 0.01 signs/100 m^2 for all transect characteristics.

Red fox signs were not distinguished from those of arctic fox in winter. Tracks were generally large enough to be considered those of red fox; where uncertainty existed, signs were identified as red, and not arctic, fox. Sign of red fox activity were sparse in winter (Table 7-11). Signs were scarce and scattered. Although red fox signs are better observed in winter, signs of red fox activity were less abundant than in summer (0.01 signs/100 m²; Table 7B-34). Signs were observed north and south of Gull and Stephens lakes, in riparian and upland areas, inside and outside Zone 1, and in four of the nine habitats surveyed. No signs were observed in black spruce treed and young regeneration on mineral and thin peatland, young regeneration on mineral and thin peatland, young regeneration on mineral and thin peatland or shallow peatland, broadleaf mixedwood on mineral and thin peatland, or black spruce treed on wet peatland habitat.

Red fox signs were common along riparian shorelines during the summer. No shoreline transects were assessed during the winter. Red fox sign abundance was sporadic and distribution was widespread (Table 7-11). Signs were observed on the north and south shorelines of Gull Lake, and none were found on islands over the three-year study period (Table 7B-35). Red fox signs were observed in riparian zones of all widths and slopes, and in all seven habitats surveyed. Mean frequency of red fox signs was greatest in black spruce mixedwood on mineral and thin peatland habitat (0.50 signs/100 m²) and was lowest in black spruce treed in on shallow peatland (0.08 signs/100 m²) over the three-year study period. Signs were only observed in 2002 in each of these habitats. Of the seven habitats surveyed, red fox signs were only observed in black spruce treed on mineral and thin peatland during all three study years. No signs were found in other habitats in 2001.

Signs of red fox activity were observed on the north and south access road routes from 2001 to 2004 (Table 7B-36). Sign abundance was scarce on both routes during all study years (range 0.01 to 0.08 signs/100 m²), and distribution was scattered to widespread (13 to 29% of transects).

Red fox signs were observed in a variety of habitats throughout the Local Study Area. They were active at lakes, on the shores of Gull Lake, and in riparian and upland areas in Zone 1 in summer and winter, suggesting that they inhabit areas to be affected by the Project.

7.3.4.3 American Marten

7.3.4.3.1 General Life History

American marten are predators whose diet varies somewhat with the season (Takats *et al.* 1999). While voles are the preferred prey (Strickland *et al.* 1982; Banfield 1987), the American marten diet extends to berries, mice, shrews, snowshoe hare, squirrels, birds, amphibians, insects, and fish, when available (Banfield 1987; Ben-David *et al.* 1997; Takats *et al.* 1999). American marten have also been known to scavenge winterkilled ungulates and other carrion (Strickland *et al.* 1982; Ben-David *et al.* 1997; Takats *et al.* 1999).

While American marten spend much of their time in trees, they also move and hunt on the ground (Banfield 1987). Contiguous, mature, or old forest is preferred by this species (Chapin *et al.* 1998) and optimum habitat includes old growth spruce/fir with a minimum of 30% canopy cover (Clark *et al.* 1987). A well-established understory of fallen logs and stumps is important for denning and dense shrub and

forb vegetation supports small mammal prey populations (Clark *et al.* 1987). American marten tend to avoid large openings such as clear cuts (Chapin *et al.* 1998), however it has been suggested that low levels of timber harvest may be a benefit in the short term, due to an increase in diversity and abundance of prey species (Buskirk and MacDonald 1984).

Due to their lack of adaptation to extremely cold weather, American marten require den sites throughout their home ranges. In winter, denning usually occurs in squirrel **midden**s, rock piles, hollow logs, and stumps (Buskirk 1984), with a preference for **subnivean** dens (Wilbert *et al.* 2000). In warmer weather, American marten may rest in the tree canopy (Buskirk 1984), or select dens in hollow trees (Strickland *et al.* 1982). While there is a tendency to think of American marten as arboreal, they spend much of their time on the ground (Francis and Stephenson 1972; Buskirk and Ruggiero 1994).

7.3.4.3.2 General Abundance and Habitat

American marten were relatively common from Lake Winnipeg to the tree line in the early 1900s, but appeared to be less abundant near Churchill (Preble 1902). American marten fur prices peaked in 1986, which increased trapping effort for this species (SE SV). Local trappers have commented that American marten numbers have been increasing over the past two decades (SE SV). The number of American marten harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged twenty-seven American marten per trapline per year (SE SV). The Split Lake Cree Post Project Environmental Review (1996a) suggests that American marten has always been an important furbearing species for First Nations Members.

The American marten is not listed by the MBCDC, and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011). A total of 16,160 American marten were trapped in Manitoba in the 2009–2010 season, and 9,007 in the 2010 to February 2011 season (Manitoba Conservation 2011a). The decline in American marten harvest corresponded with a decline in price for the 2009–2010 season (Manitoba Conservation 2011a).

7.3.4.3.3 Local Abundance and Habitat

American marten signs were common along lake perimeters in the Local and Regional Study Areas in summer[1]. No transects were surveyed in winter. While abundance was scarce, distribution was widespread (Table 7-12). Signs were observed at 1 of the 10 lakes in Zone 1. A single sign was observed in 2001. Mean frequency of American marten signs was somewhat greater at lakes south of Gull Lake than north, and at lakes outside Zone 1 than inside over the two-year study period (Table 7B-37). American marten signs were observed in three of the six habitats surveyed. No signs were observed in young regeneration on mineral and thin or shallow peatland, low vegetation or tall shrub on wet peatland, or black spruce treed on wet peatland habitat. Where signs were observed, mean frequency ranged from less than 0.01 signs/100 m^2 in black spruce treed on mineral and thin peatland to 0.03 signs/100 m^2 in black spruce treed on mineral and thin peatland or shallow peatland, and in black spruce treed on shallow

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[1] Due to an overlap in track size between larger American marten and smaller fisher, there is some unknown level of uncertainty added to these values.

peatland habitat. American marten signs were observed at lakes of all sizes; mean sign frequency was greatest at large lakes (0.07 signs/100 m²).

Table 7-12: Mean Frequency of American Marten Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.01	0.01	scarce	0.85	very widespread	common
Coarse habitat mosaics	<0.01	<0.01	scarce	0.11	scattered	sparse
Coarse habitat mosaics (winter)	0.17	0.03	sporadic	0.83	very widespread	common
Riparian shorelines	0.01	0.01	scarce	0.04	localized	sparse

Signs of American marten activity were sparse in summer on coarse habitat mosaic transects. Abundance was scarce and distribution was scattered (Table 7-12). Summer tracking transects are less suited to assess American marten abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. No signs were observed in 2001 (Table 7B-38). American marten signs were observed on transects north and south of Gull and Stephens lakes, but were not found on islands. Signs were observed in riparian and terrestrial areas, inside and outside Zone 1, and in 5 of the 13 habitats surveyed. No signs were observed in black spruce treed and young regeneration on mineral and thin peatland, young regeneration on mineral and thin peatland, black spruce mixedwood on mineral and thin peatland, broadleaf treed on all ecosites, low vegetation or tall shrub on wet peatland, or black spruce treed on wet peatland habitat. Where American marten signs were observed, mean frequency was 0.01 signs/100 m² or less for all transect characteristics.

American marten signs were common along coarse habitat mosaic transects surveyed in winter. Abundance was sporadic but signs were very widely distributed (Table 7-12). Mean frequency of American marten signs was greater on transects south of Gull and Stephens lakes (0.25 signs/100 m²) than north (0.08 signs/100 m²), and was somewhat greater in riparian (0.19 signs/100 m²) than upland (0.15 signs/100 m²) areas over the two-year study period (Table 7B-39). Signs of American marten activity were observed in all but one of the nine habitats surveyed; signs were absent from low vegetation or tall shrub on wet peatland habitat. Mean frequency of American marten signs ranged from 0.03 signs/100 m² in young regeneration on mineral and thin peatland to 0.23 signs/100 m² in black spruce treed on mineral and thin peatland habitat. As American marten signs, particularly tracks, can be difficult to detect in the absence of snow cover, a greater number were observed during the winter surveys of coarse habitat mosaic transects than during summer surveys as expected.

American marten signs were sparse on riparian shoreline transects surveyed in summer. Abundance was scarce and distribution was localized (Table 7-12). No transects were surveyed in winter. No signs were observed in 2002 (Table 7B-40). Of the three signs observed over the three-year study period, all were observed on the south shore of Gull Lake and in Zone 1. Signs were observed in two of the seven habitats surveyed. Due to the small number of signs detected, no further analysis was performed. However, as signs of other medium-sized furbearers were frequently observed on riparian shoreline transects, the scarcity of signs of American marten activity could be due to their avoidance of the Gull Lake shoreline and not the difficulty in detecting them.

American marten signs were observed on the access road routes over four study years (Table 7B-41). No signs were observed on the north route centreline in 2003, and none were found at the potential stream crossing sites in 2004.

During the final preferred route mammal stratification surveys for the proposed Bipole III Transmission Reliability Project, American marten signs were observed in the Furbearers Local Study Area and beyond, from Birthday Rapids to the location of the proposed Keewatinoow Converter Station (Manitoba Hydro 2011a). The greatest densities of American marten signs were observed along the Nelson River between Birthday Rapids and the north arm of Stephens Lake (Manitoba Hydro 2011a).

While signs of American marten activity were common at lake perimeters, they were scarce on the shoreline of Gull Lake. Signs were observed in a variety of habitats, but American marten appeared to avoid areas dominated by low vegetation or tall shrubs. While signs were occasionally observed in young regeneration habitats, these occurrences were uncommon. As American marten select mature forests and tend to avoid large openings (Chapin *et al.* 1998), their presence was not expected in young regeneration areas or other habitats with no canopy cover. American marten were active in riparian and upland areas in Zone 1, suggesting that they inhabit areas to be affected by the Project.

7.3.4.4 Fisher

7.3.4.4.1 General Life History

The fisher (*Martes pennanti*) is a common inhabitant of mature boreal forest (Banfield 1987). Mammals such as squirrels, voles, shrews, and particularly snowshoe hare constitute the majority of the fisher diet (Banfield 1987). Fisher are capable predators of porcupine (Powell 1994).

Trapping is an important source of mortality for fisher (Strickland *et al.* 1982). Mortality due to predation is more likely for kits than for adults; predators include hawks, owls, red fox, lynx, and black bear (Strickland *et al.* 1982). While fisher carry parasites and diseases, they do not appear to be a major cause of mortality (Strickland *et al.* 1982).

7.3.4.4.2 General Abundance and Habitat

Fisher distribution was relatively sparse in northern Manitoba in the early 1900s (Preble 1902). The number of fisher harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year. Local trappers have commented that fisher numbers have been in decline over the past two decades. It has been suggested that the increase in American marten in the SLRMA (see Section 7.3.4.3) may have resulted in fisher being out-competed for food resources, and subsequently, a population decline in fisher may have occurred. A resource user from FLCN noted that there were no fisher around his trapline (FLCN 2010 Draft). A contributing factor that may help explain the lower abundance of fisher is the scarcity of porcupine in northeastern Manitoba, a potential food source.

Fisher are not abundant in North America (Strickland *et al.* 1982). Their range includes most of the Canadian provinces, but generally not the Territories (Strickland *et al.* 1982). Fisher populations were extirpated in most of the United States in the 1800s and mid-1900s (Strickland *et al.* 1982). Re-introduction of fisher and harvest restrictions has allowed them to return to some of their former range (Powell 1981) and they have recently recolonized southern Ontario (Bowman *et al.* 2006).

The fisher is not listed by the MBCDC, and they are widespread and secure throughout their range in Manitoba (NatureServe 2011), if not abundant. The five-year average fisher harvest in Manitoba declined steadily from the 1994–1998 to the 2004–2008 periods, and continued to decline in the 2009–2010 and 2010 to February 2011 seasons (Manitoba Conservation 2011a). Average prices fluctuated during these periods (Manitoba Conservation 2011a).

7.3.4.4.3 Local Abundance and Habitat

Fisher signs were common along lake perimeters in the Local and Regional Study Areas in summer[1], and no transects were assessed in winter. Fisher signs were scarce over the two-year study period but distribution was widespread (Table 7-13). Mean frequency of fisher signs was somewhat greater at lakes south of Gull Lake (0.02 signs/100 m^2) than north (0.01 signs/100 m^2; Table 7B-42). Signs were observed at lakes of all sizes, and inside and outside Zone 1. Signs of fisher activity were observed in five of the six habitats surveyed. No signs were observed in low vegetation or tall shrub on wet peatland habitat. Where signs were observed, mean sign frequency ranged from less than 0.01 signs/100 m^2 in black spruce treed on shallow peatland to 0.03 signs/100 m^2 in black spruce treed on mineral and thin peatland habitat.

Table 7-13: Mean Frequency of Fisher Signs (signs/100 m^2) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.01	0.01	scarce	0.35	widespread	common
Coarse habitat mosaics	<0.01	<0.01	scarce	0.02	localized	sparse
Coarse habitat mosaics (winter)	0.03	0.01	scarce	0.43	widespread	common
Riparian shorelines	0.01	<0.01	scarce	0.04	localized	sparse

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[1] Due to an overlap in track size between larger American marten and smaller fisher, there is a level of uncertainty added to these values.

Fisher signs were sparse on coarse habitat mosaic transects surveyed in summer. Abundance was scarce and distribution was localized (Table 7-13). Summer tracking transects are less suited to assess fisher abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. Five signs were observed over the three-year study period (Table 7B-43). Signs were observed on transects north and south of Gull and Stephens lakes, but not on islands. Signs were only observed in riparian areas and were found inside and outside Zone 1 and in 3 of the 13 habitats surveyed. Where fisher signs were observed, mean frequency was 0.01 signs/100 m² or less for all transect characteristics. Summer tracking transects are less suited to assess fisher abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution.

Fisher signs appeared to be common in winter. Abundance was scarce but distribution was widespread (Table 7-13). Mean frequency of fisher signs was greater on transects south of Gull and Stephens lake (0.04 signs/100 m²) than north (0.01 signs/100 m²), and was greater in riparian (0.04 signs/100 m²) than upland (0.02 signs/100 m²) areas (Table 7B-44). Signs were observed inside and outside Zone 1, and in five of the nine habitats surveyed. No signs were found in young regeneration on mineral and thin peatland, young regeneration on mineral and thin peatland or shallow peatland, low vegetation or tall shrub on wet peatland, or black spruce treed on wet peatland. Where signs were observed, mean frequency ranged from 0.02 signs/100 m² in black spruce treed on shallow peatland and in broadleaf mixedwood on mineral and thin peatland to 0.06 signs/100 m² in black spruce treed on mineral and thin peatland or shallow peatland.

Fisher signs were sparse along riparian shorelines in summer, and no transects were assessed in winter. Two signs were observed, one in 2002 and in one 2003. Signs of fisher activity were scarce and localized (Table 7-13). Both signs were observed south of Gull and Stephens lakes, in riparian zones 0 to 30 m in width and with a slope of 0 to 32%. One sign was encountered in each of black spruce treed on mineral and thin peatland, and broadleaf mixedwood on mineral and thin peatland habitats.

Fisher signs were observed along the north and south access routes during the four-year study period (Table 7B-45). No signs were observed on the north route transects in 2003, and none were observed on the south route transects in 2004. Two signs were observed at potential stream crossing sites surveyed in 2004.

While fisher signs were not abundant in the Local Study Area, they were widely distributed, possibly indicating a few individuals utilizing large home ranges. Fisher inhabit mature forests and tend to remain near waterbodies (Banfield 1987). They appeared to avoid open habitats dominated by young regeneration or low vegetation, and were not active on the shores of Gull Lake. Fisher were active in riparian and upland areas in Zone 1, suggesting that they inhabit areas to be affected by the Project.

7.3.4.5 Weasel

7.3.4.5.1 General Life History

Ermine (*Mustela erminea*) and least weasel (*Mustela nivalis*) are the two species of weasel (collectively referred to as weasels) found in the Furbearers Regional Study Area. Ermine are the larger of the two species, while least weasels are the smallest carnivores in North America (Banfield 1987; Fagerstone 1998). Weasels have been described as both **nocturnal** (Banfield 1987) and active during the day (Fagerstone 1998), with peak activity varying with the season (Svendsen 1982). Weasels are active all year, and do not hibernate (Svendsen 1982). These species occupy similar, wide-ranging habitats (Fagerstone 1998), boreal coniferous or mixedwood forests, tundra, meadows, lakeshores, and riverbanks (Banfield 1987).

Small mammals, particularly rodents, comprise the greatest proportion of the weasel diet (Svendsen 1982). Their long, slender bodies enable them to enter small mammal dens and tunnels, making them efficient predators of burrowing animals (Fagerstone 1998). Weasels may inhabit the burrows of their prey, adapting them to suit their needs (Banfield 1987). Males are notably larger than females (Fagerstone 1998), likely to exploit different prey species, reducing competition between the sexes (Erlinge 1975; Moors 1980).

Predation is a common source of weasel mortality (Svendsen 1982; Fagerstone 1998). Owls and other raptors (Errington 1932; Korpimäki and Norrdahl 1989) prey on weasels, especially when small mammal populations are low (Korpimäki and Norrdahl 1989). Mortality may also be related to food supply, particularly when small mammal populations are low (Fagerstone 1998). Disease is likely an important factor in weasel mortality, but has not been studied in detail (Svendsen 1982; Fagerstone 1998). Mortality of young is generally greater than 50% during the first year (Fagerstone 1998).

7.3.4.5.2 General Abundance and Habitat

While ermine are common and widely distributed in Canada, least weasels are rarer (Banfield 1987). Neither of these species is listed by SARA, MESA, or the MBCDC, and they are widespread, abundant, and secure throughout Manitoba (NatureServe 2011). The ermine harvest is reported with long-tailed weasel (*Mustela frenata*) in Manitoba, and has fluctuated since 1994 (Manitoba Conservation 2011a). Long-tailed weasels are not found in northern Manitoba (Banfield 1987), and no least weasel harvest is reported by Manitoba Conservation.

7.3.4.5.3 Local Abundance and Habitat

Signs of weasel activity were scarce in the Local Study Area. Summer tracking transects are less suited to assess weasel abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution. Very few weasel signs were observed, and no analysis was performed.

Weasel signs were common on lake perimeter transects in the Local and Regional Study Areas in summer (Table 7-14). Abundance was scarce and distribution was widespread. No transects were visited in winter. No signs were observed in 2002 (Table 7B-46). Signs were found on lake perimeters located north and south of Gull Lake, inside and outside Zone 1, and around lakes of all sizes. A single sign was observed at

1 of the 10 lakes surveyed in Zone 1. Signs were observed in black spruce treed on mineral and thin peatland, black spruce treed on shallow peatland, and young regeneration on mineral and thin peatland habitats.

Table 7-14: Mean Frequency of Weasel Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.01	<0.01	scarce	0.30	widespread	common
Coarse habitat mosaics	<0.01	<0.01	scarce	0.02	localized	sparse
Coarse habitat mosaics (winter)	<0.01	<0.01	scarce	0.14	scattered	sparse
Riparian shorelines	0	0	absent	0	absent	absent

Four weasel signs were observed during summer surveys of coarse habitat mosaic transects (Table 7B-47). Signs of weasel activity were sparse, as abundance was scarce and distribution was localized (Table 7-14). Signs were observed on an island, north and south of Gull and Stephens lakes, in riparian areas, inside and outside Zone 1, and in 2 of the 13 habitats surveyed. Signs were observed in black spruce treed on mineral and thin peatland and in black spruce treed on shallow peatland habitat.

In winter, weasel signs were sparse on coarse habitat mosaic transects. Signs of weasel activity were scarce and scattered (Table 7-14). Signs were observed in both study years (Table 7B-48). Signs of weasel activity were observed on transects north and south of Gull and Stephens lakes, in riparian and upland areas, inside and outside Zone 1, and in three of the nine habitats surveyed. Signs were observed in black spruce treed on mineral and thin peatland, young regeneration on mineral and thin peatland, and black spruce treed on wet peatland habitat.

No signs of weasel were observed on riparian shoreline transects.

Signs of weasel activity were observed on the north and south access road routes in 2001 (Table 7B-49). No other signs were found.

Weasel signs were not commonly observed in the Local Study Area. As these species' signs are difficult to see and identify, it cannot be concluded that they are scarce in the Local Study Area. As some signs were observed in Zone 1, at least a few individuals may inhabit the area to be affected by the Project.

7.3.4.6 Lynx

7.3.4.6.1 General Life History

The lynx (*Lynx canadensis*) is a common inhabitant of mature boreal forest, and prefers habitat with dense understory (Banfield 1987). Snowshoe hare is an important prey species for lynx, and has been linked to cyclical population peaks and lows (*e.g.*, Brand *et al.* 1976; Banfield 1987; Poole 1994; Mowat *et al.* 1996; O'Donoghue *et al.* 1997; Krebs *et al.* 2001)

Trapping is a source of mortality for lynx (McCord and Cardoza 1982). Starvation during periods of low snowshoe hare abundance has been linked to lynx mortality (McCord and Cardoza 1982) and aggression by other lynx may result in death for kits (McCord and Cardoza 1982). Lynx reproduction is also affected by declining snowshoe hare abundance, where few if any kits are produced during the second year of snowshoe hare decline (Mowat *et al.* 1996; O'Donoghue *et al.* 1997).

7.3.4.6.2 General Abundance and Habitat

Lynx were distributed throughout the area between Lake Winnipeg and Hudson Bay in the early 1900s, and their abundance was linked to the abundance of rabbits (Preble 1902). They were uncommon around York Factory (Preble 1902). Lynx were trapped at Cache Lake by local resource users, who report that they used to be abundant (FLCN 2010 Draft). The number of lynx harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year (SE SV).

Lynx are widely distributed in Canada (McCord and Cardoza 1982). The lynx is not listed by the MBCDC, and is widespread and secure throughout its range in Manitoba (NatureServe 2011). The five-year average lynx harvest in Manitoba increased from 1992 to 2008, and decreased in the 2009–2010 and 2010–2011 seasons (Manitoba Conservation 2011a). Prices followed roughly the same pattern, with an increase from the 2009–2010 to the 2010–2011 season.

7.3.4.6.3 Local Abundance and Habitat

Signs of lynx activity were sparse in the Local Study Area. No signs were observed on lake perimeter transects or on transects on Gull Lake shorelines (Table 7-15). Lynx signs were sparse along the coarse habitat mosaic transects surveyed in summer. A single sign was observed south of Gull Lake, in an upland area, outside Zone 1, in black spruce treed on shallow peatland habitat. The sign was observed in 2003. Summer tracking transects are less suited to assess lynx abundance than winter transects, as signs are more difficult to detect in summer. Abundance is likely underestimated, and summer data should be interpreted with caution.

Table 7-15: Mean Frequency of Lynx Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0	0	absent	0	absent	absent
Coarse habitat mosaics	<0.01	<0.01	scarce	0.01	localized	sparse
Coarse habitat mosaics (winter)	0.01	<0.01	scarce	0.11	scattered	sparse
Riparian shorelines	0	0	absent	0	absent	absent

Lynx signs were also sparse in winter. Fourteen signs were detected along the coarse habitat mosaic transects surveyed in 2001 and 2002; all were observed in 2002 (Table 7B-50). Lynx signs were scarce and distribution was scattered (Table 7-15). Lynx signs were observed north and south of Gull Lake, in riparian and upland areas and inside and outside the future reservoir area in 2002. Lynx signs were found in four of the nine habitats surveyed: black spruce treed on mineral and thin peatland, black spruce treed on mineral and thin peatland or shallow peatland, black spruce treed on shallow peatland, and young regeneration on mineral and thin peatland. Mean sign frequency was 0.01 signs/100 m² or less for all transect characteristics.

Lynx signs were infrequently observed along the north and south access road routes during all four study years. No signs were observed in 2001 and 2003 (Table 7B-51).

While lynx signs were sparse on all transect types and their distribution was scattered or localized in the Local Study Area, they were not characterized as rare mammals. This species is not at the limit of its range in the Regional Study Area, and experiences cyclical population peaks and lows. Lynx signs were observed in Zone 1, indicating that the Project may overlap a portion of at least one home range.

7.3.5 Large Carnivores

Large carnivores are larger-sized mammals that prey on other animals. Large carnivores found in the Keeyask region are gray wolf and black bear. The Large Carnivores Local Study Area was Zone 4 and the Large Carnivores Regional Study Area was Zone 6 in Map 7-1.

7.3.5.1 Gray Wolf

7.3.5.1.1 General Life History

The gray wolf (*Canis lupus*) was once distributed across most of the Northern Hemisphere (Carbyn 1998), with the exception of the driest deserts (Fritts *et al.* 1994). Human settlement caused a severe decline in wolf numbers and distribution (Banfield 1987) through a variety of means, including a reduction in available prey and targeted programs to reduce numbers, such as hunting and poisoning (Young 1944).

The gray wolf population declined dramatically in Canada in the early to mid-1900s (Carbyn 1998). In the late 20th century, gray wolf populations began to recover and repopulate previously inhabited areas (Fritts *et al.* 1994). Gray wolf recovery can be attributed to recent changes in public attitudes, recovery programs, and the recovery of ungulate prey populations (Fritts *et al.* 1994).

Gray wolves have highly developed social structures and commonly form family packs (Banfield 1987). The pack follows a social hierarchy where the largest and strongest male and female are the leaders and breeding pair (Banfield 1987). Social structure of the pack affects the breeding cycle, where dominant members suppress breeding in lower ranking members (Carbyn 1998). The size of the pack is a common indicator of gray wolf abundance in a region (Rausch 1967). In order for a pack of six wolves to persist, the region must support a minimum biomass equal to 45 moose per wolf (Moose Harvest Sustainability Plan).

While ungulates are the main prey of gray wolves, smaller mammals often supplement the diet (Banfield 1987). Beavers are of particular interest; however, snowshoe hare, ground squirrels, muskrat, and mice are also important prey (Banfield 1987). In summer, wolves will supplement their diets with ground-nesting birds, fish, berries, fruit, insects, and grass (Banfield 1987). Gray wolves are not restricted to a single habitat type, as they will typically follow their primary prey (Banfield 1987; Carbyn 1998). Gray wolves are more likely to occupy mixed conifer-hardwood and forested wetland than other habitat types (Mladenoff *et al.* 1995), and prefer to inhabit areas that have a lower density of roads and human activity (Houts 2001; Larsen and Ripple 2004).

7.3.5.1.2 General Abundance and Habitat

Gray wolves were relatively common from Lake Winnipeg to Hudson Bay in the early 1900s (Preble 1902). The number of gray wolves harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one gray wolf per trapline per year (SE SV).

Manitoba Conservation states that the gray wolf population appears stable in Manitoba (Manitoba Conservation no date (n.d.)*a*). Its COSEWIC status is not at risk, and it is not listed under SARA or MESA. During the mid-1900s gray wolf numbers decreased throughout Canada because of rabies outbreak and a control program that involved heavy use of poison (Carbyn 1974; Paradiso and Nowak 1982). The number of gray wolves in Manitoba has increased from 1,500 to 2,000 individuals in the 1970s (Nowak 1974) to the present population of approximately 4,000 (Manitoba Conservation n.d.*a*).

7.3.5.1.3 Regional Abundance and Habitat

From 2003 to 2006, eight gray wolves were observed incidentally during aerial surveys for ungulates (Map 7-14). Four were observed in February 2003, three were observed in November and December 2003, and a single observation of gray wolf was made in January 2005. Fourteen gray wolf observations were recorded over three visits during the 2011–2012 aerial ungulate surveys (Map 7-15, Map 7-16, and Map 7-17). The largest groups were observed during the first two visits; six to eight individuals were observed 20 km southeast of York Landing and another group of nine was observed near Limestone Lake. Smaller groups of animals were observed throughout the Keeyask region.

The resident gray wolf population in the SLRMA in 2010 was estimated at 10 packs or 60 individuals (Moose Harvest Sustainability Plan). Gray wolf density varies by area, but the total estimated density of gray wolves in the SLRMA was 1.4 individuals/1,000 km. In addition to resident wolves, transient wolves enter the SLRMA (Moose Harvest Sustainability Plan). Transient wolves are often individuals that are dispersing (Mech 1970) or can be small groups of wolves that follow migratory caribou into the SLRMA. Based on the number of caribou in the area, it was estimated that the approximately 50 transient wolves could inhabit the SLRMA in winter, likely in small packs of approximately three (Moose Harvest Sustainability Plan).

7.3.5.1.4 Local Abundance and Habitat

Gray wolf signs were sparse during summer surveys of lake perimeters in the Local and Regional Study Areas (Table 7-16). No surveys were conducted in winter. Signs were scarce and widespread. Mean sign frequency was similar at lakes north (0.02 signs/100 m²) and south (0.01 signs/100 m²) of Gull Lake, and inside (0.02 signs/100 m²) and outside (0.02 signs/100 m²) Zone 1 (Table 7B-52). Signs of gray wolf activity were found at 6 of 10 lakes surveyed in Zone 1, and in five of the six habitats surveyed. No signs were observed in black spruce treed on wetland habitat. Where signs were observed, mean frequency ranged from less than 0.01 signs/100 m² in black spruce treed on mineral and thin peatland or shallow peatland to 0.10 signs/100 m² in black spruce treed on shallow peatland.

Signs of gray wolf activity were sparse on coarse habitat mosaic transects in summer. Signs were scarce and scattered (Table 7-16). Forty gray wolf signs were observed over the three-year study period (Table 7B-53). Signs were observed on transects north and south of Gull and Stephens lakes, in riparian and upland areas, inside and outside Zone 1, and in 8 of the 13 habitats surveyed. No signs were found in black spruce treed and young regeneration on mineral and thin peatland, black spruce treed and young regeneration on shallow peatland, young regeneration on shallow peatland, low vegetation or tall shrub on wet peatland, or black spruce treed on wet peatland habitat. Where gray wolf signs were observed, mean frequency was 0.01 signs/100 m² or less for all transect characteristics.

Table 7-16: Mean Frequency of Gray Wolf Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.01	0.01	scarce	0.40	widespread	common
Coarse habitat mosaics	0.01	<0.01	scarce	0.19	scattered	sparse
Coarse habitat mosaics (winter)	0.01	<0.01	scarce	0.10	localized	sparse
Riparian shorelines	0.28	0.05	abundant	0.54	very widespread	very common

Signs of gray wolf activity were also sparse on coarse habitat mosaic transects in winter. Signs were scarce and localized (Table 7-16). No signs were found in 2002 (Table 7B-54). Gray wolf signs were observed on transects north and south of Gull and Stephens lakes, in riparian and upland areas, inside and outside Zone 1, and in three of the nine habitats surveyed. Signs were observed in black spruce treed on mineral and thin peatland, black spruce treed on mineral and thin peatland or shallow peatland, black spruce treed on shallow peatland, and young regeneration on mineral and thin peatland. Where gray wolf signs were observed, mean frequency was 0.01 signs/100 m² or less for all transect characteristics.

Signs of gray wolf activity were very common on riparian shoreline transects in the summer. No surveys were conducted in winter. Signs were abundant and very widespread (Table 7-16). Signs were observed on island shorelines, and on the north and south shores of Gull Lake. Mean sign frequency was greatest south of Gull Lake (0.41 signs/100 m²) and lowest on islands (0.06 signs/100 m²; Table 7B-55). Mean sign frequency was similar on shorelines with narrow and moderate riparian zone width (0.30 and 0.32 signs/100 m², respectively). Mean sign frequency was greatest on shorelines with moderate slopes (0.41 signs/100 m²) and lowest on shorelines with the greatest slopes (0.18 signs/100 m²). Signs were observed in all seven habitats surveyed. Mean sign frequency ranged from 0.04 signs/100 m² in low vegetation or tall shrub on wet peatland to 0.67 signs/100 m² in black spruce treed on mineral and thin peatland or shallow peatland.

Gray wolf signs were generally scarce on the north and south access road routes. Signs were most abundant on the north route centreline transects surveyed in 2003 (0.13 signs/100 m²; Table 7B-56). No signs were observed on the south route in winter 2002. On at least one occasion in 2007, workers photographed gray wolves travelling down the north access road right of way (ROW) during winter road exploration and drilling activities being conducted by Manitoba Hydro.

Gray wolf activity was observed in a range of upland and riparian habitats in the Local Study Area. Gray wolf signs were sparse on coarse habitat mosaic transects in summer and winter. Gray wolf activity appeared to be concentrated near waterbodies such as Gull Lake and other lakes in Zone 1. Based on the density of ungulates as available prey in the SLRMA, no wolf packs are thought to centre their activity in the Local Study Area, although their territories could overlap a portion of it (Moose Harvest Sustainability Plan). Signs of some gray wolf activity were observed in Zone 1, particularly on the shores of Gull Lake, suggesting that the Project could overlap the home ranges of approximately 3 packs, or roughly 18 individuals (Moose Harvest Sustainability Plan).

During the final preferred route mammal stratification surveys for the proposed Bipole III Transmission Reliability Project, gray wolf signs were observed in the Local Study Area and beyond from Birthday Rapids to the location of the proposed Keewatinoow Converter Station (Manitoba Hydro 2011a).

7.3.5.2 Black Bear

7.3.5.2.1 General Life History

Black bears (*Ursus americanus*) are common inhabitants of coniferous and deciduous forests, swamps, and berry patches (Banfield 1987). This species is inactive in winter, seeking dens in fall in which to hibernate.

The black bear's annual diet is composed mainly of vegetation, although it also includes insects, carrion, and small mammals (Banfield 1987). Seasonal shifts in diet depend upon the availability of food sources. In spring, new plant growth is consumed, while berries are preferred in summer and fall (MacHutchon 1989). Black bears hunt moose calves in spring, when calves are most vulnerable (Garneau *et al.* 2008), and are known to take caribou calves (Rettie and Messier 1998; Wittmer *et al.* 2005). In autumn black bears begin to build up large fat stores before the winter den period (Brody and Pelton 1988).

Black bears are considered a "nuisance" species in some areas of their range (Banfield 1987). Nuisance bears typically frequent garbage dumps and other areas where human food or garbage is readily available (Banfield 1987). Their superior sense of smell aids their ability to find and exploit these resources (Banfield 1987; Kolenosky and Strathearn 1998). This type of behaviour can lead to human/bear interactions, which could result in destruction of property, injuries, and bear mortality (Banfield 1987). Despite their affinity for human food sources, black bears typically attempt to avoid human contact when they are aware of human presence (Kolenosky and Strathearn 1998).

7.3.5.2.2 General Abundance and Habitat

Black bears were relatively abundant in the area between Lake Winnipeg and Hudson Bay in the early 1900s, but were less common in the north (Preble 1902). The population of black bears in Manitoba is estimated at 25,000 to 30,000 individuals (Manitoba Conservation n.d.*b*). The species is widespread, abundance, and secure throughout its range in Manitoba (NatureServe 2011). The number of black bears harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year (SE SV).

7.3.5.2.3 Local Abundance and Habitat

Black bear signs were common along lake perimeters surveyed in the Local and Regional Study Areas in summer (Table 7-17). Abundance was scarce but signs were very widely distributed. No transects were surveyed in winter. Signs of black bear activity were observed at eight of the 10 lakes in Zone 1. Mean frequency of black bear signs was somewhat greater at lakes south of Gull Lake (0.03 signs/100 m²) than north (0.02 signs/100 m²) and inside Zone 1 (0.04 signs/100 m²) than outside (0.02 signs/100 m²) over the two-year study period (Table 7B-57). Black bear signs were observed in all six habitats surveyed. Mean sign frequency was similar in all habitats, and was somewhat greater in low vegetation or tall shrub on wet peatland. Mean sign frequency was similar on lakes of all sizes, but was somewhat lower on medium-sized lakes.

Black bear signs were common during summer surveys of coarse habitat mosaic transects. Abundance was scarce but signs were very widely distributed (Table 7-17). Signs of black bear activity were observed on islands and on transects north and south of Gull and Stephens lakes (Table 7B-58). Mean sign frequency was greatest south of the lakes (0.05 signs/100 m²) and lowest on islands (0.01 signs/100 m²). Mean sign frequency was similar in riparian (0.04 signs/100 m²) and upland (0.03 signs/100 m²) areas, and inside (0.04 signs/100 m²) and outside (0.03 signs/100 m²) Zone 1. Black bear signs were observed in all but one of the thirteen habitats surveyed. Where signs were observed, mean frequency ranged from less than 0.01 signs/100 m² in black spruce treed and young regeneration on shallow peatland to

0.05 signs/100 m² in black spruce treed on mineral and thin peatland habitat. No signs were observed during the winter surveys as expected, as bears are inactive during the winter months.

Table 7-17: Mean Frequency of Black Bear Signs (signs/100 m²) in the Keeyask Region

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.03	0.01	scarce	0.65	very widespread	common
Coarse habitat mosaics	0.04	0.01	scarce	0.53	very widespread	common
Coarse habitat mosaics (winter)	0	0	absent	0	absent	absent
Riparian shorelines	0.25	0.05	abundant	0.57	very widespread	very common

Black bear signs were very common on riparian shoreline transects on Gull Lake in summer. Signs were abundant and very widely distributed (Table 7-17). No surveys were conducted in winter. Mean frequency of black bear signs was similar north (0.27 signs/100 m²) and south (0.25 signs/100 m²) of Gull Lake (Table 7B-59) over the three-year study period. No signs were observed on island shorelines. Signs of black bear activity were observed in riparian zones of all widths and slopes, and mean sign frequency was generally abundant, with the exception of riparian zones with slopes of 66 to 100%, where abundance was sporadic. Black bear signs were observed in six of the seven habitats surveyed. No signs of black bear activity were observed in black spruce mixedwood on mineral and thin peatland habitat. Where signs were observed, mean frequency ranged from 0.14 in black spruce treed on shallow peatland to 0.88 signs/100 m² in low vegetation or tall shrub on wet peatland. Signs were also very abundant in broadleaf treed on all ecosites habitat.

No black bear signs were observed on the proposed north or south access road routes in 2001 or 2002 (Table 7B-60). As these surveys were conducted in winter, no sign of black bear activity would be expected, since these animals are generally hibernating at that time of year. Black bear signs were common or very common on the access road routes in 2003 and 2004, with the exception of 2003 north route centerline transects, where signs were absent.

Black bear signs were common or very common in the Local Study Area in summer. Signs of black bear activity were very widespread and observed in most habitats in the Local Study Area. Black bears were active at lakes, on the shores of Gull Lake, and in riparian and upland areas in Zone 1, suggesting that the Project overlaps the home ranges of one or more individuals.

7.3.5.3 Ungulates

Ungulates are hoofed mammals that contribute to ecosystem function by consuming plants and as prey for large carnivores. They are harvested by KCNs Members and other resource users in the Keeyask region. Ungulates that could occur in the Keeyask region include caribou, moose, white-tailed deer (*Odocoileus virginianus*), and mule deer. Caribou and moose are VECs and are discussed below.

White-tailed deer and mule deer ranges do not include the Keeyask region (Banfield 1987). White-tailed deer are absent to scarce in the Keeyask region and no signs were observed during field studies. Limited habitat supply and severe winters restrict white-tailed deer from becoming established residents of the Keeyask region (Bekoff 1982; Wishard 1984). Mule deer are highly unlikely to occur in the Keeyask region for similar reasons; however, one mule deer antler was found near Gull Lake. Although it was confirmed as a mule deer antler by the Manitoba Museum, it is possible that it was transported into the area from elsewhere, or it was shed by an animal that dispersed far from its documented range.

7.3.5.4 Rare and Regionally Rare Species

In addition to mammal groups, other priority mammals include rare and regionally rare species. Rare mammal species are provincially rare, regionally rare, or listed as endangered, threatened, or special concern by SARA or MESA. Boreal woodland caribou is the only rare species listed by SARA or MESA that might be found in the Keeyask region, and is discussed with caribou in the following section. Wolverine (*Gulo gulo*) was identified as a rare mammal because of its status as a species of special concern by COSEWIC. There are no provincially rare species in the Keeyask region.

Regionally rare species are American water shrew (*Sorex palustris*), little brown myotis (for which emergency consideration as a SARA-listed species has been requested by COSEWIC, but that is not officially listed), porcupine (*Erethizon dorsatum*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*). These species were considered due to their relative rarity in the Keeyask region. These species are common within their ranges elsewhere in Manitoba. Due to the wide variation in home range sizes of rare species, the Rare Mammals Local Study was Zone 4 and the Rare Mammals Regional Study Area was Zone 6 in Map 7-1.

7.3.5.4.1 American Water Shrew

An American water shrew was captured in the Churchill region in 1953, several hundred kilometres north of previous reports (Smith and Foster 1957). This species was not abundant anywhere in Manitoba in the 1970s (Wrigley *et al.* 1979). An association between beaver and American water shrew distribution was observed, as beaver dams create favourable habitat conditions for these shrews (Wrigley *et al.* 1979). Single specimens have been trapped near Churchill, Manitoba and northeast of York Factory, near Hudson Bay (Sealy 2002). American water shrew densities are thought to be low, as relatively few are captured during trapping studies (*e.g.*, Nagorsen and Peterson 1981; Kirkland and Schmidt 1982).

American water shrews appear to be sparse in the Local Study Area. This species is found throughout Manitoba (Banfield 1987), and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011). A single American water shrew was trapped along a creek near the Nelson River during the small mammal studies (see Section 7.3.2.2). Due to difficulties in detecting this species, it is unclear how sparse or common it may be in the Local Study Area and surrounding Regional Study Area.

7.3.5.4.2 Little Brown Myotis

The little brown myotis is a habitat generalist, occupying a range of habitats (Wund 2006). While they inhabit parts of Alaska and northern Canada, their wings and ears are poorly suited to the cold, and they hibernate in caves or other shelters for the winter (Banfield 1987). They occur through much of Manitoba, including the Keeyask region (Humphrey 1982). While breeding occurrences in Manitoba are rare[1], the MBCDC lists the non-breeding status of the little brown myotis as widespread, abundant, and secure in the province or throughout its range. This species is not yet listed by SARA, but an emergency order to place this and other bat species on Schedule 1 of the *Species at Risk Act* has been requested (COSEWIC 2012). The primary threat to little brown myotis is the spread of white-nose syndrome, caused by a fungus, which is predicted to result in the extirpation of little brown myotis within 16 years (Frick *et al*. 2010; Forbes 2012). While white-nose syndrome has not been identified west of Ontario, it is expected to spread to hibernacula across North America within 11 to 22 years (Frick *et al*. 2010; Forbes 2012).

Little brown myotis appear to be sparse in the Local Study Area. No little brown myotis were positively identified in the Rare Mammals Local Study Area during field surveys; however, one bat was detected in late July and August 2001 feeding at Gull Lake camp. Anecdotal reports of bat, likely little brown myotis, observations near cabins in the Local Study Area have been made, but not confirmed. Bats have also been observed in and near Gillam, Manitoba, but the species is unknown (FLCN 2010 Draft).

7.3.5.4.3 Porcupine

In the early 1900s, porcupine were distributed throughout the area between Lake Winnipeg and Hudson Bay, but were not abundant (Preble 1902). Although porcupine range is widespread in Manitoba (Dodge 1982), this species is sparse in the Rare Mammals Local Study Area. Porcupine were not found in the study areas, and only one porcupine was reported east of Gillam (WRCS unpubl. data). FLCN resource users noted "…the porcupine population has drastically declined since the 1960s to the extent that they are rarely, if ever, observed any more" (FLCN 2010 Draft), and TCN Elders observed that this species disappeared in the late 1960s (Split Lake Cree 1996a). The cause for this disappearance is unknown. In a First Nations initiative, several porcupine were live-captured in southern Manitoba, the Interlake, and western Manitoba and transplanted into the SLRMA. The trap and release took place circa 1997 (TCN resource user *pers. comm.* 2006). The reintroduction of porcupine did not appear to be successful in the Regional Study Area, as field studies did not detect a population. The porcupine is not listed by SARA or MESA, and is considered widespread, abundant, and secure throughout Manitoba (NatureServe 2011).

It is unclear why porcupine are sparse in the Local Study Area and surrounding region, but may be a function of limited preferred food availability such as white pine (*Pinus strobus*), American elm (*Ulmus americana*) (Tenneson and Oring 1985) and white spruce (*Picea glauca*) (Payette 1987). Porcupine densities

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[1] The term 'rare', in this context, is used by the MBCDC.

are often lower in areas where fisher are present, but relatively little is known about the existence of porcupine in the boreal forest (Dodge 1982). In 2010, a local resource user reported encountering a porcupine on the dykes along the Butnau Road near Gillam, and a porcupine was observed near Landing Lake in 2008.

7.3.5.4.4 Raccoon

Historically the North American raccoon population was relatively low, and its range did not include the Canadian prairies (Sanderson 1998). Following a population increase in the early 1940s, the range of the raccoon expanded north into Canada (Sowls 1949) and Manitoba (Larivière 2004). By the 1980s, raccoon range extended to the northern tip of Lake Winnipeg (Sanderson 1998). Manitoba Conservation reports that this species' range currently extends beyond The Pas toward Thompson, and it is considered common throughout the southern half of the province. The highest raccoon densities are reported from the agro region of Manitoba (Stardom 1986). The raccoon is not listed by SARA or MESA, and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011).

The raccoon is sparse in the Local and surrounding Regional Study Areas, the northern fringe of its range. A single raccoon sign was reported on a common mammal habitat transect near water over four years of mammal studies (WRCS unpubl. data). Only three raccoon were trapped in the SLRMA between 1961 and 1984.

7.3.5.4.5 Wolverine

Wolverine were widely distributed in the area between Lake Winnipeg and Hudson Bay in the early 1900s, but were particularly rare in the southern region (Preble 1902). They were somewhat more abundant in the north (Preble 1902). The western population of wolverine is not listed under SARA (Schedule 1); however, COSEWIC designated this as a species of special concern, the status of which was last revised in 2003. The Manitoba wolverine population has been estimated to be between 1,200 and 1,600 animals (COSEWIC 2003), and it is estimated that the provincial population is either increasing or stable (Environment Canada 2010). Wolverine are still being harvested for fur in Manitoba. About two wolverine are trapped annually in the SLRMA (Manitoba Conservation trapping records 1961–1984).

Wolverine are sparse in the Local Study Area and surrounding region. Wolverine signs (n = 25) were rarely observed during field studies from 2001 to 2004. Seven signs were observed in Zone 1. Local resource users report that the number of wolverine observed in the lower Nelson River area has recently increased (Mammals Working Group December 9, 2010). A FLCN Elder reported "he and others have observed increased number of wolverine over the past year [2009], and that they had disturbed many of the boxes…erected for trapping marten" (FLCN 2010 Draft). Fifty-six wolverine were trapped in the SLRMA from 1961 to 1984, and none were trapped from 1996 to 2005 (see Table 7B-2 and Table 7B-3). No wolverine were trapped in the FLRMA between 1996 and 2005 (see Table 7B-4). The number of wolverine harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year (SE SV). Wolverine den sites were not identified during field studies in the Local Study Area, but it cannot be stated that none exist in the region. The presence of wolverine signs in Zone 1 indicates that the Project could overlap a portion of at least one wolverine home range.

During the final preferred route mammal stratification surveys for the proposed Bipole III Transmission Reliability Project, wolverine signs were observed from the north arm of Stephens Lake to the location of the proposed Keewatinoow Converter Station (Manitoba Hydro 2011a). The greatest densities of wolverine signs were observed along the Limestone River east of the north arm of Stephens Lake (Manitoba Hydro 2011a).

7.3.5.4.6 Striped Skunk

Striped skunk were apparently common near Norway House and were less abundant near Oxford House in the early 1900s (Preble 1902). No reports of this species were made north of Oxford house at that time. Striped skunk are common throughout their range in Manitoba, especially in settled areas of the agro region of Manitoba (Stardom 1986); however, they are considered sparse in the Local Study Area because they are located at the northern fringe of their range. This species is not listed by SARA or MESA, and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011). No signs were observed in the Local Study Area during mammal surveys, and trapping records from the SLRMA and FLRMA dating to the 1960s do not indicate that striped skunk were captured. One striped skunk was detected east of the Long Spruce GS in 2004. Anecdotal reports of striped skunk have been made in the Ilford and Gillam areas, particularly at garbage dumps. The Keeyask Traditional Knowledge Report (FLCN 2010 Draft) states “the Fox Lake traditional area also used to have skunk. They are rare now.” A FLCN resource user “witnessed a skunk jump off the grain rail cars that come through Gillam on their way to Churchill.”

7.3.5.4.7 Coyote

Coyote are common throughout their range in Manitoba (Manitoba Conservation n.d.*c*); however, they are considered sparse in the Regional Study Area because they are located at the northern fringe of their range. This species is not listed by SARA or MESA, and is widespread, abundant, and secure throughout its range in Manitoba (NatureServe 2011). Manitoba Conservation reports that while they are most commonly found in southern agricultural areas, coyote have expanded their range into the boreal forest as far north as Thompson. A local resource user trapped coyote in the Cache Lake area, and indicted that the last one was taken in the mid-1970s. None have since been reported in the area (FLCN 2010 Draft). The number of coyote harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged less than one per trapline per year (SE SV). The number of coyote trapped in Manitoba has increased from 1995 to 2007 (Manitoba Conservation n.d.*c*). No coyote signs were observed in the Nelson River downstream of Long Spruce GS area.

7.3.6 Valued Environmental Components

As described in the Habitat and Ecosystems section of the TE SV, VECs were identified in a stepwise process that focused on issues that are relatively high scientific and social concern for the Project. The screening process led to the selection of three mammal VECs for the terrestrial wildlife effects assessment: caribou, moose, and beaver.

7.3.6.1 Description of Expert Information Models

As discussed in the Terrestrial Introduction, given the complexity of potential interactions within the ecosystem and between the Project and the ecosystem, expert information models were used to improve the understanding of patterns, processes and functions that were relevant to the assessment and to predict potential changes caused by the Project.

Expert information models were used to estimate the abundance of habitat available for the pre- and post-Project environments. Physical changes to moose, caribou, and beaver habitat were evaluated at year 30. Qualitative descriptions of habitat changes were determined for beyond year 30.

Scientific literature and expert information were used to develop primary and secondary moose and beaver coarse habitat models (Table 7-18). For caribou, a winter habitat model was developed using coarse habitat types (Table 7-19), while island and complex size was used to model primary and secondary calving and rearing habitat.

Habitat models were used to estimate changes to habitat quality, to enhance predictions, and to evaluate the future conditions under the most likely scenario. The caribou and moose models are non-spatial in the sense that they do not incorporate the adjacency of other habitat types, while the beaver model incorporated habitat types in proximity to water.

Table 7-18: Coarse Habitat Types Used for Expert Information Models

	Moose		**Beaver**		**Caribou**
Coarse Habitat Type	**Primary**	**Secondary**	**Primary**	**Secondary**	**Winter**
Black spruce mixedwood on mineral and thin peatland		✓		✓	
Black spruce mixedwood on shallow peatland		✓		✓	
Black spruce treed on mineral and thin peatland		✓		✓	✓
Black spruce treed on shallow peatland		✓			✓
Black spruce treed on wet peatland		✓		✓	✓
Broadleaf mixedwood on all ecosites	✓		✓		
Broadleaf treed on all ecosites	✓		✓		
Human					
Jack pine mixedwood on mineral and thin peatland	✓			✓	
Jack pine treed on mineral and thin peatland	✓				✓
Jack pine treed on shallow peatland	✓			✓	✓
Low vegetation on mineral and thin peatland	✓	✓		✓	
Low vegetation on shallow peatland		✓		✓	
Low vegetation on wet peatland		✓		✓	
Marsh	✓		✓		
Marsh Island			✓		

Table 7-18: Coarse Habitat Types Used for Expert Information Models

	Moose		Beaver		Caribou
Coarse Habitat Type	**Primary**	**Secondary**	**Primary**	**Secondary**	**Winter**
Tall shrub on mineral and thin peatland	✓		✓		
Tall shrub on shallow peatland	✓		✓		
Tall shrub on wet peatland	✓		✓		
Tamarack- black spruce mixture on wet peatland		✓		✓	✓
Tamarack treed on shallow peatland		✓			✓
Tamarack treed on wet peatland		✓		✓	✓
Vegetated Ice Scour					
Vegetated Riparian Peatland	✓		✓		
Vegetated Upper Beach	✓				
Water			✓		
Young regeneration on mineral and thin peatland	✓			✓	
Young regeneration on shallow peatland	✓			✓	
Young regeneration on wet peatland	✓			✓	
Burn	✓				

Table 7-19: Island and Complex Sizes (ha) used in Caribou Calving and Rearing Expert Information Model

	Calving		Rearing	
	Primary	**Secondary**	**Primary**	**Secondary**
Islands in lakes	>0.5	-	10+	0.5–10
Virtual complexes	200+	30–200	200+	30–200

7.3.6.2 Beaver

7.3.6.2.1 General Life History

Beaver (*Castor canadensis*) are aquatic mammals distributed throughout Canada, where suitable habitat exists (Pattie and Hoffmann 1990). They inhabit waterbodies in forested areas (Banfield 1987). The beaver diet is vegetarian, consisting of leaves, twigs, and bark (Banfield 1987), with a preference for aspen (*Populus* spp.) (Jenkins and Busher 1979). Their diet shifts from woody vegetation in winter to herbaceous material in spring and summer (Clements 1991).

In addition to providing sustenance, trees are felled and utilized in the construction of dams and lodges. Tree cutting occurs mainly in autumn, when a food **cache** of branches and leaves is created near the lodge (Jenkins and Busher 1979). Dams are constructed to hold back the flow of water in order to create a pond deep enough to allow swimming under winter ice, generally six to 10 feet deep (Banfield 1987). By building dams and through their feeding activities, beavers alter aquatic ecosystems (Naiman *et al.* 1986), increase the diversity of species and habitat on a landscape, and create habitat for other species that use wetlands (Wright *et al.* 2002; Rosell *et al.* 2005). Beavers are active throughout the winter, and may supplement their diet with fresh woody material, in addition to cached food (Jenkins and Busher 1979).

Diseases such as tularaemia and rabies are sources of beaver mortality (Clements 1991). Predators include bear, gray wolf, coyote, fisher, wolverine, river otter, and lynx (Banfield 1987). Most predation on beavers occurs on land or in the lodge (Banfield 1987). Aquatic furbearers such as river otter may freely enter the lodge underwater, while terrestrial predators capture beavers while they are cutting trees or by breaking into the lodge (Banfield 1987). Trapping is also a source of mortality. While in the past beaver were trapped for their pelts, the number of beavers taken has decreased due to low prices (Manitoba Conservation n.d.*d*). In addition, beaver reproduce relatively slowly but can easily compensate for local losses through rapid dispersal (Boyle and Owens 2007) and increased reproduction (Payne 1989). As such, the number of beavers in Manitoba has increased, resulting in a greater number of beaver-related problems (Manitoba Conservation n.d.*d*). Beaver removal programs and subsidies are currently in place to manage problem beavers throughout the province (Manitoba Conservation 2009a).

7.3.6.2.2 General Abundance and Habitat

Beaver have been heavily trapped in the past for their fur; consequently, there is considerable documentation of their presence in the Regional Study Area. They were the most commonly trapped furbearers in the 1930s, but were scarce in areas other than the vicinity of the Churchill River (Split Lake Cree 1996a). Prices for fur, particularly beaver, began to decline in the early 1950s (Split Lake Cree 1996a). A recovery in the mid-1970s and early 1980s is reflected in the Split Lake harvesting data (Split Lake Cree 1996a). Historically, beaver were present between Split Lake and Stephens Lake. Although all streams were considered important for beaver, nine streams were identified as suitable beaver habitat in the Gull Lake area (TCN 2000a). There are fewer beaver in the York Landing area today (YFFN Evaluation Report *(Kipekiskwaywinan)*). They were abundant along the shoreline of the Nelson River, and are now rare in these areas (FLCN 2010 Draft) due to previous hydroelectric development (FLCN 2010 Draft; YFFN Evaluation Report *(Kipekiskwaywinan)*). Declining trends are more likely to be associated with depressed fur prices and reduced trapping effort as opposed to a regional population declines; however, there is an element of uncertainty in this assertion.

Beaver are relatively common in Manitoba. The Manitoba Conservation Wildlife and Ecosystem Protection Branch lists beaver as a problem wildlife species, as its population continues to increase (Manitoba Conservation n.d.*d*). The beaver is widespread, abundant, and secure throughout Manitoba (NatureServe 2011). The beaver harvest in Manitoba has declined steadily since 1994 (Manitoba Conservation 2011a). The five-year average harvest was 30,962 individuals in the 1994–1998 seasons and was 8,175 individuals in the 2010 to February 2011 season. The average auction value of beaver declined from 1994 to 2010, but increased slightly in the 2010–2011 season. The number of beaver harvested from the Resource Use Regional Study Area between 1996 and 2008 averaged five beaver per trapline per year (SE SV). Active beaver lodges were observed throughout the Regional Study Area and beyond.

7.3.6.2.3 Regional Abundance and Habitat

The Beaver Local Study Area was Zone 3 and the Beaver Regional Study Area was Zone 4 in Map 7-1. Beaver are abundant in the Regional Study Area. Aerial surveys indicate streams (0.25 lodges/km) and ponds (0.10 lodges/km) are the preferred habitats of beaver (Table 7B-61). Beavers also inhabited small lakes and rivers (0.08 lodges/km each) and appeared to avoid islands in lakes, islands in ponds, and islands in rivers. The density of active beaver lodges was also relatively low at Gull and Stephens lakes (Map 7-18). The estimated density of active beaver lodges was 0.09 lodges/km (Table 7B-62), and the current beaver population in the Regional Study Area is estimated at 250 active colonies. In the Hayes River region, a comparison area unaffected by hydroelectric development, the density of active beaver lodges was greatest in French Creek (0.35 lodges/km), Kapaseetik Lake (0.33 lodges/km), where a single lodge was observed over 3 km surveyed, and streams (0.27 lodges/km; Table 7B-63). Few beaver lodges were observed in lakes. Ponds were also inhabited by beaver (0.12 lodges/km).

Inactive lodges can indicate potential beaver habitat. When active and inactive lodges are considered, mean lodge density was also greatest in streams (0.44 lodges/km) and ponds (0.20 lodges/km; Table 7B-64). The density of all lodges was also greatest in streams (0.45 lodges/km) in the Hayes River region (Table 7B-65). For maps of annual beaver lodge observations, refer to Appendix 7C.

Aerial surveys beyond the Regional Study Area indicate that active lodge density was also low along larger waterbodies such as Split and Assean lakes (WRCS unpubl. data). Allen (1982) indicates that larger lakes must have irregular shorelines with features such as bays and inlets to provide suitable beaver habitat (Allen 1982). A stable water level is also an important feature of suitable beaver habitat. Larger rivers with swift water and unpredictable depths (such as the Nelson River) are not suitable for beaver inhabitation (Allen 1982).

Beaver Habitat Model

Primary (preferred) habitat for beaver is near shorelines. Primary riparian environments have low exposure or low water velocity with aspen nearby, such as broadleaf mixedwood or broadleaf treed habitat, and willow, such as habitats dominated by tall shrubs (Table 7-20). The likelihood of beaver using water and vegetation located farther than 200 m from shorelines, or upland habitats located farther than 100 m from shorelines is assumed low, thus habitats outside this boundary were not considered. Primary habitats in the Local Study Area likely provide beaver with better availability and abundance of common food items (Jenkins and Busher 1979; Banfield 1987; Pattie and Hoffmann 1990; Clements 1991) such as alder, aspen, and willow materials for lodge or dam construction or shelter for bank dens. Approximately 1% of the Regional Study Area contains primary beaver habitat (Map 7-19).

Table 7-20: Primary and Secondary Beaver Habitat Types in the Beaver Regional Study Area

	Coarse Habitat Type
Primary Habitat	Broadleaf mixedwood on all ecosites
	Broadleaf treed on all ecosites
	Tall shrub on mineral and thin peatland
	Tall shrub on shallow peatland
	Tall shrub on wet peatland
	Marsh
Secondary Habitat	Black spruce mixedwood on mineral and thin peatland
	Black spruce mixedwood on shallow peatland
	Black spruce treed on mineral and thin peatland
	Black spruce treed on wet peatland
	Jack pine mixedwood on mineral and thin peatland
	Jack pine treed on shallow peatland
	Low vegetation on mineral and thin peatland
	Low vegetation on shallow peatland
	Low vegetation on wet peatland
	Tamarack-black spruce mixture on wet peatland
	Tamarack treed on wet peatland
	Young regeneration on mineral and thin peatland
	Young regeneration on shallow peatland
	Young regeneration on wet peatland

Secondary (useable but less important) habitats for beaver consist of coniferous forest (Jenkins and Busher 1979) such as black spruce and jack pine stands. Although not mapped, other secondary habitat may consist of rivers with moderate water velocity and a variety of bank conditions. Beaver were rarely or never found in the majority of habitats, which may be more a function of the proximity of the transects to water features than of the habitat itself. Eight percent of the Regional Study Area is composed of secondary beaver habitat.

7.3.6.2.4 Local Abundance and Habitat

The density of active beaver lodges was greatest in small rivers in the Local Study Area in 2001 (0.50 lodges/km) and in ponds in 2003 (0.15 lodges/km; Table 7B-66). Mean density for the two-year study period was greatest in small rivers (0.25 lodges/km), streams (0.19 lodges/km), and lakes (0.17 signs/100 m^2).

In the 2011 survey of the area to be affected by flooding, the density of active beaver lodges was 0.56 lodges/km in Zone 1 (Table 7B-67). Twenty-three lodges were observed (Map 7-20). Inactive lodges can indicate potential beaver habitat. When active and inactive lodges are considered, approximately 30 lodges could occur in Zone 1 (Table 7B-68). The density of all lodges was greatest in streams (0.54 lodges/km) and ponds (0.22 lodges/km). No lodges were observed on small lakes in Zone 1. The central Nelson River, which includes Gull Lake, does not appear to support many beavers, as only a single lodge, which was active, was observed.

With the exception of lake perimeters, signs of beaver activity were sparse on tracking transects in the Local Study Area. As beaver signs are concentrated around waterbodies, relatively few signs were observed on coarse habitat mosaic transects. No fresh signs were observed in winter. While aerial surveys in fall are the most appropriate method for estimating beaver abundance, the data collected on tracking transects are summarized below. No detailed comparisons of habitat characteristics were made.

Beaver signs were very common on lake perimeter transects in the Local and Regional Study Areas (Table 7-21). Signs were abundant and observed on all lakes surveyed. Mean sign frequency was greater at lakes south of Gull Lake (0.40 signs/100 m^2) than north (0.15 signs/100 m^2) over the two-year study period (Table 7B-69). Beaver signs were abundant inside (0.24 signs/100 m^2) and outside (0.31 signs/100 m^2) Zone 1. Signs of beaver activity were observed in all six habitats surveyed. Mean sign frequency ranged from 0.14 signs/100 m^2 in young regeneration on mineral and thin peatland or shallow peatland to 0.48 signs/100 m^2 in black spruce treed on mineral and thin peatland or shallow peatland habitat. While beaver signs were observed on lakes of all sizes, signs were more abundant on small lakes (0.36 signs/100 m^2) than larger lakes.

Table 7-21: Mean Frequency of Beaver Signs (signs/100 m^2) in the Beaver Local Study Area

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.27	0.08	abundant	1.00	very widespread	very common
Coarse habitat mosaics	0.13	0.01	sporadic	0.09	localized	sparse
Coarse habitat mosaics (winter)	-	-	-	-	-	-
Riparian shorelines	0.03	0.01	scarce	0.07	localized	sparse

Signs of beaver activity were sparse on coarse habitat mosaic transects. Abundance was sporadic and distribution was localized (Table 7-21). No signs were recorded in 2001 (Table 7B-70). As beavers are commonly found near water, signs of their activity were limited to areas near waterbodies. While two signs were found in upland areas, the majority were observed in riparian areas. All but one sign was observed south of Gull and Stephens lakes. Beaver signs were observed in four of the 13 habitats surveyed: black spruce treed on mineral and thin peatland, black spruce treed on mineral and thin peatland or shallow peatland, black spruce treed on shallow peatland, and black spruce treed on wet peatland.

Beaver signs were sparse on riparian shoreline transects at Gull Lake. Abundance was scarce and distribution was localized (Table 7-21). Beaver signs were observed in all three study years (Table 7B-71). Signs of beaver activity were observed on the north and south shores of Gull Lake, and in riparian zones of all widths. No sign of activity was observed in areas with a slope greater than 32%. Signs were observed in four of the six habitats surveyed: black spruce treed on mineral and thin peatland, black spruce treed on mineral and thin peatland or shallow peatland, broadleaf mixedwood on mineral and thin peatland, and low vegetation or tall shrub on wet peatland.

No signs of beaver were observed on the north access road route during the three-year study period (Table 7B-72). Most (26) signs were observed at the potential stream crossing sites.

Primary beaver habitat comprises 1% and secondary habitat comprises 6% of the Local Study Area. Ponds, creeks, and streams generally supported the highest densities of beaver, while larger rivers and lakes supported the lowest densities of beaver in the Local Study Area. While beaver signs were most commonly found in habitats dominated by black spruce on tracking transects, this type of survey is not appropriate for assessing beaver populations or their habitat preferences. The distribution and relative abundance of beaver often corresponds with the distribution of aspen trees or willow near water. As the environment exists today, beavers are rarely found on the Nelson River itself; however, beavers commonly occupy tributaries connected to it. Density variations were observed between habitats and by year surveyed, and can be attributed to habitat availability and quality (Novak 1998). Twenty-three active lodges were counted in Zone 1, and the area could likely support up to 30 active lodges.

7.3.6.3 Caribou

Three groupings of caribou are described for the Caribou Local and Regional Study Areas (Zones 4 and 6 in Map 7-1, respectively): barren-ground caribou (*Rangifer tarandus groenlandicus*); coastal caribou (*R. t. caribou*), which is a forest-tundra migratory woodland caribou ecotype; and summer resident caribou (summer residents), a type of woodland caribou whose exact range and herd association is uncertain

- Barren-ground caribou from the Beverly-Qamanirjuaq herd migrate from Nunavut in autumn to overwinter in Manitoba's northern forests and then leave the Regional Study Area in spring to calve. On occasion, a small fraction of the Qamanirjuaq herd may reach the Regional Study Area – about 10,000 animals migrated this far south once in the last 10 years, of the total population of 348,000 estimated in 2008.
- Coastal caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of the Regional Study Area in winter and leave the area in spring to calve. Larger groups of Pen Islands coastal caribou, numbering in the hundreds, have been observed in the Regional Study Area on occasion, but there are generally fewer than about 50 individuals in a typical winter.

- Summer resident caribou likely move within and beyond the Regional Study Area, but the extent of their core range is unknown. These caribou remain in the Regional Study Area to calve, but it is unclear whether the same individuals calve in the area year after year. Summer residents are conservatively estimated to number 20 to 50 individuals.

Caribou select habitat for a variety of reasons, particularly food availability, predator avoidance (Hirai 1998; Rettie and Messier 2000; Dyke 2008), and the level of disturbance present, as human-caused or natural alteration and fragmentation may attract moose, which in turn attract gray wolves, increasing the predation risk for caribou (Rettie and Messier 2000). Winter habitat for all caribou groups consists of undisturbed mature coniferous forest composed of black spruce, jack pine, or tamarack-dominated peatland, with a ground cover of lichens. Areas with abundant **arboreal** and terrestrial lichens (Hirai 1998; Rettie and Messier 2000) and relatively shallow snow (Johnson *et al.* 2001) are preferred. As these lichens are found in older successional stages of forest, mature forests constitute important caribou habitat (Rettie and Messier 2000). Green forage such as horsetails, **graminoids**, and forbs are commonly consumed by caribou in spring (Rettie *et al.* 1997; Rettie and Messier 2000). Summer and autumn forage consists of horsetails, graminoids, forbs, sedges, deciduous shrubs, and fungi (Rettie *et al.* 1997).

Summer habitat applies only to summer resident caribou, as the other caribou groups do not occupy the region at this time. When calving, female caribou tend to select areas that decrease the risk of predation, such as higher islands surrounded by marsh, bog or water (Hirai 1998; Dyke 2008). Summer calving and rearing habitats in the Regional Study Area consist of relatively undisturbed islands in lakes or black spruce surrounded by expansive wetlands or treeless areas (peatland complexes). Potential calving habitats are common in the Regional Study Area, and habitat does not appear to be limiting to the summer resident cows and calves.

While golden eagles, lynx, wolverine, and bears are all predators of caribou, particularly calves (Banfield 1987), gray wolves are major predators of adult caribou during winter (Cumming 1992). Caribou could avoid areas populated by moose as a way to avoid predation (Hirai 1998; Rettie and Messier 2000; Dyke 2008). In central Manitoba, caribou occupy peatlands surrounded by upland forest communities and smaller peatlands in summer and winter (Brown *et al.* 2000). Winter range tends to be smaller, a fraction of that occupied in summer (Brown *et al.* 2000).

7.3.6.3.1 Barren-ground Caribou

Barren-ground caribou (Photo 7-1) spend much of the summer in the tundra, beyond the tree line, and overwinter in the boreal forest (Kelsall 1968), where they select mature spruce stands with an abundance of lichens to consume (Rupp *et al.* 2006), as do all caribou in the Regional Study Area. Barren-ground caribou form large herds during the calving season and tend to calve *en masse*, forming nursery groups (Kelsall 1968). The rut is in late October, and occurs in Nunavut (Beverly and Qamanirjuaq Caribou Management Board 1999).

Source: WRCS, 2010

Photo 7-1: Barren-ground Caribou Herd North of the Churchill River 2010

In the Keeyask region, barren-ground caribou migrate to the area north of the Nelson River (FLCN 2010 Draft). Previous studies indicated that barren-ground caribou from the Qamanirjuaq herd ranged as far south as Split Lake and as far east as the Hudson Bay railway track running between Ilford and Churchill (Miller and Robertson 1967; Split Lake Cree 1996a). Caribou migration began to diminish in the 1950s, reducing hunting activity (Split Lake Cree 1996a). A substantial decline in barren-ground caribou numbers began in the 1950s, and after construction of the Kettle GS, there were virtually none south of the Nelson River (FLCN 2010 Draft). In the 1990s, there was a limited return of caribou (Split Lake Cree 1996a) while recently, in the winter of 2004–2005, a large number of barren-ground caribou returned to the Keeyask region (FLCN 2010 Draft). Current range data (Map 7-21) for the herd supports this distributional extent, where the southeastern limit is now near Stephens Lake. The Qamanirjuaq population was estimated at 348,000 individuals in 2008. Few were observed in Manitoba in 2011, and the Qamanirjuaq herd may be in decline (Beverly and Qamanirjuaq Management Board 2011). The potential decline is mainly attributed to climate change, human activities, loss of winter habitat due to forest fires, harvesting, and predation. Although the herd may by shrinking and/or has been redistributed, recent reports indicate that Qamanirjuaq caribou are still plentiful (Beverly and Qamanirjuaq Management Board 2011). About 10,000 Qamanirjuaq caribou have been estimated to reach the Regional Study Area, although this type of occurrence is infrequent.

The Nelson River generally serves as an extralimital boundary for Qamanirjuaq barren-ground caribou in the Keeyask region (Map 7-21). River crossing locations have been reported in the Regional Study Area and on the lower Nelson River (FLCN 2010 Draft; Map 7-22). Few river crossing sites are reported from field studies. Genetic studies indicated that most barren-ground caribou genotypes were found north of the Nelson River from 2004 to 2006 (Ball and Wilson 2007).

7.3.6.3.2 Coastal Caribou

Coastal caribou behaviour (Photo 7-2) is similar to that of barren-ground caribou, particularly during calving and migration (Thomas and Gray 2002). Coastal caribou from the Cape Churchill and Pen Islands herds occur within the Regional Study area in winter and leave in spring to calve near the Hudson Bay coast. The Pen Islands coastal caribou herd migrates from Ontario to the area south of the Nelson River (FLCN 2010 Draft), through Shamattawa to the Atkinson Lake area (WLFN 2002), as far west as the Nelson River at York Landing and as far south as Oxford House (see Map 7-21). Animals from the Pen Islands herd were first reported in the Keeyask region in the 1990s (Thompson 1994; Thompson and Abraham 1994; Abraham and Thompson 1998; Abraham *et al.* 2012). In the mid-1990s, the herd size peaked and was estimated at 10,800 individuals (Abraham and Thompson 1998; Abraham *et al.* 2012). Although larger migrations into the Regional Study Area were observed in the winters between 2001 and 2005, less than 300 animals believed to be Pen Islands caribou are observed in most winters. In the winter of 2011–2012, less than 30 caribou were observed during field studies. The rutting period of Pen Islands caribou is from mid-September to mid-October, when most of the herd is near the Hudson Bay coast (Abraham and Thompson 1998).

The Cape Churchill coastal caribou herd is currently estimated at 3,500 to 5,000 individuals and indications are that the population is likely stable. Although a large migration into the Regional Study Area was observed in winter 2010 (Manitoba Hydro 2011b), there are generally fewer than 50 animals in most winters.

While the Nelson River serves as a physical boundary for both Pen Islands and Cape Churchill coastal caribou in the Keeyask region, river crossing locations have been reported in the Regional Study Area and on the lower Nelson River (FLCN 2010 Draft; see Map 7-22). Genetic studies indicated that coastal caribou genotypes were found north and south of the Nelson River between 2004-2006. Recent radio-collaring data indicate that most of the Cape Churchill coastal caribou activity is north of the Nelson River while Pen Islands coastal caribou activity is south of the river (Manitoba Conservation unpubl. data; Manitoba Hydro 2011b). Slightly more Pen Islands coastal caribou use habitat north of the Nelson River than Cape Churchill coastal caribou (Manitoba Conservation unpubl. data; Manitoba Hydro 2011b).

Source: WRCS, 2010

Photo 7-2: Coastal Caribou Herd with Calves Near the Hudson Bay Coastline, June 2010

Aerial surveys of known calving grounds along Manitoba's Hudson Bay coastline indicate that summer residency has declined in the province, and some animals may have moved inland (Abraham *et al*. 2012). Possible causes of the shift in distribution from the Hudson Bay coast in Manitoba east to Cape Henrietta Maria in Ontario include habitat change, disturbance, nutritional stress due to range deterioration, and increased mortality due to differences in hunting and predation pressure across the range (Abrahams *et al*. 2012). Summer use of the Keeyask region is described below, including cases where Pen Islands caribou appeared to be calving in the Stephens Lake area.

7.3.6.3.3 Summer Resident Caribou

In addition to barren-ground and Pen Islands caribou, some KCNs have identified a third variety of caribou common to the Keeyask region: woodland caribou, which are present year-round and can be distinguished from migratory caribou based on their appearance (FLCN 2010 Draft; Fox Lake Aski Keskentamowin Keeyask Powistik 2012; YFFN Evaluation Report (*Kipekiskwaywinan*)). This group of caribou has recently been described as migratory woodland caribou (Mammals Working Group 2012, January 24; Fox Lake Aski Keskentamowin Keeyask Powistik 2012). The exact core range, long-term calving frequency, and herd association of the caribou that remain in the Keeyask region year-round cannot be clearly determined. This group could be coastal caribou, woodland caribou, or a mixture of both, and are referred to as summer resident caribou.

Boreal woodland caribou (*R. t. caribou*), a forest-dwelling woodland caribou ecotype, are listed as threatened under SARA and MESA and occurred historically in the Keeyask region (Manitoba Conservation 2005a). They do not tend to form large herds when calving and calve on islands when possible (Thomas and Gray 2002). The Nelson-Hayes boreal woodland caribou herd that once occurred within the Keeyask region blended with the coastal Pen Islands herd and no longer exists as a discrete population (Manitoba Conservation 2005a). The current range of boreal woodland caribou (Map 7-23) extends into the southwest corner of the Regional Study Area near Thompson, but threatened boreal woodland caribou are not recognized by Manitoba Conservation and Environment Canada as occurring in the Gull and Stephens lakes area (Manitoba Conservation 2005a; Environment Canada 2011).

The group of summer resident caribou in the Keeyask region (Photo 7-3) has been observed to calve in isolation or make use of island habitat, as is characteristic of boreal woodland caribou in Manitoba and elsewhere (Shoesmith and Storey 1977; Bergerud *et al.* 1990; Hirai 1998; Rettie and Messier 2000). Concurrently, recent data showed that a few radio-collared Pen Islands caribou cows occupied summer habitat in the Keeyask region over two years. At least one animal occupied summer habitat in the Keeyask region, but migrated long distances into Ontario the following spring (Manitoba Conservation unpubl. data; Manitoba Hydro 2011a). Winter migration distances for several collared caribou were in the order of hundreds of kilometres, separating winter range from summer range, which is uncharacteristic of forest-dwelling boreal woodland caribou in Manitoba and elsewhere (Manitoba Conservation unpubl. data; Manitoba Hydro 2011). During the winter, the summer residents most likely interact with migrating coastal caribou, which could make it difficult to differentiate among the mixed populations (Mammals Working Group 2012, January 24). It is unclear whether summer residents are coastal caribou that periodically do not return to traditional calving areas in Ontario or northern Manitoba, boreal woodland caribou beyond their current recognized range, or a mixture of both. For the purposes of the assessment of potential Project effects, the group of summer resident caribou is being treated as an independent population that uses a smaller range than the migratory groups, and is more likely to use calving and rearing habitat that occurs within the Keeyask region. Based on what is known of the area, a conservative estimate for the group of animals residing in the Regional Study Area in summer is 20 to 50 individuals.

Summer habitat is in peatlands and black spruce-dominated stands. Such habitat is selected for the availability of forage and for protection from predators, particularly during the calving season (Rettie and Messier 2000). When calving, summer residents inhabit **calving and rearing complexes**, which are clusters of islands in lakes or islands of black spruce surrounded by expansive wetlands or treeless areas (peatland complexes), to avoid predators. Primary calving and rearing habitat is defined as islands in lakes greater than 10 ha in size or peatland complexes greater than 200 ha. Secondary calving and rearing habitat is defined as islands in lakes between 0.5 and 10 ha in size or peatland complexes between 30 and 200 ha. Based on field studies, caribou do not appear to be using all of the habitat available in the Local Study Area, with the possible exception of islands in Stephens Lake, which have become a productive calving and summering area. Approximately 55% of the islands sampled in Stephens Lake and Gull Lake were occupied by adult caribou during at least one summer between 2003 and 2011. Calving and rearing was documented on 10% of the islands in lakes and 5% of the islands in peatland complexes surveyed in 2010 and 2011. The earliest date that calves were detected on islands in lakes was June 8.

Source: WRCS, 2010

Photo 7-3: A Summer Resident Caribou in the Keeyask Region

Little is known about the rutting behaviour of summer residents. Signs of the fall rut were limited during field studies. Potential indications included observations of bulls in pursuit of single cows in peatland complexes and a harem collected on a large island in Stephens Lake photographed by trail cameras (Map 7-24). Rutting habitat usually consists of unobstructed areas, including open and semi-open bogs (Darby and Pruitt 1984), which are habitats similar to calving and rearing complexes in the Keeyask region. It is unlikely that caribou rut in the Local Study Area, which is composed mainly of secondary peatland complexes that are unsuitable for mating due to their relatively small size.

7.3.6.3.4 Regional Abundance and Habitat

Caribou density was relatively low in the Regional Study Area. Observations of caribou and signs are depicted in Map 7-25. Mean density of caribou was 0.12 individuals/km² over the five-year study period

(Table 7-22). Caribou density reached a maximum of 0.26 individuals/km² in 2004. Caribou density was lowest in 2005, the same year in which no caribou were observed in the Nelson River area downstream of the Long Spruce GS. No caribou were observed during reconnaissance flights in this study year. Overall caribou density was lower in the Nelson River area downstream of the Long Spruce GS; however, this is based on two years of data and may not accurately reflect caribou densities in the area over a longer period. Results of aerial surveys are reported as densities because animals were observed and counted, whereas relative abundance is generally reported as an index of abundance, based on the number of signs of a particular species compared with that of others. Seventy-seven caribou were observed during reconnaissance flights in the 2002 study year. In 2003, 98 were observed, 25 were observed in 2004, 23 were observed in 2005, and 45 were observed in 2006. Other observations by workers in the area and KCNs Members have been reported throughout the region (Map 7-26). For maps of annual caribou observations, refer to Appendix 7C.

Table 7-22: Caribou Density in the Caribou Regional Study Area, 2002 to 2006

Study Year	Number Observed	Density (individuals/km²)
2002	24	0.03
2003	347	0.24
2004	146	0.26
2005	8	0.02
2006	16	0.05
Total/*Mean*	541	*0.12*

Based on aerial reconnaissance surveys between 2003 and 2008, Pen Islands caribou appear to move west into the Regional Study Area in late December and early January, with the greatest number of caribou occurring in late January and early February. By March, Pen Islands caribou move east of the Regional Study Area and make their way back into Ontario. In late December and early January 2010, the Qamanirjuaq herd was observed as far south as the Limestone Lake area, however most of the herd was seen just south of the Churchill River. In December 2004 and January 2005, barren-ground caribou were observed crossing PR 280 between the north arm of Stephens Lake and the PR 290 junction, some of which also crossed the Nelson River. Presently, barren-ground caribou are rarely observed that far south. Generalized migration movements of caribou into the Keeyask region in early winter are depicted in Map 7-27, and movements out of the Keeyask region in late winter are depicted in Map 7-28.

The greatest number of caribou observed in winter occurred between December 2004 and January 2005 and included Qamanirjuaq, Pen Islands, and Cape Churchill caribou. About 10,000 animals were observed moving in larger groups between the north arm of Stephens Lake and the town of Bird outside of formal aerial surveys (Manitoba Conservation, unpubl. data).

During the January and March 2009 aerial survey for moose that systematically covered a large portion of the SLRMA, 526 Qamanirjuaq, Pen Islands, and Cape Churchill caribou were recorded incidentally. In January 2010, a similar but more intensive aerial survey for moose was conducted in the same geographic region. High densities of caribou tracks were recorded in some areas, but no caribou observations were reported.

The highest number of Pen Islands caribou counted on a single occasion was on December 12, 2006 from a comparison area near the Limestone GS. The number of animals was estimated at 900 to 1,200. The animals were loosely separated into two herds and were observed moving towards the Regional Study Area. After the Pen Islands caribou migrated from the Regional Study Area in April 2009, potential late winter range was identified for approximately 12 caribou. This range was located 30 to 60 km south of the Nelson River in the Regional Study Area. In December 2009 during a survey conducted by FLCN, 400 to 500 Pen Islands caribou were observed in an area northeast of Fox River near Naismith Camp (FLCN 2010 Draft). Tracks indicated the caribou were moving west. Additional groups of 10 to 20 caribou, as well as solitary caribou, were observed along the flight path (FLCN 2010 Draft). Caribou signs were observed in the Atkinson Lake area in December 2011 (Map 7-29) and 27 caribou were observed on the eastern edge of Split Lake in January 2010 (Map 7-30). In March, 26 caribou were observed midway between the December and January observations (Map 7-31). These were likely Pen Islands caribou leaving their winter grounds and making their way east.

Caribou presence was detected on 78% of islands surveyed in calving and rearing complexes in Zone 5 in 2009, 55% in 2010 and 45% in 2011 (Table 7B-73). Signs of calves were observed on 67% of islands in 2009 and 4% in 2011. No calf signs were observed in 2010. Signs of both caribou and black bear or caribou and gray wolves were observed on 2% of the islands surveyed in 2009. The 2009 study used a different survey method, where intense searches were performed where technicians were able to follow game trails and focus on substrates more likely to hold a track rather than following a predetermined transect as was done in 2010 and 2011. The sample size in 2010 was considerably less than that in 2011, which likely explains why no calves were detected in 2010.

Trail camera studies resulted in caribou adults observed in 33% of the peatland complexes sampled in 2010 and 24% in 2011 (Map 7-32, Table 7B-74). Calves were not photographed in either year on islands in peatland complexes; however, a calf was photographed by cameras mounted between islands in 2011. Gray wolves were photographed on 8% and 24% of complexes in 2010 and 2011, respectively, while black bears were found on 25% and 12% of complexes in 2010 and 2011. In 2010, three distinct cow pairs and five bull caribou were identified by unique features including antler formations and scars. In 2011, four distinct bulls were identified. Islands are important calving areas for caribou, as they allow cows with calves to escape predators. While small islands in lakes are likely important for calving, large islands are more significant for rearing as they provide more forage. Potential calving and rearing habitat increases with the number of large islands in lakes. In Zone 5, 44 islands greater than 10 ha in size were identified as primary calving and rearing habitat, with an additional 187 islands between 0.5 and 10 ha identified as important calving habitat but less important rearing habitat, that is, secondary calving and rearing habitat.

During tracking surveys, caribou were detected on 69% islands in lakes surveyed in 2003, 46% in 2005, 92% in 2010 and 86% in 2011. Of these islands, There was evidence of calves on 49% of these islands in 2003, 8% in 2005, 29% in 2010 and 10% in 2011 (Table 7B-75). Caribou were detected on the two islands surveyed in 2009; there was evidence of a calf on one island. Gray wolves were only detected in 2010. There were signs of caribou on all three of the islands on which wolf presence was observed; signs of both caribou calves and gray wolves were observed on one. Black bears were recorded on three islands in 2010; signs of caribou adults were found on two and signs of calves were found on one. Black bear and caribou signs were observed on a single island in 2011.

Trail camera studies resulted in caribou adults observed on 64% of islands in lakes in 2010 and 36% in 2011 (Map 7-32, Table 7B-76). Calves were observed on 64% and 17% in 2010 and 2011, respectively. No predators were photographed on these islands. In 2010, nine distinct cow-calf pairs and several bull caribou were also identified by unique features including antler formations and scars. In 2011, two distinct cow-calf pairs were identified along with 12 bulls. It is likely the number of distinct animals using the islands is higher; however, a lack of unique features makes identifying individuals problematic.

Summer Resident Caribou Habitat Models

Primary calving and rearing habitat is defined as islands in lakes greater than 10 ha in size or peatland complexes greater than 2,000 ha. Secondary calving and rearing habitat is defined as islands in lakes between 0.5 and 10 ha in size or peatland complexes between 30 and 200 ha. Zone 5 (Map 7-1) contains at least 96 potential peatland complexes and at least 230 islands in lakes that are suitable for calving (Map 7-33). Many more peatland complexes and islands in lakes extend outside the area displayed in Map 7-33 and into the Regional Study Area.

Winter habitat is in black spruce, jack pine, or tamarack-dominated peatland, and is not divided into primary or secondary types (Table 7-23). Habitat is selected at multiple spatial scales and based on its level of disturbance, as human-caused or natural alteration and fragmentation could attract moose, which in turn attract wolves, increasing the predation risk for caribou (Rettie and Messier 2000).

Table 7-23: Winter Habitat Types in the Caribou Regional Study Area

Coarse Habitat Type
Black spruce treed on mineral soil
Black spruce treed on shallow peatland
Black spruce treed on wet peatland
Black spruce treed on thin peatland
Jack pine treed on mineral and thin peatland
Jack pine treed on shallow peatland

Table 7-23: Winter Habitat Types in the Caribou Regional Study Area

Coarse Habitat Type
Tamarack-black spruce mixture on wet peatland
Tamarack treed on shallow peatland
Tamarack treed on wet peatland

7.3.6.3.5 Local Abundance and Habitat

Few of the caribou observed during aerial surveys from 2002 to 2006 were observed in the Local Study Area. Observations were only made in 2002, where density was 0.05 individuals/km^2 (Table 7-24). Mean density was 0.01 individuals/km^2 over a four-year period. None of the blocks surveyed in 2006 were in the Local Study Area. During the 2011–2012 aerial survey a limited number of caribou tracks were observed during all three visits in the Local Study Area.

Table 7-24: Caribou Density in the Caribou Local Study Area, 2002 to 2006

Study Year	Number Observed	Density (individuals/km^2)
2002	21	0.05
2003	0	0
2004	0	0
2005	0	0
2006	-	-
Total/*Mean*	21	*0.01*

In the Local Study Area, signs of caribou were observed on 76% of islands sampled in peatland complexes in 2009, 57% in 2010, and 44% in 2011 during tracking studies in calving habitat (Map 7-34). Calves were found on 65% of islands surveyed in 2009 and 5% in 2011, with no signs of calves in 2010 (Table 7B-77). Signs of caribou and black bear or caribou and gray wolves were found on 2% of the islands surveyed in 2009.

Caribou signs were very common along lake perimeter transects in the Local and Regional Study Areas in summer (Table 7-25). Signs were abundant (0.21 signs/100 m^2) and were found on all transects. No lake perimeters were surveyed in winter. Signs were abundant at lakes north of Gull Lake (0.22 signs/100 m^2) and sporadic at lakes south of Gull Lake (0.19 signs/100 m^2; Table 7B-78). Mean frequency of caribou signs was similar inside (0.20 signs/100 m^2) and outside (0.21 signs/100 m^2) Zone 1. Signs of caribou activity were observed in all six habitats surveyed. Mean frequency of caribou signs ranged from 0.07 signs/100 m^2 in black spruce treed on mineral and thin peatland or shallow peatland to

0.29 signs/100 m² in low vegetation or tall shrub on wet peatland habitat. Signs were also abundant in young regeneration on mineral and thin peatland or shallow peatland (0.28 signs/100 m²) and black spruce treed on shallow peatland (0.25 signs/100 m²).

Table 7-25: Mean Frequency of Caribou Signs (signs/100 m²) in the Caribou Local Study Area

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.21	0.03	abundant	1.00	very widespread	very common
Coarse habitat mosaics	0.36	0.07	abundant	0.84	very widespread	very common
Coarse habitat mosaics (winter)	0.08	0.05	scarce	0.11	scattered	sparse
Riparian shorelines	0.72	0.21	very abundant	0.72	very widespread	very common

Signs of caribou activity were very common on coarse habitat mosaic transects in summer. Signs were abundant (Table 7-25) and observed on all transects. Caribou signs were very abundant on islands (Table 7B-79) over the three-year study period. Signs were abundant on transects north (0.33 signs/100 m²) and south (0.37 signs/100 m²) of Gull and Stephens lakes. Mean frequency of caribou signs was similar in riparian (0.35 signs/100 m²) and terrestrial (0.37 signs/100 m²) areas, and inside (0.38 signs/100 m²) and outside (0.34 signs/100 m²) Zone 1. Signs of caribou activity were observed in all thirteen habitats surveyed. Mean sign frequency ranged from 0.04 signs/100 m² in black spruce mixedwood on mineral and thin peatland to 0.50 in black spruce treed on mineral and thin peatland or shallow peatland.

Signs of caribou activity were sparse on coarse habitat mosaic transects in winter. Sign abundance was scarce and distribution was scattered (Table 7-25). Signs were scarce (0.03 signs/100 m²) on transects north of Gull and Stephens lakes and sporadic on transects south of the lakes (0.12 signs/100 m²; Table 7B-80). Mean frequency of caribou signs was greater on transects inside Zone 1 (0.21 signs/100 m²) than outside (0.16 signs/100 m²). Caribou signs were observed in four of the nine habitats surveyed. No signs were observed in black spruce treed on mineral and thin peatland or shallow peatland, young regeneration on mineral and thin peatland, young regeneration on mineral and thin peatland or shallow peatland, low vegetation or tall shrub on wetland, or on black spruce treed on wet peatland habitat. Where signs were observed, they ranged from 0.07 signs/100 m² in black spruce treed and young regeneration on mineral and thin peatland and in black spruce treed on shallow peatland, to 0.13 signs/100 m² on black spruce treed on mineral and thin peatland and in broadleaf mixedwood on mineral and thin peatland.

Caribou signs were very common along riparian transects in the local study area in the summer. Signs were very abundant and very widespread (Table 7-25). No riparian transects were surveyed in winter. Caribou signs were very abundant on the north and south shores of Gull Lake, and on island shorelines over the three-year study period (Table 7B-81). Mean sign frequency was greatest on the south shore of the lake (1.06 signs/100 m^2). Caribou signs were very abundant on transects in all widths of riparian zones, and on all slopes. Signs were observed in all but one of the seven habitats surveyed. None were found in broadleaf treed on all ecosites habitat. Where signs were observed, mean frequency ranged from 0.25 signs/100 m^2 in black spruce mixedwood on mineral and thin peatland to 2.83 signs/100 m^2 broadleaf mixedwood on mineral and thin peatland.

Signs of caribou activity ranged from scarce to abundant on the north and south access road routes (Table 7B-82). Signs were observed during all study years.

Caribou were active in the Local Study area in summer, and were scarce in winter. However, caribou density was greater in the Regional Study Area in winter. Seasonal variation in caribou density was expected, as several caribou populations migrate through the Keeyask region. The timing of movements and the habitats used may vary among caribou types and from year to year for each type of caribou. Variations in caribou densities are further explained by habitat quality, habitat availability, and the spatial distribution of habitats in the study areas (Thompson and Abraham 1994; Abraham and Thompson 1998).

7.3.6.4 Moose

7.3.6.4.1 General Life History

Moose inhabit the boreal forest of North America and their distribution follows those of preferred trees and shrubs. Winter ranges are smaller than summer ranges (Phillips *et al.* 1973). Food availability, thermal cover, and predator avoidance influence habitat selection in winter (Dussault *et al.* 2005). Moose occupy habitat in a wide range of **seral** stages, riparian and forested areas, and the periphery of burns (Irwin 1975; Coady 1982). Upland and lowland habitats are used throughout the winter and lowland riparian areas are used when snow is deep (Coady 1982).

In summer, moose home ranges expand (Stevens 1970; Phillips *et al.* 1973; Crête and Courtois 1997). Lowland and upland mature stands, shrubs, and aquatic areas are commonly inhabited (Irwin 1975; Coady 1982). Burned areas are also used in summer; deciduous burn stands are preferred but conifer burn stands may also be used (Irwin 1975); moose density peaks between 11 and 30 years after a fire (Maier *et al.* 2005). Coniferous trees near shrub stands often create **edge effects** that allow moose to browse on new growth while utilizing protective cover from the nearby canopy.

Preferred moose habitat consists of open deciduous cover, riparian zones, or recent burns (Peek 2007). It may also include a combination of riparian and upland habitats. Primary habitats likely provide moose with better availability and abundance of common food items (Slaney & Company 1974; Coady 1982) such as horsetail, reedgrass, pondweed, dogwood, alder, and willow, or common tree species such as black spruce, tamarack, and jack pine for shelter.

Moose rut in autumn (FLCN 2010 Draft). Females choose areas with elevated ridges and shorelines or small ponds (Bubenik 2007), and males can be found on shorelines of streams or lakes, where they call to attract females (FLCN 2010 Draft). No other rutting behaviour in the Keeyask region has been noted by ATK, local knowledge, or field studies.

Moose have traditional seasonal ranges with most populations having migratory and nonmigratory segments (Goddard 1970; LaResche *et al.* 1974, Hundertmark 2007). Moose migrate as a survival tactic for locating optimal forage throughout the year. Change in habitats may involve movements that vary in length and changes in elevation. Snow conditions are the prime factor in initiating winter moose migration, but in other seasons, changes in forage quality or quantity may be responsible for moose movement (LaResche *et al.* 1974).

Factors limiting moose populations include limited forage, climate, accidental death such as drowning (Crête and Courtois 1997), and snow depth (Mech *et al.* 1987). Predation, particularly by gray wolves and bears (Van Ballenberghe and Peek 1971) is a major source of moose mortality, while hunting is an effective tool in managing moose population numbers (Timmerman and Buss 2007).

7.3.6.4.2 General Abundance and Habitat

Historic evidence of moose suggests that their limit was once in the southern Keeyask region; however, in the past 200 years their range has extended as far north as Hudson Bay (Krefting 1974). Historically moose were present between Split Lake and Stephens Lake. Following hydroelectric development, their presence on the shores of Split Lake was diminished because of shoreline habitat loss (Split Lake Cree 1996a) and fluctuating water levels (YFFN Evaluation Report *(Kipekiskwaywinan)*). Anecdotal evidence from trappers and traditional knowledge suggests that populations have been recovering from the effects of past hydroelectric development (Split Lake Cree 1996a). Maps shared by TCN (TCN 2000a; 2000c) depict moose hunting areas on the south shore of the Nelson River between Split Lake and Birthday Rapids, and on the north and south shores of the Nelson River downstream of Birthday Rapids to Stephens Lake. Furthermore, TCN Members identified areas where moose have been noted feeding and breeding in the Gull Lake area (TCN 2000a; 2000c). Moose are often observed on the shores of Stephens Lake, and the islands in the lake are used by cows for calving (FLCN 2010 Draft).

Moose are widespread, abundant, and secure throughout Manitoba (NatureServe 2011). Manitoba Conservation reports that moose are found throughout the province. Since 1992, the population has increased from approximately 28,000 to 32,000 individuals (Manitoba Conservation n.d.*e*). Recently however, moose declines have been noted, especially in southern regions of Manitoba, where hunting has been closed in GHAs 13, 13A, 14, 14A, 18, 18A, 18B, 18C and 26 (Manitoba Conservation 2011b).

Moderate to high variations in moose density were apparent among habitats, seasons and years surveyed. Moose densities in the Regional Study Area are similar to previous provincial aerial surveys (1999–2000). In GHA 3[1], densities ranged from zero moose per km^2 in low strata[1] to 0.317 moose per km^2 in super

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[1] *i.e.*, a region that overlaps with a portion of the Keeyask Study Areas.

high strata. In medium strata, moose densities are 0.165 moose per km² (Manitoba Conservation unpubl. data). On average, 2002–2007 moose densities in the Regional Study Area were low to medium compared to the full range of moose strata in GHA 3. A few areas in the region may support higher moose densities than are found in super high moose strata in GHA 3. In a much larger survey area (GHA 9[2]), the 2001–2002 provincial estimate of this population was 6,822 moose (95% confidence interval = 3,406 to 10,238).

Approximately 750 moose (range = 661 to 812) are harvested per year by licensed hunters in GHA 9 and/or in parts of GHAs 1, 2, 3, and 3A (Manitoba Conservation 1993–2007 unpubl. data). This harvest level is less than the proportional harvest of most other southern GHAs in Manitoba (Rebizant *pers. comm.* 2008).

7.3.6.4.3 Split Lake Resource Management Area Abundance and Habitat

The moose population[3] was estimated at 2,600 +/- 21.4% (95% confidence interval = 2,044 to 3,155). Moose density was six individuals/100 km². In the mid-1990s, the population was estimated at 1,639 moose (Split Lake Resource Management Board 1994), indicating that the moose population may have increased in the last seventeen years; however, confidence intervals were not available from the 1994 survey for comparison.

As determined by the 2010 survey, the calf:cow ratio was 36:100. The bull: cow ratio was 118:100. Currently, the survival of calves to about nine months of age tends to be slightly low, and the sex structure of the population favours bulls. The high bull: cow ratio was likely caused by the disproportionately high number of bulls in the low-density stratum, or possibly from a disproportionately high harvest of cows.

The lowest moose densities were observed in the northeastern portion of the SLRMA while the highest were observed primarily near major rivers or water bodies and younger burns (Moose Harvest Sustainability Plan).

The SLRMB[4] has established a number of guidelines for harvesting moose, including selective hunting (*i.e.*, shooting a moose calf in the fall, targeting bull moose over cows), shooting only what is needed, and reporting moose kills. The latter is particularly important as it provides important information in developing conservation plans and changes to moose harvest. These guidelines allow for a sustainable approach to moose management in the SLRMA (Split Lake Resource Management Board 1994).

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[1] Low strata are considered as sample unit areas with low quality habitat for moose. Strata sampled may range from extra low to super high.

[2] GHA 9 extends from about Keeyask to the Manitoba-Saskatchewan border.

[3] A three-stage aerial survey for moose was conducted between March 2009 and January-February 2010. During the final stage, stratified random sampling was used to estimate the moose population over the entire SLRMA.

[4] The Split Lake Resource Management Board is a joint body composed of members of Tataskweyak Cree Nation, the Manitoba Government, and Manitoba Hydro whose goal is to balance resource use and conservation (SLRMB 1994).

Moose densities from aerial surveys conducted between 2002 and 2007 ranged from extra low (less than 0.05 moose/km²) or near zero to extra high (more than 0.36 moose/km²; Map 7-35). Low moose densities were in the range of 0.06 to 0.15 moose/km², medium densities were categorized in early studies at about 0.16 to 0.25 moose/km², and high densities ranged from 0.26 to 0.35 moose/km².

7.3.6.4.4 Regional Abundance and Habitat

The Moose Local Study Area was Zone 4 and the Moose Regional Study Area was Zone 5 in Map 7-1. Data extrapolated from the 2010 SLRMA aerial survey indicates that the moose population is approximately 950 individuals in the Regional Study Area. Aerial surveys for moose (and caribou) were conducted during winter on nine other occasions between 2002–2003 and 2006–2007. A total of 212 moose were observed in a 2,338 km² survey area during the survey periods. Moose density averaged 0.09 moose/km² (min = 0; max = 0.77) over the study periods. Resource users from FLCN indicate that the Butnau River, Kettle River, and Cache Lake are important areas for moose hunting, and that food for moose is abundant in these areas (FLCN 2010 Draft). Moose were also observed in the Regional Study Area during aerial surveys for caribou in December 2011, (Map 7-36), January 2012 (Map 7-37), and March 2012 (Map 7-38).

Aerial surveys in the regional study area indicated that overall average moose density remained about the same from 2002 to 2006 (Table 7-26). Moose density ranged from 0.02 individuals/km² in 2002 to 0.06 individuals/km² in 2004. Twenty-seven moose were observed during reconnaissance flights in 2002. Twenty-nine were observed in 2003, 26 in 2004, and 10 in 2005. Observations of moose and signs are depicted in Map 7-39. No reconnaissance flight was done in March 2006.

Table 7-26: Moose Density in the Regional Study Area, 2002 to 2006

Study Year	Number Observed	Density (individuals/km²)
2002	12	0.02
2003	63	0.04
2004	32	0.06
2005	22	0.04
2006	18	0.05
Total/*Mean*	147	*0.04*

Data collected from the 2010 SLRMA aerial survey indicates that moose densities were greater north of the Nelson River in the Regional Study Area, with the greatest densities occurring in a burn west of Stephens Lake as well as in the vicinity of Orr Lake (Moose Harvest Sustainability Plan).

Trail camera studies resulted in adult moose observed in 83% of peatland complexes in 2010 and 59% in 2011 (Map 7-40; see Table 7B-74). Calves were photographed in 25% and 12% of complexes in 2010 and 2011 respectively. Gray wolves were photographed in 8% and 24% of complexes in 2010 and 2011 respectively while black bears were found in 25% and 12% of complexes in 2010 and 2011, respectively. Moose and gray wolves were observed in 8% of complexes in 2010 and 6% in 2011, while moose and black bear were observed in 25% and 12% of complexes in 2010 and 2011, respectively. In 2010, five distinct cows and two bulls were identified by unique features including antler formations and scars. No individual moose were identified in 2011.

Trail camera studies resulted in moose adults observed on 68% of islands in lakes in 2010 and 53% in 2011 (see Table 7B-76). Calves were observed on 39% and 25% in 2010 and 2011, respectively. No predators were photographed on these islands. In 2010, 14 distinct cows and three bulls were identified by unique features including antler formations and scars. Eight distinct cows, two calves, and four bulls were identified in 2011.

Moose Habitat Model

Primary moose habitat includes forest stands dominated by broadleaf trees, jack pine, and tall shrubs (Table 7-27) and covers 38% of the Regional Study Area. Willow communities provide important winter cover and food (Palidwor *et al.* 1995). Secondary moose habitat consists of forest stands dominated by black spruce and low vegetation and covers 74% of the Regional Study Area.

Table 7-27: Primary and Secondary Moose Habitat Types in the Moose Regional Study Area

	Coarse Habitat Type
Primary Habitat	Broadleaf mixedwood on all ecosites
	Broadleaf treed on all ecosites
	Jack pine mixedwood on mineral and thin peatland
	Jack pine treed on mineral and thin peatland
	Jack pine treed on shallow peatland
	Low vegetation on mineral and thin peatland
	Marsh
	Tall shrub on mineral and thin peatland
	Tall shrub on shallow peatland
	Tall shrub on wet peatland
	Vegetated riparian peatland
	Vegetated upper beach
	Burn
Secondary Habitat	Black spruce mixedwood on mineral and thin peatland
	Black spruce mixedwood on shallow peatland

Table 7-27: Primary and Secondary Moose Habitat Types in the Moose Regional Study Area

	Coarse Habitat Type
	Black spruce treed on mineral soil
	Black spruce treed on shallow peatland
	Black spruce treed on wet peatland
	Black spruce treed on thin peatland
	Low vegetation on shallow peatland
	Low vegetation on wet peatland

7.3.6.4.5 Local Abundance and Habitat

Approximately one third of the moose observed during aerial surveys from 2002 to 2006 were in the Local Study Area (Table 7-28). Mean density was 0.13 individuals/km^2 over a four-year period. None of the blocks surveyed in 2006 were in the Local Study Area.

Table 7-28: Moose Density in the Moose Local Study Area, 2002 to 2006

Study Year	**Number Observed**	**Density (individuals/km^2)**
2002	9	0.02
2003	12	0.06
2004	20	0.27
2005	10	0.18
2006	-	-
Total/*Mean*	51	*0.13*

Moose densities were primarily extra-low to low in the Moose Local Study area as observed during the 2010 SLRMA aerial survey (Map 7-41). High densities were observed in a large burn west of the northern arm of Stephens Lake to PR 280 and south of Gull Lake (Moose Harvest Sustainability Plan).

Moose signs were very common on tracking transects in the Local Study Area (Table 7-29). Moose signs were abundant (0.35 signs/100 m^2) and found on all lake perimeter transects in the Local and Regional Study Areas. Mean frequency of moose signs was greater at lakes south of Gull Lake (0.40 signs/100 m^2) than north (0.31 signs/100 m^2; Table 7B-83). Moose signs were more abundant inside Zone 1 (0.42 signs/100 m^2) than outside (0.28 signs/100 m^2). Moose signs were observed in all six habitats surveyed. Mean sign frequency ranged from 0.21 signs/100 m² in black spruce treed on wet peatland to 0.54 signs/100 m² on young regeneration on mineral and thin peatland or shallow peatland habitat. Signs of moose activity were very abundant on small (0.39 signs/100 m²) and medium-sized (0.35 signs/100 m²) lakes, and abundant on large lakes (0.23 signs/100 m²).

Table 7-29: Mean Frequency of Moose Signs (signs/100 m²) in the Moose Local Study Area

Transect Type	Mean	S.E.	Abundance	Proportion of Transects	Distribution	Species Rarity
Lake perimeters	0.35	0.05	abundant	1.00	very widespread	very common
Coarse habitat mosaics	0.32	0.02	abundant	0.98	very widespread	very common
Coarse habitat mosaics (winter)	0.27	0.01	abundant	0.28	widespread	very common
Riparian shorelines	0.98	0.14	very abundant	0.85	very widespread	very common

Moose signs were abundant and very widespread on coarse habitat mosaic transects in summer (Table 7-29). Moose signs were abundant on transects north and south of Gull and Stephens lakes, and on islands (Table 7B-84). Mean frequency of moose signs was similar on transects in riparian and terrestrial areas (0.32 signs/100 m²). Signs of moose activity were more abundant inside Zone 1 (0.36 signs/100 m²) than outside (0.29 signs/100 m²). Signs of moose activity were observed in all 13 habitats surveyed. Mean sign frequency ranged from 0.11 signs/100 m² in young regeneration on shallow peatland to 0.68 signs/100 m² in black spruce treed and young regeneration on mineral and thin peatland habitat. Moose signs were observed on all transects in most habitats. Signs were observed on 98% of transects in black spruce treed on mineral and thin peatland and 67%of transects in broadleaf treed on all ecosites habitat.

Signs of moose activity were abundant and widespread on coarse habitat mosaic transects in winter (Table 7-29). Signs were scarce on transects north and south of Gull and Stephens lakes, in riparian and upland areas, and inside and outside Zone 1 over the two-year study period (Table 7B-85). However, the distribution of moose signs was widespread. Moose signs were observed in six of the nine habitats surveyed. No signs were observed in black spruce treed and young regeneration on mineral and thin peatland, low vegetation or tall shrub on wet peatland, or on black spruce treed on wet peatland habitat. Where signs were observed, mean frequency ranged from 0.01 signs/100 m² on black spruce treed on mineral and thin peatland or shallow peatland to 0.07 signs/100 m² in black spruce treed on shallow peatland habitat. Signs were observed on the greatest proportion (75%) of transects in young regeneration on mineral and thin peatland habitat.

Moose signs were very abundant and very widespread on riparian shoreline transects on Gull Lake (Table 7-29). Signs were very abundant on the north and south shores of the lake, and on islands (Table 7B-86). Mean sign frequency was greatest on the south shore (1.16 signs/100 m²). Moose signs were very abundant in riparian zones of all widths and slopes, with one exception; signs of moose activity were abundant on shorelines with the greatest slopes (0.48 signs/100 m²). Moose signs were observed in all seven habitats surveyed. Mean sign frequency ranged from 0.33 signs/100 m² in low vegetation or tall shrub on wet peatland to 1.17 signs/100 m² in black spruce treed on shallow peatland and in broadleaf mixedwood on mineral and thin peatland.

Signs of moose activity were observed on the north and south access road routes during all study years (Table 7B-87). Abundance ranged from scarce (0.01 signs/100 m²) on the south route in 2001 and 2002 to very abundant (0.93 signs/100 m²) at the potential stream crossing sites surveyed in 2004. Moose signs were very widely distributed on the transects surveyed in 2003 and 2004.

Moose were widely distributed and often found near water (*e.g.*, Looking-back Creek). Signs of activity were found in all habitats in the Local Study Area, although they were found in fewer habitats and were less widely distributed in winter. Highly variable moose densities (none to medium) can be expected in the Regional Study Area. The greatest moose densities were observed in the north of PR 280, and well outside the Local Study Area. Approximately 10% of the Local Study Area contains primary moose habitat and 69% contains secondary moose habitat (Map 7-42).

7.3.7 Summary of Current Conditions

Rarity of mammal species ranged from absent to very common on mammal tracking transects in the various Local Study Areas (Table 7-30). Aquatic furbearers were more common on transects associated with water, such as riparian shorelines and lake perimeters, than on upland transects. Terrestrial furbearer signs were most common in winter, when signs are more easily detected. As black bears are mostly inactive in winter, no signs were observed on the coarse habitat mosaic transects at that time.

Table 7-30: Rarity of Mammal Species on Mammal Tracking Transects in Respective Local Study Areas

Group	Species	Lake Perimeters	Coarse Habitat Mosaics (summer)	Coarse Habitat Mosaics (winter)	Riparian Shoreline
Aquatic furbearers	Muskrat	common	sparse	absent	sparse
	Mink	common	sparse	common	common
	River otter	very common	sparse	common	very common
Terrestrial furbearers	Snowshoe hare	common	very common	very common	very common
	Red fox	common	common	Sparse	common
	American marten	common	sparse	common	sparse

Table 7-30: Rarity of Mammal Species on Mammal Tracking Transects in Respective Local Study Areas

Group	Species	Lake Perimeters	Coarse Habitat Mosaics (summer)	Coarse Habitat Mosaics (winter)	Riparian Shoreline
Terrestrial furbearers	Fisher	common	sparse	common	sparse
	Weasel	common	sparse	sparse	absent
	Lynx	absent	sparse	sparse	absent
Large carnivores	Gray wolf	common	sparse	sparse	very common
	Black bear	common	common	absent	very common
VECs	Beaver	very common	sparse	-	sparse
	Caribou	very common	very common	sparse	very common
	Moose	very common	very common	very common	very common

7.3.8 Current Trends

The environment at Keeyask is undergoing changes separate from, and in addition to, changes that would occur due to the development of the Project. Mammal communities are complex, varied, and inextricably linked with the other components of the ecosystems they inhabit. Mammals of the boreal forest are affected by a range of factors, including climate and climate change, disease, the fire cycle, human activity, the composition of plant communities that provide food and shelter, and by other animals that they prey upon, or that prey upon them. These factors will continue to influence the mammal community whether or not the Project proceeds.

7.3.8.1 Expected Changes to the Mammal Community Without the Project

The boreal forest in the Keeyask region provides habitat for many mammal species. Human development such as logging, mining, and settlement expansion would affect the mammal communities of the boreal forest by fragmenting and diminishing their habitat. Such activities could involve road construction, deforestation, and draining wetlands. As no development is currently planned for the Keeyask region, habitat fragmentation by roads, sensory disturbance, habitat degradation, and increased mortality due to access effects are not expected to alter the existing mammal communities. If the Project does not proceed, mammal communities will continue to be influenced mainly by natural succession of the forest community, forest fires, and climate.

Past and existing human impacts and past climate change could influence future habitat for small mammals in the Small Mammals Regional Study Area even if the Project does not proceed. Habitat composition will continue to be an important small mammal population driver. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water (see the Habitat and Ecosystems section of the TE SV). Habitat availability for some species is likely to decline, resulting in further small changes to small mammal community. Vegetation along the Nelson River shorelines will most likely remain as secondary habitat for small mammals due to past and on-going changes in shoreline erosion that continue to affect shoreline cover. Although future habitat adjustments will likely lead to alterations in the composition of the small mammal communities in the Keeyask region, populations are expected to continue to cycle within a natural range of variation.

Past and existing human impacts and past climate change could influence future habitat for furbearers in the Furbearers Regional Study Area even if the Project does not proceed. Habitat composition and availability of prey species will continue to be important furbearer population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. Habitat availability for some species is likely to decline, resulting in further small changes to furbearer populations. Vegetation along the Nelson River shorelines will most likely remain secondary habitat for furbearers due to past and on-going changes in shoreline erosion that continue to affect shoreline food and cover. Future harvest that influences furbearer populations will likely continue to vary with fluctuating fur prices and result in highly variable numbers of animals trapped. Trapline stewardship, policy, and management will continue to influence future furbearer populations. Although future habitat adjustments will likely lead to alterations in the composition of the furbearer community, and of the prey they consume (*i.e.*, small mammals) in the Keeyask region, populations are expected to continue to act within a natural range of variation.

Past and existing human impacts and past climate change could influence future habitat for large carnivores in the Regional Study Area even if the Project does not proceed. The availability of moose and possibly caribou will continue to be an important large carnivore population driver. Because future habitat adjustments are unlikely to lead to alterations in the abundance of moose in the Keeyask region, large carnivore populations are expected to continue to act within a natural range of variation.

Past and existing human impacts and past climate change could influence future habitat for ungulates in the Regional Study Area even if the Project does not proceed. Important drivers that influence ungulate populations are discussed below. Although future habitat adjustments for some types of peatlands will likely lead to alterations in the composition of habitat in the Keeyask region, these habitats are unsuitable for white-tailed deer. White-tailed deer range expansion to include the Regional Study Area is also unlikely if severe winter conditions persist into the future.

Past and existing human impacts and past climate change could influence future habitat for rare or regionally rare species in the Regional Study Area even if the Project does not proceed. Habitat composition and availability of prey species will continue to be important rare or regionally rare species population drivers. Although future habitat adjustments for some types of peatlands will likely lead to alterations in the composition of habitat in the Keeyask region, high quality habitat is unlikely to be affected for most rare or regionally rare species. Vegetation along the Nelson River shorelines will most likely remain as secondary habitat for American water shrew due to past and on-going changes in shoreline erosion that continue to affect shoreline cover. Future harvest that influences rare or regionally rare furbearer populations (*e.g.,* wolverine and coyote, respectively) will likely continue to vary with fluctuating fur prices and result in highly variable numbers of animals trapped. Trapline stewardship, policy, and management will continue to influence future populations. Future habitat adjustments that influence food and cover is somewhat uncertain, but may lead to small alterations in the abundance and distribution of rare or regionally rare species found in the Keeyask region.

Past and existing human impacts and past climate change could influence future habitat for beaver in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important beaver population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. As these peatlands are low quality habitat for beaver, the predicted habitat composition trend is likely to be neutral. Future beaver harvest is linked to the market value of beaver pelts (Manitoba Conservation 2011), and will most likely result in highly variable numbers of beaver trapped. Trapline stewardship, policy, and management will continue to influence future beaver populations. Trappers are stewards of their traplines (Fur Institute of Canada 2003), and are responsible for sustaining local beaver populations. Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation 2009b), thus future harvest is not expected to exceed sustainable levels.

Past and existing human impacts and past climate change could influence future habitat for caribou in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important caribou population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water (see Section 6.2.3.4). The predicted habitat composition trends for caribou would likely be both positive and negative. Ground ice peatland forms some of the treed calving islands in peatland complexes. Lost calving islands will likely be replaced by wet habitat that provides caribou with protection against predators. Although both habitat components have value as caribou habitat, the net effect is uncertain. Finally, on-going changes in erosion resulting from past and existing projects will continue to reduce the size of future caribou calving islands. Because erosion will also contribute to formation of future islands, the net effect on caribou calving habitat is uncertain.

Recently, population declines have been detected for both barren-ground and coastal caribou, and management actions are being taken to reverse these trends. Qamanirjuaq barren-ground caribou are managed by the Beverly and Qamanirjuaq Caribou Management Board, while Manitoba Conservation and the Ontario Ministry of Natural Resources co-operatively manage and monitor the population of coastal caribou. With appropriate management, no changes to these caribou populations are anticipated due to predation and harvest, and long-term recovery efforts for boreal woodland caribou are also being implemented (Environment Canada 2011).

Past and existing human impacts and past climate change could influence future habitat for moose in the Regional Study Area even if the Project does not proceed. Habitat composition, predation, and harvest will continue to be important moose population drivers. Predicted trends in habitat composition include the future disappearance of the ground ice peatland types, which will be replaced by wetland peatland types and open water. As these peatlands are low quality habitat for moose, the predicted habitat composition trend for moose is likely to be neutral. The quality of habitat along the Nelson River will most likely remain low for moose due to past and on-going changes in shoreline erosion that continues to affect shoreline browse. On-going changes in shoreline erosion that resulted from past and existing projects will continue to reduce the size of future moose calving islands. Because erosion will also contribute to formation of future islands, the net effect on moose calving habitat is uncertain. Although the moose population appears stable or possibly has increased in the Regional Study Area, other moose populations in Manitoba are recovering from large declines attributed to increased access and harvest. Future moose populations in the region will continue to be managed on a sustainable harvest basis by Manitoba Conservation, with the first right of harvest belonging to First Nations.

7.4 PROJECT EFFECTS, MITIGATION, AND MONITORING

The technical analysis determined effects of the Project on mammals by considering the linkages among the physical, aquatic, and terrestrial environment and changes caused by the Project, both directly and indirectly. Changes to ecosystem function and existing disturbances were considered. The technical assessment for mammals used several approaches to consider potential effects, including scientific knowledge of causal relationships, habitat models, and proxy comparisons to other hydroelectric projects. The assessment of Project effects is based on the existing environment as it relates to mammal studies that began in 2001. This existing environment incorporates effects of past projects where possible, particularly those considered for the cumulative effects assessment. Potential Project effects on mammals include the following:

- Habitat loss, alteration, and fragmentation;
- Project-related disturbances; and
- Access effects such as increased predation and harvest.

Mammals are expected to experience a change in habitat structure, composition, and intactness through reservoir clearing and the construction of dykes, access roads, the GS, work camps, borrow pits, and other associated infrastructure.

Project-related disturbances include sensory disturbance from construction activities, blasting, and traffic. Such disturbances could decrease the amount of effective habitat available for various species, as individuals disturbed by construction activities will avoid active construction zones. Sensory disturbance could also be due to traffic on the access roads during operation. Accidental events such as spills and human-caused fire could affect areas of varying sizes, thus different numbers of individuals of particular species. Such events would be most likely to occur during the construction phase.

Linear features including roads and cutlines act as movement corridors for predators such as red fox and gray wolf, and improve access to formerly remote areas by resource users. Increased mortality of prey species and harvested animals could result from increased access. Improved hunting efficiency could benefit some predator species. Roads and other linear features also contribute to habitat fragmentation, which reduces core area size for mammals requiring large, undisturbed blocks of habitat. Fragmentation also influences ecosystem processes and species, and promotes the dispersion of invasive species.

The following sections describe the assessment on the following:

- VECs (caribou, moose, and beaver); and
- Other priority mammals, including mammal groups (small mammals, furbearers, and large carnivores, with ungulates as VECs) and rare and regionally rare species (American water shrew, little brown myotis, porcupine, racoon, wolverine, striped skunk, and coyote).

7.4.1 Small Mammals

7.4.1.1 Construction

7.4.1.1.1 Habitat Loss, Gain, and Alteration

Clearing of the reservoir area will reduce the quality of small mammal habitat by removing trees. Small mammals have small home ranges and will experience greater levels of habitat loss than mammals with larger home ranges (Andrén 1994). Small mammal species such as meadow vole that do not require trees as part of their microhabitat food and cover requirements are expected to increase in number and temporarily replace individuals affected by habitat loss (*e.g.*, red-backed vole). These potential effects are not measurable, given the very high and widely distributed population levels and high reproductive rates that are most often associated with small mammal species. As small mammals such as voles cannot safely travel long distances (Johnson and Johnson 1982), those whose home ranges are lost to clearing of the reservoir and other Project footprints will not likely relocate to habitats beyond Zone 1 and will perish. Small mammals whose home ranges are on the periphery of Project activities could find suitable habitat nearby.

7.4.1.1.2 Project–related Disturbances

Sensory disturbances from construction activities, blasting, and traffic on the south access road could negatively affect mammal habitats (AMEC Americas Limited 2005). Small mammals could respond to sensory disturbance in a manner similar to their response to a predator and alter their behaviour to avoid the risk (Frid and Dill 2002), resulting in a loss of effective habitat. After construction activity has ceased, small mammals will likely return to suitable habitat that was abandoned due to noise disturbances.

Project-related disturbances include altered movements and mortality on the south access road. Small mammals do not appear to be affected by traffic density (McGregor *et al.* 2008). While small mammal density will not necessarily decrease near roads, avoidance of the road itself will prevent small mammals from crossing (Oxley *et al.* 1974; McGregor *et al.* 2008). Despite their general avoidance of roads, road kills increase during periods consistent with small mammal breeding and dispersal (Clevenger *et al.* 2003). The effects of mortality due to road kills on the south access road will not likely be measurable in the Small Mammals Local Study Area.

Accidents and malfunctions such as spills and fires could affect small mammals. Accidental spills would affect site-specific areas for a short period. Given the low probability of occurrence, the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be no measurable effect on small mammal populations. The risk of fire would most likely be greatest during construction and would have an immediate negative effect on small mammals and their habitats. A burn would displace small mammals from an area, would alter forest composition and structure, and could result in the death of those unable to escape. Studies suggest that not all small mammals avoid burned areas (Ford *et al.* 1999) and that these areas are quickly recolonized by a succession of small mammal species (Krefting and Ahlgren 1974; Zwolak and Foresman 2007). As small mammals are prolific breeders (Banfield 1987), their populations would likely recover rapidly.

Encounters with humans could affect the small mammal population in the Local Study Area. Small mammals could present a problem at the work camp or other work areas, particularly in places associated with food and food preparation such as kitchen and dining areas. Where small mammals enter and occupy camp buildings, they will likely be controlled. Due to their rapid rate of reproduction (Banfield 1987), no measurable effects on small mammal populations in the Local Study Area are anticipated.

7.4.1.1.3 Access

Linear features such as roads could act as movement corridors for coyote (Ruggiero *et al.* 1999) and red fox, potentially resulting in improved predator mobility and hunting efficacy. As small mammals are the primary food source for these species (Banfield 1987), small mammal mortality would increase. As small mammals experience natural population cycles (Johnson and Johnson 1982) and reproduce rapidly (Banfield 1987), minimal effects on small mammals in the Local Study Area are anticipated as a result of increased predation.

7.4.1.1.4 Summary of Construction Effects

Clearing of the reservoir area will reduce the quality of small mammal habitat by removing trees. Effective habitat will likely be reduced due to construction-related sensory disturbance and due to traffic on the access roads. The access roads could create a barrier to small mammal movements; however, mortality due to road kills could increase, particularly as young disperse. A few small mammals could occupy the work camp. If mice enter camp buildings, they will be controlled. Because small mammals rapidly recolonize areas following natural or human-caused disturbances, suitable habitat is available beyond Zones 1 and 2, and predator effects on small mammal populations are not expected to be measurable, the overall effect during construction will likely be neutral. With mitigation, no measurable Project-related effects on small mammals in the Local Study Area are anticipated.

7.4.1.1.5 Mitigation

Mitigation for habitat loss or alternation is not recommended as small mammal habitat is common, and small mammals are common and resilient. Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment (*i.e.*, at the GS site) will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- Roadside ditches will be rehabilitated with native plants with low quality food values for small mammals where practicable, to minimize the attraction of predators and **incidental take**.

7.4.1.1.6 Residual Effects of Construction

Residual effects on small mammals that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable and are predicted to be limited to the Small Mammals Local Study Area and affect two or more generations.

7.4.1.2 Operation

7.4.1.2.1 Habitat Loss, Gain, and Alteration

During operation, effects of habitat loss on small mammals will become permanent in the reservoir. Long-term habitat loss or alteration is associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects (see the Habitat and Ecosystems section of the TE SV). Small mammals will likely recolonize areas that were abandoned during construction, particularly those where disturbance from operation is not expected or is minimal.

Small mammals will initially be displaced during the clearing phase of construction; however, cleared areas will likely be recolonized by small mammals before inundation. Small mammals that recolonize the area will be displaced during inundation, and will likely perish during the flood (Anderson *et al.* 2000).

7.4.1.2.2 Project-related Disturbances

During operation, the access roads will create a barrier to some small mammal movements. Once the Project is commissioned, PR 280 will be re-routed to include the north access road, the GS facility over the Nelson River, and the south access road to Gillam and the mobility of small mammals could be limited. Effects could be offset by the expected decrease in traffic on the current section of PR 280. Individuals that do not avoid the access roads will be susceptible to collisions with vehicles. Mortality due to road kills will not likely have a measurable effect on the small mammal populations in the Local Study Area.

Accidents and malfunctions such as spills, fires, and dam failure could affect small mammals during operation. The risk of spills and fires will be much smaller during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. Fire would have an immediate effect, as small mammals would abandon the area to avoid the burn, or more likely would perish. Species such as deer mouse would quickly recolonize burned areas (Krefting and Ahlgren 1974). As post-fire stands aged, other small mammals such as voles, shrews, mice, and squirrels would return (Fisher and Wilkinson 2005). The risk of spills will be considerably lower during operation, and these are not anticipated to have measurable effects on small mammal populations. Dam failure would result in flooding, habitat loss, and the death of small mammals, as they would be unable to relocate before inundation.

7.4.1.2.3 Access

When the north and south access roads become new portions of PR 280 during operation, their use by the public will not be restricted. While traffic volume does not appear to be the main factor deterring small mammals from crossing roads (McGregor *et al.* 2008), mortality due to road kills could increase. Effect could be offset by the resulting decrease in traffic on PR 280, and will likely be neutral.

Predators such as coyote (Grinder and Krausman 2001) and red fox (Frey and Conover 2006) use linear features such as roads as travel corridors for movement and dispersal. Improved access to the Local Study Area by such predators via roads and other linear features could continue during operation, leading to a slight increase in small mammal mortality, which are common prey species (Banfield 1987). As small mammals reproduce rapidly, increased predation is not expected to have a measurable effect on small mammal species in the Local Study Area.

7.4.1.2.4 Summary of Operation Effects

Effects of habitat loss will become permanent in the reservoir during operation. Small mammals are expected to recolonize areas that were abandoned during construction. Long-term habitat loss or alteration is associated with flooding, shoreline erosion, peatland disintegration and reservoir-related groundwater and edge effects. Small changes in species composition and density are expected for habitats rehabilitated with native vegetation. The main access road could create a barrier to some small mammals' movements, and accidental mortality can be expected due to road kills. Small mammal populations in the Local Study Area are abundant and resilient, and habitat supply for small mammals is not limiting, thus effects on small mammals are expected to be small.

7.4.1.2.5 Mitigation

The Project Description Supporting Volume (PD SV) includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for the effects of dam failure on small mammals.

Other mitigation measures include:

- Temporarily cleared areas and excavated materials placement areas (see the Habitat and Ecosystems section of the TE SV) will be rehabilitated to native habitat types where practicable to improve small mammal habitat.

7.4.1.2.6 Residual Effects of Operation

Residual effects on small mammals that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable and are predicted to be limited to the Local Study Area and affect two or more generations.

7.4.1.3 Conclusion About Residual Effects on Small Mammals

The extent of Project effects on small mammals is expected to be the same during construction and operation. No large effects are not expected as habitat availability does not appear to be a limiting factor for these populations. The adverse residual effects of the Project on small mammals will not overlap with future projects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and are vulnerable to the effects of future projects and activities. As small mammals are not a VEC, they are not covered in the cumulative effects assessment step that deals with future projects. There is no monitoring planned for small mammals.

7.4.2 Aquatic Furbearers

7.4.2.1 Construction

7.4.2.1.1 Habitat Loss, Gain, and Alteration

Aquatic furbearers (muskrat, mink, and river otter) require riparian habitats for travel routes and for the variety of prey species they support. Riparian habitat will mainly be lost at stream crossings and areas cleared adjacent Gull Lake, tributaries, or ponds prior to reservoir flooding. Potential resting and denning sites and vegetative shelter could be lost or disturbed.

While muskrat density was low on the central Nelson River, which includes Gull Lake, muskrat inhabit creeks and ponds in Zone 1, which will be affected by clearing. Signs of mink activity were observed on five of the 10 lakes surveyed in Zone 1 and on 39% of shoreline transects on Gull Lake. Sign of river otter activity were observed on all 10 lakes in Zone 1 and on 61% of shoreline transects on Gull Lake. As such, some individuals spend at least a portion of their time in the area to be affected. Muskrat, mink, and river otter residing in Zone 1 will be displaced during the clearing phase; however clearing of riparian zones will occur as close to impoundment as possible (PD SV).

7.4.2.1.2 Project–related Disturbances

Project-related disturbances such as sensory disturbance and increased mortality could affect aquatic furbearers during construction. Sensory disturbances, which include construction activities, blasting, and traffic, can negatively affect aquatic furbearer habitat (AMEC Americas Limited 2005). Sensory disturbances will result in a small loss of effective habitat, particularly in areas of active construction and heavy traffic (AMEC Americas Limited 2005). Disturbances due to noise from construction activities and blasting will likely reduce effective habitat near riparian areas. Blasting and the operation of heavy equipment could result in localized effects on aquatic furbearer populations, as animals will likely abandon the area for a less disturbed environment. However, aquatic furbearers are expected to return to suitable habitat after construction activity has ceased. Sensory disturbances due to traffic along the south access road could result in avoidance by some individuals. The south access road passes through a relatively low proportion of aquatic furbearer habitat relative to the amount of habitat available in the Furbearers Regional Study Area, and the effects of sensory disturbance on aquatic furbearer populations are expected to be minimal.

Muskrat will be affected by rising water levels on Gull Lake and upstream during construction. Muskrat that remain in the affected areas after clearing will likely be displaced or drowned.

Accidents and malfunctions such as spills and fires could affect aquatic furbearers. Accidental spills would affect site-specific areas for a short period. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be a small effect on aquatic furbearer populations, as spills in water would be more difficult to contain than those on land. The risk of fire would be greatest during construction and would have a negative effect on aquatic furbearer habitats. A burn would displace these animals from an area, would immediately alter habitat composition and structure, and would result in the death of individuals unable to escape. The production of some species of aquatic vegetation after fire can increase, decrease, or remain generally unaffected (Smith and Kadlec 1985). However, fire can enhance the nutritive value of some plants, increasing their value to herbivores such as muskrat (Smith and Kadlec 1985). Fire also reduces the amount of late-successional species, allowing for the regeneration of species preferred by muskrat (Ford and Grace 1998). Mink and river otter do not appear to be greatly affected by fire, except where streamside vegetation and debris is removed in the case of mink (Fischer and Bradley 1987). Where escape cover is destroyed near riparian areas, use of these areas by mink and river otter could decrease (Crane and Fischer 1986).

Aquatic furbearers could experience increased mortality through wildlife-vehicle collisions along the access road. Muskrat, mink, and river otter road kills have been recorded in several studies (*e.g.*, Case 1978; Ashley and Robinson 1996; Austin *et al.* 2003; Clevenger *et al.* 2003). When they occur, otter-vehicle collisions are most common on sections of roads within approximately 100 m of a waterbody, and the majority occur at water crossings (Philcox *et al.* 1999). It is likely that muskrat and mink would also be at greatest risk near riparian zones and water crossings. Manitoba Conservation records calls to dispatch injured animals following wildlife-vehicle collisions; no incidents have been reported in the Gillam area since 2007 (L. Myers *pers. comm.* 2010).

7.4.2.1.3 Access

As areas are opened up to easier access, trapping activity could increase in the Local and Regional Study Areas (Hodgman *et al.* 1994). If trapping effort surpasses a sustainable level, a corresponding decrease in aquatic furbearer populations in the area might be expected. The Furbearers Local Study Area currently overlaps several traplines. As trappers are stewards of their traplines (Fur Institute of Canada 2003), furbearer harvest will not likely exceed sustainable levels. Trapping effort and success in the Local Study Area will likely be limited because of the expected decrease in the number of aquatic furbearers in Zones 1 and 2 due to Project-related disturbances.

Increased access to the Local Study Area by predators via the south access road and other linear features could result in increased predation on muskrat by predators such as red fox and gray wolf. Roads and other access corridors provide easy travel routes for predators, enabling them to hunt a larger area in a shorter period of time (Frey and Conover 2006). Improved hunting efficiency could result in increased muskrat mortality.

Intactness (the extent to which an area has not been broken up into small areas by human features) and linear feature density are not predicted to change in Zone 5 because of the Project (see the Habitat and Ecosystems section of the TE SV). No substantial changes in the distribution and abundance of aquatic furbearers due to fragmentation are anticipated.

7.4.2.1.4 Summary of Construction Effects

Changes in habitat composition and connectivity due to clearing and construction could influence habitat use and movements of aquatic furbearers in Zone 2. Habitat loss or alteration in riparian areas will affect aquatic furbearers. As the majority of reservoir clearing will occur in winter, potential resting and denning sites and vegetative shelter could be lost or disturbed.

Project-related disturbances such as sensory disturbance and increased mortality could affect aquatic furbearers. Sensory disturbance due to construction-related activity and traffic on the south access road could result in a loss of effective habitat. Aquatic furbearers will mainly be affected in riparian areas, and are expected to return to abandoned areas after construction is complete. Wildlife-vehicle collisions on the south access road are a potential source of mortality.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and trapping. Predators could improve their hunting efficiency by travelling on roads and trails, benefiting predators, but increasing predation pressure on furbearing prey species. Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access road, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation.

Because intactness will not change during construction, changes in the distribution and abundance of aquatic furbearers due to habitat fragmentation will likely be small. The overall effect of fragmentation will likely be neutral.

7.4.2.1.5 Mitigation

Mitigation for habitat loss or alternation is not recommended as aquatic furbearer habitat is common in the region, and aquatic furbearers are common and resilient. Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment (*i.e.*, at the GS site) will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas, and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area; and
- Muskrats from affected areas will be trapped prior to and during reservoir clearing, and periodically until the reservoir reaches maximum capacity.

7.4.2.1.6 Residual Effects of Construction

Residual effects on aquatic furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, limited to the Local Study Area, and affect two or more generations.

7.4.2.2 Operation

7.4.2.2.1 Habitat Loss, Gain, and Alteration

During operation, effects on aquatic furbearers will include the loss and alteration of habitat in the Local Study Area. Most of the habitat lost during inundation will have been cleared during construction. The presence of muskrat, mink, and river otter was detected on lake perimeters in Zone 1, indicating that these lakes, which will be inundated, likely provide suitable habitat for aquatic furbearers. Depending on the type, habitat alteration could result in a loss or gain of cover and food resources. Some aquatic furbearers could recolonize areas that were abandoned during construction, particularly those where continued disturbance from operation is not expected or is minimal.

Reservoir impoundment will result in a loss of muskrat and aquatic furbearer habitat as creeks, tributaries, and small ponds and lakes will be flooded. During the first five years of operation, muskrat are predicted to recolonize the reservoir in bays with shoreline peatlands. Once these peatlands break down (see the Habitat and Ecosystems section of the TE SV), most muskrat are expected to abandon the reservoir.

Altered flow of the Nelson River upstream of the dam and water level fluctuations in the reservoir will likely affect the suitability of the reservoir for muskrat, which occupy areas with a balance of open water and emergent plants such as cattail (Boutin and Birkenholz 1998). Water level fluctuations, which are expected primarily upstream of the proposed GS, encourage the growth of emergent vegetation, which decreases the ratio of open water to vegetation (Boutin and Birkenholz 1998), resulting in lower quality muskrat habitat. A small dewatered area will occur downstream of the proposed GS; however no additional effects from the Project are expected. Water will continue to fluctuate in Stephens Lake and continue to affect muskrat.

Muskrat push-up density was low on Stephens Lake during spring surveys (see Table 7B-10 and Table 7B-11), thus little effect of water level fluctuations downstream of the proposed GS is expected. Similarly, push-up density was low on the central Nelson River, which includes Gull Lake. As there are relatively few muskrat using Gull Lake, little effect on the population in the Local Study Area is expected.

However, muskrat activity was observed in or near areas expected to be flooded during operation, and these individuals will be displaced or possibly drowned.

Muskrat push-ups were observed along the central Nelson River, which includes Gull Lake (see Table 7B-10 and Table 7B-11), indicating that a few individuals could be affected by fluctuating water levels, but the average daily water level fluctuation will not exceed 1 m per day at peak operating mode (PD SV). Muskrat prefer stable water levels to those that fluctuate (Bellrose and Brown 1941; Donohoe 1966). At Lake Erie, muskrat tended to select areas with relatively stable water levels over those with the potential to fluctuate between 1.2 and 1.8 m over a 24-hour period for construction of their dwellings (Donohoe 1966). Water level fluctuations upstream and downstream of the proposed GS could decrease habitat quality for muskrat in the Local Study Area, but since muskrat generally avoid large bodies of open water (Errington 1963), indicated by the low density of push-ups on Gull and Stephens lakes, little effect is anticipated.

Mink and river otter habitat will likely be affected by impoundment. River otter occur in a range of aquatic habitats; those that occupy impoundments tend to prefer those caused by beaver to those that are human-caused (Newman and Griffin 1994), or to larger lakes (Reid *et al.* 1994a). Long-term habitat loss or alteration is also associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects (see the Habitat and Ecosystems section of the TE SV), some of which will likely affect the riparian habitat of these aquatic furbearers.

7.4.2.2.2 Project-related Disturbances

Some loss of effective habitat for aquatic furbearers due to sensory disturbance is anticipated during operation. Effective habitat could be reduced due to the increase in traffic volume expected on the access roads during operation. While workers and machinery will no longer be travelling between camp and work sites, the increase in local traffic could result in avoidance of the area by muskrat, mink, and river otter. The access roads will cross five streams known to be inhabited by aquatic furbearers. The area affected by the access roads is highly localized when compared with habitat available in the Regional Study Area, and avoidance of the access roads by aquatic furbearers would decrease the potential for wildlife-vehicle collisions, which would most likely occur near waterbodies and at water crossings.

Accidents and malfunctions such as fire, spills, and dam failure could affect aquatic furbearers during operation. The risk of accidental fires will be lower during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. In the event of fire, effects would be the same as during construction. Similarly, the potential for spills and other environmental issues due to Project-related activities will be reduced during operation. Dam failure would result in flooding, habitat loss, and possibly the death of some aquatic furbearers, depending on the rate of inundation.

7.4.2.2.3 Access

Increased access to the Local Study Area created during construction will continue during operation. The potential for access-related effects will be greatest during operation, as the access roads will become part of the provincial road system and their use by the public will no longer be restricted. Increased and more efficient trapping, particularly along roads, is a likely result. This could result in increased mortality of furbearers in the Local Study Area, and possibly extend into the Regional Study Area, and trapping could surpass a sustainable level (Naiman *et al.* 1986; Payne 1989; Witmer *et al.* 1998; Boyle and Owens 2007). . Trappers are stewards of their traplines (Fur Institute of Canada 2003), and are responsible for sustaining furbearer populations on their traplines. Poaching of aquatic furbearers is a potential problem along the access roads (Koehler and Brittell 1990), which is a regulatory issue.

Muskrat mortality could increase as predators will be more easily able to access the Local Study Area via the access roads and other linear corridors. Muskrat are important prey species for coyote and red fox (Banfield 1987), and increased hunting efficiency could have a negative effect on the muskrat population.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation, therefore effects of habitat fragmentation on furbearers will likely be neutral.

7.4.2.2.4 Summary of Operation Effects

Project effects on furbearers during operation include habitat loss and alteration in the Local Study Area. Additional aquatic furbearer habitat will be lost during impoundment, most of which will have been cleared during construction. Lakes that provide suitable habitat for these species will be inundated. Long-term habitat loss or alteration is also associated with flooding, shoreline erosion, peatland disintegration and reservoir-related groundwater and edge effects. Water level fluctuations could affect muskrat habitat, but since muskrat generally avoid large bodies of open water, limited effects are anticipated.

Project-related disturbances during operation include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. The access roads will cross five streams known to be inhabited by aquatic furbearers. Effects could be balanced by the potential reduction in traffic on the existing PR 280 route. Avoidance of the access roads will decrease the risk of wildlife-vehicle collisions.

The access roads will result in improved access to the Local Study Area by resource users and predators. Poaching of some furbearers is a possibility in remote areas opened up by roads, which is a regulatory issue. Predators could benefit from increased hunting efficiency along linear corridors, to the detriment of prey species such as muskrat.

No additional change in the density of linear features and intactness is expected in the Intactness Regional Study Area during operation, therefore effects of fragmentation on aquatic furbearers will likely be neutral.

7.4.2.2.5 Mitigation

The PD SV includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for the effects of dam failure on aquatic furbearers.

Other mitigation measures include:

- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect the Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, accidental fires and access-related effects;
- A minimum of 100 m vegetated buffers will be retained wherever practicable around lakes, wetlands and creeks to minimize the loss of furbearer; and
- Mitigation for wetland function will benefit muskrat through the development of wetlands in the Local Study Area (see the Habitat and Ecosystems section of the TE SV) and could offset some of the losses in habitat for muskrat.

7.4.2.2.6 Residual Effects of Operation

Residual effects on aquatic furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements, decreased furbearer populations due to reduced habitat, and increased mortality. Effects are predicted to be within the range of natural variability, most likely limited to the Local Study Area, and affect two or more generations.

7.4.2.3 Conclusion about Residual Effects on Aquatic Furbearers

The extent of Project effects on aquatic furbearers are expected to be the same during construction and operation. No large effects are expected as habitat availability does not appear to be a limiting factor for these populations.

The adverse residual effects of the Project on aquatic furbearers will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project and Keeyask Transmission Project. These projects will increase aquatic furbearer habitat loss, reduce intactness, and contribute to access effects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and are vulnerable to the effects of future projects and activities. As aquatic furbearers are not a VEC, they are not covered in the cumulative effects assessment step that deals with future projects.

7.4.3 Terrestrial Furbearers

7.4.3.1 Construction

7.4.3.1.1 Habitat Loss, Gain, and Alteration

Changes in habitat composition due to clearing and construction could influence habitat use by terrestrial furbearers in Zone 1. Terrestrial furbearers such as snowshoe hare, red fox, American marten, fisher, weasels, and lynx occupy a wide range of habitats. Changes in habitat composition and connectivity could influence habitat use and movements of terrestrial furbearers. American marten are typically associated with older growth forests (Buskirk 1984; Buskirk and MacDonald 1984; Buskirk and Ruggiero 1994). Fisher require the overhead cover provided by closed canopies of relatively mature trees (Douglas and

Strickland 1998). Resting and denning sites are important components of American marten (Buskirk 1984; Buskirk and Ruggiero 1994; Bull and Heater 2000) and fisher (Arthur *et al.* 1989) habitat, particularly in winter. The presence of both these species was detected in Zone 1; potential resting and denning sites could be lost when the reservoir is cleared. As the majority of site clearing for the Project will occur in winter, the loss of winter dens will have a negative effect on American marten and fisher populations in the Local Study Area. Lynx select areas of dense cover for **natal** dens (Organ *et al.* 2008), which will be removed during clearing in Zone 1. Snowshoe hare utilize the dense cover provided by spruce, willow, and alder as refuge from predators (Wolff 1980). Such shelter will be lost when Zone 1 is cleared, with potentially negative effects for snowshoe hare in the Local Study Area. Habitat loss or alteration that affects prey species has an important effect on red fox populations (Voigt 1998). As the amount of habitat lost will be small when compared with habitat available in Furbearers Regional Study Area, the effect of habitat loss on terrestrial furbearers is expected to be small.

7.4.3.1.2 Project-related Disturbances

Sensory disturbances, which include construction activities, blasting, and traffic, can negatively affect terrestrial furbearer habitat, with the same general effects as those for aquatic furbearers. Sensory disturbances will result in a small loss of effective habitat, particularly in areas of active construction and heavy traffic (AMEC Americas Limited 2005). Sensory disturbances due to traffic on the south access road could result in avoidance by terrestrial furbearers such as fisher and possibly American marten (Witmer *et al.* 1998).

Accidents and malfunctions such as spills and fires would have a similar effect on terrestrial furbearers as aquatic furbearers (see Section 7.4.2.1). Accidental spills would affect site-specific areas for a short period. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be a minimal effect on terrestrial furbearer populations. Snowshoe hare and lynx prefer mid-successional boreal forest and avoid early and late stages (Fisher and Wilkinson 2005). Species such as American marten and fisher select mature forest (Fisher and Wilkinson 2005). Fire would immediately alter habitat for these species, but habitat would eventually be replaced as the forest regenerates over the long term.

Mortality of terrestrial furbearers could increase due to wildlife-vehicle collisions on the south access road. Species such as lynx (Mech 1980), snowshoe hare, and American marten (Clevenger *et al.* 2003) are susceptible to being killed by vehicles.

Encounters with humans could affect some terrestrial furbearer populations in the Furbearers Local Study Area. Red fox in particular **habituate** to human activity, especially around food sources. Animals attracted to food sources could eventually learn to ignore human presence (Whittaker and Knight 1998), resulting in increased human-wildlife encounters in camp areas. As red fox are vectors of rabies (Trewhella *et al.* 1988), their removal from camp could be necessary, by either relocation or destruction.

7.4.3.1.3 Access

As areas are opened up to easier access, terrestrial furbearer mortality due to trapping could increase (Hodgman *et al.* 1994). If trapping effort surpasses a sustainable level, a corresponding decrease in terrestrial furbearer populations in the area might be expected. The Furbearers Local Study Area currently overlaps several traplines. As trappers are stewards of their traplines (Fur Institute of Canada 2003), furbearer harvest will not likely exceed sustainable levels. Trapping effort and success in the Local Study Area will likely be limited because of the expected decrease in the number of terrestrial furbearers in Zones 1 and 2 due to Project-related disturbances.

Predators can travel more swiftly on roads and trails, increasing their hunting efficiency (Frey and Conover 2006). An increase in the number of linear features across the landscape could result in a greater influx of predators in the Local Study Area, and could lead to higher predation pressure on prey species (Jalkotzy *et al.* 1997) such as snowshoe hare. Predation is an important driver in the snowshoe hare population cycle; individuals must find a balance between survival and reproductive condition under high predation pressure, leading to decreased numbers of snowshoe hare (Hik 1995). Predators such as red fox could benefit from access corridors created by linear features such as the south access road. Roads have a negative effect on lynx travel and hunting, as these activities are disrupted by roads with rights of way (ROWs) greater than 15 m wide (Koehler and Brittell 1990). However, lynx may tolerate moderate levels of human activity such as snowmobiling, and have been reported to cross highways (Mowat *et al.* 1999), indicating that the access road may not create an impermeable barrier to lynx movement.

Construction of linear features such as access roads fragments habitat, and will result in the reduction of the amount of core habitat available (Ruggiero *et al.* 1999). Fragmentation is detrimental to species such as lynx, which are uncommon and associated with large wilderness areas (Bright 1993; Ruggiero *et al.* 1999) such as the boreal forest. Intactness will not change during construction, changes in the distribution and abundance of terrestrial furbearers will likely be minimal, and the effects on small mammal populations as food sources will likely be neutral. Effects of habitat fragmentation on terrestrial furbearers are unlikely to be measurable and the overall effect is expected to be neutral.

7.4.3.1.4 Summary of Construction Effects

Changes in habitat composition due to clearing and construction could influence habitat use by terrestrial furbearers in Zone 1. Potential resting and denning sites and vegetative shelter could be lost or disturbed. As habitat is widely available in the Local Study Area and beyond, effects of habitat loss on terrestrial furbearers will likely be minimal.

Project-related disturbances such as sensory disturbance and increased mortality could affect terrestrial furbearers into Zone 3. Sensory disturbance due to construction-related activity and on the access roads could result in a loss of effective habitat. Terrestrial furbearers are expected to return to abandoned areas after construction is complete. Wildlife-vehicle collisions on the access roads are a potential source of mortality, and a few species, such as red fox, may have to be controlled to minimize the risk to humans living in camps. With the application of Environmental Protection Plan mitigation measures, including food disposal and waste management measures, human interactions will likely be minimized.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and trapping. Predators could improve their hunting efficiency by travelling on roads and trails (Frey and Conover 2006), benefiting predators, but increasing predation pressure on furbearing prey species (Jalkotzy *et al.* 1997). Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access road, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation.

Because intactness will not change during construction, changes in the distribution and abundance of furbearers will likely be small, and the effects on small mammal populations as food sources will likely be neutral, effects on furbearers are unlikely to be measurable and the overall effect is expected to be neutral.

7.4.3.1.5 Mitigation

Mitigation for habitat loss or alternation is not recommended as terrestrial furbearer habitat is common in the region, and terrestrial furbearers are generally common and resilient. Mitigation for accidents and malfunctions includes planned measures such as training in fire response protocols, and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area.

7.4.3.1.6 Residual Effects of Construction

Residual effects on aquatic furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements, decreased furbearer populations due to reduced habitat, and increased mortality. Effects are predicted to be within the range of natural variability, most likely limited to the Local Study Area, and affect two or more generations.

7.4.3.2 Operation

7.4.3.2.1 Habitat Loss, Gain, and Alteration

During operation, effects of habitat loss on terrestrial furbearers will become permanent in the reservoir. Long-term habitat loss or alteration is also associated with flooding, shoreline erosion, peatland disintegration (Section 6.3.7), and reservoir-related groundwater and edge effects (Section 6.5.3.1). Some habitat could be regained when camp, work, and borrow areas are rehabilitated by replacing organic material in these areas to assist re-vegetation. American marten use dens to alleviate thermal stress in winter, and to avoid predators (Buskirk 1984; Buskirk and Ruggiero 1994; Bull and Heater 2000). Ground denning in red squirrel middens and coarse woody debris is common (Buskirk 1984; Buskirk and Ruggiero 1994; Bull and Heater 2000). Inundation of these dens in early winter could have adverse effects on American marten whose home ranges occupy a large portion of the reservoir. However, the cleared reservoir will provide unsuitable habitat for American marten and they will not likely be present during inundation.

7.4.3.2.2 Project-related Disturbances

The access roads could create a barrier to terrestrial furbearer movements. While larger roads may not affect American marten, highways deter fisher movement (Witmer *et al.* 1998). Larger roads could also be avoided by lynx (Koehler and Brittell 1990), although this species has also been reported to cross highways and travel road edges (Mowat *et al.* 1999). When the north and south access roads are incorporated as part of PR 280, continued sensory disturbance and wildlife-vehicle collisions are likely. These effects could be balanced by the expected reduction of traffic on the current portion of PR 280.

Accidents and malfunctions such as fire, spills, and dam failure could affect terrestrial furbearers during operation. The risk of accidental fire will be lower during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. Fire would have a negative effect, as mammals would abandon the area to avoid the burn, or would perish. As post-fire stands age, small mammals such as voles, shrews, mice, and squirrels will recolonize the area (Fisher and Wilkinson 2005). Predators such as American marten, while most commonly associated with mature forest, take advantage of the abundance of small mammal prey (Fisher and Wilkinson 2005). Other predators such as fisher and weasels generally avoid young successional stages (Fisher and Wilkinson 2005). The risk of spills and other environmental issues will be reduced during operation. Dam failure would result in flooding, habitat loss, and possibly the death of some terrestrial furbearers, depending on the rate of inundation.

7.4.3.2.3 Access

Access to areas where it was previously limited is an outcome of the construction of roads and dykes. During operation, the construction of these linear corridors will be complete, and their incorporation as part of PR 280 will result in unrestricted use by the public. Increased access could result in increased trapping effort, particularly along the access roads. This could have a direct effect on terrestrial furbearer populations, as trapping could surpass a sustainable level (Naiman *et al.* 1986; Payne 1989; Witmer *et al.* 1998; Boyle and Owens 2007). Species such as red fox, American marten, fisher, ermine, and lynx could be affected. Human activity appears to have a considerable effect on lynx mortality (Mech 1980; Koehler and Brittell 1990; Ruggiero *et al.* 1999). American marten are vulnerable to over-harvest due to their low rate of reproduction (Strickland and Douglas 1998), especially in areas with road access (Hodgman *et al.* 1994). However, trappers are responsible for managing wildlife resources on their traplines (Manitoba Conservation 2011a). Red fox has a high reproductive rate and the ability to disperse quickly, and will likely be unaffected by a somewhat greater level of mortality (Voigt 1998). As trappers are stewards of their traplines (Fur Institute of Canada 2003), furbearer harvest will not likely exceed sustainable levels. In addition, the Provincial Government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation 2009b). Poaching of some terrestrial furbearers is a concern in remote areas opened up by roads (Koehler and Brittell 1990), which is a regulatory issue.

Linear corridors could have a positive or negative effect on terrestrial furbearers, depending on the species. Predators such as red fox will benefit from increased hunting efficiency along roads, cutlines, and other linear features (Frey and Conover 2006), with potentially negative consequences for prey species such as snowshoe hare. As snowshoe hare are very common in the Local Study Area, increased hunting efficiency of predators will not likely have a measurable effect on the population.

Changes to the ice regime could facilitate predator movement in the future reservoir area. Ice cover in the reservoir will form more quickly, spanning a greater distance in a shorter amount of time (Physical Environment Supporting Volume (PE SV)). Average expected thickness of the ice in the reservoir is expected to be less than current levels (PE SV), but will be sufficient to support terrestrial furbearers. Movement across the reservoir could be facilitated, which would increase hunting efficiency for species such as red fox, American marten, fisher, and lynx.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation, therefore effects on terrestrial furbearers will likely be neutral.

7.4.3.2.4 Summary of Operation Effects

Project effects on terrestrial furbearers during operation include habitat loss and alteration in the Local Study Area. Additional terrestrial furbearer habitat will be lost during impoundment, most of which will have been cleared during construction.

Project-related disturbances during operation include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. The access roads could create a barrier to movements of species such as fisher and, to some extent, lynx. Effects could be balanced by the potential reduction in traffic on the existing PR 280 route. Avoidance of the access roads will likely decrease the risk of wildlife-vehicle collisions.

The access roads could result in improved access to the Local Study Area by resource users and predators. Poaching of some furbearers is a possibility in remote areas opened up by roads, which is a regulatory issue. Predators could benefit from increased hunting efficiency along linear corridors, to the detriment of some prey species.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation, therefore effects no effects of habitat fragmentation on terrestrial furbearers are anticipated.

7.4.3.2.5 Mitigation

The Project Description includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for the effects of dam failure on terrestrial furbearers.

Other mitigation measures include:

- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, accidental fires and access-related effects.

7.4.3.2.6 Residual Effects of Operation

Residual effects on terrestrial furbearers that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, most likely limited to the Local Study Area, and affect two or more generations.

7.4.3.3 Conclusion about Residual Effects on Terrestrial Furbearers

The extent of Project effects on terrestrial furbearers are expected to be the same during construction and operation. No large effects are anticipated, as habitat availability does not appear to be a limiting factor for these populations.

The adverse residual effects of the Project on terrestrial furbearers will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project and Keeyask Transmission Project. These projects will increase terrestrial furbearer habitat loss, reduce intactness, and contribute to access effects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and are vulnerable to the effects of future projects and activities. As terrestrial furbearers are not a VEC, they are not covered in the cumulative effects assessment step that deals with future projects.

7.4.4 Large Carnivores

7.4.4.1 Construction

7.4.4.1.1 Habitat Loss, Gain, and Alteration

Large carnivores generally require large areas of contiguous habitat (Schoen 1990; Noss *et al.* 1996). Gray wolf habitat selection depends more upon available prey than landscape features (Carbyn 1998). Similarly, black bears require large tracts of forest habitat, rather than relying on a specific habitat type (Schoen 1990; Kolenosky and Strathearn 1998). Habitat loss and alteration affecting prey species will likely have the greatest, although indirect, effect on large carnivores. Based on the density of prey species in the Keeyask region, the territories of resident packs are not expected to overlap the Local Study Area (Moose Harvest Sustainability Plan), indicating that habitat loss in Zone 1 may not have a large effect on this species. However, signs of wolf activity were most common on transects on the shores of Gull Lake, and were sparse on coarse habitat mosaic transects, thus some gray wolf habitat will likely by affected by clearing in the reservoir area. Habitat loss and alteration affecting prey and other food sources are expected to have a minimal, indirect effect on large carnivores. Should black bear or gray wolf dens occur in Zone 1, they could be inadvertently disturbed during clearing.

7.4.4.1.2 Project-related Disturbances

Noise associated with construction activities such as blasting and heavy machinery could affect large carnivores into Zone 3. Denning black bears may tolerate disturbances occurring more than 1 km from their dens (Linnell *et al.* 2000). Individual reactions to disturbance in closer proximity range from tolerance to den abandonment (Linnell *et al.* 2000). Den abandonment by females could result in cub mortality (Linnell *et al.* 2000). In wilderness areas, gray wolves generally have a low tolerance for human disturbance near den sites (Thiel *et al.* 1995). However, gray wolves appear to be less sensitive to human disturbance in areas where they are not persecuted (Mech 1995).

While some large carnivores could avoid the south access road, sensory disturbance due to human activity and construction will not likely affect the gray wolf or black bear population in the Large Carnivores Local Study Area. Wolves tend to prefer habitat with relatively low road density (Thiel 1985; Mech *et al.* 1988), but will use roads to facilitate travel (Mladenoff *et al.* 1999). Avoidance of areas with higher road density is generally not due to traffic or sensory disturbance; minimization of contact with humans appears to the main reason (Mech *et al.* 1988). Where they are not persecuted by humans, gray wolves disperse over the landscape despite such obstacles as highways, habitat fragmentation, and human settlements (Mech *et al.* 1988). The reaction of black bears to roads is similar to that of gray wolves. Where hunting is permitted, black bears avoid roads (Brody and Pelton 1989). Black bears are more likely to cross roads with lower traffic volume than busier roads (Brody and Pelton 1989). Where large carnivores do not avoid the south access road, populations could experience increased mortality through wildlife-vehicle collisions (Mech 1977; Brody and Pelton 1989; Forman and Alexander 1998). At the Wuskwatim GS construction site, human encounters with gray wolves and black bears occurred along the access road, at camp, and at the generating station during construction. Two wolf-vehicle collisions occurred over a five-year period (WRCS unpubl. data), indicating that some individuals will not be deterred by construction noise and could be susceptible to accidents.

Accidents and malfunctions such as spills and fires could affect large carnivores. Accidental spills would affect site-specific areas for a short period. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be a minimal effect on large carnivore populations. A burn would displace these animals from the affected area, would immediately alter habitat composition and structure, and would result in the death of individuals unable to escape. Over the long term, a fire produces high-quality habitat for a variety of species, particularly those that like edge and successional habitats. Density of moose, a common prey species of large carnivores, tends to increase in recently burned areas (Peek 1974; Fisher and Wilkinson 2005), benefiting predators and their offspring (Schwartz and Franzmann 1991).

Human encounters with wildlife, particularly black bears, are a potential source of animal mortality. Black bears are often attracted to human foods and garbage (Herrero 1985). Black bears that are repeatedly encountered in camps or work areas could be a hazard to people. Government agencies may prefer to kill problem black bears rather than relocate them (Witner and Whittaker 2001). Relocation can be hazardous to black bears and to humans involved in the process (Witner and Whittaker 2001). Relocated black bears often return to their original home range, and mortality of relocated black bears is high (Fies *et al.* 1987; Linnell *et al.* 1997).

7.4.4.1.3 Access

Vulnerability of large carnivores such as black bears (Brody and Pelton 1989) and gray wolves (Thurber *et al.* 1994; Witmer *et al.* 1998) to hunting could increase with increased access to formerly remote areas. Fox Lake Elders "point out that wolves frequently follow the transmission lines which are easier to travel along than in the bush" (FLCN 2010 Draft). While roads facilitate travel and hunting for gray wolves, they increase gray wolf mortality, either accidental or intentional (Mladenoff *et al.* 1999). Black bear mortality increases with increased human access, primarily due to hunting (Brody and Pelton 1989).

Because intactness is not expected to change during construction, no large change in the distribution and abundance of large carnivores is expected. Effects on moose as a food source for wolves (see Section7.4.6.3) will likely be small, and the overall effect of habitat fragmentation on large carnivores is expected to be minimal.

7.4.4.1.4 Summary of Construction Effects

Potential Project effects on black bear and gray wolf include habitat loss and alteration due to clearing in Zone 1. Large carnivores generally require large areas of contiguous habitat, rather than relying on specific habitat. Habitat loss and alteration affecting prey and other food sources are expected to have a small, indirect effect on large carnivores.

Project-related disturbances that could affect large carnivores include sensory disturbances and increased mortality into Zone 3. Individual reactions to sensory disturbance due to construction activity near dens range from tolerance to den abandonment. Large carnivores could avoid roads, apparently to minimize contact with humans; however, gray wolves use roads to facilitate travel. Large carnivore populations could experience mortality through wildlife-vehicle collisions on the access roads. Human interactions with large carnivores, particularly near food sources, could increase. As these animals can pose a danger to workers in the area, they may have to be removed from areas with human activity, or destroyed. With the application of Environmental Protection Plan mitigation measures, including proper food disposal and waste management measures, human interactions are expected to be minimal.

Project effects also include those related to improved access to the Local Study Area. Vulnerability to hunting could increase due to improved access of resource users to formerly remote areas. However, linear corridors could improve large carnivore hunting efficiency, potentially benefiting these species.

Because intactness is not expected to change during construction, changes in the distribution and abundance of large carnivores are expected to be small, and the effects on moose as a food will likely be small, the overall effect on large carnivores is predicted to be small.

7.4.4.1.5 Mitigation

Mitigation for habitat loss or alternation is not recommended as large carnivore habitat is common in the region, and large carnivores in the Regional Study Area appear to be common and resilient. Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- Where possible, 100 m buffers will be established around active gray wolf and black bear dens within Zone 1 to minimize the disturbance of animals during sensitive periods;
- Firearms will be prohibited in camps and at work sites to reduce mortality due to hunting during construction; and
- Roadside ditches will be rehabilitated with native plants with low quality food values for black bear where practicable, to minimize attraction, and the risk of wildlife-vehicle collisions and incidental take.

7.4.4.1.6 Residual Effects of Construction

The residual effect on large carnivores that is expected and likely once the appropriate mitigation measures are applied will be decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, limited to the Local Study Area, and affect one or two generations.

7.4.4.2 Operation

7.4.4.2.1 Habitat Loss, Gain, and Alteration

Some additional habitat loss or alteration associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects in the Local Study Area is anticipated during operation. If black bears are denning at the time of inundation, disturbance or mortality could result. Denning periods vary with location and local weather, and may begin in autumn or winter (Banfield 1987). In northern climates, black bears may den as early as October (Banfield 1987). While no large carnivore dens were identified during field surveys, a few dens might be located in Zone 1. Den locations would most likely be limited to dry mineral soil habitat. Most of the reservoir is composed of black spruce-dominated peatland habitat and this area is moderately unlikely to contain dens because the soil conditions are not appropriate for den construction. Black bears that abandoned their dens lose more weight than those whose dens are not disturbed, possibly due to the extra energy expended to create a new den (Tietje and Ruff 1980). Second and third dens excavated by black bears are often of poorer quality than those constructed first (Tietje and Ruff 1980).

It is likely that some wildlife will recolonize areas that were abandoned during construction, particularly those where continued disturbance from operations is not expected or is minimal (*e.g.*, along dykes, cutlines, and at borrow areas). As these sites could represent small portions of black bear or gray wolf home range, they will likely not result in a substantial amount of additional habitat for these species. However, recolonization of disturbed sites by prey species such as snowshoe hare could benefit large carnivores.

7.4.4.2.2 Project-related Disturbances

Project-related disturbances include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. As the access roads will replace a portion of the existing PR 280, traffic will likely increase, potentially creating a barrier to large carnivore movements. Sensory disturbance due to traffic could reduce effective habitat for large carnivores. Individuals that do not avoid the road would be susceptible to wildlife-vehicle collisions. Effects could be partially offset by the corresponding decrease in traffic on the current PR 280 route.

Accidents and malfunctions such as fire, spills, and dam failure could affect large carnivores during operation. The risk of accidental fire will be lower during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. Fire would have an immediate negative effect, as mammals would abandon the area to avoid the burn, or would perish. The potential for spills and other environmental issues will also be reduced during operation. Dam failure would result in flooding, habitat loss, displacement of affected individuals, and possibly the death of some large carnivores, depending on the rate of inundation.

7.4.4.2.3 Access

Use of the north and south access roads by the public will not be restricted after the construction phase, and their utilization for travel between Gillam and Thompson will likely increase. When the access roads become a provincial road, restrictions on firearms and hunting in the area will no longer be enforceable by Manitoba Hydro or their contractors. A licence is required to hunt black bears in Manitoba, and gray wolves may be hunted by anyone in possession of a big game hunting licence, with minor restrictions (Manitoba Conservation 2011b). It is illegal to hunt from a vehicle or from, across, or along a provincial road or provincial trunk highway (Manitoba Conservation 2011b). However, the opportunity for killing large carnivores increases with increased access to the area (Person and Russell 2008), whether legally or illegally. Large carnivores could continue to use roads for ease of travel and more efficient hunting, particularly when and where traffic volume is low.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation (see the Habitat and Ecosystem section of the TE SV), therefore no additional effects of habitat fragmentation on large carnivores are anticipated.

7.4.4.2.4 Summary of Operation Effects

Project effects on large carnivores during operation include habitat loss and alteration associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects. It is likely that some wildlife will recolonize areas that were abandoned during construction. Recolonization of disturbed sites by prey species could benefit large carnivores.

Project-related disturbances include barriers to movement, sensory disturbance, and mortality due to wildlife-vehicle collisions. The access roads will replace a portion of the existing PR 280 and traffic will likely increase, potentially creating a barrier to large carnivore movements. Sensory disturbance due to traffic could reduce effective habitat for large carnivores. Individuals that do not avoid the road will be susceptible to wildlife-vehicle collisions.

Effects of improved access to the Local Study Area could include increased mortality due to hunting and trapping. Black bear and gray wolf harvest is regulated as big game in Manitoba; however, the opportunity for harvesting large carnivores will increase with increased access to the area, whether legally or illegally. No appreciable change in large carnivore populations is anticipated.

Access for large carnivores can improve hunting efficiency. Large carnivores could continue to use linear corridors for ease of travel and more efficient hunting in the Local Study Area, particularly when human activity is low. Because access trails will be rehabilitated for the protection of caribou, and no additional change in the density of linear features and intactness is expected in Zone 5 during operation, effects of habitat fragmentation on large carnivores will likely be neutral.

7.4.4.2.5 Mitigation

The Project Description (PD SV) includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for the effects of dam failure on large carnivores and there are currently no measures proposed to mitigate other Project-related effects on large carnivores during operation.

7.4.4.2.6 Residual Effects of Operation

The residual effect on large carnivores that is expected and likely once the appropriate mitigation measures are applied will be decreased populations due to reduced habitat and increased mortality. Effects are predicted to be within the range of natural variability, extend to the Regional Study Area, and affect two or more generations.

7.4.4.3 Conclusion about Residual Effects on Large Carnivores

The extent of Project effects on large carnivores is expected to be the same during construction and operation. No large effects are expected for these species, as habitat availability does not appear to be a limiting factor for these populations.

The adverse residual effects of the Project on large carnivores will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Conawapa Generation Project. These projects will mainly increase mortality due to increased human presence and access effects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and are vulnerable to the effects of future projects and activities. As large carnivores are not a VEC, they are not covered in the cumulative effects assessment step that deals with future projects.

7.4.5 Ungulates

No ungulate species other than caribou and moose, which are VECs, are found in the Keeyask region, therefore construction and operation effects were not assessed.

7.4.6 Valued Environmental Components

While all mammals are important components of ecosystems, some play a more important role than others in terms of controlling ecosystem function. For example, moose can influence gray wolf distributions, which in turn can influence caribou populations in an area. Beavers modify their surroundings by building dams, creating favourable conditions for species such as moose and river otter. Beaver, caribou, and moose were selected as VECs based in part on their importance to the KCNs and other resource users, and on indications that they are important components of several ecological pathways and/or indicators of one or more other species. Predicted effects on VECs can serve as examples for other ecosystem components and ecosystem health.

7.4.6.1 Beaver

7.4.6.1.1 Construction

Habitat Loss, Gain, and Alteration

Project effects on the beaver population during construction include habitat loss and mortality in Zone 1. Although vegetation clearing will begin during construction, habitat loss for beaver is considered in operation effects, where it will primarily occur during reservoir impoundment, and become permanent. Between 20 and 30 active beaver colonies will be removed during clearing in Zone 1, which is less than 10% of the estimated population in the Regional Study Area. Beavers reproduce relatively slowly but can easily compensate for local losses through rapid dispersal (Boyle and Owens 2007). As beaver can replace annual mortality of 30% and can compensate for greater losses with increased reproduction (Payne 1989), the effect of removing 20 to 30 beaver colonies is expected to be small.

Project-related Disturbances

Sensory disturbances including construction activities, blasting, and traffic can negatively affect beavers' use of habitat (AMEC Americas Limited 2005). Disturbances due to noise from construction activities and blasting could result in a small loss of effective habitat via habitat avoidance or temporary abandonment (AMEC Americas Limited 2005). These effects are expected to be greatest during the construction phase. In addition to sensory disturbances, wildlife-vehicle collisions at stream crossings along the south access road could result in a marginal increase in beaver mortality. Such events are expected to be infrequent and effects on the beaver population are expected to be negligible.

The risk of accidental fires could increase during the construction phase and would have a negative effect on beaver habitat. While the probability of an accidental fire is small, fire would have a dramatic effect on the landscape. A burn would displace beavers from the affected area and immediately alter forest composition and structure, thereby affecting food availability (Morgan 1991; Schimmel and Granström

1996; Roques *et al.* 2001; Hood *et al.* 2007). However, over the long term a fire can produce high-quality food for beaver (Potvin *et al.* 2005), and it is not expected to have a large effect on beaver populations or distribution.

Beavers often come in conflict with humans, particularly in construction areas where they plug culverts and create impoundments next to roads. These plugs typically need to be removed (Roblee 1987). This, in addition to wildlife control measures such as removal or destruction of problem beavers, could result in increased beaver mortality. Effects on the beaver population in the Local Study Area will likely be site-specific and small.

Access

Potential effects of improved access to the Local Study Area include increased mortality due to predation and trapping. Beaver populations have been heavily affected by trapping in the past (Naiman *et al.* 1986; Payne 1989; Boyle and Owens 2007) and their populations were depleted in the 1930s (YFFN Evaluation Report *(Kipekiskwaywinan)*). As areas are opened up to easier access trapping activity could increase. If trapping effort surpasses a sustainable level there will be a corresponding decrease in beaver populations in the Local Study Area. Access to the Local Study Area will be controlled by an Access Management Plan. Although trappers will be allowed to access their traplines using the main access road, trapping effort is expected to be limited due to disturbances caused by construction activities. Potential increases in trapping activity are considered under operation.

The construction of linear features on the landscape will likely facilitate predator movement in the Keeyask region (Thurber *et al.* 1994; James and Stuart-Smith 2000). Gray wolves are important predators of beavers (Smith *et al.* 1994). Changes in habitat composition and connectivity could indirectly affect beavers by influencing habitat use and movements of alternate prey of wolves (*i.e.*, caribou and moose). If changes result in a decrease in the amount of alternate prey in the area then predation pressure on beaver could increase. Conversely, if habitat changes result in an increase in alternate prey species then beaver predation would likely decrease. No habitat changes affecting caribou and moose are anticipated, and no indirect or alternate prey effects are expected for the beaver population.

Mitigation

Use of the access roads by resource users will be addressed in the Access Management Plan. Mitigation for accidents and malfunctions includes planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A minimum of a 100 m buffer will be left at creeks, streams, ponds and lakes to the extent practicable to maintain existing beaver habitat;
- Individuals from affected areas will be trapped prior to and during reservoir clearing, and periodically until the reservoir reaches maximum capacity to manage inadvertent winter mortality that is highly likely to occur during operation; and
- Beaver baffles will be used where culverts and control structures are repeatedly blocked due to beaver dam construction to minimize mortality due to conflicts with humans.

Summary of Construction Effects

Project effects on the beaver population include habitat loss and mortality in Zone 1. Approximately 20 to 30 active colonies will be removed during clearing.

Project-related disturbances during construction include sensory disturbances and mortality. Sensory disturbance from traffic, machinery, and blasting could result in a loss of effective habitat, leading to habitat avoidance or temporary abandonment. As the effects of sensory disturbance will be temporary, the loss of effective habitat will most likely be negligible to small. Wildlife-vehicle collisions on the south access road could result in a marginal increase in beaver mortality, but such events are infrequent. Beaver often come into conflict with humans, particularly in construction areas where they plug culverts and create impoundments next to roads. Lethal wildlife control measures will result in increased mortality.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and trapping. The creation of linear features could facilitate predator movement in the Local Study Area, resulting in increased beaver predation, or a relative decrease if predation is focuses on alternate prey. Access to the Local Study Area will be controlled with the Access Management Plan. Although trappers will be allowed to access their traplines using the main access roads, trapping effort is expected to be limited due to disturbances caused by construction activities.

Residual Effects of Construction

The residual effects on beaver that are expected and likely once the appropriate mitigation measure is applied will be increased mortality. The effects will be small, limited to the Local Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the likely residual effects of Project construction on beaver are expected to be adverse, small in extent, long-term in duration, and small in magnitude.

7.4.6.1.2 Operation

Habitat Loss, Gain, and Alteration

Project effects on the beaver population during construction include habitat loss in Zone 2. Primary beaver habitat covers about 1% of the Local Study Area and 6% is secondary beaver habitat. In comparison, 1% of the Regional Study Area is primary habitat, and 8% is secondary habitat. Approximately 5% of beaver habitat will be affected in the Regional Study Area (Map 7-43) and the effect of habitat loss in the Local Study Area will likely be moderate (Table 7-31). High quality beaver habitat will mainly be lost at stream crossings and in riparian areas that will be cleared prior to reservoir flooding.

Table 7-31: Benchmarks for Beaver Determination of Magnitude of Effects

Threat to Population Persistence	Range of Values Relative to Magnitude of Effect	
Physical habitat loss	Low	<1% of the region
	Moderate	1–10% of the region
	High	>10% of the region

Flooding will result in a permanent loss of beaver habitat as creeks, tributaries, and small ponds and lakes are flooded. Long-term habitat losses are associated with reservoir impoundment, erosion, and peatland disintegration. Since beaver use floating and anchored peatland habitat in Wuskwatim Lake (WRCS unpubl data), and because peatland habitat is predicted to form in the reservoir for a period of time (see the Habitat and Ecosystems section of the TE SV), beaver are expected to recolonize the reservoir in bays with shoreline peatlands during about the first five years of operation. Once these peatlands break down, most beaver will likely abandon the reservoir.

Fluctuations in water levels in the reservoir area will make any potential habitat unsuitable, as in Stephens Lake, where the density of beaver lodges is very low. Water level fluctuations greater than 0.7 m can cause beaver to abandon their lodges and likely contribute to mortality in winter (Smith and Peterson 1991). The difference between the Full Supply Level of the reservoir and the Minimum Operating Level will be 1.0 m (PD SV) exceeding beavers' tolerance. In addition to causing habitat abandonment, fluctuating water levels could destroy winter food caches for beaver. Effects of water level fluctuations will be greater on beaver colonies near the GS than those further downstream. No effects are expected in Clark Lake and Stephens Lake. The effects of fluctuating water levels will likely be small compared with the habitat available in ponds, creeks, and lakes in the Regional Study Area.

Project-related Disturbances

Traffic can be an important influence on populations since the sensory disturbance that accompanies it could cause beaver to avoid high-quality habitat and choose less favourable areas, where they could be susceptible to increased predation or environmental stress. Sensory disturbances due to traffic along the north and south access roads, which will be incorporated as a portion of PR 280, could result in localized avoidance of the area. However, beaver commonly build dams in roadside ditches and block culverts (Curtis and Jensen 2004), thus vehicular traffic will not likely reduce effective habitat. Sensory disturbances are expected to be greatest during construction and extremely limited during operation. A corresponding reduction in traffic on the current PR 280 route could also restore effective habitat for beaver near this portion of the road.

The risk of accidental fires will likely be less of a concern during the operation phase, as there will be considerably fewer workers and heavy machinery operating. Fire would have an immediate negative effect, as beaver would abandon the area to avoid the burn and to search for new browse and building materials (Morgan 1991; Schimmel and Granström 1996; Roques *et al.* 2001; Hood *et al.* 2007). As the area progresses to a mid-successional stage, beaver would benefit from the growth of aspen and birch (Potvin *et al.* 2005), which are not common in the Regional Study Area. Willow and alder, which are more common in the Regional Study Area, would regenerate in many habitat types, providing food and cover for beaver.

Wildlife-vehicle collisions could increase beaver mortality (Brown and Ross 1994), particularly around stream crossings. While collisions with vehicles have been recorded, they are not common (*e.g.*, Fudge *et al.* 2007; Smith-Patten and Patten 2008; Barthelmess and Brooks 2010; DeWoody *et al.* 2010). The risk of collision will likely negligible and highly localized at stream crossings. As traffic will increase on the new portion of PR 280, it will likely decrease on the current route, offsetting potential regional effects to a small extent.

Access

Effects of improved access to the Local Study Area by resource users and predators will likely include increased beaver mortality. Effects will be greatest during operation, as the access roads will become part of the provincial road system and their use by the public will no longer be restricted. Increased access could increase trapping effort in the Local Study Area, resulting in a direct effect on beaver populations if trapping surpasses a sustainable level (Naiman *et al.* 1986; Payne 1989; Boyle and Owens 2007). Trappers manage furbearer populations on individual traplines (Fur Institute of Canada 2003), and few traplines overlap the Local Study Area (SE SV). Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers (Manitoba Conservation 2009b. Even with the potential removal of occasional nuisance animals along the access roads, beaver harvest is not expected to exceed sustainable levels.

An influx of predators such as gray wolf and increased hunting efficiency due to linear corridors could also result in increased beaver mortality. As predator density and intactness are not anticipated to change, the effect will likely be neutral.

Mitigation

The PD SV includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for dam failure.

Other mitigation measures include:

- Beaver baffles will be used where culverts and control structures are repeatedly blocked due to beaver dam construction to minimize mortality due to conflicts with humans.

Summary of Operation Effects

Project effects on beaver during operation include habitat loss and alteration, partly due to fluctuating water levels, and changes in beaver distribution within the Local Study Area. Reservoir impoundment will result in a loss of beaver habitat as creeks, tributaries, ponds, and small lakes will be flooded. Long-term habitat losses are associated with reservoir impoundment, erosion, and peatland disintegration. Fluctuations in water levels in the reservoir will make any potential habitat unsuitable. As approximately 5% of habitat in the Regional Study Area will be affected, the effects of habitat loss are expected to be moderate.

Project-related disturbances to beaver include sensory disturbance and mortality due to wildlife-vehicle collisions. As beaver commonly build dams in roadside ditches and block culverts, vehicular traffic will not likely reduce effective habitat for beaver. Mortality could increase due to collisions with vehicles, particularly near riparian areas and wetland habitats, although the risk of collisions will likely be site specific and considered negligible. While traffic will likely increase on the access roads during operation, a corresponding decrease in traffic could occur on the existing PR 280 route, offsetting potential regional effects to a small extent.

Effects of improved access to the Local Study Area by resource users and predators will likely include increased beaver mortality. Trappers are stewards of their traplines, and are responsible for sustaining beaver populations on their traplines. Additionally, the provincial government is reviewing a draft Furbearer Management Policy to maintain sustainable populations of furbearers, thus future harvest is not expected to exceed sustainable levels. No appreciable change in beaver populations is anticipated. An influx of predators such as gray wolf and increased hunting efficiency due to linear corridors could also result in increased beaver mortality. As predator density is not expected to change, the effect on beaver will likely be neutral.

Residual Effects of Operation

The residual effects on beaver that are expected and likely once the appropriate mitigation measures are applied will be a decreased population due to reduced habitat, distributional changes, and increased mortality. The effects are predicted to be small, limited to the Local Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the residual effects of Project operation on beaver are expected to be adverse, small in extent, long-term in duration, and small in magnitude.

7.4.6.1.3 Conclusion About Residual Effects on Beaver

Residual effects on beaver are expected to be adverse, small in extent, long-term in duration, and small in magnitude. There is a high degree of certainty in the assessment because of high confidence in estimates of population abundance and distribution, habitat availability estimates, and the ability to mitigate and manage potential Project effects. The adverse residual effects of the Project on beaver will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Gillam redevelopment. These projects will mainly increase mortality due to increased human presence and access effects. Cumulative effects are discussed in more detail in Section7.4.8.1.

7.4.6.2 Caribou

7.4.6.2.1 Construction

Habitat Loss, Gain, and Alteration

Potential Project effects on caribou, including summer residents, during construction include habitat loss and alteration from land clearing in Zone 2 and changes in caribou distribution within the Caribou Local Study Area. Physical habitat losses include the reduction of food and cover available to caribou. About 6% (6,825 ha) of the physical caribou winter habitat in the Local Study Area will be affected (Map 7-44). In comparison, approximately 1% of caribou winter habitat in the Zone 5, the study zone in which intactness was assessed (see the Habitat and Ecosystems section of the TE SV) will be affected. By extrapolation, less than 1% of the winter habitat in the Caribou Regional Study Area will be affected As less than 1% of the vast winter range of the Qamanirjuaq, Cape Churchill, and Pen Islands herds will be affected, the effect of winter habitat loss on migratory caribou will likely be negligible to small (Table 7-32). Although it is unclear whether summer resident caribou use the Regional Study Area in winter, if they do, the effect of habitat loss is also expected to be negligible to small, especially if summer resident caribou travel with the migratory herds and range outside the Caribou Regional Study Area (Manitoba Conservation, unpubl. data).

Summer resident caribou calving and rearing habitat will be lost in the Local Study Area. The loss of these habitats could cause caribou to refrain from using high-quality calving grounds and use marginal habitats instead (Johnson *et al.* 2005). High-quality calving grounds are selected for predator avoidance (Rettie and Messier 2000), and mortality due to predation is a potential outcome of selection of lower-quality calving habitat. A lack of nearby forage could affect the nutrition of lactating females, leading to worsened body condition and potential reduction of future reproductive success (Nellemann and Cameron 1995). Evidence of calving was documented on approximately 10% of the islands in Gull and Stephens lakes and only 5% of the peatland complexes surveyed in 2010 and 2011, indicating that there is likely more habitat available than caribou are currently using. Two islands will be lost at the GS site, which comprise less than 1% of the primary calving and rearing habitat in the Regional Study Area. One of these islands was occupied by caribou with calves during field studies. No suitable primary and secondary calving and rearing complexes will be directly affected by the Project during construction. The initial loss of the islands at the GS site will likely be negligible.

Table 7-32: Benchmarks for Caribou Determination of Magnitude of Effects

Threat to Population Persistence	Range of Values Relative to Magnitude of Effect	
Physical habitat loss	Low	<1% of the region
	Moderate	1–10% of the region
	High	>10% of the region
Intactness	Low	<35% of the region
	Moderate	35–45% of the region
	High	>45% of the region
Linear feature density	Low	<0.6 km/km²
	Moderate	0.6–1.2 km/km²
	High	>1.2 km/km²
Gray wolf density	Low	<4 wolves/1,000 km²
	Moderate	4–6 wolves/1,000 km²
	High	>6 wolves/1,000 km²

Project-related Disturbances

Potential Project-related disturbances include sensory disturbances and mortality due to wildlife-vehicle collisions on the south access road. Sensory disturbances, including heavy machinery associated with construction activities, blasting, heavy traffic, and other human activity, can reduce effective habitat for caribou. Factors that influence caribou response to disturbance include distance from the stimulus, visibility of the stimulus, reproductive condition, sex and age class, habitat type, and previous experience. Unlike moose, caribou do not experience a substantial increase in energy costs while running (Murphy and Curatolo 1987).

Habitat avoidance or temporary abandonment could result near construction activity. Although a few caribou may habituate to small levels of noise disturbances and not all will be affected, blasting is unpredictable and could scare away most animals from the blasting zone. In heavy construction areas, some summer resident caribou activity will likely decline within 2 km of the south access road and up to at least 4 km from the GS, which will most likely result in a loss of effective habitat (Manitoba Hydro 2011c). Caribou could choose less favourable areas where they may be susceptible to increased predation or environmental stress (James and Stuart-Smith 2000; Dyer *et al.* 2002; Schindler *et al.* 2007). Wapisu woodland caribou activity decreased approximately 80% within 4 km of the Wuskwatim generating station site after construction began (WRCS unpubl. data). Similar effects could be expected for caribou in the Local Study Area, as caribou activity is reported to decrease within 1 to 10 km of industrial developments (*e.g.*, Vors *et al.* 2007).

In winter, construction could have an effect on the Cape Churchill, Pen Islands, and occasionally Qamanirjuaq herds if these animals enter the Local Study Area during their migration. Sensory disturbances will likely result in a temporary 12% loss of effective winter habitat in the Local Study Area. It is predicted that 2% of winter habitat will be affected in Zone 5, and by extrapolation, less than 1% of winter habitat in the Regional Study Area will be affected. The level of disturbance expected during construction could change animal distributions and influence migration routes. If the Qamanirjuaq caribou reach the Local Study Area, traditional movement patterns to the south would most likely be deflected east or west of the Local Study Area to avoid construction zones. However, there is little caribou activity in the Local Study Area in winter, and caribou that move away from affected winter habitat are expected to find suitable habitat elsewhere in the Local or Regional Study Areas. As less than a 1% loss of effective winter habitat is anticipated in the Regional Study Area, the overall effect of sensory disturbance on caribou will likely be negligible to small.

Sensory disturbance could result in a temporary loss of effective calving and rearing habitat and altered movements (Mahoney and Schaefer 2002) in Local Study Area. About 510 ha (5%) of the primary calving and rearing habitat in the Local Study Area is expected to be affected by sensory disturbance, all on islands in Gull Lake. Additionally, 695 ha (24%) of secondary calving and rearing habitat in the Local Study Area will likely be affected, including 23% of peatland complexes and less than 1% of islands in Gull Lake. In all, 1,205 ha (9%) of primary and secondary calving and rearing habitat will be affected in the Local Study Area. Of this, 5% will be in peatland complexes and 4% will be on islands in lakes. Given the large amount of calving and rearing habitat, particularly peatland complexes, available on the landscape (Map 7-45), less than 1% of effective primary and secondary calving and rearing habitat in the Regional Study Area is expected to be affected by sensory disturbance. Caribou that encounter sensory disturbances prior to calving will likely move to unoccupied calving and rearing habitats elsewhere in the Local or Regional Study Areas. Sensory disturbance during the summer resident calving period could result in a very small number of cows and calves abandoning protective habitat in order to escape the disturbance, increasing the predation risk and, consequently, mortality.

Caribou could avoid the Local Study Area due to construction noise, but the disturbance will be local and temporary, and no interruption of long-distance seasonal migration is anticipated. Caribou show a high level of site fidelity and do not readily abandon suitable areas due to disturbance useless they are actively pursued (Tucker and Mahoney 1990; Dyke 2008). They will often return to disturbed areas once the disturbance ends (Tucker and Mahoney 1990). As less than 1% of the available calving and rearing habitat in the Regional Study Area will be affected, the overall effects on caribou will likely be negligible to small.

Accidental spills would affect site-specific areas over a short period and have a small, negative effect on caribou or caribou habitat. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there will likely be no effect on the caribou population.

Heavy construction activity and increased human presence could increase the likelihood of accidental fire in the region. Fire can quickly alter habitat, making it unfavourable for caribou, as lichens and other browse are destroyed. Over 100 years or more, fire plays an important role in maintaining caribou habitat (Klein 1982; Joly *et al.* 2003). In addition to destroying browse, fires can change the structure, composition, and connectivity of quality caribou habitat in the region. This could result in limitations to caribou movement and distribution as animals would likely avoid burned areas. Increases in fire frequency, severity and/or total area burned could create long-term effects habitat composition and many ecosystem patterns and processes (*e.g.*, ecosystem diversity, species distributions and abundances, carbon storage; see the Habitat and Ecosystems section of the TE SV) in the Regional Study Area, including a potential change in food, cover, and habitat suitability for caribou in the Region.

Potential Project effects on the caribou populations in Local Study Area include mortality due to collisions with vehicles. Both traffic volume and vehicle speed have been positively linked to the number of caribou accidents (Brown and Ross 1994). Collisions with vehicles are not typically listed as an important source of caribou mortality (Jalkotzy *et al.* 1997; Environment Canada 2011) and would likely be limited to caribou movement corridors and high-quality habitats between Thompson and the GS. With mitigation, effects of mortality due to increased wildlife-vehicle collisions in the Regional Study Area will likely be small and with mitigation are expected to be negligible.

Access

Increased access to the Local Study Area during construction could result in increased mortality due to predation and hunting. Predators, particularly gray wolves, often use linear features to travel and to hunt (James and Stuart-Smith 2000); wolves have been observed using transmission lines to move (Mammals Working Group 2010, December 9). Greater hunting efficiency and a potential influx of predators could increase predation on caribou, which is among the threats to some populations (Environment Canada 2011). Predators could interrupt breeding and reduce the number of calves in the population (Bergerud and Ballard 1988). Habitat changes could result in the displacement of moose into areas occupied by caribou, increasing predation on caribou as predators follow (Kinley and Apps 2001). Both resident and transient wolves occur in the Regional Study Area. Most transient wolves are habitually wandering wolves that follow migratory caribou into the region. Resident wolves require moose as their primary prey base because there is not enough caribou and other alternate food biomass to sustain a wolf population with small or medium-sized territories in the Regional Study Area year-round (Moose Harvest Sustainability Plan). When migratory caribou move into the territories of resident wolf packs for part of the year; however, wolves usually hunt them while they are available. Limited prey switching can also occur if transient wolves opportunistically prey on moose. When the migratory prey leave, so do the transient wolves; the resident wolves remain and live off the regional population of moose.

Because the number and distribution of moose is not expected to change or shift substantially during construction (see Section 7.4.6.2), resident wolf density will not likely increase and distribution will not likely change. Mortality above the current rate for caribou as an alternative prey source is therefore highly unlikely during construction. Resident and transient gray wolf density in the Regional Study Area is low (estimated at less than 1.4/1,000 km² in the SLRMA) and is not expected to change with the Project; therefore, predation effects on summer resident caribou are predicted to remain small (see Table 7-32).

As the density of linear features is predicted to decline in the Local Study Area during construction, predation efficacy will not likely change, thus the overall effect of predation on all caribou should remain small.

Effects of improved access to the Local Study Area could also include increased mortality due to hunting. Opportunistic harvest of caribou by workers and other resource users could increase during construction due to improved access to the Local Study Area, also increasing caribou mortality. FLCN Members are particularly concerned that increased access will increase hunting pressure (FLCN Environment Evaluation Report (Draft)). However, GHA 3, the area where caribou hunting is permitted, overlaps only a small portion of the Local Study Area near Gillam (Map 7-46), and the small number of resident licences available for caribou harvest is managed by the Province (SE SV). The potential increase in caribou mortality due to workers hunting will be managed (see Mitigation) and the overall effect will likely be neutral. In addition, as the north access road will be the main access route to the GS during construction (PD SV), effects are expected to be neutral on the south access road during construction.

As access to the Local Study Area will increase during the construction phase, ungulates could migrate into the region, potentially bringing parasites and diseases. During construction, the potential risk will be very small, as sensory disturbances will encourage individuals to avoid the area. Additionally, there are no recognized diseases prevalent in the surrounding source populations that could be distributed very far given the relatively small area of the Project. The spread of parasites within the regional caribou population, and the transfer or spread of parasites or disease from other ungulates (*e.g.*, white-tailed deer or moose) to caribou could increase if these species use linear corridors and interact more often. Currently, white-tailed deer range extends as far north as Flin Flon (Manitoba Conservation n.d.*f*), which is well outside of the Regional Study Area. As the climate and habitat in the Regional Study Area is unsuitable for white-tailed deer and will likely remain so for the foreseeable future, range expansion into the Keeyask region is unlikely. As brainworm (*Parelaphostrongylus tenuis*) is not found in northern Manitoba, no Project effects on the spread of this parasite are expected. While similar parasites occur in the regional caribou population (Crichton *pers. comm.* 2010), creation of the access road is not expected to contribute to their spread (Mammals Working Group 2010, April 15).

Fragmentation, a landscape-level process in which human features progressively subdivide habitat blocks into smaller and more isolated fragments, is described in the Habitat and Ecosystems section of the TE SV. The potential for the access roads to fragment the surrounding habitat, compounded by increases in traffic (Laurian *et al.* 2008), could influence caribou by acting as a barrier to movement, contribute to mortality from predation and hunting access, and reduce core area size. Including the Thompson area, the density of existing linear features in Zone 5 (0.45 km/km^2) is low (see Table 7-32). The density of existing linear features in Zone 5 decreases when the area around Thompson is excluded (0.32 km/km^2), and the current magnitude of the effect of existing features is small. A small net decrease (less than 1%) in linear feature density is anticipated with the construction of the Project, as some existing linear features will be removed during clearing of borrow areas and camps, and some cutlines will be converted into a main access road. For caribou, the overall effect of a reduction in linear feature density will be negligible to small and positive. The number of core areas larger than 200 ha or 1,000 ha that caribou most likely use is expected to decrease by only 1% in Zone 5. As 82% of the largest core areas will remain intact, the overall effect of habitat fragmentation will likely be small.

The federal government outlines draft criteria to assess boreal woodland caribou ranges to measure the long-term viability of a caribou population. Habitat disturbance considers the effects of fire in addition to human features. A minimum of 65% of habitat should remain undisturbed in order to sustain a population (Environment Canada 2011). Currently, 48% of the estimated range for caribou in Zone 5 is intact (Map 7-47). Fire has the largest effect on caribou habitat in the Keeyask region, and currently affects 36% of Zone 5, where the age class of forest is less than 40 years old (Map 7-48). Consequently, the Keeyask region is unlikely to support a sustainable sedentary boreal woodland caribou population if undisturbed habitat is the only factor to consider. The current range of the summer resident caribou population is thus not considered self-sustaining, especially where a local group ranges from 20–50 animals. Other factors to consider in the overall analysis include range, type of caribou, other habitat factors, and gray wolf density. Recent radio-collaring data have shown some caribou spent a summer in the Keeyask region and migrated to the coast the following year (Manitoba Conservation unpubl. data). As such, at least some of the summer residents are likely coastal caribou that have switched to solitary calving behaviours. Radio-collaring data have also shown large migratory movements nearing Shamattawa, which are not consistent with the shorter migratory movements of forest-dwelling woodland caribou populations found elsewhere in Manitoba. These movements indicate the actual range use of collared caribou extends beyond the Regional Study Area, and the undisturbed portion of their overall range is likely greater than in the Regional Study Area (Manitoba Hydro 2011b). The islands in Stephens Lake are frequently used for calving, and this area should be recognized as suitable habitat. Finally, recognized boreal woodland caribou populations in Manitoba have persisted on landscapes with less than the recommended 65% undisturbed habitat benchmark; however, the long-term viability of these populations is uncertain (Environment Canada 2011). Because some of the summer resident caribou are likely coastal caribou, caribou are not using all of the calving and rearing habitat currently available in the Regional Study Area, and the proportion of undisturbed habitat is greater beyond the Regional Study Area, the effect of habitat disturbance on summer resident caribou is predicted to be small.

Mitigation

Use of the access roads by resource users will be addressed in the Construction Access Management Plan. Mitigation for accidents and malfunctions includes planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- The excavated material placement areas were sited to avoid caribou calving complexes and reduce habitat loss;

- Future calving islands greater than 0.5 ha in the reservoir area will be flagged and left undisturbed to protect the vegetation that will remain on these islands from clearing disturbances;
- The access roads were routed to avoid caribou calving complexes and reduce loss of effective habitat;
- Blasting will be minimized to the extent practicable from May 15 to June 30, to reduce the effects on calving females and their young;
- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area;
- Gates will be added to the north and south dykes, to be kept closed and locked from May 15 to June 30 and during other sensitive periods as may be determined by monitoring (*e.g.*, the arrival of migratory caribou) to minimize disturbances by humans;
- Firearms will be prohibited in camps and at work sites to reduce mortality due to hunting during construction;
- Warning signs will be placed along the access roads near caribou travel corridors and high-quality habitats to reduce the potential of wildlife-vehicle collisions;
- Roadside ditches will be rehabilitated with native plants with low quality food value for caribou where practicable, to minimize attraction and the risk of collisions and harvest opportunities; and
- Fire prevention measures will be employed in remote working environments to minimize the risk of habitat loss for caribou.

Summary of Construction Effects

Project effects on caribou during construction, including summer residents, include habitat loss and alteration from land clearing in Zone 2 and changes in caribou distribution within the Caribou Local Study Area. About 6% or 6,825 ha of the physical caribou winter habitat in the Local Study Area will be affected, compared with 1% of winter habitat in Zone 5 and, by extension, less than 1% of the habitat in the Regional Study Area. Summer resident caribou calving habitat will also be lost in the Local Study Area. These losses comprise less than 1% of the calving and rearing habitat available in the Regional Study Area. The effects of habitat loss on caribou will be negligible to small.

Project-related disturbances include sensory disturbances and mortality due to wildlife-vehicle collisions on the access roads. Sensory disturbances from blasting, machinery, and people will most likely influence a few caribou to avoid some winter habitat. In addition to physical winter habitat loss, sensory disturbance will likely result in an additional 12% loss of effective habitat in the Local Study Area. Approximately 2% of winter habitat will be affected in Zone 5, and by extrapolation, less than 1% of the winter habitat in the Regional Study Area will likely be affected. Caribou that move away from affected winter habitat will most likely find suitable habitat elsewhere in both the Local and Regional Study Areas, and the overall effect of winter habitat loss during construction is negligible to small.

In addition to effects on winter habitat, sensory disturbance could result in a loss of effective calving and rearing habitat. In total, about 9% of primary and secondary calving and rearing habitat will be affected in the Local Study Area, and less than 1% is expected to be affected in the Regional Study Area. Caribou that encounter sensory disturbances prior to calving will likely move to unoccupied calving and rearing habitats elsewhere in the Local or Regional Study Areas. Sensory disturbances during the summer resident calving period could result in a very small number of cows and calves abandoning protective habitat in order to escape the disturbance. This could result in increased mortality through predation, as calves could leave protective habitat, resulting in increased predation risk. As less than 1% of the available calving and rearing habitat in the Caribou Regional Study Area will be affected, the overall effects will likely be negligible to small.

Effects of improved access to the Local Study Area include increased mortality due to predation. Predators, particularly gray wolves, often use linear features to travel and to hunt; wolves have been observed using transmission lines to move. Greater hunting efficiency and a potential influx of predators could increase caribou mortality, which is among the threats to some caribou populations. Habitat changes could result in the displacement of moose into areas occupied by caribou, increasing predation on caribou as predators follow. Because the number and distribution of moose is not expected to change or shift substantially during construction, resident wolf density will not likely increase and distribution will not likely change. Mortality above the current rate for caribou as an alternative prey source is therefore highly unlikely during construction, and the overall effect of predation on all caribou should be small.

Effects of improved access to the Local Study Area also include increased mortality due to hunting. As licensed hunting is only permitted in a small portion of the Local Study Area, the increase in caribou mortality due to workers hunting will be managed, and use of the south access road will be restricted during construction, no change in hunting mortality is expected, and effects are expected to be neutral.

Project-related changes in the intactness of caribou habitat and linear feature density could affect caribou habitat and movements in the Local Study Area. Linear feature density in Zone 5 is expected to decrease, and the overall effect on caribou will be small and positive. As 82% of the largest core areas will remain intact, the effect on caribou will likely be small.

Residual Effects of Construction

Residual effects on caribou that are expected and likely once the appropriate mitigation measures are applied will be localized altered movements due to sensory disturbance, distributional changes, decreased abundance due to reduced habitat available in the Local Study Area, and increased mortality. Most Project effects will be negligible to small, particularly since habitat currently appears to be under-utilized, limited mainly to the Local Study Area, and affect two or more generations. Regional effects could include any indirect caribou mortality associated with the Project, but these are also expected to be negligible to small.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the likely residual effects of Project construction on caribou are expected to be adverse, small in extent, long-term in duration, and small in magnitude.

7.4.6.2.2 Operation

Habitat Loss, Gain, and Alteration

During operation, effects on caribou, including summer resident caribou, will include additional habitat loss and alteration. Long-term habitat losses are associated with reservoir impoundment, erosion, peatland disintegration, and reservoir-related groundwater and edge effects (see the Habitat and Ecosystems section of the TE SV). No additional loss of winter habitat is expected above construction losses, although with flooding, habitat loss will be permanent. As no additional loss of winter habitat is anticipated, effects are expected to be negligible to small.

Approximately 257 ha, or less than 2%, of primary calving and rearing habitat will be affected in the reservoir by year 30 of operation in the Local Study Area. A 65% increase in the area of islands in lakes between 0.5 and 10 ha is anticipated. Ground water effects on vegetation could reduce the quality of potential caribou habitat on new islands formed in the reservoir and on existing islands such as Caribou Island. In a worst-case scenario, all islands in the reservoir could change from primary to secondary calving and rearing habitat, predicted with a moderate level of uncertainty. In total, less than 1% of all calving habitat in the Regional Study Area is expected to be affected by the Project during operation. As such, the effects of the loss or alteration of calving and rearing habitat will likely be small.

Project-related Disturbances

Project-related disturbances to caribou during operation include sensory disturbance from traffic on the access roads and from noise and workers at the GS site. Sensory disturbance from traffic on the access roads could result in avoidance of the area by some caribou (Dyer *et al.* 2002), particularly Pen Islands animals and summer residents on the south side of Stephens Lake in the Local Study Area. Caribou avoid roads at a minimum of 250 m in open coniferous forest, and at smaller distances in closed coniferous forest (Dyer *et al.* 2001). The degree of avoidance will likely depend on the volume of traffic on the access roads (Jalkotzy *et al.* 1997; Dyer *et al.* 2001). It is predicted that primary calving and rearing habitat within 2 km of the GS will be less suitable for calving, and will be more likely to be used by adults without calves. Summer resident caribou with fidelity to existing calving sites will very likely cross the highway to gain access to high quality calving habitat on Stephens Lake. Early in the operation phase, caribou will likely re-occupy most habitats avoided during construction, but some loss of effective habitat, up to 500 m from the road and less for cutlines, will continue over the long term. Less than 1% of the available calving and rearing habitat in the Regional Study Area is expected to be affected, thus effects will likely be negligible to small. As less than 1% of the available calving and rearing habitat in the Regional Study Area will be affected, overall, these effects will likely be negligible to small (see Table 7-32).

While few river crossing sites were found between Clark Lake and Gull Rapids, and very few caribou were recorded crossing the Nelson River during technical studies, resource users from the KCNs have observed caribou crossing the Nelson River just downstream of Gull Rapids (FLCN 2010 Draft). Based on experience with past hydroelectric projects, the KCNs raised concerns about caribou drowning as a potential Project effect due to an altered ice regime. Although no increase in caribou drowning as a direct result of the Project is anticipated, there is uncertainty associated with the conditions under which the risk of mortality can change. The earlier formation of thin ice across the reservoir, which coincides with the arrival of caribou in the Local Study Area, could increase the risk of drowning mortality. However, once the ice has formed, an increase in caribou drowning is unlikely on the reservoir because post-Project conditions include the formation of a stable ice cover on the reservoir (*i.e.*, smoother and more consistent than the existing environment), including maintaining a steady reservoir level during freeze-up and monitoring ice thickness (Project Description Supporting Volume), and less variation in water levels once the reservoir is established relative to current conditions (Mammals Working Group 2011, June 28). Monitoring will be required.

Other potential Project-related disturbances could include reduced local movements by caribou along shorelines due to woody debris. Past flooding has resulted in debris accumulating on shorelines, making them difficult to access by wildlife (FLCN Environment Evaluation Report (Draft)). However, the area flooded during the creation of the Kettle reservoir (*i.e.*, Stephens Lake) was not cleared prior to inundation, submerging trees and other vegetation that periodically float to the surface and collect on the shorelines. A negligible to small effect is anticipated because the Forebay Clearing Plan and Waterways Management Plan will reduce these effects.

The risk of accidental fire will be likely be reduced during the operation phase, as there will be considerably fewer workers and heavy machinery operating in the area. Fire plays an important role in maintaining caribou habitat (Klein 1982; Joly *et al*. 2003). Fire suppression may be limited to areas in proximity to infrastructure, and would not affect large tracts of forest. The risk of spills and other environmental events will also be reduced.

Collisions with vehicles are generally not listed as an important source of caribou mortality (Environment Canada 2011). As the risk of wildlife-vehicle collisions is unlikely to change during operation, the effects of mortality due to collisions with vehicles in the Regional Study Area is expected to remain negligible to small.

Access

Effects of improved access to the Local Study Area include increased mortality due to predation and hunting. During operation, the number and length of linear features in the Local Study Area is not expected to change, nor will the overall numbers of gray wolves or moose. As a result, the overall effect of predation on caribou is not expected to change and the effect will remain small during operation.

Effects of improved access also include increased caribou mortality due to hunting (Bergerud *et al*. 1984). With their low reproductive rate, caribou cannot sustain high losses due to hunting, which could increase as new access to the Local Study Area becomes available via the north and south access roads. There is no licensed harvest of caribou in GHA 9, which overlaps the Local Study Area, and there is no licensed hunting of boreal woodland caribou in Manitoba (Manitoba Conservation 2011b). Access to the area already includes waterbodies and watercourses, the existing PR 280, cutlines and trails, railways, and transmission lines, whose use as transportation routes to support the sustainable domestic harvest in the Regional Study Area varies seasonally. Once the Project is commissioned, PR 280 will be re-routed to include the north access road, the GS facility over the Nelson River and the south access road to Gillam. This new section of PR 280 could increase local caribou hunting activity by domestic resource users.

Increased access is also expected due to the provision of boat launches above and below the GS. The traditional harvest of caribou by the KCNs usually occurs in winter and focuses on migratory caribou populations. With the exception of one large harvest of migratory caribou in the last 10 years (Manitoba Hydro 2011b), few caribou are harvested from the Local Study Area (CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report *(Kipekiskwaywinan)*; FLCN 2010 Draft). However, many caribou are harvested from the Regional Study Area, from the surrounding GHAs, and into Ontario and Nunavut by all resource users. Including considerations for sustainable caribou management by the province (mainly via regulation of licensed hunting in Manitoba), the effects of harvest on caribou populations in the Local Study Area are not expected to contribute substantially to the effects of the broader regional harvest, thus the effect is expected to be small during operation.

AEA offsetting programs will, among other purposes, provide alternate harvesting opportunities in the SLRMA to replace the loss of traditional resource use areas due to the Project. These programs are expected to disperse existing harvest pressures in the Local Study Area. For waterfowl and moose, traditional wildlife harvests happen in the spring and fall respectively. The traditional harvest of caribou occurs in winter, and because there is no overlap with other hunting seasons, the harvest of caribou is not expected to increase in the SLRMA and effects of AEA offsetting programs on caribou will likely be neutral.

Increased access could also allow caribou and other ungulates to move into the region from other locations. While this may improve genetic diversity, it comes with the potential risk of introducing parasites and disease into the area (Fitzgibbon *et al.* 2005). The spread of brainworm is of concern. The spread of parasites within the regional caribou population, and the transfer or spread of parasites or disease from other ungulates, such as white-tailed deer or moose, to caribou may increase if these species use linear corridors and interact more often. Currently, white-tailed deer range extends as far north as Flin Flon (Manitoba Conservation n.d.*f*), which is well outside of the Regional Study Area. As brainworm is not found in northern Manitoba, the Project is expected to have no effect on the spread of this parasite. While similar parasites occur in the regional caribou population (Crichton *pers. comm.* 2010), the access road is not expected to contribute to their spread, and no effect on the caribou population is anticipated.

No additional change in the density of linear features is expected in Zone 5 during operation, therefore effects of habitat fragmentation on caribou during operation will likely be neutral.

Mitigation

The PD SV includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; and inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for dam failure.

Other mitigation measures include:

- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, invasive plant spreading, accidental fires and access-related effects;
- Temporarily cleared areas and excavated materials placement areas (see the Habitat and Ecosystems section of the TE SV) will be rehabilitated to native habitat types where feasible to improve caribou habitat;
- Warning signs should be maintained in areas along the access roads with caribou activity to caution motorists; and
- A plan is being developed to coordinate caribou mitigation and monitoring activities among Manitoba Hydro's northern developments, as well as with government authorities and existing caribou committees and management boards.

Summary of Operation Effects

During operation, effects on caribou, including summer resident caribou, will include additional habitat loss and alteration. Long-term habitat losses are associated with reservoir impoundment, erosion, peatland disintegration, and reservoir-related groundwater and edge effects. No additional loss of winter habitat is expected above construction losses, and the effect of alteration of winter habitat is expected to be negligible to small. Less than 2% of primary calving and rearing habitat will be affected in the reservoir by year 30 of operation. While some primary calving habitat will be lost, the availability of secondary calving and rearing habitat will increase. The overall Project effects on caribou habitat during operation will likely be small.

Potential effects include Project-related disturbances from the access roads and from noise and workers at the GS site, and mortality due to collisions with vehicles on access roads. Early in the operation phase, caribou are expected to re-occupy most habitats that were avoided during construction, but some loss of effective habitat will be long-term. Effects of sensory disturbances are expected to be negligible to small. Collisions with vehicles are not an important source of caribou mortality, thus a negligible to small effect is anticipated.

Effects of improved access to the Local Study Area include increased mortality due to predation and hunting. During operation, the number and length of linear features in the Local Study Area is not expected to change, nor will the overall numbers of gray wolves or moose. As a result, the overall effect of predation on caribou is not expected to change and the effect will remain small during operation. With their low reproductive rate, caribou cannot sustain high losses due to hunting, which could increase as new access to the Local Study Area becomes available via the north and south access roads. The effects of harvest on caribou populations in the Local Study Area are not expected to contribute substantially to the effects of the broader regional harvest, thus the effect is expected to be small during operation. No additional change in the density of linear features or intactness is expected in Zone 5 during operation, therefore effects on caribou will likely be neutral.

Residual Effects of Operation

Residual effects on caribou that are expected and likely once the appropriate mitigation measures are applied will be altered movements due to reduced intactness and sensory disturbance, and decreased populations due to reduced habitat and increased mortality. Effects will be small, extend towards the Regional Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the most likely residual effects of Project operation on caribou are expected to be adverse, medium in extent, long-term in duration, and small in magnitude.

7.4.6.2.3 Conclusion About Residual Effects on Caribou

Residual effects on caribou are expected to be adverse, small to medium in extent, long-term in duration, and small in magnitude. There is a moderate to high degree of certainty in the assessment because of some unpredictability regarding the long-term frequency and variability of habitat use and movements, but high confidence in habitat availability, existing core areas, and regional intactness estimates, and in the ability to mitigate and manage potential Project effects. The adverse residual effects of the Project on caribou will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, Conawapa Generation Project, and Gillam redevelopment. These projects will increase habitat loss, reduce intactness, increase fragmentation and increase mortality due to increased human presence and access effects. The cumulative effects are discussed in more detail in Section7.4.8.2. Monitoring plans are being developed to address uncertainties.

7.4.6.3 Moose

7.4.6.3.1 Construction

Habitat Loss, Gain, and Alteration

Project effects on the moose population during construction include habitat loss and alteration in Zone 2, habitat fragmentation, and changes in moose distribution within the Moose Local Study Area. Important moose calving and rearing habitat in the Local Study Area includes islands in lakes and peatland complexes that are similar to those sued by summer resident caribou (see Map 7-33), and peninsulas and shorelines of lakes and rivers. Primary moose habitat covers about 10% of the Local Study Area (Map 7-49) and 69% is secondary moose habitat. In comparison, 38% of the Moose Regional Study Area consists of primary moose habitat, and the remainder is considered secondary habitat. Approximately 1% of physical moose habitat will be lost in the Regional Study Area. Portions of primary habitat are located in areas of low or very low moose density. A substantial portion of the primary habitat located near Zone 1 is burned habitat, which is expected to become secondary habitat as it matures. The distribution, quantity, and quality of habitat are also expected to change in the long term, within a range of natural variation driven by the fire regime (see the Habitat and Ecosystems section of the TE SV). As less than 1% of moose habitat in the Regional Study Area is expected to be lost during construction, and habitat alteration will likely be within the range of natural variation, the effect on moose will likely be negligible to small (Table 7-33).

Table 7-33: Benchmarks for Moose Determination of Magnitude of Effects

Threat to Population Persistence	Range of Values Relative to Magnitude of Effect	
Physical habitat loss	Low	<1% of the region
	Moderate	1–10% of the region
	High	>10% of the region
Harvest	Low	<10% of regional population
	Moderate	11–20% of regional population
	High	>20% of regional population
Gray wolf density	Low	<4 wolves/1,000 km²
	Moderate	4–6 wolves/1,000 km²
	High	>6 wolves/1,000 km²

Fragmentation of habitat by the access roads could affect the moose population in the Local Study Area; however, moose are often found along highways and roads (Forman and Deblinger 2000; Laurian *et al.* 2008; Manitoba Hydro 2011c) where edge habitat is preferred. Because moose are adapted to survival in edge habitats, and overall intactness is unlikely to change (see the Habitat and Ecosystems section of the TE SV), the effects on moose are expected to be neutral.

Project-related Disturbances

Project-related disturbances include sensory disturbances and mortality due to wildlife-vehicle collisions on the access roads. Sensory disturbances (*e.g.*, traffic, machinery, blasting), could result in a loss of effective habitat and the temporary abandonment of calving habitat. Important moose calving and rearing habitat in the Local Study Area includes islands in lakes and peatland complexes that are similar to those often used by summer resident caribou (see Map 7-33), and peninsulas and shorelines of lakes and rivers. Moose exhibit a high level of site fidelity and will not easily abandon suitable areas due to disturbance (Renewable Resources Consulting Services Ltd. (RRCS) 1994), often returning once the disturbance ends (Colescott and Gillingham 1998). Moose cows and calves were reported by workers during construction of the Wuskwatim GS, and overall moose activity levels remained high throughout the access road construction period (Manitoba Hydro 2011c). Similarly, the effects of sensory disturbances on moose in the Local Study Area are expected to be negligible to small.

Collisions with vehicles on the access roads could result in increased moose mortality. Collisions with moose have been recorded in Manitoba (Manitoba Conservation 2005b), and are most likely to occur during the periods of peak moose activity at dusk, night, and dawn, when roadside visibility is poor for vehicle operators (Joyce and Mahoney 2001). Riparian mammals may be localized near stream crossings, ponds, ditches or other high-quality habitats. While collisions with deer are much more common in Manitoba, 72 collisions with moose were reported in rural Manitoba in 2005 (Manitoba Conservation 2005b). One moose-vehicle collision occurred during construction of the Conawapa road (Windsor *pers. comm. circa* 1992), and none have occurred to date on the Wuskwatim access road. While vehicles may occasionally collide with moose in the Local and Regional Study Areas, such events are uncommon and will likely have a minimal effect on the moose population in the Regional Study Area.

Accidental spills would affect site-specific areas over a short period and have a small, negative effect on moose or moose habitat. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there will likely be no effect on the moose population.

The risk of accidental fire is likely to increase during the construction phase. Should a fire occur, it could have both positive and negative effects on moose habitat. At the time of the initial burn, moose will be displaced from the area. In addition, fire will have an immediate impact on forest composition and structure. This will mean a temporary loss of moose habitat; however, as vegetation begins to re-grow the burned area will develop into quality moose habitat (LaResche and Davis 1973; LaResche *et al.* 1974; Oldemeyer 1974; Cushwa and Coady 1976; Oldemeyer *et al.* 1977; MacCraken and Viereck 1990). Increases in fire frequency, severity and/or total area burned could create long-term effects on Regional Study Area habitat composition (see the Habitat and Ecosystems section of the TE SV), including a potential change in food, cover, and habitat suitability for moose in the Regional Study Area.

Access

In the Regional Study Area, most moose are harvested along waterbodies and watercourses using boats for access (FLCN Environment Evaluation Report (Draft)). Harvest of moose by workers and local resource users including the KCNs could increase during construction due to improved access to the Local Study Area, increasing moose mortality. The moose harvest will occur throughout the SLRMA where the distribution of resource use will change as a result of AEA offsetting programs. The south access road and trails will facilitate hunting in the Local Study Area and could lead to an increase in moose mortality. Most moose kills occur within 1.6 km of the road, and the most successful hunters tend to use all-terrain vehicles (Jalkotzy *et al.* 1997). Moose congregating at salt licks also tend to be more tolerant of human presence, which increases their susceptibility to hunters (Miller and Litvaitis 1992).

Resident moose hunters (residents of Manitoba) in the Keeyask region are generally from Gillam or associate with people from Gillam (SE SV). Resident harvest data specific Keeyask region is unavailable (SE SV). Non-resident (non-resident Canadian citizens or foreign citizen) hunting licenses are limited and can only be purchased through a licensed outfitter or lodge operator (SE SV). The KCNs participate in the domestic harvest of moose (SE SV). The current harvest in the SLRMA is estimated at less than 10% of the regional population (Moose Harvest Sustainability Plan). With mitigation (see below) and continued regulation of licensed hunting by Manitoba Conservation, the moose harvest will not likely exceed sustainable limits and is expected to have a negligible effect on the regional moose population.

The creation of new linear corridors, such as the south access road, could alter the population dynamics between moose and their predators during construction. If moose travel on the access road or are attracted to habitat nearby, they could be more susceptible to predation by wolves (Thurber *et al.* 1994; Jalkotzy *et al.* 1997). An increase in linear feature density across the landscape could result in an influx of predators in the Local Study Area. This, combined with changes in cover, could result in an increase in predator success rate (Kunkel and Pletscher 2001). Resident and transient gray wolf density in the

Regional Study Area is low (estimated at less than 4/1,000 km²) and is not expected to change because of the Project. As no net increase in the density of linear features is predicted in the Local Study Area during construction, predation efficacy will not likely change, and the effect of predation on moose will likely be small.

As access is increased during the construction phase, ungulates may migrate into the Regional Study Area, potentially bringing parasites and diseases. It is unlikely that diseases rates will transmitted during construction. There is a small chance that over time white-tailed deer could use linear features associated with the project to inhabit the region. White-tailed deer can harmlessly carry the brainworm parasite, which is passed through feces into water sources where it infects terrestrial molluscs such as *Deroceras laeve* and *Zonitoides arboreus,* which are then consumed by deer (Anderson 1972) or other cervids. These molluscs occur throughout Canada, including the north, and are tolerant of lower temperatures (Karlin 1956; Getz 1959). Brainworm can be fatal in caribou and moose; where these species co-exist all are susceptible (*e.g.*, Anderson 1972; Schmitz and Nudds 1994; McLoughlin *et al.* 2003; Manitoba Model Forest 2005). As of the early 1970s, the distribution of brainworm in white-tailed deer in Manitoba was limited to the southern third of the province (Bindernagel and Anderson 1972). As white-tailed deer were not observed in the Regional Study Area, were not reported by KCNs, and would not likely survive in the existing environment, the spread of brainworm in the region is unlikely.

Mitigation

Use of the access roads by resource users will be addressed in the Construction Access Management Plan. Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A Moose Harvest Sustainability has been prepared by TCN to guide the management of their Adverse Effects Agreement Access Program to ensure the sustainability of the moose population in the SLRMA;
- Roadside ditches will be rehabilitated with native plants with low quality food values for moose where practicable, to minimize attraction of moose to the road and the risk of wildlife-vehicle collisions and harvest opportunities;
- Information about wildlife awareness will be provided for workers to reduce the risk of wildlife-vehicle collisions; and

- Firearms will be prohibited in camps and at work sites to reduce mortality due to hunting during construction.

Summary of Construction Effects

Project effects on the moose population during construction include habitat loss and alteration in Zone 2, habitat fragmentation, and changes in moose distribution within the Local Study Area. As less than 1% of moose habitat in the Regional Study Area is expected to be lost during construction, and habitat alteration will likely be within the range of natural variation, the effect on moose will likely be negligible to small.

Fragmentation of habitat by the access roads could affect the moose population in the Local Study Area; however, moose are often found along highways and roads. Because moose are adapted to survival in edge habitats, and overall intactness is unlikely to change, the effects of habitat fragmentation on moose are expected to be neutral.

Project-related disturbances include sensory disturbances and mortality due to collisions with vehicles on the south access road. Moose exhibit a high level of site fidelity and will not easily abandon suitable calving areas due to disturbance, and will often returning once the disturbance ends. Moose activity in a similar construction zone suggests that not all moose will avoid the area. If moose do not avoid the south access road during construction, collisions with vehicles could result in increased moose mortality. While vehicles could occasionally collide with moose in the Local Study Area, such events will likely be uncommon and are expected to have a minimal effect on the moose population in the Regional Study Area. The effects of Project-related disturbances on moose in the Local Study Area are expected to be negligible to small.

Potential effects of improved access to the Local Study Area include increased mortality due to predation and hunting. Greater hunting efficiency and a potential influx of predators such as gray wolves could increase moose mortality. No change is predicted in the density of resident and transient gray wolves or intactness in the Regional Study Area, thus effects of increased predation on moose will likely be small. Harvest of moose by workers and local resource users could increase during construction, increasing moose mortality. With mitigation and the regulation of licensed hunting by Manitoba Conservation, the moose harvest will not likely exceed sustainable limits and is expected to have a negligible effect on the regional moose population.

Residual Effects of Construction

Residual effects on moose that are expected and likely once the appropriate mitigation measures are applied will be altered movements due to sensory disturbance, distributional changes, and a decreased population due to altered habitat and increased mortality. Effects will be negligible to small, extend to the Regional Study Area due to traffic and offset resource use programs, and affect one to two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the likely residual effects of Project construction on moose are expected to be adverse, large in extent, medium-term to long-term in duration, and small in magnitude.

7.4.6.3.2 Operation

Habitat Loss, Gain, and Alteration

During operation, effects on moose will likely include further alteration of habitat in the Local Study Area and the permanent loss of habitat in the reservoir. Long-term habitat loss or alteration is associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects. As primary and secondary moose habitat covers a large portion of the Regional Study Area, the effects of additional habitat loss on moose will likely be negligible to small.

Project-related Disturbances

Potential Project-related disturbances to moose include sensory disturbance from traffic on the access roads, changes in habitat connectivity, and mortality due to wildlife-vehicle collisions. When the north and south access roads are incorporated as part of PR 280, local traffic volume can be expected to increase on this new route. Traffic volume and speed are positively linked to the number of collisions between vehicles and moose (Beland 1995), as has the presence of salt licks (Fraser and Thomas 1982). Sensory disturbances from traffic can negatively affect moose habitat and could result in some moose avoidance (Jalkotzy *et al.* 1997). While some moose could avoid roads, particularly where traffic is heavy, they are often found near roads (Laurian *et al.* 2008) and are known to cross them (Joyce and Mahoney 2001; Dussault *et al.* 2007). As such, collisions with vehicles could increase moose mortality in the Local Study Area. There would likely be a corresponding decrease in traffic along the current PR 280 route, which could offset some of the effects of the new provincial road. The effects of sensory disturbance and collisions with vehicles are expected to be small and negligible, respectively.

The risk of accidental spills will decrease during operation, as there will be less equipment and heavy machinery operating. Proper containment and inventory control will be used to minimize the risk of a spill. If a spill were to occur, any effect on moose habitat would be localized to the contaminated area and would have minimal effect on moose.

The risk of accidental fire should decrease during operation, as there will be considerably fewer workers and heavy machinery operating in the area. Fire would have an immediate effect on vegetation composition, structure, and connectivity, but it can be positive for moose in the long term (Oldemeyer 1974; Oldemeyer *et al.* 1977; MacCraken and Viereck 1990; Ball *et al.* 2007). Moose are often found in previously burned habitat, as they browse on young vegetation (MacCraken and Viereck 1990). Consequently, fire could encourage the movement of moose into an area in search of quality browse. If fire frequency increases above the natural fire cycle (see the Habitat and Ecosystems section of the TE SV), there could be a reduction in food and cover for moose.

Access

Access to the Local Study Area by the public will increase when the access roads are incorporated as a portion of PR 280, and an increase in moose hunting mortality is expected during the operation phase (Jalkotzy *et al.* 1997). Increased access to the Local Study Area could increase local moose hunting by resource users. Increased access is also expected due to the provision of boat launches above and below the GS. AEA offsetting programs will, among other purposes, provide alternate harvesting opportunities in the SLRMA to replace the loss of traditional resource use areas due to the Project. These programs are expected to disperse existing harvest pressures in the Local Study Area, and moose mortality in the SLRMA will be an on-going effect. The current harvest in the SLRMA is estimated at less than 10% of the regional population (Moose Harvest Sustainability Plan). With mitigation (see below) and continued regulation of licensed hunting by Manitoba Conservation, the moose harvest will not likely exceed sustainable limits and is expected to have a small effect on the regional moose population.

Predation on moose could increase with increased access to the Local Study Area. Increased predation could result in an overall decrease in the local moose population, particularly if cows and calves experience the greatest predation pressure (Larsen and Ripple 2004). No additional change in the density of linear features is expected in Zone 5 during operation, and the density of gray wolves is not expected to change. The effects of increased predation on moose will likely be negligible to small.

Increased access could also allow caribou and other ungulates to move into the region from other locations. While this may improve genetic diversity, it comes with the potential risk of introducing parasites and disease into the area (Fitzgibbon *et al.* 2005). The likelihood of this event occurring is very low, and no effect on the moose population is anticipated.

Mitigation

Mitigation measures for moose include the following:

- Continue to communicate and coordinate with TCN Members to verify that recommendations in the moose harvest sustainability plan are being implemented;
- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, accidental fires and access-related effects; and
- Mitigation for wetland function will benefit moose through the development of wetlands in the Local Study Area (see the Habitat and Ecosystems section of the TE SV) and could offset some of the losses in habitat for moose.

Summary of Operation Effects

Long-term habitat losses are associated with reservoir impoundment, erosion, peatland disintegration, and reservoir-related groundwater and edge effects. During operation, effects on moose will likely include the further alteration of habitat in the Local Study Area and the permanent loss of habitat in the reservoir. As primary and secondary moose habitat covers a large portion of the Regional Study Area, the effects of additional habitat loss on moose will likely be negligible to small.

Project-related disturbances to moose include sensory disturbance from the access roads and mortality due to wildlife-vehicle collisions. While moose may avoid roads, particularly where traffic is heavy, they are often found near roads. As such, effects of sensory disturbance and changes in habitat connectivity will likely be small. Collisions with vehicles could increase moose mortality. While traffic could increase on the access roads during operation, a corresponding decrease in traffic will likely occur on the existing PR 280 route and effects are expected to be negligible.

Effects of improved access to the Local Study Area by resource users and predators could include increased moose mortality. Increased access to the Local Study Area could increase local moose hunting by resource users. Moose mortality due to harvest in the SLRMA because of AEA offsetting programs will be an on-going effect. No additional change in the density of linear features is expected in Zone 5 during operation, and the density of gray wolves is not expected to change. The effects of increased predation on moose will likely be negligible to small. TCN has prepared a Moose Harvest Sustainability Plan to guide the management of their Adverse Effects Agreement Access Program to ensure the sustainability of the moose population in the Split Lake Resource Management Area.

Residual Effects of Operation

The residual effects on moose that are expected and likely once the appropriate mitigation measures are applied will be a decreased population due to altered habitat, and increased mortality. The effects are predicted to be negligible to small, extend to the Regional Study Area, and affect two or more generations.

Using the criteria established to determine the significance of Project effects for regulatory purposes, the likely residual effects of Project operation on moose are expected to be adverse, large in extent, long-term in duration, and small in magnitude.

7.4.6.3.3 Conclusion About Residual Effects on Moose

Residual effects on moose are expected to be adverse, large in extent, medium-term to long-term in duration, and small in magnitude. There is a high degree of certainty for moose in the assessment because of high confidence in estimates of population abundance, distribution, and habitat availability estimates, and the ability to mitigate and manage potential Project effects. The adverse residual effects of the Project on moose will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, Conawapa Generation Project, and Gillam Redevelopment. These projects will increase habitat loss and mortality due to increased human presence and access effects. The cumulative effects are discussed in more detail in Section7.4.8.3. Monitoring plans are being developed to address uncertainties, including the effects of harvest.

7.4.7 Rare or Regionally Rare Species

Other than boreal woodland caribou, which may or may not occur in the Keeyask region and is discussed in Section 7.4.6.2, there are no threatened, endangered, or provincially rare mammal species in the Keeyask region. With the exception of wolverine, which is listed as a species of special concern by COSEWIC, and little brown myotis, which is being considered for emergency status as an endangered species, the remaining species (American water shrew, porcupine, raccoon, striped skunk, and coyote), are regionally rare in the Keeyask region but are common elsewhere in Manitoba.

7.4.7.1 Wolverine

7.4.7.1.1 Construction

Habitat Loss, Gain, and Alteration

Potential Project effects on wolverine include habitat loss, gain, or alteration during clearing in Zone 1. Changes in habitat composition and connectivity could influence habitat use and movements of wolverine, which are considered one of the most sensitive species of ecological integrity (COSEWIC 2003). Habitat loss in Zone 1 represents a small portion of the average wolverine home range (50,000 to 60,000 ha; COSEWIC 2003), and because wolverine are sparse in the Rare Mammals Local Study Area, habitat loss is expected to affect a few individuals at most. The effects of habitat loss will most likely be indirect, as wolverine select habitat with adequate prey availability, and not for specific topographic features (COSEWIC 2003; Krebs *et al.* 2007). Clearing in winter, however, could disturb denning females. The home range of at least one wolverine overlaps the south access road, but effects will not likely extend to the population and are expected to be negligible to small.

Project-related Disturbances

Disturbances due to noise from construction activities and blasting will likely reduce effective habitat where these activities occur. Blasting and the operation of heavy equipment may result in localized effects on wolverine, as human activities are known to influence wolverine behaviours such as denning, travel, and foraging (COSEWIC 2003; Krebs *et al.* 2007). As wolverine will pass through areas with human activity as they move about their home ranges (Hash 1987), and due to their rarity in the Local and Regional Study Areas, effects of sensory disturbance are expected to be small and temporary.

Accidents and malfunctions such as spills and fires could affect wolverine. Accidental spills would affect site-specific areas over a short period and have a small, negative impact on these animals or portions of their home ranges. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be a minimal effect on the wolverine population. A burn would displace these animals from an area, would immediately alter habitat composition and structure, and would result in the death of individuals unable to escape. The risk of accidental fires could increase during construction and would have a small negative effect on habitat. As wolverine are not habitat-specific and occupy large home ranges (COSEWIC 2003), a localized fire would likely have a minimal effect on the population.

Access

As areas are opened up to easier access, trapping activity could increase (COSEWIC 2003; Krebs *et al.* 2007). Where it occurs, trapping often accounts for a relatively large proportion of wolverine mortality (*e.g.*, Banci 1994; COSEWIC 2003). If trapping effort surpasses a sustainable level, a corresponding decrease in the number of wolverine in the area might be expected. As the trapper is responsible for managing furbearer populations on his or her trapline, trapping effort is not expected to exceed a sustainable level. Some wolverine could be taken accidentally, as they are highly susceptible to trapping and are trapped incidentally (Hornocker and Hash 1981; Hash 1987; Banci 1994; Dawson *et al.* 2010). However, the wolverine population is stable in Manitoba (COSEWIC 2003; Slough 2007), but may be of long-term concern (NatureServe 2011) and wolverine harvest effort is expected to decline in the province (COSEWIC 2003), thus the effects on the wolverine population in the Local Study Area will likely be small.

As linear features are established in the Local Study Area, predators such as gray wolf will have greater ability to reach areas they may have had limited access to in the past (Thurber *et al.* 1994; James and Stuart-Smith 2000). As carrion is a significant food source for wolverine (Hash 1987; Banci 1994) and gray wolf kills are frequently scavenged (van Dijk *et al.* 2008; Wilson and Wolkovich 2011), wolverine may indirectly benefit from an influx of predators. However, gray wolves are an occasional source of wolverine mortality (Banci 1994; COSEWIC 2003), which could offset these benefits to some degree. Where ungulate and gray wolf abundance is not expected to change because of the Project, it is unlikely that wolverine will be affected.

Wolverine require large areas with little human activity (Hash 1987; Banci 1994). They tend to avoid roads (Copeland *et al.* 2007; Bowman *et al.* 2010), but may use seasonal snowmobile trails (Copeland *et al.* 2007). Narrow roads (less than 50 m) appear to have less of an effect on wolverine movements than roads greater than 100 m in width (Austin 1998). As the south access road ROW will be 100 m (PD SV) it could restrict the ability of some individuals to move across the landscape to some extent (COSEWIC 2003; Krebs *et al.* 2007). Because intactness in the Rare Mammals Regional Study Area will not change during construction, and changes in the distribution and abundance of wolverine will most likely be negligible, wolverine are unlikely to be measurable, and the overall effect is considered neutral.

Mitigation

Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area.

Summary of Construction Effects

Potential Project effects on wolverine include habitat loss or alteration during clearing in Zone 1. The effects of habitat loss will most likely be indirect, as wolverine select habitat with adequate prey availability, and not for specific topographic features. Effects will not likely extend to the population and are expected to be small.

Disturbances due to noise from construction activities and blasting will likely reduce effective habitat where these activities occur. As wolverine will pass through areas with human activity as they move about their home ranges, and due to the rarity of wolverine in the Local and Regional Study Areas, effects of sensory disturbance on wolverine are expected to be small and temporary.

As areas are opened up to easier access, trapping activity could increase. Wolverine harvest effort is expected to decline in the province (COSEWIC 2003), thus the effects on the wolverine population in the Local Study Area will likely be small.

Residual Effects of Construction

Residual effects on wolverine that are expected and likely once the appropriate mitigation measures are applied will be decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, extend to the Regional Study Area, and affect two or more generations.

7.4.7.1.2 Operation

Habitat Loss, Gain, and Alteration

During operation, habitat loss will become permanent in the reservoir. Additional habitat loss will be associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects. Some habitat may be regained when camp, work, and borrow areas are rehabilitated by replacing organic material in these areas to assist re-vegetation.

If female wolverine are forced to abandon their dens due to inundation there will likely be an increase in kit mortality (Buskirk and Ruggiero 1994; COSEWIC 2003; Jens *et al.* 2006). Denning periods vary with location and local weather, generally beginning in autumn or winter (Banfield 1987). In northern climates, female wolverine enter natal dens from mid-February until late April, when they move to a maternal den. Kits will leave the den 12 to14 weeks after birth (Jens *et al.* 2006).

Clearing of the reservoir during construction will likely cause wolverine to vacate the area prior to inundation. During operation, wolverine may revisit the portions of their home ranges that were abandoned during construction, particularly those where continued disturbance from operation is not expected. However, wolverine generally avoid areas with human activity (Hash 1987; Banci 1994; COSEWIC 2003) and developments that permanently alter habitat (Banci 1994). It is likely that wolverine will avoid the Local Study Area during operation, particularly permanent infrastructure such as the generation station and the access roads.

Project-related Disturbances

Potential Project-related disturbances during operation include obstructions to dispersal. Major roads can limit movements (Austin 1998; COSEWIC 2003), as wolverine tend to avoid them (Copeland *et al.* 2007; Bowman *et al.* 2010). When the north and south access roads are incorporated as part of PR 280, local traffic volume can be expected to increase on this new route. This effect may be offset by the expected decrease in traffic on the current PR 280 route.

Accidents and malfunctions such as fire, spills, and dam failure could affect wolverine during operation. The risk of accidental fire will be lower during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. Fire will have an immediate negative effect, as individuals would abandon the area to avoid the burn, or would perish. The potential for spills and other environmental issues will also be reduced during operation. Dam failure would result in flooding, habitat loss, displacement of affected individuals, and possibly the death of some wolverine, depending on the rate of inundation. As wolverine will likely avoid the Local Study Area during operation, effects of dam failure may less severe on the wolverine population relative to those of other mammals.

Access

Access to new areas is an outcome of the construction of linear corridors such as roads and dykes. Access to the area will be greatest during the operation phase, as the new portion of PR 280 will be open to the public. Increased access has the potential for greater trapping effort, particularly along the road. This could result in a direct negative effect on the wolverine population, as this species is susceptible to overharvest (Krebs and Lewis 1999) and trapping could surpass a sustainable level (COSEWIC 2003; Krebs *et al.* 2007). With traditional sustainable harvest practices, and because wolverine harvest effort is expected to decline in Manitoba (COSEWIC 2003), trappers are not likely to over-harvest wolverine on their traplines. However, wolverine are regularly trapped incidentally (Hornocker and Hash 1981; Hash 1987; Banci 1994; Dawson *et al.* 2010), and continuous accidental harvest of wolverine, which are already rare in the Local Study Area, could eventually lead to a decline in the population. Increased human presence in the area will also limit effective habitat for wolverine, as they will likely avoid areas of human activity.

Wolverine use linear features in winter for ease of travel (Wright and Ernst 2004). Their hunting efficiency in the Local Study Area could increase with improved access, which would benefit a few individuals. Linear features in the Local Study Area will continue to allow predators such as gray wolf to reach areas they had limited access to pre-construction (Thurber *et al.* 1994; James and Stuart-Smith 2000). As carrion is a significant food source for wolverine (Hash 1987; Banci 1994 and gray wolf kills are frequently scavenged (van Dijk *et al.* 2008; Wilson and Wolkovich 2011), wolverine could indirectly benefit from an influx of predators. However, gray wolves are an occasional source of wolverine mortality (Banci 1994; COSEWIC 2003), which could offset these benefits to some degree. As ungulate and gray wolf densities are not expected to change because of the Project, it is unlikely that wolverine will be affected.

Mitigation

The PD SV includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for dam failure.

Other mitigation measures include the following:

- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, accidental fires and access-related effects; and
- Temporarily cleared areas and excavated materials placement areas (see the Habitat and Ecosystems section of the TE SV) will be rehabilitated to native habitat types where feasible.

Summary of Operation Effects

Project-related effects on wolverine during operation could include habitat loss or alteration. During reservoir impoundment, some additional terrestrial habitat will be lost in the Local Study Area.

Potential Project-related disturbances to wolverine include barriers to movements, sensory disturbance, and increased mortality. The access roads could create a barrier to wolverine dispersal, as wolverine tend to avoid roads (Bowman *et al.* 2010). Sensory disturbance due to traffic on the access road could reduce effective habitat for wolverine. Wolverine will likely avoid the Local Study Area, particularly around permanent infrastructure.

Effects of improved access to the Local Study Area by resource users could include increased wolverine mortality. As roads and other linear features will improve access to the area, trapping effort and harvest, both deliberate and incidental, of wolverine could increase (COSEWIC 2003). As trappers are stewards of their traplines, furbearer harvest will not likely exceed sustainable levels, but the population could be susceptible to accidental overharvest.

Roads can fragment wolverine habitat and create a barrier to movements. Because intactness in the Rare Mammals Regional Study Area will not change during operation, and changes in the distribution and abundance of wolverine are unlikely to be measurable, and the overall effect is considered neutral.

Residual Effects of Operation

Residual effects on wolverine that are expected and likely once the appropriate mitigation measure is applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, and are predicted to be limited to the Local Study Area and affect two or more generations.

7.4.7.1.3 Conclusion about Residual Effects on Wolverine

The extent of Project effects on wolverine are expected to be the same during construction and operation. No large effects are expected, as habitat availability does not appear to be a limiting factor outside the Regional Study Area. The adverse residual effects of the Project on wolverine will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project and Conawapa Generation Project. These projects will likely contribute to access effects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As wolverine is not a VEC, it is not covered in the cumulative effects assessment.

7.4.7.2 Regionally Rare Species

The Rare Mammals Regional Study Area includes the geographic ranges of several mammals that were rarely or never detected during surveys. A single sign of each of coyote and racoon was observed, in the Regional and Local Study Areas, respectively. Occasional sightings of striped skunk have been reported in the Regional Study Area, particularly at garbage dumps, but no signs of this species were detected on mammal tracking transects. A single bat was located during the bat surveys conducted, but was not positively identified. Two reports detail sightings of bats, likely little brown myotis, near cabins in the Regional Study Area (CNP Member and FLCN Member, *pers. comm.*). Although American water shrew range includes the Regional Study Area, only one individual was caught during small mammal surveys. Porcupine are rare in the Keeyask region, and were not found in the Local or Regional Study Areas. A single porcupine sign was incidentally observed east of Gillam near the community of Bird.

These species are common and secure in other parts of Manitoba and beyond. Studies suggest that few if any of these species exist in large numbers in the Regional Study Area, thus potential effects of the Project outlined below are not expected to influence populations.

7.4.7.2.1 Construction

Habitat Loss, Gain, and Alteration

Potential Project effects on regionally rare species include habitat loss, gain, or alteration during clearing in Zone 1. American water shrew range extends across Manitoba (Banfield 1987), including the Regional Study Area. American water shrews are found near waterbodies (Conaway 1952; Spencer and Pettus 1966; Wrigley *et al.* 1979; Banfield 1987), and potential habitat could be lost in the reservoir and other riparian areas to be cleared. While individuals in the Rare Mammals Local Study Area could be affected, no effects are anticipated on the American water shrew population beyond Zone 1.

Little brown myotis range encompasses the Regional Study Area (Humphrey 1982; Banfield 1987). Some habitat for little brown myotis could be lost to clearing in Zone 1. Males roost in coniferous forest stands with snags (Broders and Forbes 2004) and maternity roosts are commonly found in human constructions (Barclay *et al.* 1980; Barclay and Cash 1985; Jung and Slough 2005; Broders *et al.* 2006; Coleman and Barclay 2011). Hydroelectric generation facilities at Pointe du Bois, Manitoba have been used by bats for roosting and feeding (Bung *pers. comm.*). Foraging activity is greatest near and over lakes (Furlonger *et al.* 1987; Broders and Forbes 2004; Broders *et al.* 2006). As such, habitat loss or alteration may affect some roosting and foraging habitat in the Local Study Area, but because little brown myotis are rare and similar habitat is widely available in the Regional Study Area, affected individuals, if any, are expected to find suitable habitat elsewhere.

Porcupine range encompasses most of Manitoba (Banfield 1987), including the Regional Study Area. Porcupine habitat will likely be affected during the construction phase, particularly by clearing. In summer, porcupine rest in coniferous and deciduous trees (Griesemer *et al.* 1998). In winter, they prefer to shelter on the ground, in existing cavities such as rocky caves, tree stumps, and cavities in trees (Banfield 1987; Griesemer *et al.* 1998; Morin *et al.* 2005). Such denning sites would be lost upon clearing of the reservoir.

Raccoon are typically found around water, including forested streams and marshes (Sanderson 1998), and habitat could be lost in the reservoir and other riparian areas to be cleared. Raccoon range can extend to the same latitude as Stephens Lake (Lynch 1971) and is reported to include the Regional Study Area (Kaufmann 1982). However, the Minnedosa area has more recently been described as the northern extent of raccoon range in Manitoba (Pitt *et al.* 2008), and individuals reported at extreme northern latitudes are occasional, as established populations are found in only in southern areas of the province (Kaufmann 1982). Raccoon are rare in Local Study Area; a few individuals could be affected by habitat loss, but no effects are anticipated on raccoon beyond Zone 1.

Striped skunk can be found in most habitats in North America (Bixler and Gittleman 2000), and their range extends well beyond the Regional Study Area (Godin 1982). While terrestrial habitat will be lost during clearing in Zone 1, the amount is small compared with that in the Regional Study Area. Striped skunk have relatively small home ranges (19 to 27 ha; Bixler and Gittleman 2000) with a high degree of overlap with the home ranges of other individuals (Larivière and Messier 1998; Bixler and Gittleman 2000), and any individuals displaced by clearing are expected to find suitable habitat elsewhere in the Regional Study Area.

The reported range of coyote in Manitoba varies from the northern tip of Lake Winnipeg (Banfield 1987) to all but the most northeastern portions of the province (Bekoff 1982). Manitoba Conservation states that the species ranges as far north as Thompson (Manitoba Conservation n.d.*c*). Coyote are extremely rare in the Regional Study Area; a few individuals could be affected by habitat loss in the Local Study Area, but no effects are anticipated on coyote beyond Zone 1.

Project-related Disturbances

Porcupine, striped skunk, and raccoon are all susceptible to collisions with vehicles, partly due to their smaller body size, which makes them difficult to see (Barthelmess and Brooks 2010). Increased mortality could result from traffic on the south access road. Porcupine, striped skunk, and raccoon road kills increase with increased road width (Oxley *et al.* 1974). Coyote are occasionally killed by vehicles on roads (Case 1978; Clevenger *et al.* 2003). Given their rarity in the Local Study Area, the risk of collisions with vehicles is very low, and the effects on rare mammals in the Regional Study Area will likely be small. Striped skunk and raccoon populations are resilient and common. Porcupine are also common elsewhere, and the unlikely loss of individuals is not anticipated to affect the population beyond the region.

Sensory disturbance, which includes construction activities, blasting, and traffic, can have a negative effect on regionally rare species habitat in the Local Study Area. As striped skunk, raccoon, and coyote are all associated with urban areas and human settlement, little or no effect on these species is expected. As striped skunk are known to den in riparian areas (Bixler and Gittleman 2000), dens could be disturbed during reservoir clearing. American water shrew, little brown myotis, and porcupine in the Local Study Area could be temporarily affected by sensory disturbance during construction, but effects are unlikely to extend to populations in the Regional Study Area.

Accidents and malfunctions such as spills and fires would have a similar effect on regionally rare species as terrestrial furbearers (see Section 7.4.3). Accidental spills would affect site-specific areas over a short period and have a small, negative effect on these animals and their habitats. Given the low probability of occurrence and the regulation requirements for storing, handling, and transporting fuels, oils, and other hazardous materials under the *Dangerous Goods Handling and Transportation Act*, there would likely be a minimal effect on populations of regionally rare species. Habitat generalists such as raccoon, coyote, and possibly skunk may benefit from the diverse landscape created by a forest fire (Oehler and Litvaitis 1996). Forest habitat for other species such as porcupine would be lost.

Human encounters with striped skunk and raccoon during construction will likely have a negative effect on individuals, as they are often removed from camp and work areas. Humans are a significant cause of striped skunk mortality (Godin 1982) and human activity is a major source of raccoon mortality (Kaufmann 1982). As these species are rare in the Local Study Area, it is unlikely that they will be encountered, and no effects on their populations are anticipated.

Access

Linear features such as the south access road could increase the susceptibility of species such as porcupine to predation. While porcupine remain sheltered in treed areas where possible, they move to open areas to access high-quality forage (Sweitzer and Berger 1992), where they are more vulnerable to predators such as fisher and coyote. New linear features may benefit coyote, as individuals could use these corridors to access the Local Study Area and exploit prey species (Ruggiero *et al.* 1999). Colonization of the Regional Study Area by coyote may be limited by interference competition with gray wolves, which aggressively defend access to resources (Berger and Gese 2007).

Improved access to the Local Study Area via the south access road could lead to increased mortality of furbearers such as coyote and raccoon due to trapping. On average, less than one coyote is harvested in the Keeyask region annually, and no raccoon were reported (SE SV). Mortality by trapping will likely be due to incidental harvest, which may affect the occasional individual in the Local and Regional Study Areas.

Striped skunk and raccoon do not appear sensitive to habitat fragmentation, but the presence of coyote tends to decrease with decreasing patch size (Crooks 2002). Use of habitat by striped skunk decreases with increasing distance from edge (Larivière and Messier 2000), suggesting that this species may benefit from fragmentation. Because intactness will not change during construction and changes in the distribution and abundance of regionally rare mammals will most likely be negligible, effects on regionally rare mammals are unlikely to be measurable, and the overall effect is considered neutral.

Mitigation

Mitigation for accidents and malfunctions include planned measures such as training in fire response protocols and the presence of fire suppression equipment at the GS site will reduce the extent of fire damage. Additionally, the removal or disposal of vegetation cleared for the reservoir, camp areas and other sites will prevent the creation of barriers to wildlife movement and will reduce the availability of fuel for a fire (Manitoba Hydro 2006). Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All material will be stored and handled in accordance with established policies and regulations. Legislation and regulations will be followed for the transportation of dangerous goods, and on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

Other mitigation measures include:

- A Construction Access Management Plan will be implemented to reduce the effects of increased access to the Local Study Area.

Summary of Construction Effects

Project effects on regionally rare species include habitat loss, gain, or alteration during clearing in Zone 1. Porcupine denning sites could be lost upon clearing of the reservoir, but maternity roosts for little brown myotis, which are commonly in human constructions (Barclay and Cash 1985), will not likely be affected. Species such as striped skunk and raccoon may benefit from the habitat diversity created by fragmentation (Oehler and Litvaitis 1996; Larivière and Messier 2000).

Project-related disturbances to regionally rare species during construction include sensory disturbance and increased mortality. Sensory disturbance due to construction activity and traffic on the access road could affect regionally rare species. Effective habitat for regionally rare species will likely be reduced in these areas, but individuals are expected to return to abandoned areas upon completion of construction. Porcupine, striped skunk, and raccoon are all susceptible to collisions with vehicles, partly due to their smaller body size, which makes them difficult to see (Barthelmess and Brooks 2010). Human encounters with some regionally rare species could have a negative effect, as human activity is a major source of striped skunk (Godin 1982) and raccoon (Kaufmann 1982) mortality. These species may be removed from camp and work areas, increasing mortality.

Potential effects of improved access to the Local Study Area include increased mortality of some regionally rare species, and improved hunting efficiency of others. As areas are opened up to easier access, trapping activity could increase (Buskirk and Ruggiero 1994; COSEWIC 2003; Krebs *et al.* 2007), potentially affecting coyote. As trappers are stewards of their traplines, and these coyote are not common in the Regional Study Area, the harvest will not likely exceed sustainable levels. Coyote could benefit from the creation of linear features, which could improve hunting efficiency and access to the Local Study Area.

Residual Effects of Construction

Residual effects on regionally rare species that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, and are predicted to be limited to the Local Study Area and affect two or more generations.

7.4.7.2.2 Operation

Habitat Loss, Gain, and Alteration

Project effects on regionally rare species during operation include habitat loss or alteration associated with flooding, shoreline erosion, peatland disintegration, and reservoir-related groundwater and edge effects. Some habitat may be regained when camp, work, and borrow areas are rehabilitated by replacing organic material in these areas to assist re-vegetation. Little brown myotis, which make extensive use of human-made structures for roosting (Barclay and Cash 1985), may benefit from the structural components of the Project; however, feeding habitat and some cover will be affected in the long-term.

Project-related Disturbances

Potential Project-related disturbances to regionally rare species include sensory disturbance, and increased mortality. Sensory disturbance due to traffic on the access roads, which will be incorporated as a portion of PR 280, could reduce effective habitat for regionally rare species. A corresponding decrease in traffic on the current PR 280 route could offset some effects. Mortality due to wildlife-vehicle collisions will likely continue to be a source of mortality for coyote, raccoon, striped skunk, and porcupine. The number of animals killed or injured could increase or decrease depending on traffic volume and speed. Local traffic volume can be expected to increase on the new PR 280 route and the risk of collisions will increase. A decrease in road kills on the current PR 280 route may result.

Human encounters with coyote, raccoon, and striped skunk could occur during operation, which could be detrimental to these species. These animals may become habituated to humans and their garbage, can damage property, and can carry diseases such as rabies. Human encounters with wildlife may result in the mortality of a few individuals, but since these species are rare in the Local Study Area, few encounters are anticipated, and effects on these populations will likely be negligible.

Accidents and malfunctions such as fire, spills, and dam failure could affect regionally rare species during operation. The risk of accidental fire will be lower during operation than during construction as there will be considerably fewer workers and less heavy machinery operating. Fire would have an immediate negative effect, as individuals would abandon the area to avoid the burn, or would perish. The potential for spills and other environmental issues will also be reduced during operation. Dam failure would result in flooding, habitat loss, displacement of affected individuals, and possibly the death of some regionally rare species, depending on the rate of inundation. No other direct effects of Project-related disturbances are anticipated for regionally rare species. Due to their rarity in the Keeyask region, effects on regionally rare species will likely be negligible.

Access

Effects of improved access to the Local Study Area by resource users and predators could include increased mortality of some species, and improved hunting efficiency of others. Improved access to the Local Study Area via the access roads could increase coyote and raccoon mortality due to trapping. However, the number of trappers in the area is limited, and trappers are responsible for managing the harvest on their traplines (Fur Institute of Canada 2003). Due to the rarity of these species in the

Regional Study Area, mortality by trapping will likely be due to incidental harvest, which could affect the occasional individual in the Local and Regional Study Areas.

Increased access to the Local Study Area could benefit predators such as coyote (Ruggiero *et al.* 1999). As porcupine are preyed on by fisher (Powell 1994; Powell and Zielinski 1995; Zielinski *et al.* 1999; Bowman *et al.* 2006; Mabille *et al.* 2010) linear features such as cutlines and trails could increase porcupine mortality due to predation, but there is little indication that fisher make extensive use of these features. Effects would be limited to a few individuals in the Local Study Area. Due to the rarity of these species in the Keeyask region, effects on regionally rare species will likely be negligible.

No additional change in the density of linear features and intactness is expected in Zone 5 during operation, therefore effects on regionally rare species will likely be neutral.

Mitigation

The PD SV includes measures to be taken to reduce the effects of accidents and malfunctions. A spill response plan for all activities during operation and maintenance will be kept at various locations, including the control room and with emergency response crews. Petroleum products will be stored in the powerhouse with spill containment equipment; inventory will be monitored and documented. Firebreaks will be maintained to minimize the extent of accidental fires. There is no mitigation for dam failure.

Other mitigation measures include:

- Except for the existing resource-use trails (see Construction Access Management Plan), Project-related cutlines and trails will be blocked where they intersect Zone 1, and the portions of these features within 100 m of Zone 1 will be re-vegetated to minimize the risk of habitat disturbance, accidental fires and access-related effects; and
- Temporarily cleared areas and excavated materials placement areas (see the Habitat and Ecosystems section of the TE SV) will be rehabilitated to native habitat types where feasible.

Summary of Operation Effects

Project effects on regionally rare species during operation include habitat loss and alteration. Little brown myotis, which make extensive use of human-made structures for roosting, could benefit from the structural components of the Project.

Potential Project-related disturbances to regionally rare species include sensory disturbance and increased mortality. Sensory disturbance due to traffic on the access roads could reduce effective habitat for regionally rare species. Individuals of any species that do not avoid the road will be susceptible to wildlife-vehicle collisions, potentially increasing mortality. Human encounters with some species could also result in increased mortality. Given the rarity of these species in the Local and Regional Study Areas, such events are unlikely and the effect will likely be negligible.

Effects of improved access to the Local Study Area by resource users and predators could include increased mortality of some species, and improved hunting efficiency of others. As roads and other linear features will improve access to the area by resource users, trapping effort and harvest of species such as coyote could increase. As trappers are stewards of their traplines, and these species are rare in the area, harvest will not likely exceed sustainable levels. Linear features such as cutlines and trails could increase the susceptibility of some regionally rare species to predation, while benefiting others such as coyote. However, no additional change in the density of linear features is expected in Zone 5 during operation, therefore effects on regionally rare species will be neutral.

Residual Effects of Operation

Residual effects on regionally rare species that are expected and likely once the appropriate mitigation measures are applied will be altered movements and decreased populations due to reduced habitat and increased mortality. Effects will be unlikely to be detectable or measurable, limited to the Local Study Area, and affect two or more generations.

7.4.7.2.3 Conclusion about Residual Effects on Other Rare Species

The extent of Project effects on other rare species is expected to be the same during construction and operation. No large effects are expected for these species overall as habitat availability does not appear to be a limiting factor for these populations outside the Regional Study Area. The adverse residual effects of the Project on other rare species will overlap spatially and temporally with effects from the following future projects: Bipole III Transmission Project, Keeyask Transmission Project, and Conawapa Generation Project. These projects will likely contribute to access effects. The cumulative effects assessment step that deals with future projects and activities focuses on VECs that are adversely affected by the Project and vulnerable to the effects of future projects and activities. As regionally rare species are not a VEC, they are not covered in the cumulative effects assessment. Monitoring plans are being developed for little brown myotis.

7.4.8 Cumulative Effects

7.4.8.1 Beaver

7.4.8.1.1 Effects of Past and Current Projects and Activities

Effects of past and present projects on beaver include the loss and alteration of wetland habitat on the Nelson River system and increased mortality from resource harvesting and predator access along linear features. Historically, beaver were present on the Nelson River. Following hydroelectric development, their presence was diminished considerably because of changes to shoreline wetland habitat, inland wetland habitat loss from flooding, and fluctuating water levels, which continue to affect beaver today. The magnitude of decline in the beaver population is scientifically uncertain because large comparison rivers that are unaffected by hydroelectric development (*i.e.*, Gods and Hayes rivers) tend to have fewer beaver; however, beaver are abundant in wetland habitat connected to these rivers. Today, beaver are still common and widely distributed in the Beaver Regional Study Area wherever there is suitable riparian habitat. The KCNs are concerned about beaver populations and the loss and alteration of wetland habitat on the Nelson River system.

7.4.8.1.2 Summary of Cumulative Effects of the Project with Past and Current Projects/Activities

Beaver abundance is likely to decrease during construction and operation, primarily as a result of habitat loss and the removal of about 20 colonies near the Nelson River. Improved trapping access could reduce the population if local trapping efforts increase. Although habitat effects will be large primarily as a result of past projects in the Regional Study Area, beaver are resilient, have the ability to create habitat, and can reproduce and colonize rapidly. Overall, the beaver population is widely distributed and abundant throughout the Regional Study Area. Thus, Project effects on beaver will likely remain small and further changes in the Regional Study Area are highly unlikely to affect the sustainability of the beaver population. Trappers are stewards of their traplines, and are responsible for sustaining beaver populations on their registered traplines. Provincial furbearer management policies should be in place before the Project proceeds, and their application will further ensure that provincial harvest does not exceed sustainable levels, where trapping effort generally follows the price of fur.

7.4.8.1.3 Cumulative Effects of the Project Including Future Projects/Activities

Residual Project effects on beaver are expected to overlap with the effects of the transmission line projects and Gillam redevelopment. Regional beaver populations are highly likely to maintain viable levels. Beaver populations are most likely to remain sustainable because beaver are widely distributed and abundant in creeks, steams, ponds and lakes, they create their own habitat in most areas where water occurs, can breed quickly, and are under harvest management regulations. The regional population will most likely continue to be depressed on the Nelson River because of water level regulation, and because beaver are unlikely to successfully re-colonize new shoreline wetland habitat in the long term. As such, the system will most likely remain as it is today, and continue to depend on future fur prices and harvest. No measurable residual cumulative effects of the Project in combination with other future projects are anticipated.

7.4.8.2 Caribou

7.4.8.2.1 Effects of Past and Current Projects and Activities

Effects of past and present projects on migratory caribou local movements and abundance in the Caribou Regional Study Area include habitat loss, habitat alteration, and mortality risks associated with access, predation, and resource harvest. Large and long-term population variability most likely resulted from natural shifts in range use and migration patterns that prevent over-utilization of food by caribou, habitat loss from large fires, snow fall and melt patterns, the timing and location of plant growth on the calving grounds, and long-term population cycles associated with food and predation. Habitat loss and access effects from past and present developments (*e.g.*, flooding of Stephens Lake, linear developments) can further depress populations that are periodically in decline from increased predation, and potentially from harvest over the entire migratory caribou range. KCNs Members have expressed concerns about the disappearance of large caribou herds in the region since the 1950s, and the limited return of caribou beginning in about the early 1990s and continuing today. Recent declines in migratory caribou and population sustainability are of further scientific attention and KCNs concern.

Today, caribou populations occasionally mix in the Regional Study Area. The KCNs distinguish a small group of woodland caribou from migratory barren-ground and coastal caribou herds in the Regional Study Area. Summer residents remain in the Regional Study area to calve, and are conservatively estimated to number 20 to 50 individuals. The long-term population trend of these animals is unclear given the recent return of caribou to this area, but these animals may have declined historically, as fewer caribou are now seen today. Similar to the technical scientific issues, the KCNs are concerned about past and present habitat loss, fragmentation, predation, harvest, changes in movement patterns, and accidental mortality of summer resident caribou attributed to development. Although past projects reduced winter habitat, and likely affected traditional movement corridors in the Local Study Area, primary calving habitat (islands greater than 10 ha in size in lakes or peatland complexes greater than 200 ha) increased. Suitable calving habitat is not limited in the Regional Study Area, but it appears to be underutilized except for Stephens Lake, which has become a highly productive calving and summering area for the small number of summer resident caribou. Range behaviour indicates that some summer resident caribou are coastal caribou.

7.4.8.2.2 Summary of Cumulative Effects of the Project with Past and Current Projects/Activities

The main residual effects of the Project on caribou in combination with past and current projects are localized altered movements due to reduced intactness and sensory disturbance, distributional changes, and decreased populations due to decreased habitat and increased mortality. Most effects of the Project will be negligible to small, particularly since habitat currently appears to be underutilized, and affect two or more generations.

Large variability in migratory caribou populations' ranges and migration routes will continue with the Project in response to natural shifts in range use and migration patterns that prevent an over-utilization of food, habitat effects from large fires, snow fall and melt patterns, the timing and location of plant growth on the calving grounds, and long-term population cycles associated with food and predation. These changes will be exacerbated to a small degree by the Project in combination with past and present human developments. Past and current project effects have resulted in regional habitat loss and alteration but most of these changes are limited to habitat near the Nelson River. In comparison, habitat effects over migratory caribou ranges are negligible to small. Potentially, and with moderate scientific certainty, habitat effects, additive mortality from resource harvest and increased predator access, accidental mortality, and localized movement effects, which cumulatively affect the regional caribou populations, have occurred to a small degree in the Regional Study Area.

Summer resident caribou abundance, distribution, and movements are likely to be altered by the Project during construction and operation, primarily because of calving habitat loss and alteration from groundwater and peatland disintegration. Fragmentation effects are predicted for the south access road. With mitigation, and as measured by population and habitat benchmarks described (Section 7.4.6.2), Project effects on summer resident caribou are likely to remain negligible to small in the Regional Study Area.

The small loss of calving habitat that will occur in the Local Study Area will in part be offset by an increase in the number of smaller islands in the Keeyask reservoir. Small changes in habitat are expected compared to its regional availability and use by caribou. Gray wolf numbers are not expected to change given that no changes in the moose population are expected as a result of the Project. Predator hunting efficacy is not predicted to change because linear feature density will not change.

A negligible change in cumulative effects measures, including intactness (as measured by core habitat availability and size), and fragmentation (as measured by linear feature density), is expected as a result of the Project. Finally, resource harvesting is also not expected to change, and it is most likely manageable with provincial harvest regulations and policy if it does increase unexpectedly for caribou. Therefore, only a small cumulative effect for the regional caribou populations is anticipated from the Project in combination with past and present projects.

Scientific uncertainty exists where human disturbance could exacerbate long-term natural changes in populations and habitat, and where these on-going effects could be affected by climate change, could reduce habitat availability and limit abundance in caribou ranges. The KCNs predict that with more development, caribou will most likely disappear from the area and not return for a very long time. There is further concern that caribou may not return at all. Caribou activity in the Keeyask region will be monitored (Section 7.4.10).

7.4.8.2.3 Cumulative Effects of the Project Including Future Projects/Activities

Residual Project effects on caribou are expected to overlap with the effects of reasonably foreseeable future projects including Conawapa Generation Project, Bipole III Transmission Project, the Keeyask Transmission Project, and Gillam redevelopment.

The Beverly and Qamanirjuaq barren-ground caribou herds may be in decline. The potential decline is mainly attributed to climate change, human activities, loss of winter habitat due to forest fires, harvesting and predation. Although the herd may be shrinking and/or has been redistributed, recent reports indicate that Qamanirjuaq caribou are still plentiful (about 348,000 estimated population in 2008). The redistribution of Pen Islands coastal caribou has also been reported. A combination of causes for the change include increased mortality of animals due to differences in predation and hunting pressure across the traditional range, nutritional stress due to range deterioration, and redistribution of animals in response to habitat change or to disturbance, among other hypotheses.

The Project is not anticipated to measurably affect caribou in the Regional Study Area. However, cumulative effects associated with future projects, including habitat loss and/or alteration, fragmentation, and access-related mortality from hunting and predation could delay the cycle and recovery of wide-ranging caribou populations currently experiencing declines. Incremental changes in addition to the Project are highly unlikely to contribute to a measurable decline of the regional caribou population; especially with the mitigation measures associated with each individual project, or compared with the broader context of the range-wide requirements of coastal and barren-ground caribou beyond the Regional Study Area. Range-wide management efforts by provincial and federal governments, and stakeholder representation on resource boards, including the Beverly and Qamanirjuaq Management Board, the Northeastern Caribou Committee, and the Split Lake, Fox Lake, and York Factory Resource Management Boards, are working to manage and monitor all risks associated with range-wide cumulative effects associated with harvestable caribou populations.

Incremental habitat fragmentation effects for summer resident caribou from the Project in combination with future projects are a concern within the Regional Study Area because of the scientific uncertainty associated with abundance and range use. For summer residents, the cumulative reduction in intactness (1%) is small compared to the Regional Study Area, and is highly unlikely to result in a measurable change to the population. While the Keeyask Transmission Project could result in one or more transmission line rights-of-way south of Stephens Lake, it is not likely to limit caribou passing through the area and calving on islands in the lake. Less traffic on the old portion of PR 280 is expected to improve the quality of adjacent caribou habitat and improve access to calving islands from the north shore. Existing human and fire disturbance in the Regional Study Area is already large, and may not support a boreal woodland caribou population. The density of predators, however, is not expected to increase with a small increase in fragmentation because there is likely not enough caribou and moose biomass in the Regional Study Area to support a dense predator population. As such, incremental habitat fragmentation effects from future projects are more likely to have a small effect on the summer resident caribou population, whether they are coastal caribou, boreal woodland caribou, or both.

The management of access to and harvest of migratory coastal and barren-ground caribou in the lower Nelson River area has a high scientific and KCNs concern. Infrequent but potentially high harvest events, coupled with incremental habitat effects over a broad region, could result in a decrease and prolonged decline of coastal caribou populations in particular. Although this type of event is unlikely to occur under existing harvest regulations and the management of caribou populations by the province, all Project-related caribou mortality in association with other effects will be monitored to decrease the risk of cumulative effects (Section 7.4.10). A plan is being developed to coordinate caribou monitoring activities among northern hydroelectric developments, as well as with government authorities and existing caribou committees and management boards.

7.4.8.3 Moose

7.4.8.3.1 Effects of Past and Current Projects and Activities

Effects of past and present projects on moose include habitat alteration and increased mortality from resource harvesting and predator access along linear features. Historically, moose occurred between Split Lake and Stephens Lake. Following hydroelectric development, their presence on the shores of Split and Stephens lakes was diminished because of shoreline habitat loss and fluctuating water levels, and although animals are still hunted here, local resource users tend to go further afield to harvest them (SE SV). Today, moose appear to be common, widely distributed, and clustered in the Moose Regional Study Area, particularly in burned areas, and the population appears to be increasing. Islands and shorelines continue to be important for calving and rearing, including those in Gull Lake and Stephens Lake. The KCNs are concerned about the sustainability of moose populations, and TCN has prepared a Moose Harvest Sustainability Plan to guide the management of their Adverse Effects Agreement Access Program.

7.4.8.3.2 Summary of Cumulative Effects of the Project with Past and Current Projects/Activities

The main residual effects of the Project on moose in combination with past and current projects are altered movements, distributional changes, and a decreased population. Moose abundance, distribution, and movements are likely to be changed by the Project during construction and operation, primarily as a result of habitat alterations along the Nelson River. With mitigation, and as measured by population and habitat benchmarks described (Section 7.4.6.3), it is highly likely that Project effects on moose will be negligible to small in the Regional Study Area. A small loss of calving habitat will occur in the Local Study Area, which in part would be offset by an increase in the number of smaller islands, and by at least one large island in the Keeyask reservoir. Small changes in habitat are expected compared to the regional availability. Gray wolf numbers are not expected to change given that no changes in the moose population are expected as a result of the Project. A negligible change in cumulative effects measures, including intactness and fragmentation, is expected as a result of the Project. Finally, although resource harvesting is not expected to increase with the offsetting program, opportunities and access will have improved, and there could be an increase in licensed hunters in the region.

TCN has prepared a Moose Harvest Sustainability Plan to guide the management of their Adverse Effects Agreement Access Program to ensure the sustainability of the moose population in the Split Lake Resource Management Area The province is responsible for managing licensed harvest while recognizing the priority of Aboriginal harvesting rights Therefore, only a small cumulative effect is anticipated for the regional moose population.

7.4.8.3.3 Cumulative Effects of the Project Including Future Projects/Activities

Residual Project effects on moose are expected to overlap with the effects of reasonably foreseeable future projects including Conawapa Generation Project, Bipole III Transmission Project, the Keeyask Transmission Project, and Gillam redevelopment. Although the Split Lake Resource Management Area moose population appears to be secure, recent declines in the abundance of moose in western and southeastern Manitoba have occurred, where it is thought that access and harvesting are the main issues affecting these moose. Although minor changes including habitat alteration are likely to occur with each project, access issues and sustainable moose harvest are of particular concern. TCN has prepared a Moose Harvest Sustainability Plan to guide the management of their Adverse Effects Agreement Access Program to ensure the sustainability of the moose population in the Split Lake Resource Management Area. The province is responsible for managing licensed harvest while recognizing the priority of Aboriginal harvesting rights.

7.4.9 Sensitivity of Effects to Climate Change

As described in the PE SV, climate change scenarios, on average, project increasing temperatures and precipitation in the Keeyask region. The greatest change is projected for winter, with annual temperature and precipitation increasing between the 2020s and the 2080s. A smaller subset of climate change scenarios also projects increasing evapotranspiration for the same period, although climate modeling uncertainty is not well captured in the limited subset of scenarios.

Climate change could affect mammals through a number of pathways including changes to the physical environment (see PE SV). The main effect on mammals is habitat alteration in northern environments. Additional affects could include increases in physiological stresses resulting from severe and less predictable factors requiring adaptation while continuing to have to cope with the biological ones, such as competition and predation (Boonstra 2004). The predicted future changes to climate that could alter residual effects predictions for terrestrial habitat, intactness, fire regime and ecosystem diversity, and wetland function are described in the Habitat and Ecosystems section of the TE SV. Those that could affect mammals are:

- Increased total reservoir area and rate at which the reservoir expands. These changes would create small increases the amounts of peatland loss;
- Increased amount of Nelson River shoreline wetland from a longer shoreline;
- Increased risk that an accidental fire will become a large fire, but this is manageable with the application of EnvPP measures;
- Increased terrestrial habitat loss and alteration are not expected to lead to extirpation of any of the native broad habitat types. The proportion of common and uncommon habitat types could be altered slightly and higher reservoir expansion would predominantly affect very wet peatland types; and
- Reduced ability to develop an off-system wetland marsh type, and increased amounts of wetland area losses or conversions of some moderate quality wetland types to lower quality types. Increased area losses would have to very large before the magnitude of effects could increase from moderate to high.

No change in about 80% of the terrestrial habitat in Zone 1 is predicted. Increases would have to be very large to change Projects effects on remaining common broad habitat types from moderate to high magnitude. Climate change will not alter the length of the linear features in the Keeyask region. A very large change in core area percentage would be required to transition from moderate to high magnitude effects on habitat and ecosystems.

Mawdsley *et al.* (2009) report that potential effects on mammals due to climate change could include:

- Changes in species distributions;
- Shifts of timing in life-history events (*e.g.*, breeding, mating);
- Altered reproduction or survival rates;
- Decreased population sizes, particularly in boreal populations;
- Extirpation or extinction of range-restricted species;
- Direct loss of habitat due to fires or insect infestations;
- Increased spread of wildlife diseases;

- Increased competition between species; and
- Increased spread of non-native species.

7.4.9.1 General Effects of Climate Change on Valued Environmental Components

7.4.9.1.1 Beaver

Literature suggests that rather than being affected by climate change, beavers can mitigate the effects of drought in some ecosystems, as they create areas of open water and alter vegetation communities, creating habitat for many species (*e.g.*, Bridgham *et al.* 1995; Hood *et al.* 2007; Hood and Bayley 2008; Popescu and Gibbs 2009; Bird *et al.* 2011). More frequent or severe fires resulting from a warmer climate could reduce habitat suitability for beavers, as they tend to abandon lodges in recent burns (Hood *et al.* 2007). As beaver are able to create their own habitat, and their impoundments appear resistant to flooding and drought (Hood and Bayley 2008), a wetter climate will not likely affect the population.

7.4.9.1.2 Caribou

Effects of climate change on caribou could include habitat loss, reduced food availability, increased susceptibility to disease, insect harassment, and increased mortality due to predation. Peatland disintegration caused by melting permafrost due to increased temperatures (Camill 2005) could result in a loss of caribou habitat. While fire plays an important role in maintaining caribou habitat over time, around 100 years or more (Klein 1982; Joly *et al.* 2003), more frequent or severe fires will result in recurrent disruption of caribou habitat and a decrease in available browse. Increased winter precipitation will result in greater snow depth, which could result in caribou selecting more accessible, but poorer quality, lichens in winter (Johnson *et al.* 2001). Changes in plant composition along migration routes could reduce the availability of food sources (White and Trudell 1980).

Warmer temperatures could lead to a northward range expansion of white-tailed deer, increasing the risk of spreading parasites such as brainworm to caribou populations. Brainworm can be fatal in caribou; where these species co-exist all are susceptible (*e.g.*, Anderson 1972; McLoughlin *et al.* 2003; Manitoba Model Forest 2005). Warm summer temperatures could prolong the insect season, increasing insect harassment of caribou and affecting body condition (Weladji *et al.* 2002). An increase in moose density in their northern range (see below) and the colonization of white-tailed deer could increase predator density, indirectly increasing predation on caribou (Rempel 2011).

7.4.9.1.3 Moose

There is limited information regarding the effect of climate change on moose. Effects could include habitat alteration, physical stress due to a warmer climate, possible shift in range, and increased susceptibility to disease. More frequent fires could result in increased or improved habitat for moose, as vegetation begins to regenerate and develops into quality moose habitat (LaResche and Davis 1973; LaResche *et al.* 1974; Oldemeyer 1974; Cushwa and Coady 1976; Oldemeyer *et al.* 1977; MacCraken and Viereck 1990). Deeper snow could alter moose habitat selection and foraging behaviour (Lundmark 2008), and feeding activity could be reduced in summer (Rodgers 2010). Thermoregulation may become problematic, as moose can experience stress and discomfort at temperatures above -5°C in winter and above 14°C in summer (Renecker and Hudson 1986).

Increased temperatures could lead to decreased moose populations in their southern ranges, and increased populations in their northernmost ranges (Rempel 2011). Warmer temperatures could lead to a northward range expansion of white-tailed deer, which could increase the risk of spreading parasites such as brainworm to northern moose populations. Brainworm can be fatal in moose; where these species co-exist all are susceptible (*e.g.*, Anderson 1972; Schmitz and Nudds 1994). The range expansion of white-tailed deer could lead to a greater density of gray wolves, indirectly increasing predation on moose (Rempel 2011).

7.4.9.2 Discussion and Conclusions

Terrestrial habitat predictions are the foundation for potential Project effects on mammals. Because the effects of climate change would have to be very large to change the residual effects predictions for terrestrial habitat from moderate to large effects (see the Habitat and Ecosystems section of the TE SV), the residual effects predictions for mammals are also unlikely to change. Potential effects of future climate change on the terrestrial habitat and ecosystems assessment that are relevant for mammals are discussed below.

No effects on beaver habitat or primary moose habitat due to increased total reservoir area are anticipated. The increased rate at which the reservoir expands would create small increases in peatland loss. More wet peatland habitat would improve predator barriers for caribou and possibly moose, but decrease the number of calving and rearing islands in peatland complexes. A very large loss or alteration of caribou calving and rearing habitat would be required for residual Project effects to increase from small to moderate magnitude.

An increased amount of Nelson River shoreline wetland resulting from a longer shoreline would not affect beaver because this species would still be affected by the water regime. Although an increased amount of shoreline wetlands would be beneficial to moose and caribou as movement corridors in proximity to escape cover would be lengthened, the change would have to be very large to be measurable. This potential change would not alter the residual effects conclusions for VECs.

No change is expected in about 80% of the terrestrial habitat in Zone 1. Terrestrial habitat losses would have to be very large to change effects on remaining common broad habitat types from moderate to high magnitude. Increased terrestrial habitat loss and alteration are not expected to lead to the extirpation of any native broad habitat types. The proportion of common and uncommon habitat types could be altered slightly and greater reservoir expansion would predominantly affect very wet peatland types, which is discussed for caribou and moose above. Habitat loss in a small area could increase effects on some of the regionally rare habitat types. Small areas of regionally rare habitat losses are unlikely to affect wide-ranging species, or species with moderate or large home ranges that include moose and caribou. Climate change is unlikely to affect most of the terrestrial habitats affected by the Project. A very large loss or alteration of terrestrial habitat would be needed to increase the magnitude of effects from negligible or small to moderate for beaver, moose, or caribou.

Because climate change is not expected to change the length of linear features in the Keeyask region, no effects on mammals are anticipated. Because post-Project core area percentage is predicted to be considerably higher than the benchmark value (see the Habitat and Ecosystems section of the TE SV), a very large change in core area percentage would be required to transition from moderate to high magnitude effects on habitat and ecosystems. As such, a very large decrease in intactness would be required to change the effects of habitat fragmentation on most mammal species from negligible or small to moderate. Undisturbed caribou habitat that includes potential changes to wet peatlands is characterized above. A very large loss or alteration of caribou calving and rearing habitat in core areas would be required for the magnitude of residual Project effects to increase in magnitude.

Beaver, moose, and caribou are susceptible to habitat effects related to changes in the fire regime. The increased risk of an accidental fire becoming a large fire is manageable with the application of EnvPP measures. Therefore, this potential change would not affect the residual effects conclusions.

In relation to the Project, potential changes in wetland function would include reduced ability to develop an off-system wetland marsh type, and increased amounts of wetland area losses or conversions of some moderate quality wetland types to lower quality types. Increased area losses would have to very large before the magnitude of effects would increase from moderate to high. These Project-related changes are highly unlikely to affect primary beaver and moose habitat, and this potential change would not affect the residual effects conclusions. Potential changes to wet peatland habitat for caribou are described above.

In conclusion, the primary and most likely pathway for climate change to alter predicted Project effects on mammals is through increased terrestrial habitat loss due to greater reservoir expansion. This could also result in a longer reservoir shoreline and could increase the amount of Nelson River shoreline wetland. For mammals, a very large loss or alteration of habitat would be required for residual Project effects to increase from small to moderate magnitude. Overall, as the residual effects of the Project on the physical environment will not be affected by predicted changes in future climate conditions, the Project is not expected to contribute to the effects of climate change on mammals in the Keeyask region.

7.4.10 Environmental Monitoring and Follow-up

Monitoring will be required to verify the short and long-term effects of the Project on mammals. The recommended monitoring and follow-up includes both VECs and some supporting topics during construction and operation phases (Table 7-34). While this table provides a summary of the topics and species requiring monitoring, information on the methods and procedures are outlined in the Terrestrial Effects Monitoring Program and will be provided in further detail as the Monitoring and Follow-up Plans are developed during the review process. Monitoring is outlined for situations where the ATK and technical assessments differ, where a prediction has substantial uncertainty or a difference between predicted and actual residual effects could substantially alter the effects assessment.

Table 7-34: Monitoring and Follow-Up Program for Mammals

Supporting Topic or VEC	Issue/Rationale	Monitoring/Adaptive Management	Timelines
Beaver (VEC)	To verify whether predicted effects to regional beaver population occur	Monitor beaver population in locations within the Project Footprint and the Regional Study Area post-impoundment using counts	Regularly during construction and continuing for up to 15 years of operation, depending on results
		Monitor the removal of beaver (and muskrat) during reservoir clearing and adjusting protocol as needed	Regularly during reservoir clearing activities
	To address uncertainties of future habitat quality in the reservoir, wetland mitigation areas, and adjacent creeks	Monitor habitat changes during operation using mapping	Periodically during operation, for up to 15 years
Caribou (VEC)	To address uncertainties with respect to cumulative effects and the viability of caribou populations in the lower Nelson River region	Monitoring vital measures of caribou populations including productivity, mortality, and recruitment using sample counts and records from the lower Nelson River area	Regularly during construction and continuing for up to 30 years of operation, depending on results
	To verify direct and indirect predicted effects to summer resident caribou and habitat and evaluate performance of mitigation measures	Sampling, site records and mapping for summer resident caribou calving and rearing habitat effects in areas associated with Project effects	Regularly during construction and continuing for up to 30 years of operation, depending on results

Table 7-34: Monitoring and Follow-Up Program for Mammals

Supporting Topic or VEC	Issue/Rationale	Monitoring/Adaptive Management	Timelines
	To address uncertainties associated with productivity, distribution, movements and accidental caribou mortality	Collect caribou activity, movements, and mortality data in areas where effects are predicted to occur	Regularly during construction and continuing for up to 30 years of operation, depending on results
Moose (VEC)	To determine whether predicted effects to moose habitat occur and to evaluate performance of mitigation measures	Sampling, site records and mapping for moose habitat effects in predicted locations	Regularly during construction and continuing for up to 30 years of operation, depending on results
	To address uncertainties associated with productivity, distribution and accidental moose mortality	Collect moose activity, movements, and mortality data in areas where effects may occur	Regularly during construction and continuing for up to 30 years of operation, depending on results
	To address uncertainties with respect to the redistribution of harvest effort affecting the viability of moose in the Split Lake Resource Management Area	Monitor vital measures of moose population including productivity, mortality and recruitment using sample counts and records from the Split Lake Resource Management Area. Use special moose management units, harvest strategies and models to project the future population and adjust protocols as needed	Regularly during construction and continuing for up to 30 years of operation, depending on results

Table 7-34: Monitoring and Follow-Up Program for Mammals

Supporting Topic or VEC	Issue/Rationale	Monitoring/Adaptive Management	Timelines
Gray Wolf and Other Predators (Supporting Topic)	To address uncertainties with respect to the behavioural response of predators associated with disturbances and habitat effects	Monitoring gray wolf and black bear distribution and abundance using sample counts and marking measures	Annually during construction, annually during the first five years of operation, and then every five years until caribou and moose monitoring is concluded
Other Mammals (Supporting Topic)	To confirm effects predictions where problem wildlife control measures are implemented in construction camps and worksites	Monitor relocation and mortality of black bear, gray wolf, red fox, arctic fox and beaver using site records	Regularly during construction
Rare or Regionally Rare Species (Supporting Topic)	To address uncertainties with respect to the behavioural response of little brown myotis and wolverine associated with Project disturbances	Monitor little brown myotis and wolverine abundance in the Gull and Stephens lakes area using sample counts and marking measures	Annually during construction, annually during the first 5 years of operation, and then every five years for up to 30 years of operation, depending on results
Mercury in Wildlife (Supporting Topic)	To verify predicted increases and address uncertainties regarding duration of mercury levels in country foods and top-level predators during operation	Monitor mercury levels in beaver, muskrat, river otter, and mink, and in other wild game samples voluntarily supplied in the Keeyask and Stephens Lake areas, and in nearby off-system areas where no increase in mercury levels is predicted	Annually during operation until maximum levels are reached and then every three years until concentrations reach pre-impoundment levels (up to 30 years)

APPENDIX 7A

Mammal Survey Methods

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7.5 APPENDIX 7A – MAMMAL SURVEY METHODS

7.5.1 Mammal Sign Surveys

The purpose of the mammal sign surveys was to determine the presence, distribution, and relative abundance of mammal species across the landscape in the Local Study Areas in representative habitat types. Sign surveys had the secondary goal of identifying rare species in the area, particularly those listed as threatened or endangered under the federal *Species at Risk Act* or *The Endangered Species Act* of Manitoba.

Studies were conducted from 2001 to 2004 in Zones 1, 2, 3, and 4 (see Map 7-1). Study areas were determined for mammal groups based on home range sizes and the area into which a particular population may extend or be compared (Table 7A-1). Transects were established in a range of habitats and locations. Mammal signs were recorded along the length of each transect and included scat, tracks, trails, browse and feeding sites, and shelters. Presence/absence data was collected during island reconnaissance surveys. An estimate of relative abundance of the mammal species in their respective Local Study Areas was generated (see the Habitat and Ecosystems section of the TE SV).

Table 7A-1: Study Zones and Mammal Study Areas in the Keeyask Region

Mammal Group	Local Study Area	Regional Study Area
Mammals	Zone 3	Zone 6
Furbearers	Zone 3	Zone 4
Large carnivores	Zone 4	Zone 6
Beaver	Zone 3	Zone 4
Caribou	Zone 4	Zone 6
Moose	Zone 4	Zone 5
Other priority mammals	Zone 4	Zone 6

Initially, sign surveys were conducted in coarse habitat mosaics (Table 7A-2), on riparian shorelines (Table 7A-3), and along lake perimeters (Table 7A-4).

Surveys were also conducted along the north and south access road routes from 2001 to 2004 (Table 7A-5). Common habitat types and rare communities were identified from preliminary analyses of the ground cover in the Local Study Areas. Transects were established in six general common habitats and four rare communities. Rare communities were originally targeted for over-sampling due to their potential significance as mammal habitat. Subsequent, more detailed analysis of vegetation and land cover resulted in the re-classification of habitat types in the Keeyask region. As such, some habitats originally classified as rare were in fact common.

Table 7A-2: Survey Effort for Coarse Habitat Mosaic Transects in the Keeyask Region

			Local Study Area		
Mammal Group	**Year**	**Season**	**Number of Transects**	**Total Length (m)**	**Total Coverage (m²)**
Furbearers	2001	Summer	50	24,550	143,475
		Winter	54	26,350	52,725
	2002	Summer	100	50,290	279,900
		Winter	67	32,770	129,130
	2003	Summer	118	57,605	243,610
Large carnivores	2001	Summer	51	25,050	146,465
		Winter	55	26,850	53,720
	2002	Summer	122	61,155	328,585
		Winter	72	35,380	139,545
	2003	Summer	136	66,370	297,200
Beaver	2001	Summer	50	24,550	143,475
		Winter	54	26,350	52,725
	2002	Summer	100	50,290	279,900
		Winter	67	32,770	129,130
	2003	Summer	118	57,605	243,610
Caribou	2001	Summer	51	25,050	146,465
		Winter	55	26,850	53,720
	2002	Summer	122	61,155	328,585
		Winter	72	35,380	139,545
	2003	Summer	136	66,370	297,200
Moose	2001	Summer	51	25,050	146,465
		Winter	55	26,850	53,720
	2002	Summer	122	61,155	328,585
		Winter	72	35,380	139,545
	2003	Summer	136	66,370	297,200

Table 7A-2: Survey Effort for Coarse Habitat Mosaic Transects in the Keeyask Region

			Local Study Area		
Mammal Group	**Year**	**Season**	**Number of Transects**	**Total Length (m)**	**Total Coverage (m^2)**
Other priority mammals	2001	Summer	51	25,050	146,465
		Winter	55	26,850	53,720
	2002	Summer	122	61,155	328,585
		Winter	72	35,380	139,545
	2003	Summer	136	66,370	297,200

Table 7A-3: Survey Effort for Riparian Shoreline Transects in Zone 1, Summer 2001 to 2003

Year	Number of Transects	Total Length (m)	Total Coverage (m^2)
2001	53	5,300	10,600
2002	53	5,300	10,600
2003	54	5,400	10,800

Table 7A-4: Survey Effort for Lake Perimeter Transects in the Keeyask Region in Each of Two Summers, 2002 and 2003

	Local Study Area			Regional Study Area		
Mammal Group	**Number of Transects**	**Total Length (m)**	**Total Coverage (m^2)**	**Number of Transects**	**Total Length (m)**	**Total Coverage (m^2)[1]**
Furbearers	18	40,605	81,185	20	43,260	86,495
Large carnivores	20	43,260	86,495	0	-	-
Beaver	18	40,605	81,185	20	43,260	86,495
Caribou	20	43,260	86,495	0	-	-
Moose	20	43,260	86,495	0	-	-
Other priority mammals	20	43,260	86,495	0	-	-

Table 7A-5: Survey Effort along the North and South Access Roads, 2001 to 2004

Year	Transects	Total Length (m)[1]	Total Coverage (m^2)[1]
2001	North road	17,565	35,135
	South road	50,890	101,780
2002	North road	17,565	35,135
	South road	44,930	89,860
2003	Habitat-based transects	15,115	30,220
	Centreline	4,905	9,825
2004	South road transects	5,790	11,580
	Potential stream crossings	1,290	2,580

1. Values rounded to the nearest 5 m

In order to classify habitat types in the Keeyask region, the Coarse Habitat category provided by the Terrestrial Habitat Plants and Ecosystem specialists was employed to assess the area covered by the study areas. Where tracking transects crossed one or more coarse habitats, these were combined to form a "coarse habitat mosaic." Tracking transects were established in sixteen coarse habitats or coarse habitat mosaics (Table 7A-6), henceforth referred to as habitats or habitat types. Five infrequently occurring, or rare, habitat types, each composing less than 1% of the landscape, were identified. Tracking transects were located in three rare habitats. None were located in jack pine treed on uplands or jack pine mixedwood on uplands habitats. No transects were located in the common jack pine treed on uplands and young regeneration or low vegetation habitat.

Table 7A-6: Coarse Habitats Included in Habitat Mosaics in the Mammals Regional and Local Study Areas

Habitat code	Coarse Habitat or Habitat Mosaic	Rarity	Coarse Habitats Included[1]
H01	Black spruce treed on mineral and thin peatland	Common	Black spruce treed on mineral and thin peatland
H02	Black spruce treed and young regeneration on mineral and thin peatland	Common	Black spruce treed on mineral and thin peatland Young regeneration on mineral and thin peatland
H03	Black spruce treed on mineral and thin peatland or shallow peatland	Common	Black spruce treed on shallow peatland Black spruce treed on mineral and thin peatland
H04	Black spruce treed on shallow peatland	Common	Black spruce treed on shallow peatland
H05	Black spruce treed and young regeneration on shallow peatland	Common	Black spruce treed on mineral and thin peatland Black spruce treed on shallow peatland Young regeneration on shallow peatland Low vegetation on mineral and thin peatland Low vegetation on wet peatland
H06	Jack pine treed on mineral and thin peatlands	Rare	Jack pine treed on mineral and thin peatlands Jack pine mixedwood on mineral and thin peatland

Table 7A-6: Coarse Habitats Included in Habitat Mosaics in the Mammals Regional and Local Study Areas

Habitat code	Coarse Habitat or Habitat Mosaic	Rarity	Coarse Habitats Included[1]
H07	Jack pine treed, young regeneration, or low vegetation on mineral and thin peatland	Common	Jack pine treed on mineral and thin peatland Young regeneration on mineral and thin peatland Low vegetation on mineral and thin peatland
H08	Jack pine mixedwood on mineral and thin peatland	Rare	Jack pine mixedwood on mineral and thin peatland
H09	Young regeneration on mineral and thin peatland	Common	Young regeneration on mineral and thin peatland
H10	Young regeneration on mineral and thin peatland or shallow peatland	Common	Young regeneration on shallow peatland Black spruce treed on shallow peatland Young regeneration on mineral and thin peatland Low vegetation on wet peatland Tall shrub on shallow peatland Tall shrub on wet peatland
H11	Young regeneration on shallow peatland	Common	Young regeneration on shallow peatland Young regeneration on wet peatland
H12	Black spruce mixedwood on mineral and thin peatland	Rare	Black spruce mixedwood on mineral and thin peatland Black spruce treed on mineral and thin peatland

Table 7A-6: Coarse Habitats Included in Habitat Mosaics in the Mammals Regional and Local Study Areas

Habitat code	Coarse Habitat or Habitat Mosaic	Rarity	Coarse Habitats Included[1]
H13	Broadleaf mixedwood on mineral and thin peatland	Rare	Broadleaf mixedwood on all ecosites Black spruce treed on mineral and thin peatland Black spruce treed on shallow peatland
H14	Broadleaf treed on all ecosites	Rare	Broadleaf treed on all ecosites
H15	Low vegetation or tall shrub on wet peatland	Common	Low vegetation on wet peatland Tall shrub on wet peatland
H16	Black spruce treed on wet peatland	Common	Black spruce treed on wet peatland Black spruce-tamarack mixture on wet peatland

1. All lake perimeter transects but one also included at least one water-related coarse habitat: marsh, vegetated upper beach, vegetated ice scour, and/or water

Sign abundance was the basis on which mammal community composition and relative abundance were assessed and was measured using sign frequency and the proportion of transects on which they occurred. Sign frequency was calculated as the mean number of sign per 100 square metres (m^2) on each transect, averaged across all transects sampled for any given species or study area unit and was used for coarse habitat mosaic, riparian shoreline, and lake perimeter surveys. Proportion of transects was calculated as the number of transects on which a species was detected and was used in part to measure species distribution in the area of interest. Island reconnaissance surveys collected presence/absence data, and variables such as mean island size and mean linear distance from the mainland for groups of islands were used for statistical comparisons. Table 7A-7 outlines the different types of transects surveyed from 2001 to 2004.

In addition to habitat classification, coarse habitat mosaic transects were identified as north or south of Gull or Stephens lakes. Transects were also located on islands in Gull Lake. In the sub-regional study area, transects were identified as located in riparian (occurring near a waterbody) or upland (at a distance from a waterbody) areas. Transects in Zone 1 (the Project Footprint) will become part of the reservoir following inundation.

Riparian shoreline transects surveyed in the local study area were identified as occurring on islands in Gull Lake, or north or south of the lake. In low water years, the width of the riparian zone extended from near shore to the top of the bank or further. It usually encompassed grassland and shrubland communities up to the nearest forest edge. Three categories of riparian zone were established: 0 to 30 m, 31 to 100 m, and greater than 100 m. The slope of the bank was measured, and categorized as a grade of 0 to 32%, 33 to 65%, or 66 to 100%. The habitat type of each transect was also identified.

Lake perimeters were identified as located north or south of Gull Lake, and inside or outside Zone 1. Habitat type was identified, and lakes were classified based on their circumferences: less than 2,000 m, 2,000 to 4,000 m, and 4,001 to 6,000 m.

Table 7A-7: Mammal Studies in Zone 1 and Local Study Areas

Transect Type	Season	Purpose	Zone 1	Year	Number of Transects
Coarse habitat mosaic	Summer	To compare the presence, distribution, and relative abundance of terrestrial mammal species along upland habitats and the gradient between	Inside	2001	29
				2002	48
				2003	54
			Outside	2001	22
				2002	74
				2003	82
	Winter	To compare the presence, distribution, and relative abundance of terrestrial mammal species along upland habitats and the gradient between shorelines and habitats.	Inside	2001	33
				2002	39
			Outside	2001	22
				2002	33
Riparian shoreline	Summer	To determine the presence and relative abundance of aquatic and terrestrial mammals in riparian habitat and to obtain detailed information on riparian habitat features.	Inside	2001, 2002	53
				2003	54
Lake perimeter	Summer	To determine the presence and relative abundance of aquatic and terrestrial mammals along the shores of small lakes and ponds.	Inside	2002, 2003	10
			Outside	2002, 2003	10

7.5.2 Aquatic Furbearer Studies

Aerial surveys for aquatic furbearers (beaver and muskrat) were conducted by helicopter along watercourses and waterbodies in spring and fall 2001 and 2003, and in spring 2006. An additional survey was done south of Stephens Lake in fall 2009, and Zone 1 was surveyed in fall 2011, to determine how many beaver colonies will be affected by clearing and flooding. The number of beaver lodges and muskrat push-ups along waterbodies of varying sizes was counted and their positions were marked using a GPS. Beaver lodges were classified as active or inactive based on the presence of food caches and evidence of recent maintenance on the lodge. The linear distance surveyed in the beavers/furbearers Regional (Zone 4) and Local (Zone 3) Study Areas was determined (Table 7A-8, Table 7A-9). This information was then analyzed using a geographic information system (GIS), where waterbodies greater than 0.5 km^2 in area were considered lakes while those less than 0.5 km^2 were considered ponds. Named lakes were classified separately. Rivers were depicted by a dual polyline on a 1:50,000 topographic maps; creeks were depicted by a single line. Named rivers were classified separately.

In fall 2011 waterbodies in Zone 1 were surveyed to determine the number of beaver colonies likely to be affected by flooding (Table 7A-10). The survey did not include waterbodies in the Beaver Local or Regional Study Areas, and results were analyzed separately from previous years’ studies.

Table 7A-8: Distance Surveyed (km) for Aquatic Furbearers Aerial Surveys in the Beaver / Furbearers Regional Study Area

Type of Waterbody	Name of Waterbody	Fall		Spring		
		2001	2003	2001	2003	2006
Island in lake	Stephens	-	10	-	-	-
Island in pond	Clark	2	2	2	2	-
	Stephens	20	10	14	29	1
	Unnamed	6	6	6	6	5
Island in river	Nelson central[1]	8	5	5	7	5
	Nelson downstream	1	1	<1	-	-
	Unnamed	1	1	6	<1	<1
Lake	Clark	22	28	23	16	-
	Stephens	169	139	139	119	6
	Unnamed	116	115	109	87	81
Ponds		156	122	137	120	78
Rivers	Nelson central[1]	144	40	127	66	42
	Nelson downstream	32	29	8	3	-
	Unnamed	29	24	2	26	6
Streams		213	134	121	191	151
Total		919	666	693	674	375

1. Includes Gull Lake

Table 7A-9: Distance Surveyed (km) for Aquatic Furbearers Aerial Surveys in the Beaver/Furbearers Local Study Area

Type of Waterbody	Name of Waterbody	Fall		Spring		
		2001	2003	2001	2003	2006
Island in pond	Stephens	8	7	7	15	3
	Unnamed	2	3	5	12	1
Island in river	Nelson central[1]	8	5	5	7	5
	Unnamed		1		1	1
Unnamed lakes		33	33	29	23	25
Ponds		56	48	52	45	34
Rivers	Nelson central[1]	144	40	127	66	42
	Unnamed	2	3	3	3	2
Streams		79	51	35	66	68
Total		333	190	258	225	180

1. Includes Gull Lake

Table 7A-10: Distance Surveyed (km) for Aquatic Furbearers Aerial Surveys in Zone 1, Fall 2011

Water Body	Distance
Island in pond	<1
Island in central Nelson River[1]	3
Unnamed lakes	40
Ponds	36
Nelson River central[1]	75
Streams	74
Total	228

1. Includes Gull Lake

7.5.3 Ungulate Studies

Aerial Surveys

Aerial surveys for ungulates (moose and caribou) were conducted in winter 2002 to 2006, and in the winter of 2011–2012. For the 2002 to 2006 surveys, two or three observers and a pilot flew in a fixed wing aircraft at approximately 100 m altitude. Ungulate counts included actual observation of individuals as well as signs of their presence (*e.g.*, tracks and feeding craters). Surveys typically consisted of both reconnaissance trajectories and township flight blocks (Table 7A-11, Table 7A-12). Reconnaissance trajectories were designed to locate ungulate populations, particularly caribou, and followed coverage patterns recommended from local knowledge and expert information. The township flight blocks were selected by incorporating habitat (*i.e.*, common habitat types, burns, and linear feature replicates) into the design, and determined ungulate densities throughout the surveyed areas. Flights consisted of linear transects flown from north to south, and covered 15% to 100% of the block. The line of sight was estimated at 200 m on either side of the aircraft.

Table 7A-11: Survey Effort for Aerial Ungulate Surveys in the Caribou Regional Study Area, 2002 to 2006

		Township Blocks			Reconnaissance	All
Study Year	**Survey Period**	**Townships[1]**	**Distance (km)**	**Area (km^2)**	**Distance (km)**	**Total Distance (km)**
2002	February 22-23, 2003	3	258	103	737	995
	March 16-20, 2003	8	1,671	668	165	1,836
	Total	8	1,929	771	902	2,831
2003	November 7, 2003	-	-	-	540	540
	November 19-22, 2003	18	973	390	458	1,431
	December 12, 2003	10	410	164	128	538
	December 16-17, 2003	8	545	218	147	692
	February 5-9, 2004	29	1,722	690	459	2,181
	Total	27	3,650	1,462	1,732	5,382

Table 7A-11: Survey Effort for Aerial Ungulate Surveys in the Caribou Regional Study Area, 2002 to 2006

		Township Blocks			Reconnaissance	All
Study Year	Survey Period	Townships[1]	Distance (km)	Area (km^2)	Distance (km)	Total Distance (km)
2004	December 6, 9, 2004	-	-	-	1,579	1,579
	January 18-20, 2005	22	1,397	559	0	1,397
	Total	21	1,397	559	1,579	3,516
2005	December 6, 2005	-	-	-	408	408
	January 12-15, 2006	20	829	332	77	906
	March 30, 2006	19	619	181	0	619
	Total	20	1,448	513	485	1,933
2006	January 21-23, 2007	19	838	336	-	838

1. Some townships were surveyed more than once in a survey period.

Table 7A-12: Survey Effort for Aerial Ungulate Surveys in Township Blocks in the Caribou Local Study Area, 2002 to 2006

Study Year	Survey Period	Townships[1]	Distance (km)	Area (km²)
2002	February 22-23, 2003	1	178	71
	March 16-20, 2003	4	940	376
	Total	4	1,118	447
2003	November 19-22, 2003	3	193	77
	February 5-9, 2004	5	324	130
	Total	5	517	207
2004	January 18-20, 2005	3	182	73
2005	March 30, 2006	2	143	57

1. Some townships were surveyed more than once in a survey period

Densities were calculated for township blocks in the Caribou Local and Regional Study Areas as individuals/km². Overall density was calculated as the mean of caribou densities over the survey period.

In the winter of 2011–2012, three observers and a pilot flew in a fixed wing aircraft at approximately 80 m above ground level (AGL). Flights consisted of linear transects flown from north to south, 2 km apart. The area surveyed was 8,738 km² in total. All observations of large mammals were recorded. When animals were observed, an attempt was made to count, age, and sex them based on morphological traits. Other observations of interest, such as individuals wearing radio collars, or fresh kill sites, were recorded. Where signs such as tracks were observed, these were also recorded. The location of all observations was marked with a GPS unit.

Tracking Surveys and Trail Cameras

Islands located within bog complexes throughout the regional study area were surveyed for caribou calving suitability and sign of use from July 7 to July 18, 2009. Caribou calving suitability and use was estimated using ground tracking methods involving time limited and transect type surveys. Suitability and use of the islands was based on the presence or absence of caribou and caribou calf sign. Islands were categorized according to size in order to assess differences in use arising from variation in available forage and cover provided by islands of varying size.

Furthermore, areas of contiguous forest, islands with unfavourable vegetation communities, islands having narrow separation from surrounding forest, and burned areas were surveyed using ground surveys. These areas were categorized as poor caribou calving habitat and sampled using transect type surveys. As with the caribou calving islands, suitability of caribou use for these areas were based on the number of caribou and caribou calf sign present.

In 2010, a trail camera study was conducted in the Stephens Lake and Gull Lake area to collect additional baseline materials to corroborate information collected from 2001 to 2009 for the Keeyask GS environmental assessment. Activity levels, distribution and number of summer resident caribou and/or coastal caribou that occupy the islands in these two lakes, and for any animals that occupy islands in bog habitats (*i.e.*, caribou calving complexes) adjacent to the north and south access road routes. Data collected indicated distribution, number, and activity levels of caribou bulls, calves and cows, moose bulls, cows and calves, and predator (*e.g.*, gray wolf and black bear) distribution and numbers.

Eighty-one RECONYX™ trail cameras were deployed on islands in lakes and on islands in bogs within a verified or potential caribou calving complex.

Islands were accessed by helicopter or boat just prior to the calving season in spring. A single camera was set up on most islands, but two cameras were set up on six of the largest islands to improve detectability coverage. Two cameras were set up in each of two calving and rearing complexes. Cameras were operational from mid-May to early September 2010, when all but one camera was removed. A mammal sign survey was conducted simultaneously with the set up, maintenance, and removal of trail cameras. Tracking transects totalled 83.2 km in length.

7.5.4 Small Mammal Trapping Program

Trapping blocks were established in the Small Mammals Regional (Zone 3) and Local (Zone 2) Study Areas from 2001 to 2004 (Table 7A-13). Each block consisted of 100 traps, typically divided into two groups of 50 traps of equal numbers of Victor and Museum Special snap-traps. Traps were located in riparian and upland areas separated by approximately 300 m. Traps were typically set, checked and reset daily over a four-day period, with some exceptions due to weather. Small mammals were captured, weighed, measured, and positively identified by dental characteristics. The small mammal trapping program was designed to estimate the occurrence, abundance, and distribution of small mammals and to compare small mammal abundance between riparian and upland habitats.

Table 7A-13: Survey Effort for Small Mammals in the Small Mammals Local and Regional Study areas, 2001 to 2004

	Local Study Area				Regional Study Area			
Year	Number of Blocks	Riparian Trap Nights	Upland Trap Nights	Total Trap Nights	Number of Blocks	Total Trap Nights	Riparian Trap Nights	Upland Trap Nights
2001	16	2,700	2,373	5,073	22	6,873	3,600	3,273
2002	18	3,800	3,400	7,200	28	11,300	5,850	5,450
2003	17	3,750	2,950	6,700	34	13,500	6,350	7,150
2004	5	850	850	1,700	7	2,400	1,200	1,200
Total	27	11,100	9,753	20,673	46	34,073	17,000	17,073

The skulls of captured animals were collected and processed using insect digestion and enzyme bath defleshing methods, then identified to species when possible, or to genus. Captured mammals were weighed (within 0.1 g), tail and body length (mm) were measured, and sex was recorded. Deer mice were not measured or handled due to the potential risk of Hantavirus.

SYSTAT 11.0 was used to calculate species frequency in the Small Mammals Regional and Local Study Areas, reported as the number of individuals trapped per 100 trap nights (TN) across all trapping blocks in the respective study areas.

7.5.5 Ground Surveys for Muskrat

As part of the wetland function assessment (see the Habitat and Ecosystems section of the TE SV), lakes, ponds, and riverbanks were surveyed for muskrat sign from August 16 to September 3, 2006. Suitability of waterbodies for muskrat habitat was estimated during the aerial surveys of 2001 and 2003, and categorized as non-habitat, poor to fair or good. Suitability was estimated based on the number of muskrat push-ups recorded, and the apparent availability of muskrat habitat, such as the size of the waterbody, the number of bays in it, and the number of creeks radiating to or from it. In order to increase the sample size, two waterbodies not assessed for suitability were also surveyed.

Ground sampling consisted of up to three observers walking approximately 5 m apart on predetermined transect segments along the shore at each lake, pond, river or creek. Habitats selected for survey included bays, treed and treeless areas, peatlands, and a range of narrow to steep bank slopes. Segments were approximately 200 m in length. Signs of muskrat such as lodges, burrows, runs, clippings, tracks, scat, and feeding or loafing platforms were recorded. The relative abundance of active dwellings, (*i.e.*, lodges and burrows), was standardized over 100 m to account for differences in segment lengths.

Where vegetation clipped by muskrat or beaver were encountered, a sample was collected, labelled and frozen for subsequent analysis. Clippings were identified to genus or species, and the abundance of each plant species was recorded as a percentage of the total sample.

APPENDIX 7B
Tables

7.6 APPENDIX 7B - TABLES

Table 7B-1: Mammal Species Occurring Historically in the Mammals Regional Study Area

Common Name	Scientific Name	Breeds in Manitoba	Nature of Occurrence[1]	Manitoba Distribution[2]	Manitoba Abundance[3]	Degree of Confidence in Manitoba Data[4]	Most Likely Breeding Status in the Mammals Regional Study Area[5]	Most Likely Distribution in the Mammals Regional Study Area[6]	Expected Abundance in the Mammals Regional Study Area[7]	Most Likely Species Rarity in the Mammals Regional Study Area	Found During Studies in the Mammals Regional Study Area[8]
ORDER: INSECTIVORA (Insectivores)											
Masked shrew	*Sorex cinereus*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Very abundant	Very common	Yes
American water shrew	*Sorex palustris*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Scarce to Sporadic	Common	Yes
Arctic shrew	*Sorex arcticus*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Sporadic	Common	Yes
Pygmy shrew	*Sorex hoyi*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Sporadic	Common	Yes
ORDER: CHIROPTERA (Bats)											
Little brown myotis (bat)	*Myotis lucifugus*	Yes	Resident-Migratory	Very widespread	Very abundant (breeding) to scarce (non-breeding)	B	Breeding?	Wide	Scarce to Sporadic	Rare to Uncommon	Yes? not confirmed
Hoary bat	*Lasiurus cinereus*	Yes	Migratory	Widespread	Sporadic (breeding)	C	Breeding?	Wide	Scarce to Sporadic	Rare	No
Snowshoe hare	*Lepus americanus*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Very abundant	Very common	Yes
ORDER: RODENTIA (Rodents)											
Least chipmunk	*Tamias minimus*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Sporadic to Very abundant	Common to Very common	Yes
Woodchuck	*Marmota monax*	Yes	Resident	Very widespread	Very abundant	C	Breeding?	Narrow	Sporadic to Abundant	Rare to Uncommon	Yes Incidental
Red squirrel	*Tamiasciurus hudsonicus*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Very abundant	Very common	Yes

Table 7B-1: Mammal Species Occurring Historically in the Mammals Regional Study Area

Common Name	Scientific Name	Breeds in Manitoba	Nature of Occurrence[1]	Manitoba Distribution[2]	Manitoba Abundance[3]	Degree of Confidence in Manitoba Data[4]	Most Likely Breeding Status in the Mammals Regional Study Area[5]	Most Likely Distribution in the Mammals Regional Study Area[6]	Expected Abundance in the Mammals Regional Study Area[7]	Most Likely Species Rarity in the Mammals Regional Study Area	Found During Studies in the Mammals Regional Study Area[8]
Northern flying squirrel	*Glaucomys sabrinus*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Abundant to possibly Very abundant	Very common	Yes Incidental
Beaver	*Castor canadensis*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Very abundant	Very common	Yes
Deer mouse	*Peromyscus maniculatus*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Very abundant	Very common	Yes
Gapper's red-backed vole	*Clethrionomys gapperi*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Very abundant	Very common	Yes
Northern bog lemming	*Synaptomys borealis*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Sporadic to possibly Abundant	Common to possibly Very common	Yes
Heather vole	*Phenacomys intermedius*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Abundant	Very common	Yes
Muskrat	*Ondatra zibethicus*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Abundant to Very abundant	Very common	Yes
Meadow vole	*Microtus pennsylvanicus*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Very abundant	Very common	Yes
Meadow jumping mouse	*Zapus hudsonius*	Yes	Resident	Very widespread	Very abundant	C	Breeding	Wide	Very abundant	Very common	Yes
Porcupine	*Erethizon dorsatum*	Yes	Resident?	Very widespread	Very abundant	C	Non-breeding?	Absent	Extirpated?	Absent	No
ORDER: CARNIVORA (Carnivores)											
Coyote	*Canis latrans*	Yes	Resident	Scattered	Very abundant	C	Breeding?	Narrow	Scarce	Rare	Yes
Gray wolf	*Canis lupus*	Yes	Resident	Very widespread	Abundant	B	Breeding	Wide	Sporadic to Abundant	Common to Very common	Yes

Table 7B-1: Mammal Species Occurring Historically in the Mammals Regional Study Area

Common Name	Scientific Name	Breeds in Manitoba	Nature of Occurrence[1]	Manitoba Distribution[2]	Manitoba Abundance[3]	Degree of Confidence in Manitoba Data[4]	Most Likely Breeding Status in the Mammals Regional Study Area[5]	Most Likely Distribution in the Mammals Regional Study Area[6]	Expected Abundance in the Mammals Regional Study Area[7]	Most Likely Species Rarity in the Mammals Regional Study Area	Found During Studies in the Mammals Regional Study Area[8]
Arctic fox	*Alopex lagopus*	Yes	Migratory - Nomadic? (Occasional)	Scattered	Very abundant	B	Non-breeding	Narrow	Absent to Abundant	Rare to Uncommon	Yes Incidental
Red fox	*Vulpes vulpes*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Abundant	Very common	Yes
Black bear	*Ursus americanus*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Abundant to Very abundant	Very common	Yes
Grizzly bear (Plains)	*Ursus arctos*	No	Migratory - Nomadic? (Occasional)	Localized	NA	A	Non-breeding	Absent	Extirpated	Absent	No
Grizzly bear (Barren-ground)	*Ursus arctos*	No	Migratory - Nomadic? (Occasional)	Localized	NA	C	Non-breeding	Absent	Extirpated	Absent	No
Raccoon	*Procyon lotor*	Yes	Resident?	Scattered	Very abundant	B	Breeding?	Narrow	Scarce	Rare	Yes
American marten	*Martes americana*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Sporadic to Very abundant	Common to Very common	Yes
Fisher	*Martes pennanti*	Yes	Resident	Widespread	Abundant	B	Breeding	Wide	Sporadic	Common	Yes
Ermine	*Mustela erminea*	Yes	Resident	Very widespread	Very abundant	B	Breeding	Wide	Abundant to Very abundant	Very common	Yes Incidental
Least weasel	*Mustela nivalis*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Abundant	Very common	Not identified to species
Mink	*Mustela vison*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Abundant to Very abundant	Very common	Yes
Wolverine	*Gulo gulo*	Yes	Resident	Very widespread	Abundant	B	Breeding	Narrow	Scarce to Sporadic	Rare	Yes
Striped skunk	*Mephitis mephitis*	Yes	Resident	Widespread	Very Abundant	B	Breeding	Wide	Scarce to Sporadic	Common	No

Table 7B-1: Mammal Species Occurring Historically in the Mammals Regional Study Area

Common Name	Scientific Name	Breeds in Manitoba	Nature of Occurrence[1]	Manitoba Distribution[2]	Manitoba Abundance[3]	Degree of Confidence in Manitoba Data[4]	Most Likely Breeding Status in the Mammals Regional Study Area[5]	Most Likely Distribution in the Mammals Regional Study Area[6]	Expected Abundance in the Mammals Regional Study Area[7]	Most Likely Species Rarity in the Mammals Regional Study Area	Found During Studies in the Mammals Regional Study Area[8]
River otter	*Lontra canadensis*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Sporadic to Very abundant	Common to Very common	Yes
Lynx	*Lynx canadensis*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Abundant	Very common	Yes

Table 7B-1: Mammal Species Occurring Historically in the Mammals Regional Study Area

Common Name	Scientific Name	Breeds in Manitoba	Nature of Occurrence[1]	Manitoba Distribution[2]	Manitoba Abundance[3]	Degree of Confidence in Manitoba Data[4]	Most Likely Breeding Status in the Mammals Regional Study Area[5]	Most Likely Distribution in the Mammals Regional Study Area[6]	Expected Abundance in the Mammals Regional Study Area[7]	Most Likely Species Rarity in the Mammals Regional Study Area	Found During Studies in the Mammals Regional Study Area[8]
ORDER: ARTIODACTYLA (Cloven-hoofed Mammals)											
Boreal woodland caribou	*Rangifer tarandus caribou*	Yes	Resident - Nomadic	Widespread	Abundant	B	Breeding?	Narrow	Scarce to Sporadic	Rare	Uncertain
Summer resident caribou	*Rangifer tarandus caribou*	Yes	Summer resident	Localized	Scarce to Sporadic	C	Breeding	Narrow	Scarce to Sporadic	Rare	Yes
Coastal caribou	*Rangifer tarandus caribou*	Yes	Nomadic	Localized	Scarce to Very abundant	B	Breeding?	Wide	Sporadic to Very abundant	Common to Very common	Yes
Barren-ground caribou	*Rangifer tarandus groenlandicus*	Yes	Nomadic	Localized	Scarce to Very abundant	B	Non-breeding	Wide	Sporadic to Very abundant	Common to Very common	Yes
White-tailed deer	*Odocoileus virginianus*	Yes	Resident	Scattered	Very Abundant	B	Non-breeding	Absent	Absent to Scarce	Absent	No
Mule deer	*Odocoileus hemionus*	Yes	Resident - Nomadic? -	Localized	Sporadic	C	Non-breeding	Absent	Extirpated	Absent	Yes Incidental
Moose	*Alces alces*	Yes	Resident	Very widespread	Very Abundant	B	Breeding	Wide	Sporadic to Abundant	Common to Very common	Yes

1. Nature of Occurrence:

Resident - A species that remains year-round

Resident? - A species that would remain year-round if it definitely occurred in the study area

Migratory - A species that can be seen only during brief periods in spring, summer and/or fall. It may or may not breed here

Nomadic - Occasionally equivalent to migratory, but species movements may occur as either less predictable patterns, or total distances moved are not as long as traditional migrants

2. Manitoba Distribution:

Very widespread - Range includes >75% of the province

Widespread - Range includes 50-75% of the province

Scattered - Range includes 25-49% of the province

Localized - Range includes <25% of the province

3. Manitoba Abundance:

Very Abundant - Not listed by the Manitoba Conservation Data Centre (MBCDC), assumed to be widespread, abundant, and secure throughout its range or in the province, and essentially impossible to eradicate under present conditions

Abundant - Listed by the MBCDC as widespread, abundant, and apparently secure throughout its range or in the province, with many occurrences (>100), but may be of long-term concern.

Sporadic - Listed as by the MBCDC as uncommon throughout its range or in the province (21 to 100 occurrences)

Scarce - Listed by the MBCDC as rare or very rare throughout its range or in the province (20 or fewer occurrences). May be vulnerable to extirpation

4. Degree of Confidence in Manitoba Data

A – high degree of confidence

B – reliable but data limited

C – unreliable.

5. Most Likely Breeding Status in the Regional Study Area:

Using the following scale of probabilities (*i.e.*, Breeding, Breeding?, Non-breeding? Non-breeding), whether or not a species breeds in the study area. Probabilities are based on a review of available materials.

Non-breeding and breeding = 100% probability

Non-breeding? = <50% chance

Breeding? = >50% chance

6. Most Likely Distribution in the Regional Study Area:

Wide- Very widespread or widespread

Narrow- Scattered or localized

7. Expected Abundance in the Regional Study Area:

Very abundant - Can be observed on all visits in preferred habitat during the proper season, usually in large numbers

Abundant - Can be observed on most visits in preferred habitat during the proper season; numbers vary considerably

Sporadic - Infrequently observed in preferred habitat, usually in low numbers

Scarce - Seldom observed but can be expected to occur annually

Rare - Listed by the federal Species at Risk Act or the Manitoba Endangered Species Act

Absent - Not found

Extirpated - See legal parameters

Extinct - See legal parameters

NA' - Not Available and/or Not Applicable

8. Found During Studies in the Regional Study Area:

Yes – Found during tracking, trapping or aerial studies.

Yes Incidental– Observed, but not during formal studies.

No – Not found during tracking, trapping or aerial studies.

Not indentified to species – not distinguished from other similar species

M- Migrant or a species that can be seen only during brief periods in spring, summer and/or fall. It may or may not breed here.

B - Breeding: Refers to a breeding population of this species in the study area.

Furbearers - Abundance, range and trends from Stardom (1986). Five categories of density are based on relative abundances (Very Abundant = High, Abundant = Moderate, Sporadic = Low, Rare = Rare and Absent).

Table 7B-2: Furbearing Species Trapped in the Split Lake Resource Management Area, 1961 to 1984

Species	Number Trapped
Arctic fox	565
Beaver	18,471
Black bear	22
Coyote	15
Ermine	1,877
Fisher	620
Gray wolf	66
Lynx	1,790
American marten	107
Mink	5,765
Muskrat	21,787
River otter	1,640
Raccoon	3
Red fox	2,891
Red squirrel	1,923
Wolverine	56

Table 7B-3: Furbearing Species Trapped in the Split Lake Resource Management Area, 1996 to 2005

Species	Number Trapped
Arctic fox	718
Badger	1
Beaver	3,733
Black bear	4
Coyote	4
Ermine	96
Fisher	76
Gray wolf	77
Lynx	186
American marten	15,791
Mink	1,423
Muskrat	904
River otter	627
Red Fox	667
Red squirrel	147
Weasel	7

Table 7B-4: Furbearing Species Trapped in the Fox Lake Resource Management Area, 1996 to 2005

Species	Number Trapped
Arctic fox	194
Beaver	287
Black bear	0
Coyote	1
Ermine	12
Fisher	6
Gray wolf	18
Lynx	21
American marten	2,843
Mink	130
Muskrat	109
River otter	67
Raccoon	0
Red fox	132
Red squirrel	27
Weasel	3

Table 7B-5: Mammal Species Identified in the Keeyask Region

Common Name	Scientific Name	Observed During Formal Studies	Observed Outside of Formal Studies[1]
Masked shrew	*Sorex cinereus*	✓	
American water shrew	*Sorex palustris*	✓	
Arctic shrew	*Sorex arcticus*	✓	
Pygmy shrew	*Sorex hoyi*	✓	
Little brown myotis	*Myotis lucifugus*	species unconfirmed	species unconfirmed
Hoary bat	*Lasiurus cinereus*		
Snowshoe hare	*Lepus americanus*	✓	
Least chipmunk	*Tamias minimus*	✓	
Woodchuck	*Marmota monax*		✓
Red squirrel	*Tamiasciurus hudsonicus*	✓	
Northern flying squirrel	*Glaucomys sabrinus*		✓
American beaver	*Castor canadensis*	✓	
Deer mouse	*Peromyscus maniculatus*	✓	
Gapper's red-backed vole	*Clethrionomys gapperi*	✓	
Northern bog lemming	*Synaptomys borealis*	✓	
Heather vole	*Phenacomys intermedius*	✓	
Muskrat	*Ondatra zibethicus*	✓	
Meadow vole	*Microtus pennsylvanicus*	✓	
Meadow jumping mouse	*Zapus hudsonius*	✓	
Porcupine	*Erethizon dorsatum*		✓
Coyote	*Canis latrans*	✓	
Gray wolf	*Canis lupus*	✓	
Arctic fox	*Alopex lagopus*		
Red fox	*Vulpes vulpes*	✓	
American black bear	*Ursus americanus*	✓	
Racoon	*Procyon lotor*	✓	
American marten	*Martes americana*	✓	
Fisher	*Martes pennanti*	✓	
Ermine	*Mustela erminea*	✓	
Least weasel	*Mustela nivalis*		
American mink	*Mustela vison*	✓	

Table 7B-5: Mammal Species Identified in the Keeyask Region

Common Name	Scientific Name	Observed During Formal Studies	Observed Outside of Formal Studies[1]
Wolverine	*Gulo gulo*	✓	
Striped skunk	*Mephitis mephitis*		✓
Northern river otter	*Lontra canadensis*	✓	
Lynx	*Lynx canadensis*	✓	
Barren-ground caribou	*Rangifer tarandus groenlandicus*	✓	
Coastal caribou	*Rangifer tarandus caribou*	✓	
Boreal woodland caribou[2]	*Rangifer tarandus caribou*		✓
Summer resident caribou	*Rangifer tarandus caribou*	✓	
White-tailed deer[3]	*Odocoileus virginianus*		
Moose	*Alces alces*	✓	

1. Only noted if not observed during formal studies; observed incidentally during field studies or reported by KCNs
2. Beyond current range
3. Not expected to occur regularly in the region due to range and habitat limitations

Table 7B-6: Small Mammal Capture Frequency in the Small Mammals Regional Study Area, 2001 to 2004

		Riparian			Upland			Total		
Year	**Species**	**Number Captured[1]**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**
2001	Arctic shrew	1	0.03	0.05	2	0.06	0.12	3	0.04	0.14
	Deer mouse	8	0.22	0.29	6	0.18	0.24	14	0.20	0.36
	Masked shrew	173	4.81	0.86	146	4.46	0.94	319	4.64	0.95
	Meadow vole	2	0.06	0.10	1	0.03	0.06	3	0.04	0.14
	Meadow jumping mouse	16	0.44	0.38	4	0.12	0.18	20	0.29	0.45
	Pygmy shrew	2	0.06	0.10	0	0	0	2	0.03	0.09
	Red-backed vole	69	1.92	0.67	37	1.13	0.65	106	1.54	0.73
	American water shrew	1	0.03	0.05	0	0	0	1	0.01	0.05
	Total	272	7.56	1.00	196	5.99	1.00	468	6.81	1.00
2002	Arctic shrew	2	0.03	0.04	1	0.02	0.04	3	0.03	0.04
	Deer mouse	54	0.92	0.48	37	0.68	0.46	100	0.88	0.61
	Heather vole	27	0.46	0.37	69	1.27	0.46	96	0.85	0.54
	Masked shrew	55	0.94	0.56	30	0.55	0.46	85	0.75	0.75
	Meadow vole	237	4.05	0.78	106	1.94	0.69	343	3.04	0.86
	Meadow jumping mouse	17	0.29	0.30	2	0.04	0.08	19	0.17	0.29
	Northern bog lemming	20	0.34	0.41	15	0.28	0.31	35	0.31	0.54
	Pygmy shrew	1	0.02	0.04	0	0	0	1	0.01	0.04
	Red-backed vole	1,003	17.15	1.00	935	17.16	1.00	1,146	17.22	1.00
	Total	1,416	24.21	1.00	1,195	21.93	1.00	2,628	23.26	1.00
2003	Arctic shrew	1	0.02	0.03	0	0	0	1	0.01	0.03
	Deer mouse	89	1.40	0.55	49	0.69	0.36	145	1.07	0.56
	Heather vole	248	3.91	0.79	288	4.03	0.85	540	4.00	0.88
	Masked shrew	34	0.54	0.45	39	0.55	0.42	73	0.54	0.53
	Meadow vole	72	1.13	0.48	37	0.52	0.33	109	0.81	0.50

Table 7B-6: Small Mammal Capture Frequency in the Small Mammals Regional Study Area, 2001 to 2004

		Riparian			Upland			Total		
Year	**Species**	**Number Captured[1]**	**Frequency (number / 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number / 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number / 100 TN)**	**Proportion of Blocks**
2003	Meadow jumping mouse	6	0.09	0.14	4	0.06	0.12	11	0.08	0.26
	Northern bog lemming	12	0.19	0.28	6	0.08	0.12	18	0.13	0.29
	Pygmy shrew	0		0	1	0.01	0.03	1	0.01	0.03
	Red-backed vole	810	12.76	1.00	1,058	14.80	1.00	1,903	14.10	1.00
	Total	1,272	20.03	1.00	1,482	20.73	1.00	2,801	20.75	1.00
2004	Deer mouse	7	0.58	0.17	2	0.17	0.14	9	0.38	0.29
	Heather vole	0	0	0	3	0.25	0.43	3	0.13	0.43
	Masked shrew	1	0.08	0.17	0	0	0	1	0.04	0.14
	Meadow vole	1	0.08	0.17	0	0	0	1	0.04	0.14
	Red-backed vole	41	3.42	1.00	28	2.33	1.00	69	2.88	1.00
	Total	50	4.17	1.00	33	2.75	1.00	83	3.46	1.00
All	Arctic shrew	4	0.02	0.07	3	0.02	0.05	7	0.02	0.09
	Deer mouse	158	0.93	0.64	94	0.55	0.49	268	0.79	0.72
	Heather vole	275	1.62	0.67	360	2.11	0.74	639	1.88	0.78
	Masked shrew	263	1.55	0.71	215	1.26	0.67	478	1.40	0.76
	Meadow vole	312	1.84	0.69	144	0.84	0.60	456	1.34	0.74
	Meadow jumping mouse	39	0.23	0.36	10	0.06	0.19	50	0.15	0.46
	Northern bog lemming	32	0.19	0.38	21	0.12	0.28	53	0.16	0.43
	Pygmy shrew	3	0.02	0.07	1	0.01	0.02	4	0.01	0.09
	Red-backed vole	1,923	11.31	0.98	2,058	12.05	1.00	4,024	11.81	0.98
	American water shrew	1	0.01	0.02	0	0	0	1	<0.01	0.02
	Total	3,010	17.71	1.00	2,906	17.02	1.00	5,980	17.55	1.00

1. Riparian versus upland captures were not always recorded

Table 7B-7: Red-backed Voles Captured in Coarse Habitat Mosaics in the Small Mammals Regional Study Area, 2001 to 2004

Year	Habitat	Number of Blocks Surveyed	Trap Nights	Frequency (number / 100 TN)	Proportion of Blocks Captured
2001	H01	5	1,473	0.75	0.60
	H03	5	1,500	1.53	1.00
	H04	4	1,200	2.75	0.75
	H05	2	600	0.17	0.50
	H09	3	900	0.56	0.33
	H10	1	300	0.67	1.00
	H11	1	300	5.33	1.00
	H13	1	600	2.50	1.00
2002	H01	7	2,900	11.59	1.00
	H03	4	1,600	24.56	1.00
	H04	3	1,200	18.75	1.00
	H05	3	1,300	13.23	1.00
	H09	3	1,200	13.75	1.00
	H10	2	800	16.63	1.00
	H13	1	400	39.00	1.00
2003	H01	13	5,100	12.10	1.00
	H03	3	1,200	5.92	1.00
	H04	2	800	15.50	1.00
	H05	2	800	21.50	1.00
	H09	3	1,200	22.50	1.00
	H10	2	800	22.00	1.00
	H12	2	800	11.88	1.00
	H13	1	400	13.25	1.00
2004	H01	2	700	0.57	1.00
	H04	1	400	4.25	1.00
	H05	1	300	3.00	1.00
	H09	2	600	4.83	1.00

Table 7B-7: Red-backed Voles Captured in Coarse Habitat Mosaics in the Small Mammals Regional Study Area, 2001 to 2004

Year	Habitat	Number of Blocks Surveyed	Trap Nights	Frequency (number / 100 TN)	Proportion of Blocks Captured
2004	H13	1	400	2.50	1.00
All	H01	13	7,473	12.95	1.00
	H03	6	3,500	13.91	1.00
	H04	4	2,400	16.63	0.75
	H05	3	2,300	15.39	1.00
	H09	3	2,100	22.33	1.00
	H10	3	1,100	28.27	1.00
	H11	1	300	5.33	1.00
	H12	2	800	11.88	1.00
	H13	1	1,000	23.40	1.00
	Total	36	20,973	15.89	0.97

Table 7B-8: Small Mammal Capture Frequency in the Small Mammals Local Study Area, 2001 to 2004

		Riparian			Upland			Total		
Year	Species	Number Captured[1]	Frequency (number / 100 TN)	Proportion of Blocks	Number Captured	Frequency (number / 100 TN)	Proportion of Blocks	Number Captured	Frequency (number / 100 TN)	Proportion of Blocks
2001	Arctic shrew	1	0.04	0.06	2	0.08	0.18	3	0.06	0.19
	Deer mouse	4	0.15	0.25	2	0.08	0.09	6	0.12	0.25
	Masked shrew	119	4.41	0.88	92	3.88	0.91	211	4.16	0.94
	Meadow vole	1	0.04	0.06	1	0.04	0.09	2	0.04	0.13
	Meadow jumping mouse	12	0.44	0.31	1	0.04	0.09	13	0.26	0.38
	Pygmy shrew	1	0.04	0.06	0	0	0.64	1	0.02	0.06
	Red-backed vole	54	2.00	0.69	23	0.97	1.00	77	1.52	0.75
	American water shrew	1	0.04	0.06	0	0	0	1	0.02	0.06
	Total	193	7.15	0.94	121	5.10	1.00	314	6.19	1.00
2002	Arctic shrew	2	0.05	0.06	1	0.03	0.06	3	0.04	0.06
	Deer mouse	21	0.55	0.41	25	0.74	0.44	55	0.76	0.59
	Heather vole	18	0.47	0.47	53	1.56	0.56	71	0.99	0.65
	Masked shrew	36	0.95	0.53	18	0.53	0.44	54	0.75	0.82
	Meadow vole	136	3.58	0.76	49	1.44	0.63	185	2.57	0.88
	Meadow jumping mouse	8	0.21	0.24	1	0.03	0.06	9	0.13	0.24
	Northern bog lemming	8	0.21	0.29	11	0.32	0.31	19	0.26	0.47
	Pygmy shrew	1	0.03	0.06	0	0	0	1	0.01	0.06
	Red-backed vole	712	18.74	1.00	632	18.59	1.00	1,348	18.72	1.00
	Total	942	24.79	1.00	790	23.24	1.00	1,745	24.24	1.00
2003	Arctic shrew	1	0.03	0.06	0	0	0.31	1	0.01	0.06
	Deer mouse	53	1.41	0.63	13	0.44	0.88	73	1.09	0.61
	Heather vole	133	3.55	0.81	150	5.08	0.38	283	4.22	0.83
	Masked shrew	23	0.61	0.50	15	0.51	0.25	38	0.57	0.50
	Meadow vole	60	1.60	0.44	8	0.27	0.13	68	1.01	0.39

Table 7B-8: Small Mammal Capture Frequency in the Small Mammals Local Study Area, 2001 to 2004

		Riparian			Upland			Total		
Year	**Species**	**Number Captured[1]**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**	**Number Captured**	**Frequency (number/ 100 TN)**	**Proportion of Blocks**
2003	Meadow jumping mouse	5	0.13	0.19	2	0.07	0.19	8	0.12	0.33
	Northern bog lemming	10	0.27	0.38	5	0.17	1.00	15	0.22	0.39
	Red-backed vole	563	15.01	1.00	600	20.34	1.00	1,171	17.48	0.94
	Total	848	22.61	1.00	793	26.88	1.00	1,657	24.73	0.94
2004	Deer mouse	7	0.82	0.20	1	0.24	0.20	9	0.53	0.40
	Heather vole	0	0	0	1	0.12	0.20	1	0.06	0.20
	Masked shrew	1	0.12	0.20	0	0	0	1	0.06	0.20
	Meadow vole	1	0.12	0.20	0	0	0	1	0.06	0.20
	Red-backed vole	31	3.65	1.00	20	3.65	1.00	51	3.00	1.00
	Total	40	4.71	1.00	23	4.71	1.00	63	3.71	1.00
All	Arctic shrew	4	0.04	0.12	3	0.03	0.08	7	0.03	0.15
	Deer mouse	85	0.77	0.69	42	0.43	0.42	143	0.69	0.74
	Heather vole	11	1.36	0.62	204	2.09	0.71	355	1.72	0.70
	Masked shrew	179	1.61	0.77	125	1.28	0.67	304	1.47	0.81
	Meadow vole	198	1.78	0.73	58	0.59	0.58	256	1.24	0.78
	Meadow jumping mouse	25	0.23	0.35	4	0.04	0.17	30	0.15	0.48
	Northern bog lemming	18	0.16	0.35	16	0.16	0.33	34	0.16	0.44
	Pygmy shrew	2	0.02	0.08	0	0	0	2	0.01	0.07
	Red-backed vole	1,360	12.25	0.96	1,275	13.07	1.00	2,647	12.80	0.96
	American water shrew	1	0.01	0.04	0	0	0	1	<0.01	0.04
	Total	2,023	18.23	1.00	1,727	17.71	1.00	3,779	18.28	1.00

1. Riparian versus upland captures were not always recorded

Table 7B-9: Red-backed Voles Captured in Coarse Habitat Mosaics in the Small Mammals Local Study Area, 2001 to 2004

Year	Habitat	Number of Blocks Surveyed	Trap Nights	Frequency (number/100 TN)	Proportion of Blocks Captured
2001	H01	2	573	1.57	1.00
	H03	4	1,200	1.58	1.00
	H04	2	600	1.67	0.50
	H05	2	600	0.17	0.50
	H09	3	900	0.56	0.33
	H10	1	30	0.67	1.00
	H11	1	300	5.33	1.00
	H13	1	600	2.50	1.00
2002	H01	2	800	19.13	1.00
	H03	3	1,200	24.58	1.00
	H04	1	400	18.50	1.00
	H05	3	1,300	13.23	1.00
	H09	3	1,200	13.75	1.00
	H10	2	800	16.63	1.00
	H13	1	400	39.00	1.00
2003	H01	5	1,900	16.95	1.00
	H03	2	800	5.88	1.00
	H05	2	800	21.50	1.00
	H09	3	1,200	22.50	1.00
	H10	2	800	22.00	1.00
	H13	1	400	13.25	1.00
2004	H01	1	400	0.75	1.00
	H05	1	300	3.00	1.00
	H09	2	600	4.83	1.00
	H13	1	400	2.50	1.00
All	H01	5	3,673	13.26	1.00
	H03	4	3,200	11.28	1.00

Table 7B-9: Red-backed Voles Captured in Coarse Habitat Mosaics in the Small Mammals Local Study Area, 2001 to 2004

Year	Habitat	Number of Blocks Surveyed	Trap Nights	Frequency (number / 100 TN)	Proportion of Blocks Captured
All	H04	2	1,000	8.40	0.50
	H05	3	3,000	11.80	1.00
	H09	3	3,900	12.03	1.00
	H10	3	1,900	16.37	1.00
	H11	1	300	5.33	1.00
	H13	1	1,800	13.00	1.00
	Total	22	18,773	12.34	0.96

Table 7B-10: Muskrat Push-up Density on Waterbodies in the Furbearers Regional Study Area, Spring 2001, 2003, and 2006

		2001		2003		2006		Mean
Water Type		**Number**	**Density[1]**	**Number**	**Density**	**Number**	**Density**	**Density**
Island pond	Clark Lake	0	0	0	0	-	-	0
	Stephens Lake	0	0	0	0	0	0	0
	Unnamed lakes	0	0	1	0.17	0	0	0.06
Island river	Nelson River central[2]	0	0	0	0	0	0	0
	Nelson River downstream	0	0	-	-	-	-	-
	Unnamed rivers	-	-	0	0	0	0	0
Lake	Clark	1	0.04	1	0.06	0	0	0.03
	Stephens	5	0.04	6	0.05	0	0	0.03
	Unnamed	18	0.17	19	0.22	10	0.12	0.17
Ponds		37	0.27	32	0.27	10	0.13	0.22
Rivers	Nelson River central[2]	8	0.06	4	0.06	0	0	0.04
	Nelson River downstream	0	0	0	0	-	-	0
	Unnamed rivers	0	0	6	0.06	2	0.33	0.13
Streams		27	0.22	73	0.38	52	0.34	0.31
Total		96	0.14	142	0.21	74	0.20	0.18

1. Push-ups/km
2. Includes Gull Lake

Table 7B-11: Muskrat Push-up Density on Waterbodies in the Furbearers Local Study Area, Spring 2001, 2003, and 2006

Water Type		2001		2003		2006		
		Number	Density[1]	Number	Density	Number	Density	Mean Density
Island pond	Stephens Lake	0	0	0	0	0	0	0
	Unnamed lakes	0	0	1	0.08	0	0	0.03
Island river	Nelson River central[2]	0	0	0	0	0	0	0
	Unnamed rivers	-	-	0	0	0	0	0
Lakes	Unnamed lakes	5	0.17	10	0.43	5	0.20	0.27
Ponds		15	0.29	11	0.24	5	0.15	0.23
Rivers	Nelson River central[2]	8	0.06	4	0.06	0	0	0.04
	Unnamed rivers	0	0	0	0	1	0.50	0.17
Streams		10	0.29	27	0.41	17	0.25	0.32
Total		38	0.15	53	0.24	28	0.16	0.22

1. Push-ups/km
2. Includes Gull Lake

Table 7B-12: Mean Frequency of Muskrat Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	23	0.06	0.03	1	<0.01	<0.01	24	0.03	0.02
	South	50	0.25	0.11	6	0.01	0.01	56	0.13	0.06
Zone 1	Inside	43	0.18	0.09	5	0.01	0.01	48	0.09	0.05
	Outside	30	0.12	0.07	2	0.01	<0.01	32	0.06	0.04
Habitat type	H01	41	0.29	0.13	0	0	0	41	0.15	0.08
	H03	13	0.14	0.06	5	0.03	0.03	18	0.09	0.04
	H04	6	0.03	0.02	2	0.01	0.01	8	0.02	0.01
	H10	3	0.03	0.03	0	0.03	0.03	3	0.02	0.02
	H15	10	0.34	0.31	0	0	0	10	0.17	0.16
	H16	0	0	.	0	0	.	0	0	0
Perimeter size (m)	<2000	55	0.23	0.09	1	<0.01	<0.01	56	0.11	0.05
	2000-4000	7	0.04	0.02	1	0.01	0.01	8	0.02	0.01
	4001-6000	11	0.04	0.02	5	0.02	0.02	16	0.03	0.01
Total		73	0.15	0.06	7	0.01	<0.01	80	0.08	0.03

1. Signs/100 m²

Table 7B-13: Mean frequency of Muskrat Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	3	<0.01	<0.01	0.02
2003	7	<0.01	<0.01	0.03
All	10	<0.01	<0.01	0.04

1. Signs/100 m²

Table 7B-14: Number of Muskrat Signs on Riparian Shoreline Transects in the Furbearers Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	Island	0	0	0	2	0.03	0.03	0	0	0	2	0.11	0.11
	North	2	0.03	0.02	8	0.14	0.07	8	0.13	0.09	18	0.10	0.04
	South	0	0	0	0	0	0	0	0	0	0	0	0
Width of riparian zone (m)	0-30	1	0.01	0.01	5	0.06	0.04	0	0	0	6	0.03	0.01
	31-100	1	0.06	0.06	1	0.06	0.06	8	0.44	0.28	10	0.19	0.10
	>100	0	0	0	4	0.40	0.29	0	0	0	4	0.13	0.10
Maximum slope (%)	0-32	2	0.03	0.02	7	0.12	0.06	8	0.13	0.09	17	0.10	0.04
	33-65	0	0	0	3	0.11	0.08	0	0	0	3	0.04	0.03
	66-100	0	0	0	0	0	0	0	0	0	0	0	0
Habitat type	H01	1	0.01	0.01	1	0.01	0.01	7	0.09	0.07	9	0.04	0.02
	H03	0	0	.	0	0	.	0	0	.	0	0	0
	H04	1	0.08	0.08	7	0.58	0.27	0	0	0	8	0.22	0.11
	H12	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*	*0*	*0*	*0*
	H13	*0*	*0*	*0*	*1*	*0.25*	*0.25*	*1*	*0.25*	*0.25*	*2*	*0.17*	*0.11*
	H14	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*
	H15	0	0	0	1	0.13	0.13	0	0	0	1	0.04	0.04
Total		2	0.02	0.01	10	0.09	0.04	8	0.07	0.05	20	0.06	0.02

1. Signs/100 m^2

Table 7B-15: Frequency of Muskrat Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	0	0	-
	South route	0	0	-
2002	North route	0	0	-
	South route	0	0	-
2003	North route transects	0	0	0
	North route centreline	0	0	0
2004	South route transects	0	0	0
	Stream crossing sites	8	0.31	0.43

1. Signs/100 m²

Table 7B-16: Mean Frequency of Mink Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	12	0.04	0.02	39	0.02	0.01	18	0.03	0.01
	South	27	0.08	0.03	6	0.07	0.03	50	0.07	0.02
Zone 1	Inside	17	0.04	0.02	8	0.02	0.01	25	0.03	0.01
	Outside	22	0.08	0.03	21	0.07	0.03	43	0.07	0.02
Habitat type	H01	4	0.02	0.02	11	0.07	0.06	15	0.04	0.03
	H03	12	0.12	0.02	4	0.04	<0.01	16	0.08	0.03
	H04	19	0.10	0.04	13	0.06	0.02	32	0.08	0.02
	H10	1	0.02	0.02	0	0	0	1	0.01	0.01
	H15	0	0	0	0	0	0	0	0	0
	H16	3	0.06	.	1	0.02	.	4	0.04	0.02
Perimeter size (m)	<2000	18	0.06	003	20	0.06	0.03	38	0.06	0.02
	2000-4000	8	0.06	0.03	1	0.01	0.01	9	0.03	0.02
	4001-6000	13	0.05	0.03	8	0.03	0.01	21	0.04	0.01
Total		39	0.06	0.02	29	0.04	0.02	68	0.05	0.01

1. Signs/100 m²

Table 7B-17: Mean Frequency of Mink Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	4	<0.01	<0.01	0.03
2003	28	0.01	0.01	0.10
All	32	0.01	<0.01	0.10

1. Signs/100 m^2

Table 7B-18: Mean Frequency of Mink Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	4	0.01	0.01	0.05
2002	20	0.02	<0.01	0.24
All	24	0.01	<0.01	0.28

1. Signs/100 m^2

Table 7B-19: Mean Frequency of Mink Signs on Riparian Shoreline Transects in the Furbearers Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	Island	0	0	0	0	0	0	1	0.17	0.17	1	0.06	0.06
	North	2	0.03	0.02	1	0.02	0.02	21	0.35	0.13	24	0.14	0.05
	South	6	0.14	0.05	2	0.05	0.03	5	0.12	0.08	13	0.10	0.03
Width of riparian zone (m)	0-30	5	0.06	0.03	1	0.01	0.01	19	0.24	0.10	25	0.11	0.04
	31-100	3	0.17	0.08	0	0	0	7	0.39	0.22	10	0.19	0.08
	>100	0	0	0	2	0.20	0.12	1	0.10	0.10	3	0.10	0.05
Maximum slope (%)	0-32	2	0.03	0.02	2	0.03	0.02	10	0.17	0.08	14	0.08	0.03
	33-65	3	0.11	0.06	1	0.04	0.04	13	0.46	0.24	17	0.20	0.09
	66-100	3	0.15	0.08	0	0	0	4	0.20	011	7	0.12	0.05
Habitat type	H01	6	0.08	0.03	2	0.03	0.02	18	0.24	0.10	26	0.11	0.04
	H03	1	0.50	.	1	0.50	.	0	0	.	2	0.33	0.17
	H04	0	0	0	0	0	0	1	0.08	0.08	1	0.03	0.03
	H12	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*	*0*	*0*	*0*
	H13	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*0.75*	*0.75*	*3*	*0.25*	*0.25*
	H14	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*
	H15	1	0.13	0.13	0	0	0	5	0.63	0.47	6	0.25	0.17
Total		8	0.08	0.03	3	0.03	0.02	27	0.25	0.08	38	0.12	0.03

1. Signs/100 m^2

Table 7B-20: Frequency of Mink Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	1	<0.01	-
	South route	6	0.01	-
2002	North route	6	0.02	-
	South route	8	0.01	-
2003	North route transects	0	0	0
	North route centreline	1	0.01	0.05
2004	South route transects	0	0	0
	Stream crossing sites	1	0.04	0.14

1. Signs/100 m²

Table 7B-21: Percent Composition of Fish Species in River Otter Scat Samples Collected in the Regional and Lower Nelson River Study Areas

Species	Percent Composition of Samples	Number of Samples of Relative Fish Size[1]		
		Large	Small	Total
Burbot	1	1	0	1
Cisco	2	2	0	2
Freshwater drum	13	12	0	12
Minnow	1	1	0	1
Northern pike	28	6	20	27
Perch	4	0	4	4
Sucker	9	5	4	9
Unknown	36	4	27	35
White sucker	1	1	0	1
Whitefish	2	2	0	2
Yellow perch	2	0	2	2
Total	100	34	57	96

1. Some fish sizes unknown

Table 7B-22: Mean Frequency of River Otter Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	165	0.47	0.18	272	0.79	0.28	437	0.63	0.17
	South	164	0.27	0.07	165	0.69	0.32	329	0.48	0.17
Zone 1	Inside	75	0.16	0.05	164	0.63	0.29	239	0.39	0.15
	Outside	254	0.57	0.17	273	0.85	0.30	527	0.71	0.17
Habitat type	H01	77	0.25	0.12	27	0.18	0.09	104	0.21	0.07
	H03	33	0.31	0.03	49	0.31	0.28	82	0.31	0.14
	H04	163	0.63	0.23	212	1.02	0.40	375	0.83	0.23
	H10	3	0.03	0.03	51	0.91	0.91	54	0.47	0.44
	H15	13	0.08	0.04	31	1.00	0.88	44	0.54	0.44
	H16	40	0.76	.	67	1.26	.	107	1.01	0.25
Perimeter size (m)	<2000	107	0.24	0.07	202	0.69	0.27	309	0.47	0.14
	2000-4000	90	0.62	0.35	166	1.13	0.50	256	0.88	0.30
	4001-6000	132	0.43	0.10	69	0.26	0.17	201	0.35	0.10
Total		329	0.37	0.10	437	0.74	0.21	766	0.55	0.12

[1] Signs/100 m^2

Table 7B-23: Mean Frequency of River Otter Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	0	0	0	0
		South	5	0.01	0.01	0.07
	Gradient	Riparian	5	0.01	0.01	0.07
		Upland	0	0	0	0
	Zone 1	Inside	5	0.01	0.01	0
		Outside	0	0	0	0.04
	Habitat Type[2]	H01	2	0.01	0.01	0.04
		H02	0	0	.	0
		H03	3	0.02	0.02	0.10
		H04	0	0	0	0
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*0*	*0*	*0*	*0*
		H15	0	0	.	0
		H16	0	0	.	0
	Total		5	0.01	<0.01	0.04
2002	Shore	Island	8	0.04	0.04	0.17
		North	3	<0.01	<0.01	0.02
		South	31	0.02	0.02	0.05
	Gradient	Riparian	42	0.02	0.02	0.06
		Upland	0	0	0	0
	Zone 1	Inside	8	0.01	0.01	0.02
		Outside	34	0.02	0.02	0.05
	Habitat type	H01	30	0.02	0.02	0.03
		H02	0	0	0	0
		H03	4	0.01	<0.01	0.13
		H04	0	0	0	0
		H05	8	0.09	0.09	0.33

Table 7B-23: Mean Frequency of River Otter Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H09	0	0	0	0
		H10	0	0	0	0
		H12	*0*	*0*	*0*	*0*
		H13	*0*	*0*	*0*	*0*
		H14	*0*	*0*	.	*0*
		H15	0	0	.	0
		H16	0	0	0	0
	Total		42	0.02	0.01	0.04
2003	Shore	Island	1	0.01	0.01	0.17
		North	3	<0.01	<0.01	0.05
		South	29	0.02	0.01	0.15
	Gradient	Riparian	33	0.02	0.01	0.15
		Upland	0	0	0	0
	Zone 1	Inside	8	0.01	0.01	0.11
		Outside	25	0.01	0.01	0.10
	Habitat type	H01	21	0.01	0.01	0.13
		H02	0	0	.	0
		H03	3	0.02	0.02	0.07
		H04	4	0.01	<0.01	0.15
		H05	0	0	0	0
		H09	0	0	0	0
		H10	0	0	0	0
		H11	0	0	.	0
		H12	*5*	*0.06*	*0.06*	*0.33*
		H13	*0*	*0*	*0*	*0*
		H14	*0*	*0*	*0*	*0*
		H15	0	0	0	0
		H16	0	0	0	0

Table 7B-23: Mean Frequency of River Otter Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2003	Total		33	0.01	<0.01	0.10
All	Shore	Island	9	0.03	0.02	0.33
		North	6	<0.01	<0.01	0.05
		South	65	0.02	0.01	0.15
	Gradient	Riparian	80	0.02	0.01	0.18
		Upland	0	0	0	0
	Zone 1	Inside	21	0.01	<0.01	0.12
		Outside	59	0.01	0.01	0.11
	Habitat type	H01	53	0.02	0.01	0.11
		H02	0	0	0	0
		H03	10	0.02	0.01	0.22
		H04	4	<0.01	<0.01	0.14
		H05	8	0.04	0.04	0.25
		H09	0	0	0	0
		H10	0	0	0	0
		H11	0	0	.	0
		H12	*5*	*0.03*	*0.03*	*0.33*
		H13	*0*	*0*	*0*	*0*
		H14	*0*	*0*	*0*	*0*
		H15	0	0	0	0
		H16	0	0	0	0
	Total		80	0.01	0.01	0.11

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-24: Mean Frequency of River Otter Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency^1	Standard Error	Proportion of Transects
2001	Shore	North	7	0.03	0.01	0.16
		South	4	0.02	0.01	0.10
	Gradient	Riparian	5	0.02	0.01	0.14
		Upland	6	0.02	0.01	0.11
	Zone 1	Inside	6	0.02	0.01	0.12
		Outside	5	0.02	0.01	0.14
	Habitat Type^2	H01	5	0.02	0.01	0.15
		H02	0	0	.	0
		H03	2	0.02	0.02	0.09
		H04	4	0.05	0.03	0.25
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*0*	*0*	*0*	*0*
		H16	0	0	.	0
	Total		11	0.02	0.01	0.13
2002	Shore	North	17	0.02	0.01	0.19
		South	9	0.02	0.01	0.14
	Gradient	Riparian	11	0.02	0.01	0.12
		Upland	15	0.02	0.01	0.21
	Zone 1	Inside	18	0.02	0.01	0.21
		Outside	8	0.02	0.01	0.12
	Habitat type	H01	13	0.02	0.01	0.13
		H02	3	0.08	0.08	0.50
		H03	5	0.02	0.01	0.27
		H04	3	0.01	0.01	0.11
		H09	1	0.01	0.01	0.25
		H10	1	0.03	0.03	0.50
		H13	*0*	*0*	*0*	*0*

Table 7B-24: Mean Frequency of River Otter Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H15	0	0	.	0
		H16	0	0	0	0
	Total		26	0.02	0.01	0.17
All	Shore	North	24	0.02	0.01	0.28
		South	13	0.02	0.01	0.19
	Gradient	Riparian	17	0.02	0.01	0.21
		Upland	20	0.02	0.01	0.26
	Zone 1	Inside	24	0.02	0.01	0.28
		Outside	13	0.02	0.01	0.18
	Habitat type	H01	18	0.02	0.08	0.21
		H02	3	0.05	0.05	0.50
		H03	7	0.21	0.01	0.36
		H04	7	0.03	0.02	0.22
		H09	1	0.01	0.01	0.25
		H10	1	0.02	0.02	0.50
		H13	*0*	*0*	*0*	*0*
		H15	0	0	.	0
		H16	0	0	.	0
	Total		37	0.02	0.01	0.24

1. Signs/100 m²
2. Italics indicate rare habitat

Table 7B-25: Mean Frequency of River Otter Signs on Riparian Shoreline Transects in the Furbearers Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	Island	0	0	0	0	0	0	0	0	0	0	0	0
	North	2	0.03	0.02	3	0.05	0.04	45	0.75	0.20	50	0.28	0.08
	South	3	0.07	0.04	16	0.38	0.24	27	0.64	0.31	46	0.37	0.13
Width of riparian zone (m)	0-30	3	0.04	0.02	16	0.21	0.13	51	0.64	0.15	70	0.30	0.07
	31-100	1	0.06	0.06	0	0	0	13	0.72	0.66	14	0.26	0.22
	>100	1	0.10	0.10	3	0.30	0.20	8	0.80	0.68	23	0.40	0.24
Maximum slope (%)	0-32	3	0.05	0.03	5	0.09	0.04	47	0.78	0.25	55	0.31	0.09
	33-65	0	0	0	0	0	0	21	0.75	0.33	21	0.25	0.12
	66-100	2	0.10	0.07	14	0.70	0.50	4	0.20	0.11	20	0.33	0.17
Habitat type	H01	4	0.05	0.03	17	0.22	0.14	53	0.70	0.22	74	0.33	0.09
	H03	0	0	.	0	0	.	1	0.50	.	1	0.17	0.17
	H04	0	0	0	0	0	0	2	0.17	0.17	2	0.06	0.06
	H12	*0*	*0*	.	*0*	*0*	.	*6*	*1.50*	*1.00*	*6*	*0.75*	*0.60*
	H13	*0*	*0*	*0*	*0*	*0*	*0*	*4*	*1.00*	*1.00*	*4*	*0.33*	*0.33*
	H14	*0*	*0*	.	*0*	*0*	.	*1*	*0.50*	.	*1*	*0.17*	*0.17*
	H15	1	0.13	0.13	2	0.03	0.03	5	0.63	0.47	8	0.33	0.18
Total		5	0.05	0.02	19	0.18	0.10	72	0.67	0.16	96	0.30	0.07

1. Signs/100 m²

Table 7B-26: Frequency of River Otter Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	11	0.03	-
	South route	9	0.01	-
2002	North route	4	0.01	-
	South route	10	0.01	-
2003	North route transects	0	0	0
	North route centreline	0	0	0
2004	South route transects	0	0	0
	Stream crossing sites	3	0.11	0.14

1. Signs/100 m²

Table 7B-27: Mean Frequency of Snowshoe Hare Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2001 to 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	3	0.01	<0.01	12	0.03	0.01	15	0.02	0.01
	South	57	0.10	0.05	6	0.01	<0.01	63	0.05	0.03
Zone 1	Inside	16	0.05	0.04	13	0.03	0.01	29	0.04	0.02
	Outside	44	0.05	0.03	5	0.01	<0.01	49	0.03	0.02
Habitat type	H01	30	0.06	0.06	2	0.01	0.01	32	0.03	0.03
	H03	13	0.22	0.22	1	0.01	0.01	14	0.11	0.11
	H04	15	0.03	0.02	8	0.02	0.01	23	0.03	0.01
	H10	0	0	0	0	0	0	0	0	0
	H15	2	0.01	0.01	7	0.06	0.03	9	0.03	0.02
	H16	0	0	.	0	0	.	0	0	0
Perimeter size (m)	<2000	20	0.05	0.04	13	0.03	0.01	33	0.04	0.02
	2000-4000	0	0	0	0	0	0	0	0	0
	4001-6000	40	0.13	0.09	5	0.02	0.01	45	0.07	0.05
Total		60	0.05	0.03	18	0.02	0.01	78	0.03	0.01

1. Signs/100 m^2

Table 7B-28: Mean Frequency of Snowshoe Hare Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	68	0.10	0.03	0.42
		South	84	0.12	0.03	0.52
	Gradient	Riparian	90	0.13	0.03	0.56
		Upland	62	0.09	0.03	0.38
	Zone 1	Inside	56	0.07	0.02	0.41
		Outside	96	0.16	0.04	0.55
	Habitat Type[2]	H01	77	0.12	0.03	0.54
		H02	0	0	.	0
		H03	42	0.16	0.06	0.60
		H04	14	0.08	0.05	0.33
		H09	1	0.01	0.01	0.25
		H10	0	0	.	0
		H13	*18*	*0.20*	*0.10*	*0.67*
		H15	0	0	.	0
		H16	0	0	.	0
	Total		152	0.11	0.02	0.47
2002	Shore	Island	8	0.04	0.04	0.17
		North	449	0.28	0.05	0.77
		South	405	0.29	0.05	0.77
	Gradient	Riparian	632	0.31	0.05	0.72
		Upland	230	0.20	0.03	0.77
	Zone 1	Inside	152	0.25	0.06	0.65
		Outside	322	0.29	0.04	0.80
	Habitat type	H01	544	0.34	0.05	0.79
		H02	19	0.21	0.06	1.00
		H03	143	0.26	0.08	0.87
		H04	59	0.12	0.05	0.50
		H05	27	0.30	0.18	0.67

Table 7B-28: Mean Frequency of Snowshoe Hare Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H09	5	0.03	0.03	0.40
		H10	4	0.05	0.05	0.33
		H12	*9*	*0.22*	*0.10*	*1.00*
		H13	*41*	*0.43*	*0.22*	*0.75*
		H14	*4*	*0.13*	*.*	*1.00*
		H15	0	0	.	0
		H16	7	0.10	0.07	1.00
	Total		862	0.27	0.03	0.74
2003	Shore	Island	6	0.03	0.12	0.67
		North	498	0.47	0.12	0.63
		South	743	0.68	0.14	0.86
	Gradient	Riparian	1,011	0.63	0.11	0.82
		Upland	236	0.38	0.14	0.52
	Zone 1	Inside	435	0.61	0.17	0.63
		Outside	812	0.51	0.09	0.82
	Habitat type	H01	679	0.52	0.01	0.80
		H02	40	4.00	.	1.00
		H03	168	1.07	0.34	0.86
		H04	128	0.36	0.18	0.80
		H05	6	0.05	0.01	1.00
		H09	16	0.10	0.06	0.43
		H10	14	0.24	0.24	0.50
		H11	0	0	.	0
		H12	*77*	*1.02*	*0.31*	*1.00*
		H13	*119*	*1.19*	*0.91*	*0.71*
		H14	*0*	*0*	*0*	*0*
		H15	0	0	0	0
		H16	0	0	0	0

Table 7B-28: Mean Frequency of Snowshoe Hare Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2003	Total		1,247	0.55	0.09	0.74
All	Shore	Island	14	0.04	0.02	0.67
		North	1,015	0.34	0.06	0.80
		South	1,232	0.42	0.06	0.92
	Gradient	Riparian	1,733	0.43	0.06	0.90
		Upland	528	0.25	0.06	0.77
	Zone 1	Inside	813	0.36	0.08	0.75
		Outside	1,448	0.38	0.05	0.93
	Habitat type	H01	1,300	0.39	0.05	0.89
		H02	59	0.93	0.77	1.00
		H03	353	0.52	0.14	1.00
		H04	201	0.23	0.09	0.91
		H05	33	0.18	0.10	1.00
		H09	22	0.06	0.03	0.71
		H10	18	0.10	0.08	0.33
		H11	0	0	.	0
		H12	*86*	*0.62*	*0.23*	*1.00*
		H13	*178*	*0.76*	*0.46*	*0.88*
		H14	*4*	*0.03*	*0.03*	*0.33*
		H15	0	0	0	0
		H16	7	0.04	0.03	0.25
	Total		2,261	0.37	0.04	0.86

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-29: Mean Frequency of Snowshoe Hare Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	76	0.30	0.0	0.80
		South	80	0.35	0.08	0.73
	Gradient	Riparian	86	0.38	0.08	0.86
		Upland	70	0.27	0.05	0.67
	Zone 1	Inside	99	0.37	0.07	0.76
		Outside	57	0.26	0.05	0.77
	Habitat Type[2]	H01	74	0.38	0.08	0.73
		H02	2	0.20	.	1.00
		H03	21	0.21	0.04	0.91
		H04	36	0.43	0.12	0.75
		H09	9	0.23	0.10	0.75
		H10	0	0	.	0
		H13	*14*	*0.47*	*0.17*	*1.00*
		H16	0	0	.	0
	Total		156	0.33	0.05	0.76
2002	Shore	North	531	0.75	0.15	0.86
		South	583	0.89	0.17	0.94
	Gradient	Riparian	551	0.89	0.15	0.94
		Upland	563	0.75	0.17	0.87
	Zone 1	Inside	419	0.59	0.11	0.87
		Outside	695	1.08	0.20	0.94
	Habitat type	H01	755	1.05	0.18	0.95
		H02	28	0.71	0.71	0.50
		H03	148	0.74	0.19	1.00
		H04	98	0.54	0.29	0.78
		H09	16	0.22	0.13	0.75
		H10	4	0.10	0.05	1.00
		H13	*59*	*1.01*	*0.13*	*1.00*

Table 7B-29: Mean Frequency of Snowshoe Hare Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H15	0	0	.	0
		H16	6	0.15	0.10	1.00
	Total		1,114	0.82	0.11	0.90
All	Shore	North	607	0.56	0.09	0.92
		South	663	0.64	0.10	0.97
	Gradient	Riparian	637	0.66	0.09	0.97
		Upland	633	0.55	0.10	0.92
	Zone 1	Inside	518	0.49	0.07	0.95
		Outside	752	0.75	0.13	0.94
	Habitat type	H01	829	0.78	0.12	0.94
		H02	30	0.54	0.44	1.00
		H03	169	0.47	0.11	1.00
		H04	134	0.49	0.16	0.89
		H09	25	0.22	0.08	1.00
		H10	4	0.07	0.04	1.00
		H13	73	*0.74*	*0.15*	*1.00*
		H15	*0*	0	.	0
		H16	6	0.10	0.08	1.00
	Total		1,270	0.60	0.07	0.94

1. Signs/100 m²
2. Italics indicate rare habitat

Table 7B-30: Mean Frequency of Snowshoe Hare Signs on Riparian Shorelines in the Furbearers Local Study Area, 2001 to 2003

		2003		
		Number of Signs	**Mean Frequency[1]**	**SE**
Shore	Island	3	0.50	0.29
	North	68	1.13	0.46
	South	50	1.19	0.59
Width of riparian zone (m)	0-30	106	1.33	0.44
	31-100	10	0.56	0.44
	>100	5	0.50	0.50
Maximum slope (%)	0-32	79	1.32	0.56
	33-65	28	1.00	0.79
	66-100	14	0.70	0.60
Habitat type	H01	113	1.49	0.47
	H03	0	0	.
	H04	8	0.67	0.40
	H12	0	0	0
	H13	0	0	0
	H14	0	0	.
	H15	0	0	0
Total		121	1.12	0.34

1. Signs/100 m²

Table 7B-31: Frequency of Snowshoe Hare Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	163	0.46	-
	South route	245	0.24	-
2002	North route	207	0.59	-
	South route	324	0.36	-
2003	North route transects	237	0.98	0.84
	North route centreline	77	0.78	0.15
2004	South route transects	514	4.44	0.86
	Stream crossing sites	73	2.89	0.71

1. Signs/100 m²

Table 7B-32: Mean Frequency of Red Fox Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	10	0.03	0.02	7	0.02	0.01	17	0.02	0.01
	South	14	0.07	0.04	10	0.02	0.01	24	0.04	0.02
Zone 1	Inside	10	0.04	0.02	7	0.01	0.01	17	0.03	0.01
	Outside	4	0.06	0.04	10	0.02	0.01	24	0.04	0.02
Habitat type	H01	1	0.01	0.01	1	0.01	0.01	2	0.01	0.01
	H03	0	0	0	4	0.03	0.03	4	0.01	0.01
	H04	14	0.08	0.06	7	0.03	0.01	21	0.05	0.03
	H10	5	0.09	0.09	2	0.02	0.02	7	0.06	0.04
	H15	3	0.06	0.04	0	0	0	3	0.03	0.02
	H16	1	0.02	.	3	0.06	.	4	0.04	0.02
Perimeter size (m)	<2000	18	0.07	0.04	7	0.02	0.01	25	0.04	0.02
	2000-4000	5	0.04	0.04	3	0.02	0.01	8	0.03	0.02
	4001-6000	1	<0.01	<0.01	7	0.03	0.01	8	0.01	0.01
Total		24	0.05	0.02	17	0.02	0.01	41	0.03	0.01

1. Signs/100 m^2

Table 7B-33: Mean Frequency of Red Fox Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	4	<0.01	<0.01	0.08
2002	15	0.01	<0.01	0.11
2003	43	0.04	0.02	0.21
All	62	0.02	0.01	0.25

1. Signs/100 m^2

Table 7B-34: Mean Frequency of Red Fox Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	16	0.01	<0.01	0.15
All	16	0.01	<0.01	0.15

1. Signs/100 m^2

Table 7B-35: Mean Frequency of Red Fox Signs on Riparian Shoreline Transects in the Furbearers Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	**Mean[1]**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**
Shore	Island	0	0	0	0	0	0	0	0	0	0	0	0
	North	1	0.02	0.02	27	0.47	0.16	6	0.10	0.04	34	0.19	0.06
	South	2	0.05	0.03	11	0.26	0.15	18	0.43	0.16	31	0.25	0.08
Width of riparian zone (m)	0-30	2	0.03	0.02	33	0.42	0.14	21	0.26	0.09	56	0.24	0.06
	31-100	1	0.06	0.06	2	0.11	0.07	1	0.06	0.06	4	0.07	0.04
	>100	0	0	0	3	0.30	0.20	2	0.20	0.20	5	0.17	0.09
Maximum slope (%)	0-32	2	0.03	0.02	15	0.26	0.10	16	0.27	0.12	33	0.19	0.05
	33-65	1	0.04	0.04	15	0.54	0.29	4	0.14	0.08	20	0.24	0.10
	66-100	0	0	0	3	0.40	0.30	4	0.20	0.08	12	0.20	0.10
Habitat type	H01	3	0.04	0.02	20	0.26	0.11	20	0.26	0.09	43	0.19	0.05
	H03	0	0	.	1	0.50	.	0	0	.	1	0.17	0.17
	H04	0	0	0	3	0.25	0.25	0	0	0	3	0.08	0.08
	H12	*0*	*0*	*.*	*4*	*2.00*	*.*	*0*	*0*	*0*	*4*	*0.50*	*0.50*
	H13	*0*	*0*	*0*	*1*	*0.25*	*0.25*	*3*	*0.75*	*0.75*	*4*	*0.33*	*0.25*
	H14	*0*	*0*	*.*	*1*	*0.50*	*.*	*0*	*0*	*.*	*1*	*0.17*	*0.17*
	H15	0	0	0	8	1.00	0.71	1	0.13	0.13	9	0.38	0.26
Total		3	0.03	0.02	38	0.36	0.11	24	0.22	0.07	65	0.20	0.04

1. Signs/100 m^2

Table 7B-36: Frequency of Red Fox Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	8	0.02	-
	South route	6	0.01	-
2002	North route	8	0.02	-
	South route	15	0.02	-
2003	North route transects	4	0.02	0.13
	North route centreline	6	0.06	0.25
2004	South route transects	9	0.08	0.29
	Stream crossing sites	1	0.04	0.14

1. Signs/100 m^2

Table 7B-37: Mean Frequency of American Marten Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	0	0	0	2	0.01	0.01	2	<0.01	<0.01
	South	1	<0.01	<0.01	14	0.04	0.02	15	0.02	0.01
Zone 1	Inside	0	0	0	4	0.01	0.01	4	0.01	0.01
	Outside	1	<0.01	<0.01	12	0.04	0.02	13	0.02	0.01
Habitat type	H01	1	<0.01	<0.01	2	<0.01	<0.01	3	<0.01	<0.01
	H03	0	0	0	4	0.07	0.07	4	0.03	0.03
	H04	0	0	0	10	0.05	0.02	10	0.03	0.01
	H10	0	0	0	0	0	0	0	0	0
	H15	0	0	0	0	0	0	0	0	0
	H16	0	0	.	0	0	.	0	0	0
Perimeter size (m)	<2000	0	0	0	11	0.03	0.02	11	0.02	0.01
	2000-4000	0	0	0	2	0.02	0.02	2	0.01	0.01
	4001-6000	1	<0.01	<0.01	3	0.01	0.01	4	0.07	<0.01
Total		1	<0.01	<0.01	16	0.03	0.01	17	0.01	0.01

1. Signs/100 m²

Table 7B-38: Mean Frequency of American Marten Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	5	<0.01	<0.01	0.04
2003	20	0.01	<0.01	0.10
All	25	<0.01	<0.01	0.11

1. Signs/100 m^2

Table 7B-39: Mean Frequency of American Marten Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	16	0.06	0.02	0.32
		South	24	0.11	0.03	0.53
	Gradient	Riparian	24	0.10	0.03	0.50
		Upland	16	0.07	0.03	0.37
	Zone 1	Inside	18	0.08	0.03	0.36
		Outside	22	0.10	0.03	0.55
	Habitat Type[2]	H01	32	0.15	0.03	0.65
		H02	0	0	.	0
		H03	4	0.04	0.02	0.36
		H04	1	0.01	0.01	0.13
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*3*	*0.11*	*0.07*	*0.67*
		H16	0	0	.	0
	Total		40	0.09	0.02	0.44
2002	Shore	North	40	0.09	0.02	0.61
		South	68	0.37	0.07	0.97
	Gradient	Riparian	128	0.26	0.08	0.76
		Upland	152	0.21	0.03	0.82
	Zone 1	Inside	136	0.24	0.07	0.69
		Outside	144	0.22	0.03	0.91
	Habitat type	H01	164	0.29	0.07	0.89
		H02	12	0.30	0.20	1.00
		H03	62	0.30	0.10	0.73
		H04	21	0.09	0.04	0.44
		H09	5	0.07	0.03	0.75
		H10	5	0.13	0.13	0.50

Table 7B-39: Mean Frequency of American Marten Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	*H13*	*8*	*0.14*	*0.06*	*1.00*
		H15	0	0	.	0
		H16	3	0.07	0.02	1.00
	Total		280	0.23	0.04	0.79
All	Shore	North	84	0.08	0.02	0.69
		South	236	0.25	0.04	0.97
	Gradient	Riparian	152	0.19	0.05	0.85
		Upland	168	0.15	0.02	0.82
	Zone 1	Inside	154	0.17	0.04	0.74
		Outside	166	0.18	0.02	0.94
	Habitat type	H01	196	0.23	0.04	0.95
		H02	12	0.20	0.15	1.00
		H03	66	0.17	0.06	0.92
		H04	22	0.05	0.02	0.44
		H09	5	0.03	0.02	0.75
		H10	5	0.08	0.08	0.50
		H13	*11*	*0.12*	*0.04*	*1.00*
		H15	0	0	.	0
		H16	3	0.05	0.03	0.50
	Total		320	0.17	0.03	0.83

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-40: Mean Frequency of American Marten Signs on Riparian Shoreline Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error
2001	1	0.01	0.01
2002	0	0	0
2003	2	0.02	0.02
All	3	0.01	0.01

1. Signs/100 m²

Table 7B-41: Frequency of American Marten Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	50	0.14	-
	South route	88	0.09	-
2002	North route	14	0.04	-
	South route	77	0.09	-
2003	North route transects	2	0.01	0.03
	North route centreline	0	0	0
2004	South route transects	4	0.03	0.21
	Stream crossing sites	0	0	0

1. Signs/100 m²

Table 7B-42: Mean Frequency of Fisher Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	2	0.01	<0.01	2	0.01	<0.01	4	0.01	<0.01
	South	2	<0.01	<0.01	11	0.04	0.03	13	0.02	0.02
Zone 1	Inside	2	0.01	<0.01	2	0.01	0.01	4	0.01	<0.01
	Outside	2	<0.01	<0.01	11	0.04	0.03	13	0.02	0.01
Habitat type	H01	1	0.01	0.01	8	0.06	0.06	9	0.03	0.03
	H03	0	0	0	2	0.03	0.03	2	0.02	0.02
	H04	2	<0.01	<0.01	2	0.01	<0.01	4	<0.01	<0.01
	H10	1	0.02	0.02	0	0	0	1	0.01	0.01
	H15	0	0	0	0	0	0	0	0	0
	H16	0	0	.	1	0.20	.	1	0.01	0.01
Perimeter size (m)	<2000	0	0	0	11	0.03	0.02	11	0.02	0.01
	2000-4000	2	0.01	0.01	1	0.01	0.01	3	0.01	0.01
	4001-6000	2	0.01	0.01	1	<0.01	<0.01	3	<0.01	<0.01
Total		4	<0.01	<0.01	13	0.02	0.02	17	0.01	0.01

1. Signs/100 m²

Table 7B-43: Mean Frequency of Fisher Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	1	<0.01	<0.01	0.01
2003	4	0.01	0.01	0.02
All	5	<0.01	<0.01	0.02

1. Signs/100 m^2

Table 7B-44: Mean Frequency of Fisher Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	5	0.02	0.01	0.20
		South	20	0.08	0.02	0.57
	Gradient	Riparian	16	0.06	0.02	0.46
		Upland	9	0.04	0.01	0.33
	Zone 1	Inside	16	0.06	0.01	0.42
		Outside	9	0.05	0.01	0.36
	Habitat Type[2]	H01	13	0.06	0.02	0.42
		H02	0	0	.	0
		H03	8	0.08	0.03	0.64
		H04	3	0.04	0.02	0.38
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*1*	*0.04*	*0.04*	*0.33*
		H16	0	0	.	0
	Total		25	0.05	0.01	0.40
2002	Shore	North	7	0.01	<0.01	0.17
		South	9	0.02	0.01	0.22
	Gradient	Riparian	10	0.02	0.01	0.24
		Upland	6	0.01	<0.01	0.15
	Zone 1	Inside	10	0.02	0.01	0.21
		Outside	6	0.01	<0.01	0.18
	Habitat type	H01	7	0.01	0.01	0.18
		H02	2	0.05	0.05	0.50
		H03	5	0.03	0.02	0.36
		H04	2	0.01	0.01	0.22
		H09	0	0	0	0
		H10	0	0	0	0
		H13	*0*	*0*	*0*	*0*

Table 7B-44: Mean Frequency of Fisher Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H15	0	0	.	0
		H16	0	0	0	0
	Total		16	0.01	<0.01	0.19
All	Shore	North	12	0.01	<0.01	0.28
		South	19	0.04	0.01	0.58
	Gradient	Riparian	26	0.04	0.01	0.55
		Upland	15	0.02	0.01	0.33
	Zone 1	Inside	26	0.03	0.01	0.46
		Outside	15	0.02	0.01	0.39
	Habitat type	H01	20	0.03	0.01	0.45
		H02	2	0.03	0.03	0.50
		H03	13	0.06	0.02	0.73
		H04	5	0.02	0.01	0.33
		H09	0	0	0	0
		H10	0	0	0	0
		H13	*1*	*0.02*	*0.02*	*0.33*
		H15	0	0	.	0
		H16	0	0	0	0
	Total		41	0.03	0.01	0.43

1. Signs/100 m²
2. Italics indicate rare habitat

Table 7B-45: Frequency of Fisher Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	13	0.04	-
	South route	26	0.03	-
2002	North route	4	0.01	-
	South route	12	0.01	-
2003	North route transects	0	0	0
	North route centreline	1	0.01	0.05
2004	South route transects	0	0	0
	Stream crossing sites	2	0.08	0.29

1. Signs/100 m²

Table 7B-46: Mean Frequency of Weasel Signs on Lake Perimeter Transects in the Furbearers Regional Study Area, 2002 and 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	0	0	0	0
2003	6	0.01	0.01	0.30
All	6	0.01	<0.01	0.30

1. Signs/100 m²

Table 7B-47: Mean Frequency of Weasel Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	1	<0.01	<0.01	0.01
2003	3	<0.01	<0.01	0.02
All	4	<0.01	<0.01	0.02

1. Signs/100 m²

Table 7B-48: Mean Frequency of Weasel Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	4	0.01	<0.01	0.07
2002	9	0.01	<0.01	0.08
All	13	0.01	<0.01	0.14

1. Signs/100 m²

Table 7B-49: Frequency of Weasel Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	6	0.01	-
	South route	21	0.02	-
2002	North route	0	0	-
	South route	0	0	-
2003	North route transects	0	0	0
	North route centreline	0	0	0
2004	South route transects	0	0	0
	Stream crossing sites	0	0	0

1. Signs/100 m²

Table 7B-50: Mean Frequency of Lynx Signs on Coarse Habitat Mosaic Transects in the Furbearers Local Study Area, Winter 2001 and 2002

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	14	0.01	0.01	0.11
All	14	0.01	<0.01	0.11

1. Signs/100 m²

Table 7B-51: Frequency of Lynx Signs (signs/100 m²) on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	0	0	-
	South route	0	0	-
2002	North route	2	0.01	-
	South route	1	<0.02	-
2003	North route transects	0	0	0
	North route centreline	0	0	0
2004	South route transects	1	0.04	0.07
	Stream crossing sites	0	0	0

1. Signs/100 m²

Table 7B-52: Mean Frequency of Gray Wolf Signs on Lake Perimeter Transects in the Large Carnivores Local Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	**Mean[1]**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**
Shore	North	13	0.03	0.02	3	<0.01	<0.01	16	0.02	0.01
	South	4	0.02	0.01	1	0.01	0.01	5	0.01	0.01
Zone 1	Inside	14	0.03	0.02	3	<0.01	<0.01	17	0.02	0.01
	Outside	3	0.02	0.01	1	0.01	0.01	4	0.01	0.01
Habitat type	H01	4	0.03	0.02	0	0	0	4	0.02	0.01
	H03	1	0.01	0.01	0	0	0	1	<0.01	<0.01
	H04	3	0.01	0.01	1	0.01	0.01	4	0.10	0.10
	H10	9	0.11	0.07	0	0	0	9	0.05	0.04
	H15	0	0	0	3	0.01	0.01	3	0.01	0.01
	H16	0	0	.	0	0	.	0	0	0
Perimeter size (m)	<2000	5	0.02	0.01	4	0.01	0.01	9	0.01	0.01
	2000-4000	11	0.05	0.03	0	0	0	11	0.03	0.02
	4001-6000	1	<0.01	<0.01	0	0	0	1	<0.01	<0.01
Total		17	0.02	0.01	4	<0.01	<0.01	21	0.01	0.01

1. Signs/100 m^2

Table 7B-53: Mean Frequency of Gray Wolf Signs on Coarse Habitat Mosaic Transects in the Large Carnivores Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	6	<0.01	<0.01	0.12
2002	15	0.01	<0.01	0.10
2003	19	0.01	<0.01	0.11
All	40	0.01	<0.01	0.19

1. Signs/100 ^{2}

Table 7B-54: Mean Frequency of Gray Wolf Signs on Coarse Habitat Mosaic Transects in the Large Carnivores Local Study Area, Winter 2001 and 2002

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	10	0.02	0.01	0.13
2002	0	0	0	0
All	10	0.01	<0.01	0.10

1. Signs/100 m^2

Table 7B-55: Mean Frequency of Gray Wolf Signs on Riparian Shoreline Transects in the Large Carnivores Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	Island	0	0	0	0	0	0	1	0.17	0.17	1	0.06	0.06
	North	0	0	0	26	0.45	0.20	10	0.17	0.06	36	0.21	0.07
	South	1	0.24	0.24	31	0.73	0.11	19	0.45	0.10	51	0.41	0.06
Width of riparian zone (m)	0-30	1	0.01	0.01	47	0.60	0.15	22	0.28	0.06	70	0.30	0.06
	31-100	0	0	0	9	0.50	0.20	8	0.44	0.13	17	0.32	0.09
	>100	0	0	0	1	0.10	0.10	0	0	0	1	0.03	0.03
Maximum slope (%)	0-32	0	0	0	17	0.57	0.19	10	0.17	0.06	27	0.24	0.07
	33-65	1	0.04	0.04	7	0.61	0.21	16	0.57	0.14	34	0.41	0.09
	66-100	0	0	0	33	0.35	0.15	4	0.20	0.08	11	0.18	0.06
Habitat type	H01	0	0	0	54	0.71	0.16	23	0.30	0.07	77	0.34	0.06
	H03	1	0.50	.	1	0.50	.	2	1.00	.	4	0.67	0.17
	H04	0	0	0	1	0.08	0.08	1	0.08	0.08	2	0.06	0.04
	H12	*0*	*0*	*.*	*0*	*0*	*.*	*1*	*0.25*	*0.25*	*1*	*0.13*	*0.13*
	H13	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0.25*	*0.25*	*1*	*0.08*	*0.08*
	H14	*0*	*0*	*.*	*1*	*0.50*	*.*	*1*	*0.50*	*3*	*2*	*0.33*	*0.17*
	H15	0	0	0	0	0	0	1	0.13	0.13	1	0.04	0.04
Total		1	0.01	0.01	57	0.54	0.12	30	0.28	0.05	88	0.28	0.05

1. Signs/100 m^2

Table 7B-56: Frequency of Gray Wolf Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	4	0.01	-
	South route	9	0.01	-
2002	North route	5	0.01	-
	South route	0	0	-
2003	North route transects	1	<0.01	0.03
	North route centreline	13	0.13	0.40
2004	South route transects	8	0.07	0.21
	Stream crossing sites	1	0.04	0.14

1. Signs/100 m²

Table 7B-57: Mean Frequency of Black Bear Signs on Lake Perimeter Transects in the Large Carnivores Local Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	4	0.01	<0.01	17	0.04	0.01	21	0.02	0.01
	South	8	0.04	0.03	13	0.02	0.01	21	0.03	0.01
Zone 1	Inside	6	0.04	0.03	20	0.04	0.01	26	0.04	0.01
	Outside	6	0.01	0.01	10	0.21	0.01	16	0.02	0.01
Habitat type	H01	2	0.02	0.10	7	0.03	0.01	9	0.02	0.01
	H03	1	0.01	0.01	7	0.04	0.04	8	0.02	0.02
	H04	5	0.01	0.01	7	0.03	0.02	12	0.02	0.01
	H10	1	0.01	0.01	2	0.02	0.02	3	0.02	0.01
	H15	2	0.09	0.09	3	0.02	0.01	5	0.06	0.04
	H16	1	0.02	.	4	0.08	.	5	0.05	0.03
Perimeter size (m)	<2000	5	0.03	0.02	16	0.03	0.01	21	0.03	0.01
	2000-4000	2	0.01	0.01	3	0.01	0.01	5	0.01	0.01
	4001-6000	5	0.02	0.01	11	0.04	0.02	16	0.03	0.01
Total		12	0.02	0.01	30	0.03	0.01	42	0.03	0.01

1. Signs/100 m^2

Table 7B-58: Mean Frequency of Black Bear Signs on Coarse Habitat Mosaic Transects in the Large Carnivores Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	3	<0.01	<0.01	0.13
		South	13	0.04	0.03	0.22
	Gradient	Riparian	12	0.04	0.03	0.22
		Upland	4	<0.01	<0.01	0.13
	Zone 1	Inside	11	0.04	0.03	0.24
		Outside	5	0.01	0.01	0.09
	Habitat Type[2]	H01	9	0.04	0.03	0.13
		H02	1	0.03	.	1.00
		H03	2	0.01	0.01	0.20
		H04	3	0.01	0.01	0.33
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*1*	*0.01*	*0.01*	*0.33*
		H15	0	0	.	0
		H16	0	0	.	0
	Total		16	0.02	0.02	0.18
2002	Shore	Island	2	0.01	0.01	0.33
		North	28	0.02	0.01	0.29
		South	34	0.03	0.01	0.28
	Gradient	Riparian	47	0.03	0.01	0.31
		Upland	17	0.02	0.01	0.23
	Zone 1	Inside	35	0.03	001	0.38
		Outside	29	0.02	0.01	0.23
	Habitat type	H01	39	0.03	0.01	0.31
		H02	5	0.06	0.03	0.67
		H03	4	0.10	0.10	0.20
		H04	10	0.02	0.01	0.25
		H05	0	0	0	0

Table 7B-58: Mean Frequency of Black Bear Signs on Coarse Habitat Mosaic Transects in the Large Carnivores Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H09	2	0.01	0.01	0.20
		H10	0	0	0	0
		H12	*1*	*0.02*	*0.02*	*0.33*
		H13	*1*	*0.01*	*0.01*	*0.25*
		H14	*0*	*0*	*.*	*0*
		H15	1	0.03	.	1.0
		H16	1	0.02	0.02	0.5
	Total		64	0.02	<0.01	0.29
2003	Shore	Island	0	0	0	0
		North	61	0.05	0.01	0.39
		South	98	0.07	0.01	0.58
	Gradient	Riparian	111	0.06	0.01	0.45
		Upland	48	0.05	0.01	0.51
	Zone 1	Inside	52	0.07	0.02	0.37
		Outside	107	0.05	0.01	0.54
	Habitat type	H01	109	0.07	0.01	0.54
		H02	0	0	.	0
		H03	12	0.04	0.03	0.21
		H04	21	0.06	0.02	0.50
		H05	1	<0.01	<0.01	0.33
		H09	1	0.01	0.01	0.14
		H10	2	0.07	0.03	1.00
		H11	0	0	.	0
		H12	*5*	*0.06*	*0.01*	*1.00*
		H13	*6*	*0.05*	*0.02*	*0.57*
		H14	*1*	*0.03*	*0.03*	*0.33*
		H15	1	0.05	0.05	0.50
		H16	0	0	0	0

Table 7B-58: Mean Frequency of Black Bear Signs on Coarse Habitat Mosaic Transects in the Large Carnivores Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2003	Total		159	0.06	0.01	0.47
All	Shore	Island	2	0.01	<0.01	0.33
		North	92	0.03	0.01	0.47
		South	145	0.05	0.01	0.59
	Gradient	Riparian	170	0.04	0.01	0.56
		Upland	69	0.03	0.01	0.47
	Zone 1	Inside	98	0.04	0.01	0.52
		Outside	141	0.03	<0.01	0.53
	Habitat type	H01	157	0.05	0.01	0.57
		H02	6	0.04	0.02	0.67
		H03	18	0.02	0.01	0.33
		H04	34	0.04	0.01	0.64
		H05	1	<0.01	<0.01	0.25
		H09	3	0.01	0.01	0.29
		H10	2	0.02	002	0.67
		H11	0	0	.	0
		H12	*6*	*0.04*	*0.01*	*1.00*
		H13	*8*	*0.03*	*0.01*	*0.50*
		H14	*1*	*0.03*	*0.03*	*0.33*
		H15	2	0.03	0.02	0.50
		H16	1	0.01	0.01	0.25
	Total		239	0.04	0.01	0.53

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-59: Mean Frequency of Black Bear Signs on Riparian Shoreline Transects in the Large Carnivores Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	Island	0	0	0	0	0	0	0	0	0	0	0	0
	North	4	0.07	0.03	21	0.36	0.19	23	0.38	0.12	48	0.27	0.08
	South	7	0.17	0.05	8	0.19	0.06	17	0.41	0.11	32	0.25	0.05
Width of riparian zone (m)	0-30	1	0.09	0.03	7	0.24	0.13	3	0.33	0.09	11	0.22	0.06
	31-100	8	0.17	0.08	19	0.11	0.11	2	0.67	0.19	52	0.32	0.09
	>100	2	0.10	0.10	26	0.80	0.34	12	0.20	0.20	17	0.37	0.15
Maximum slope (%)	0-32	8	0.14	0.04	14	0.24	0.09	20	0.33	0.11	42	0.24	0.05
	33-65	1	0.04	0.04	13	0.46	0.35	13	0.46	0.17	27	0.32	0.13
	66-100	2	0.10	0.07	7	0.10	0.07	7	0.35	0.17	11	0.18	0.07
Habitat type	H01	8	0.11	0.03	10	0.13	0.05	25	0.33	0.09	43	0.19	0.04
	H03	0	0	.	1	0.50	.	2	1.00	.	3	0.50	0.29
	H04	0	0	0	4	0.33	0.17	1	0.08	0.08	5	0.14	0.07
	H12	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*	*0*	*0*	*0*
	H13	*1*	*0.25*	*0.25*	*0*	*0*	*0*	*2*	*0.50*	*0.50*	*3*	*0.25*	*0.17*
	H14	*1*	*0.50*	*.*	*0*	*0*	*.*	*4*	*2.00*	*.*	*5*	*0.83*	*0.60*
	H15	1	0.13	0.13	14	1.75	1.18	6	0.75	0.32	21	0.88	0.42
Total		11	0.10	0.03	29	0.27	0.11	40	0.37	0.08	80	0.25	0.05

1. Signs/100 m^2

Table 7B-60: Frequency of Black Bear Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	0	0	-
	South route	0	0	-
2002	North route	0	0	-
	South route	0	0	-
2003	North route transects	35	0.14	0.59
	North route centreline	0	0	0
2004	South route transects	12	0.10	0.50
	Stream crossing sites	2	0.08	0.29

1. Signs/100 m²

Table 7B-61: Density of Active Beaver Lodges on Waterbodies in the Beaver Regional Study Area, Fall 2001 and 2003

		2001		2003		Mean
Water Type		Number	Density[1]	Number	Density	Density
Island lake	Stephens	-	-	0	0	-
Island pond	Clark	0	0	0	0	0
	Stephens	0	0	0	0	0
	Unnamed	0	0	0	0	0
Island river	Nelson central[2]	1	0.13	0	0	0.07
	Nelson downstream	0	0	0	0	0
	Unnamed	0	0	0	0	0
Lake	Clark	0	0	0	0	0
	Stephens	6	0.04	0	0	0.02
	Unnamed	12	0.10	7	0.06	0.08
Ponds		16	0.10	12	0.10	0.10
Rivers	Nelson central[2]	2	0.01	1	0.03	0.02
	Nelson downstream	1	0.03	0	0	0.02
	Unnamed	2	0.07	2	0.08	0.08
Streams		57	0.27	30	0.22	0.25
Total		97	0.11	52	0.08	0.10

1. Lodges/km
2. Includes Gull Lake

Table 7B-62: Estimated Density of Active Beaver Lodges on Waterbodies in the Beaver Regional Study Area

Water Type	Mean Density in Surveyed Portion of Regional Study Area (2001 and 2003) [1]	Total Shoreline in Regional Study Area (km)	Estimated Lodge Density	Range
Named lakes	0.02	951	0.02	0–0.03
Unnamed lakes	0.08	170	0.08	0.06–0.10
Ponds	0.10	464	0.10	0.10
Nelson River central[2]	0.02	199	0.02	0.01–0.03
Nelson River downstream	0.02	59	0.02	0–0.03
Rivers	0.08	33	0.08	0.07–0.08
Streams	0.25	678	0.25	0.25–0.27
Total	0.09	2,885	0.09	0.08–0.11

1. Lodges/km
2. Includes Gull Lake

Table 7B-63: Density of Active Beaver Lodges on Waterbodies in the Hayes River Region, Fall 2009

Water Type		Survey Length (km)	Number	Density[1]
Lake	Bilodeau	8	0	0
	Coal Oil	6	0	0
	Kapaseetik	3	1	
	North Ministik	11	0	0
	Sako	19	0	0
	Unnamed	28	1	0.04
Ponds		121	14	0.12
Sub-arctic ponds		18	1	0.06
Rivers	Fox	66	7	0.11
	French Creek	20	7	0.35
	Gods and Hayes	343	23	0.07
	Pennycutaway	44	5	0.11
	Stupart	18	2	0.11
	Unnamed	10	2	0.20
Streams	Blackwater	4	0	0
	Little Hayes	6	0	0
	Lowe	1	0	0
	Prost	1	0	0
	Ten Shilling	13	0	0
	Unnamed	236	63	0.27
Total		976	126	0.13

1. Lodges/km

Table 7B-64: Density of All Active and Inactive Beaver Lodges on Waterbodies in the Beaver Regional Study Area, Fall 2001 and 2003

Water Type		2001 Number	2001 Density[1]	2003 Number	2003 Density	Mean Density
Island lake	Stephens	-	-	0	0	-
Island pond	Clark	0	0	0	0	0
	Stephens	0	0	0	0	0
	Unnamed	0	0	1	0.17	0.09
Island river	Nelson central[2]	1	0.13	0	0	0.07
	Nelson downstream	0	0	0	0	0
	Unnamed	0	0	0	0	0
Lake	Clark	0	0	1	0.04	0.02
	Stephens	7	0.04	1	0.01	0.03
	Unnamed	21	0.18	13	0.12	0.15
Ponds		33	0.21	26	0.19	0.20
Rivers	Nelson central[2]	3	0.02	2	0.02	0.02
	Nelson downstream	1	0.03	0	0	0.02
	Unnamed	4	0.03	2	0.02	0.03
Streams		112	0.52	44	0.36	0.44
Total		182	0.20	90	0.13	0.17

1. Lodges/km
2. Includes Gull Lake

Table 7B-65: Density of Active and Inactive Beaver Lodges (lodges/km) on Waterbodies in the Hayes River Region, Fall 2009

Water Type		Survey Length (km)	Number	Density[1]
Lake	Bilodeau	8	0	0
	Coal Oil	6	0	0
	Kapaseetik	3	1	0.33
	North Ministik	11	0	0
	Sako	19	0	0
	Unnamed	28	3	0.11
Ponds		121	26	0.21
Sub-arctic ponds		18	3	0.17
Rivers	Fox	66	13	0.20
	French Creek	20	7	0.35
	Gods and Hayes	343	35	0.10
	Pennycutaway	44	10	0.23
	Stupart	18	3	0.17
	Unnamed	10	3	0.30
Streams	Blackwater	4	0	0
	Little Hayes	6	0	0
	Lowe	1	0	0
	Prost	1	0	0
	Ten Shilling	13	0	0
	Unnamed	236	107	0.45
Total		976	211	0.22

1. Lodges/km

Table 7B-66: Density of Active Beaver Lodges on Waterbodies in the Beaver Local Study Area, Fall 2001 and 2003

Water Type		2001 Number	2001 Density[1]	2003 Number	2003 Density	Mean Density
Island pond	Stephens	0	0	0	0	0
	Unnamed	0	0	0	0	0
Island river	Nelson central[2]	1	0.13	0	0	0.07
	Unnamed	-	-	0	0	0
Lake	Unnamed	7	0.21	4	0.12	0.17
Ponds		6	0.11	7	0.15	0.13
Rivers	Nelson central[2]	2	0.01	0	0	0.01
	Unnamed	1	0.50	0	0	0.25
Streams		22	0.28	5	0.10	0.19
Total		39	0.12	16	0.08	0.10

1. Lodges/km
2. Includes Gull Lake

Table 7B-67: Density of Active Beaver Lodges on Waterbodies in Zone 1, 2011

Water Type	Number	Density[1]
Unnamed lakes	0	0
Ponds	4	0.10
Streams	18	0.44
Nelson River central[2]	1	0.02
Total	23	0.56

1. Lodges/km
2. Includes Gull Lake

Table 7B-68: Density of Active and Inactive Beaver Lodges on Waterbodies in Zone 1, 2011

Water Type	Number	Density[1]
Unnamed lakes	0	0
Ponds	9	0.22
Streams	22	0.54
Nelson River central[1]	1	0.02
Total	32	0.78

1. Lodges/km
2. Includes Gull Lake

Table 7B-69: Mean Frequency of Beaver Signs on Lake Perimeter Transects in the Beaver Regional Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	52	0.14	0.05	57	0.17	0.06	109	0.15	0.04
	South	54	0.22	0.08	157	0.58	0.28	211	0.40	0.15
Zone 1	Inside	46	0.19	0.08	94	0.29	0.13	140	0.24	0.08
	Outside	60	0.16	0.05	120	0.46	0.27	180	0.31	0.14
Habitat type	H01	44	0.21	0.03	37	0.15	0.05	81	0.18	0.03
	H03	13	0.22	0.22	52	0.75	0.60	65	0.48	0.30
	H04	20	0.11	0.06	98	0.60	0.38	118	0.35	0.20
	H10	1	0.01	0.01	15	0.27	0.27	16	0.14	0.13
	H15	15	0.33	0.25	7	0.11	0.08	22	0.22	0.13
	H16	13	0.25	.	5	0.09	.	18	0.17	0.08
Perimeter size (m)	<2000	67	0.22	0.07	151	0.50	0.24	218	0.36	0.12
	2000-4000	22	0.15	0.09	28	0.21	0.11	50	0.18	0.07
	4001-6000	17	0.06	0.05	35	0.12	0.04	52	0.09	0.03
Total		106	0.18	0.05	214	0.37	0.15	320	0.27	0.08

1. Signs/100 m^2

Table 7B-70: Mean Frequency of Beaver Signs on Coarse Habitat Mosaic Transects in the Beaver Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	0	0	0	0
2002	19	0.01	<0.01	0.07
2003	29	0.21	0.02	0.05
All	48	0.13	0.01	0.09

1. Signs/100 m²

Table 7B-71: Number of Beaver Signs on Riparian Shoreline Transects in the Local Study Area, 2001 to 2003

Year	Number of Signs	Mean Frequency[1]	Standard Error
2001	2	0.02	0.01
2002	4	0.04	0.02
2003	2	0.02	0.02
All	8	0.02	0.01

1. Signs/100 m²

Table 7B-72: Frequency of Beaver Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	0	0	-
	South route	3	<0.01	-
2002	North route	0	0	-
	South route	0	0	-
2003	North route transects	0	0	0
	North route centreline	11	0.11	0.30
2004	South route transects	0	0	0
	Stream crossing sites	26	1.01	0.71

1. Signs/100 m²

Table 7B-73: Tracking Survey Results on Islands in Complexes in Zone 5

	2009		2010		2011	
	Number of Islands in Complexes	Proportion of Islands Surveyed	Number of Islands in Complexes	Proportion of Islands Surveyed	Number of Islands in Complexes	Proportion of Islands Surveyed
Caribou adult	142	0.78	17	0.55	160	0.45
Caribou adult with moose adult	32	0.18	15	0.48	99	0.28
Caribou adult with moose calf	6	0.03	3	0.10	11	0.03
Caribou adult with gray wolf	4	0.02	0	0	3	0.01
Caribou adult with black bear	3	0.02	0	0	6	0.02
Caribou calf	121	0.67	0	0	16	0.04
Caribou calf with moose adult	22	0.12	0	0	11	0.03
Caribou calf with moose calf	1	0.01	0	0	3	0.01
Caribou calf with gray wolf	4	0.02	0	0	0	0
Caribou calf with black bear	2	0.01	0	0	0	0
Moose adult	54	0.30	29	0.94	212	0.59
Moose adult with gray wolf	0	0	0	0	5	0.01
Moose adult with black bear	2	0.01	1	0.03	7	0.02
Moose calf	13	0.07	4	0.13	16	0.04
Moose calf with gray wolf	0	0	0	0	0	0
Moose calf with black bear	0	0	0	0	2	0.01
Gray wolf	4	0.02	0	0	5	0.01
Gray wolf with black bear	0	0	0	0	0	0
Black bear	3	0.02	1	0.03	11	0.03
Total islands surveyed	181		31		537	

Table 7B-74: Trail Camera Results in Complexes in the Caribou Local Study Area

	2010		2011	
	Number of Complexes	Proportion of Complexes	Number of Complexes	Proportion of Complexes
Caribou adult	4	0.33	4	0.24
Caribou adult with moose adult	3	0.25	4	0.24
Caribou adult with moose calf	1	0.08	2	0.12
Caribou adult with gray wolf	1	0.08	0	0
Caribou adult with black bear	2	0.17	1	0.06
Caribou calf	0	0	0	0
Caribou calf with moose adult	0	0	0	0
Caribou calf with moose calf	0	0	0	0
Caribou calf with gray wolf	0	0	0	0
Caribou calf with black bear	0	0	0	0
Moose adult	10	0.83	10	0.59
Moose adult with gray wolf	1	0.08	1	0.06
Moose adult with black bear	3	0.25	2	0.12
Moose calf	3	0.25	2	0.12
Moose calf with gray wolf	0	0	0	0
Moose calf with black bear	2	0.17	0	0
Gray wolf	1	0.08	4	0.24
Gray wolf with black bear	1	0.08	1	0.06
Black bear	3	0.25	2	0.12
Total complexes surveyed	12		17	

Table 7B-75: Tracking Survey Results on Islands in Lakes

	2003		2005		2009		2010		2011	
	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands
Caribou adult	46	0.69	11	0.46	2	1.00	45	0.92	51	0.86
Caribou adult with moose adult	14	0.21	0	0	1	0.50	40	0.82	25	0.42
Caribou adult with moose calf	9	0.13	0	0	0	0	17	0.35	2	0.03
Caribou adult with gray wolf	0	0	0	0	0	0	3	0.06	0	0
Caribou adult with black bear	0	0	0	0	0	0	2	0.04	1	0.02
Caribou calf	33	0.49	2	0.08	1	0.50	14	0.29	6	0.10
Caribou calf with moose adult	10	0.15	0	0	0	0	13	0.27	4	0.07
Caribou calf with moose calf	5	0.07	0	0	0	0	9	0.18	1	0.02
Caribou calf with gray wolf	0	0	0	0	0	0	1	0.02	0	0
Caribou calf with black bear	0	0	0	0	0	0	1	0.02	0	0
Moose adult	25	0.37	8	0.33	1	0.50	44	0.90	28	0.47
Moose adult with gray wolf	0	0	0	0	0	0	3	0.06	0	0
Moose adult with black bear	0	0	0	0	0	0	3	0.06	1	0.02
Moose calf	14	0.21	14	0.58	0	0	18	0.37	2	0.03

Table 7B-75: Tracking Survey Results on Islands in Lakes

	2003		2005		2009		2010		2011	
	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands	Number of Islands in Lakes	Proportion of Islands
Moose calf with gray wolf	0	0	0	0	0	0	3	0.06	0	0
Moose calf with black bear	0	0	0	0	0	0	1	0.02	0	0
Gray wolf	0	0	0	0	0	0	3	0.06	0	0
Gray wolf with black bear	0	0	0	0	0	0	1	0.02	0	0
Black bear	0	0	0	0	0	0	3	0.06	1	0.02
Total islands surveyed	67		24		2		49		59	

Table 7B-76: Trail Camera Results on Islands in Lakes

	2010		2011	
	Number of Islands	**Proportion of Islands**	**Number of Islands**	**Proportion of Islands**
Caribou adult	28	0.64	19	0.36
Caribou adult with moose adult	16	0.36	14	0.26
Caribou adult with moose calf	7	0.16	7	0.13
Caribou adult with gray wolf	0	0	0	0
Caribou adult with black bear	0	0	0	0
Caribou calf	28	0.64	9	0.17
Caribou calf with moose adult	10	0.23	8	0.15
Caribou calf with moose calf	4	0.09	3	0.06
Caribou calf with gray wolf	0	0	0	0
Caribou calf with black bear	0	0	0	0
Moose adult	30	0.68	28	0.53
Moose adult with gray wolf	0	0	0	0
Moose adult with black bear	0	0	0	0
Moose calf	17	0.39	13	0.25
Moose calf with gray wolf	0	0	0	0
Moose calf with black bear	0	0	0	0
Gray wolf	0	0	0	0
Gray wolf with black bear	0	0	0	0
Black bear	0	0	0	0
Total islands surveyed	44		53	

Table 7B-77: Tracking Survey Results on Islands in Complexes in the Caribou Local Study Area

	2009		2010		2011	
	Number of Islands in Complexes	Proportion of Complexes	Number of Islands in Complexes	Proportion of Complexes	Number of Islands in Complexes	Proportion of Complexes
Caribou adult	87	0.76	13	0.57	77	0.44
Caribou adult with moose adult	22	0.19	11	0.48	51	0.29
Caribou adult with moose calf	5	0.04	1	0.04	4	0.02
Caribou adult with gray wolf	2	0.02	0	0	3	0.02
Caribou adult with black bear	2	0.02	0	0	2	0.01
Caribou calf	74	0.65	0	0	8	0.05
Caribou calf with moose adult	16	0.14	0	0	5	0.03
Caribou calf with moose calf	1	0.01	0	0	2	0.01
Caribou calf with gray wolf	2	0.02	0	0	0	0
Caribou calf with black bear	1	0.01	0	0	0	0
Moose adult	39	0.34	21	0.91	108	0.61
Moose adult with gray wolf	0	0	0	0	5	0.03
Moose adult with black bear	1	0.01	1	0.04	2	0.01
Moose calf	11	0.10	1	0.04	8	0.05
Moose calf with gray wolf	0	0	0	0	0	0
Moose calf with black bear	0	0.00	0	0	1	0.01
Gray wolf	2	0.02	0	0	5	0.03
Gray wolf with black bear	0	0	0	0	0	0
Black bear	2	0.02	1	0.04	5	0.03
Total complexes surveyed	114		23		176	

Table 7B-78: Mean Frequency of Caribou Signs on Lake Perimeter Transects in the Caribou Local Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	80	0.23	0.06	76	0.22	0.07	156	0.22	0.05
	South	112	0.24	0.08	61	0.15	0.04	173	0.19	0.05
Zone 1	Inside	63	0.18	0.07	78	0.23	0.07	141	0.20	0.05
	Outside	129	0.29	0.71	59	0.14	0.04	188	0.21	0.04
Habitat type	H01	56	0.22	0.07	23	0.08	0.03	79	0.15	0.04
	H03	4	0.07	0.07	12	0.07	0.07	16	0.07	0.04
	H04	96	0.34	0.10	41	0.16	0.05	137	0.25	0.06
	H10	8	0.09	0.09	30	0.46	0.22	38	0.28	0.14
	H15	21	0.24	0.21	28	0.35	0.09	49	0.29	0.11
	H16	7	0.13	.	3	0.06	.	10	0.10	0.04
Perimeter size (m)	<2000	96	0.27	0.08	54	0.16	0.05	150	0.21	0.05
	2000-4000	28	0.17	0.05	42	0.28	0.12	70	0.22	0.06
	4001-6000	68	0.21	0.11	41	0.14	0.01	109	0.17	0.05
Total		192	0.23	0.05	137	0.18	0.04	329	0.21	0.03

1. Signs/100 m^2

Table 7B-79: Mean Frequency of Caribou Signs on Coarse Habitat Mosaic Transects in the Caribou Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	19	0.03	0.01	0.25
		South	56	0.07	0.02	0.59
	Gradient	Riparian	30	0.04	0.01	0.37
		Upland	45	0.06	0.02	0.50
	Zone 1	Inside	24	0.03	0.01	0.31
		Outside	51	0.08	0.02	0.59
	Habitat Type[2]	H01	44	0.06	0.02	0.50
		H02	0	0	.	0
		H03	20	0.07	0.02	0.60
		H04	6	0.03	0.02	0.33
		H09	2	0.02	0.02	0.25
		H10	0	0	.	0
		H13	*3*	*0.03*	*0.03*	*0.33*
		H15	0	0	.	0
		H16	0	0	.	0
	Total		75	0.05	0.01	0.43
2002	Shore	Island	27	0.12	0.03	0.83
		North	151	0.09	0.02	0.62
		South	161	0.10	0.03	0.44
	Gradient	Riparian	263	0.12	0.03	0.52
		Upland	76	0.07	0.01	0.56
	Zone 1	Inside	100	0.09		0.67
		Outside	239	0.11	0.03	0.45
	Habitat type	H01	136	0.08	0.02	0.47
		H02	7	0.08	0.06	0.67
		H03	119	0.26	0.10	0.67
		H04	43	0.08	0.02	0.63
		H05	11	0.12	0.03	1.00

Table 7B-79: Mean Frequency of Caribou Signs on Coarse Habitat Mosaic Transects in the Caribou Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H09	3	0.02	0.02	0.40
		H10	4	0.05	0.02	0.67
		H12	*0*	*0*	*0*	*0*
		H13	*11*	*0.10*	*0.04*	*0.75*
		H14	*0*	*0*	.	*0*
		H15	0	0	.	0
		H16	5	0.08	0.05	1.00
	Total		339	0.10	0.02	0.53
2003	Shore	Island	191	0.85	0.27	0.83
		North	567	0.63	0.14	0.83
		South	642	0.77	0.27	0.80
	Gradient	Riparian	986	0.65	0.14	0.82
		Upland	414	0.83	0.34	0.80
	Zone 1	Inside	636	0.82	0.28	0.80
		Outside	764	0.62	0.15	0.83
	Habitat type	H01	736	0.82	0.25	0.79
		H02	4	0.40	.	1.00
		H03	212	1.08	0.45	0.93
		H04	267	0.67	0.17	0.90
		H05	68	0.64	0.29	1.00
		H09	55	0.62	0.24	1.00
		H10	3	0.12	0.08	1.00
		H11	9	0.10	.	1.00
		H12	*7*	*0.08*	*0.04*	*1.00*
		H13	*11*	*0.04*	*0.02*	*0.43*
		H14	*6*	*0.08*	*0.08*	*0.33*
		H15	6	0.28	0.28	0.50
		H16	16	0.28	0.25	1.00

Table 7B-79: Mean Frequency of Caribou Signs on Coarse Habitat Mosaic Transects in the Caribou Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2003	Total		1,400	0.70	0.14	0.82
All	Shore	Island	218	0.49	0.17	1.00
		North	737	0.33	0.07	0.86
		South	859	0.37	0.11	0.82
	Gradient	Riparian	1,279	0.35	0.07	0.87
		Upland	535	0.37	0.14	0.81
	Zone 1	Inside	760	0.38	0.12	0.90
		Outside	1,054	0.34	0.07	0.81
	Habitat type	H01	916	0.41	0.12	0.82
		H02	11	0.13	0.08	0.67
		H03	351	0.50	0.18	1.00
		H04	316	0.36	0.09	0.86
		H05	79	0.38	0.17	1.00
		H09	60	0.28	0.13	1.00
		H10	7	0.06	0.03	1.00
		H11	9	0.10	.	1.00
		H12	*7*	*0.04*	*0.03*	*1.00*
		H13	*25*	*0.05*	*0.02*	*0.63*
		H14	*6*	*0.05*	*0.05*	*0.33*
		H15	6	0.14	0.14	0.50
		H16	21	0.15	0.10	1.00
	Total		1,814	0.36	0.07	0.84

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-80: Mean Frequency of Caribou Signs on Coarse Habitat Mosaic Transects in the Caribou Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	21	0.08	0.04	0.16
		South	54	0.18	0.18	0.03
	Gradient	Riparian	16	0.05	0.03	0.07
		Upland	59	0.22	0.02	0.09
	Zone 1	Inside	16	0.05	0.03	0.09
		Outside	59	0.25	0.25	0.09
	Habitat Type[2]	H01	54	0.21	0.21	0.04
		H02	52	0.20	.	1.00
		H03	0	0	0	0
		H04	11	0.13	0.08	0.25
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*8*	*0.30*	*0.30*	*0.33*
		H16	0	0	.	0
	Total		75	0.14	0.10	0.09
2002	Shore	North	54	<0.01	<0.01	0.03
		South	55	0.08	0.07	0.08
	Gradient	Riparian	0	0	0	0
		Upland	57	0.07	0.06	0.10
	Zone 1	Inside	0	0	0	0
		Outside	57	0.09	0.08	0.12
	Habitat type	H01	55	0.07	0.07	0.08
		H02	0	0	0	0
		H03	0	0	0	0
		H04	2	0.01	0.01	0.11
		H09	0	0	0	0
		H10	0	0	0	0
		H13	*0*	*0*	*0*	*0*

Table 7B-80: Mean Frequency of Caribou Signs on Coarse Habitat Mosaic Transects in the Caribou Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H15	0	0	.	0
		H16	0	0	0	0
	Total		57	0.04	0.04	0.06
All	Shore	North	23	0.03	0.02	0.14
		South	109	0.12	0.09	0.08
	Gradient	Riparian	16	0.02	0.02	0.09
		Upland	116	0.13	0.09	0.13
	Zone 1	Inside	16	0.21	0.13	0.08
		Outside	116	0.16	0.11	0.15
	Habitat type	H01	109	0.13	0.09	0.08
		H02	2	0.07	0.07	0.50
		H03	0	0	0	0
		H04	13	0.07	0.04	0.33
		H09	0	0	0	0
		H10	0	0	0	0
		H13	*8*	*0.13*	*0.13*	*0.33*
		H15	0	0	.	0
		H16	0	0	0	0
	Total		132	0.08	0.05	0.11

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-81: Mean Frequency of Caribou Signs on Riparian Shoreline Transects in the Caribou Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	**Mean[1]**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**
Shore	Island	0	0	0	4	0.67	0.44	5	0.83	0.33	9	0.50	0.20
	North	1	0.02	0.02	109	1.88	0.82	58	0.97	0.23	168	0.96	0.29
	South	2	0.05	0.03	12	0.29	0.10	120	2.86	1.00	134	1.06	0.37
Width of riparian zone (m)	0-30	2	0.03	0.02	115	1.47	0.62	142	1.78	0.54	259	1.10	0.28
	31-100	0	0	0	8	0.44	0.18	23	1.28	0.42	31	0.57	0.18
	>100	1	0.10	0.10	2	0.20	0.12	18	1.80	1.56	21	0.70	0.53
Maximum slope (%)	0-32	2	0.03	0.02	63	1.09	0.47	141	2.35	0.68	206	1.17	0.29
	33-65	1	0.04	0.04	56	2.00	1.44	14	0.50	0.25	71	0.85	0.49
	66-100	0	0	0	6	0.30	0.17	28	1.40	0.87	34	0.57	0.31
Habitat type	H01	2	0.03	0.02	73	0.96	0.39	132	1.74	0.52	207	0.91	0.22
	H03	0	0	3	0	0	.	2	1.00	.	2	0.33	0.33
	H04	0	0	0	8	0.67	0.28	13	1.01	0.44	21	0.58	0.20
	H12	*0*	*0*	*.*	*0*	*0*	*.*	*2*	*0.50*	*0*	*2*	*0.25*	*0.14*
	H13	*1*	*0.25*	*0.25*	*2*	*0.50*	*0.50*	*31*	*7.75*	*4.25*	*34*	*2.83*	*1.91*
	H14	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*.*	*0*	*0*	*0*
	H15	0	0	0	42	5.25	4.92	3	0.38	0.38	45	1.88	1.65
Total		3	0.03	0.02	125	1.18	0.46	183	1.70	0.42	311	0.72	0.21

1. Signs/100 m²

Table 7B-82: Frequency of Caribou Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency[1]	Proportion of Transects
2001	North route	22	0.06	-
	South route	55	0.05	-
2002	North route	4	0.01	-
	South route	55	0.06	-
2003	North route transects	77	0.32	0.69
	North route centreline	4	0.04	0.20
2004	South route transects	15	0.13	0.57
	Stream crossing sites	3	0.11	0.14

1. Signs/100 m²

Table 7B-83: Mean Frequency of Moose Signs on Lake Perimeter Transects in the Moose Local Study Area, 2002 and 2003

		2002			2003			Total		
		Number of Signs	Mean[1]	SE	Number of Signs	Mean	SE	Number of Signs	Mean	SE
Shore	North	53	0.13	0.03	194	0.48	0.10	247	0.31	0.06
	South	113	0.32	0.07	150	0.48	0.12	263	0.40	0.07
Zone 1	Inside	95	0.26	0.06	215	0.58	0.12	310	0.42	0.07
	Outside	71	0.19	0.06	129	0.38	0.08	200	0.28	0.05
Habitat type	H01	41	0.24	0.11	87	0.43	0.12	128	0.33	0.08
	H03	44	0.49	0.19	46	0.38	0.19	90	0.41	0.12
	H04	47	0.16	0.05	85	0.41	0.11	132	0.29	0.07
	H10	16	0.23	0.02	57	0.85	0.29	73	0.54	0.27
	H15	14	0.21	0.10	51	0.64	0.31	65	0.42	0.18
	H16	4	0.08	.	18	0.34	.	22	0.21	0.13
Perimeter size (m)	<2000	94	0.28	0.06	174	0.49	0.10	268	0.39	0.06
	2000-4000	20	0.11	0.05	97	0.58	0.16	117	0.35	0.11
	4001-6000	52	0.18	0.06	73	0.27	0.13	125	0.23	0.07
Total		166	0.22	0.04	344	0.48	0.07	510	0.35	0.05

1. Signs/100 m^2

Table 7B-84: Mean Frequency of Moose Signs on Coarse Habitat Mosaic Transects in the Moose Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	123	0.18	0.02	0.96
		South	88	0.14	0.04	0.93
	Gradient	Riparian	116	0.18	0.04	0.96
		Upland	95	0.14	0.02	0.92
	Zone 1	Inside	110	0.15	0.03	0.93
		Outside	101	0.16	0.02	0.95
	Habitat Type[2]	H01	102	0.18	0.04	0.96
		H02	3	0.10	.	1.00
		H03	41	0.15	0.04	1.00
		H04	30	0.15	0.03	1.00
		H09	18	0.16	0.04	1.00
		H10	3	0.10	.	1.00
		H13	*12*	*0.13*	*0.07*	*0.67*
		H15	0	0	.	0
		H16	2	0.06	.	1.00
	Total		211	0.16	0.02	0.94
2002	Shore	Island	53	0.40	0.32	0.83
		North	369	0.24	0.03	1.00
		South	326	0.25	0.04	0.88
	Gradient	Riparian	485	0.26	0.04	0.90
		Upland	263	0.22	0.04	0.97
	Zone 1	Inside	353	0.29	0.05	1.00
		Outside	395	0.23	0.04	0.88
	Habitat type	H01	333	0.24	0.04	0.89
		H02	56	0.60	0.35	1.00
		H03	99	0.21	0.03	1.00
		H04	123	0.31	0.12	0.94
		H05	21	0.23	0.10	1.00

Table 7B-84: Mean Frequency of Moose Signs on Coarse Habitat Mosaic Transects in the Moose Local Study Area, 2001 to 2003

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H09	48	0.32	0.08	1.00
		H10	20	0.22	0.08	1.00
		H12	*22*	*0.45*	*0.35*	*0.67*
		H13	*9*	*0.08*	*0.03*	*1.00*
		H14	*4*	*0.13*	*.*	*1.00*
		H15	2	0.63	.	1.00
		H16	11	0.16	0.13	1.00
	Total		748	0.25	0.03	0.93
2003	Shore	Island	105	0.50	0.14	1.00
		North	634	0.54	0.06	0.98
		South	510	0.34	0.04	0.92
	Gradient	Riparian	806	0.40	0.04	0.95
		Upland	443	0.52	0.09	0.98
	Zone 1	Inside	544	0.53	0.07	0.94
		Outside	705	0.38	0.04	0.96
	Habitat type	H01	547	0.35	0.04	0.94
		H02	15	1.50	.	1.00
		H03	152	0.78	0.20	1.00
		H04	256	0.50	0.08	1.00
		H05	59	0.41	0.19	1.00
		H09	78	0.77	0.15	1.00
		H10	22	0.47	0.17	1.00
		H11	10	0.11	.	1.00
		H12	*13*	*0.17*	*0.07*	1.00
		H13	*31*	*0.14*	*0.05*	*0.86*
		H14	*18*	*0.22*	*0.17*	*0.67*
		H15	21	0.86	0.73	1.00
		H16	27	0.46	0.14	1.00

Table 7B-84: Mean Frequency of Moose Signs on Coarse Habitat Mosaic Transects in the Moose Local Study Area, 2001 to 2003

Year			**Number of Signs**	**Mean Frequency[1]**	**Standard Error**	**Proportion of Transects**
2003	Total		1,249	0.44	0.04	0.96
All	Shore	Island	158	0.45	0.17	1.00
		North	1,126	0.36	0.03	0.99
		South	924	0.27	0.03	0.98
	Gradient	Riparian	1,407	0.32	0.02	0.98
		Upland	801	0.32	0.04	0.98
	Zone 1	Inside	1,007	0.36	0.04	0.99
		Outside	1,201	0.29	0.03	0.98
	Habitat type	H01	982	0.28	0.04	0.98
		H02	74	0.68	0.30	1.00
		H03	292	0.40	0.08	1.00
		H04	409	0.38	0.06	1.00
		H05	80	0.32	0.10	1.00
		H09	144	0.48	0.10	1.00
		H10	45	0.29	0.08	1.00
		H11	10	0.11	.	1.00
		H12	*35*	*0.31*	*0.17*	*1.00*
		H13	*52*	*0.12*	*0.03*	*1.00*
		H14	*22*	*0.20*	*0.13*	*0.67*
		H15	23	0.45	0.38	1.00
		H16	40	0.26	0.10	1.00
	Total		2,208	0.32	0.02	0.98

1. Signs/100 m^2
2. Italics indicate rare habitat

Table 7B-85: Mean Frequency of Moose Signs on Coarse Habitat Mosaic Transects in the Moose Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2001	Shore	North	25	0.05	0.02	0.20
		South	30	0.02	0.01	0.17
	Gradient	Riparian	28	0.03	0.02	0.14
		Upland	27	0.04	0.02	0.22
	Zone 1	Inside	33	0.03	0.02	0.12
		Outside	22	0.05	0.02	0.27
	Habitat Type[2]	H01	10	0.04	0.02	0.23
		H02	0	0	.	0
		H03	1	0.01	0.01	0.09
		H04	9	0.09	0.05	0.38
		H09	0	0	0	0
		H10	0	0	.	0
		H13	*0*	*0*	*0*	*0*
		H16	0	0	.	0
	Total		55	0.03	0.01	0.18
2002	Shore	North	36	0.03	0.01	0.28
		South	36	0.01	0.01	0.08
	Gradient	Riparian	33	<0.01	<0.01	0.03
		Upland	39	0.04	0.01	0.31
	Zone 1	Inside	39	0.02	0.01	0.21
		Outside	33	0.02	0.01	0.15
	Habitat type	H01	6	0.01	0.01	0.08
		H02	0	0	0	0
		H03	3	0.01	0.01	0.18
		H04	8	0.05	0.03	0.33
		H09	7	0.09	0.03	0.75
		H10	3	0.08	0.08	0.50
		H13	*3*	*0.05*	*0.05*	*0.33*

Table 7B-85: Mean Frequency of Moose Signs on Coarse Habitat Mosaic Transects in the Moose Local Study Area, Winter 2001 and 2002

Year			Number of Signs	Mean Frequency[1]	Standard Error	Proportion of Transects
2002	Habitat type	H15	0	0	.	0
		H16	0	0	0	0
	Total		72	0.02	0.01	0.18
All	Shore	North	61	0.04	0.01	0.33
		South	66	0.02	0.01	0.22
	Gradient	Riparian	61	0.02	0.01	0.12
		Upland	66	0.04	0.01	0.41
	Zone 1	Inside	72	0.02	0.01	0.28
		Outside	55	0.03	0.01	0.27
	Habitat type	H01	16	0.02	0.01	0.24
		H02	0	0	0	0
		H03	4	0.01	0.01	0.27
		H04	17	0.07	0.03	0.67
		H09	7	0.05	0.02	0.75
		H10	3	0.05	0.05	0.50
		H13	*3*	*0.03*	*0.03*	*0.33*
		H15	0	0	3	0
		H16	0	0	0	0
	Total		127	0.27	0.01	0.28

1. Signs/100 m²
2. Italics indicate rare habitat

Table 7B-86: Mean Frequency of Moose Signs on Riparian Shoreline Transects in the Moose Local Study Area, 2001 to 2003

		2001			2002			2003			Total		
		Number of Signs	**Mean[1]**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**	**Number of Signs**	**Mean**	**SE**
Shore	Island	0	0	0	5	0.83	0.44	10	1.67	0.60	15	0.83	0.32
	North	6	0.10	0.05	89	1.53	0.31	59	0.98	0.23	154	0.88	0.14
	South	3	0.07	0.04	99	2.36	0.70	44	1.05	0.33	146	1.16	0.28
Width of riparian zone (m)	0-30	6	0.08	0.04	154	1.97	0.40	69	0.86	0.22	229	0.97	0.17
	31-100	2	0.11	0.07	31	1.72	0.84	32	1.78	0.43	65	1.20	0.34
	>100	6	0.10	0.10	8	0.80	0.46	12	1.20	0.34	21	0.70	0.21
Maximum slope (%)	0-32	6	0.10	0.04	126	2.17	0.51	82	1.37	0.27	214	1.22	0.21
	33-65	3	0.11	0.08	44	1.57	0.39	25	0.89	0.33	72	0.86	0.19
	66-100	0	0	0	6	1.15	0.70	6	0.30	0.20	29	0.48	0.25
Habitat type	H01	6	0.08	0.03	165	2.17	0.43	64	0.84	0.20	235	1.03	0.18
	H03	0	0	.	6	3.00	.	1	0.50	.	7	1.17	0.93
	H04	0	0	0	13	1.08	0.54	27	2.25	0.72	40	1.11	0.36
	H12	*1*	*0.50*	*.*	*2*	*1.00*	*.*	*4*	*1.00*	*0.50*	*7*	*0.88*	*0.24*
	H13	*0*	*0*	*0*	*4*	*1.00*	*1.00*	*10*	*2.50*	*1.50*	*14*	*1.17*	*0.65*
	H14	*2*	*1.00*	*.*	*1*	*0.50*	*.*	*1*	*0.50*	*.*	*4*	*0.67*	*0.17*
	H15	0	0	0	2	0.25	0.25	6	0.75	0.32	8	0.33	0.16
Total		9	0.09	0.03	193	1.82	0.33	113	1.05	0.18	315	0.98	0.14

1. Signs/100 m^2

Table 7B-87: Frequency of Moose Signs on the North and South Access Road Routes, 2001 to 2004

Year	Transects	Number of Signs	Frequency	Proportion of Transects
2001	North route	28	0.08	-
	South route	9	0.01	-
2002	North route	17	0.05	-
	South route	12	0.01	-
2003	North route transects	151	0.62	0.97
	North route centreline	85	0.87	1.00
2004	South route transects	81	0.70	0.93
	Stream crossing sites	24	0.93	1.00

1. Signs/100 m^2

APPENDIX 7C

Additional Maps