Labrador – Island Transmission Link

Caribou and Their Predators (Labrador and Newfoundland) Component Study

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EXECUTIVE SUMMARY

Nalcor Energy is proposing to develop the *Labrador-Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from Central Labrador to the Avalon Peninsula on the Island of Newfoundland. In preparation for and support of the environmental assessment (EA) of the Project, this *Caribou and Their Predators Component Study* has been completed with the objective to gather, summarize and present information on caribou (*Rangifer tarandus caribou*) populations and their predators in the area of, and which may therefore interact with, the proposed Project.

Caribou are a key focus for the EA because of their occurrence throughout the province, their importance as a dominant herbivore and prey species in the ecosystem and from a cultural and economic perspective, and because several herds are provincially and/or federally listed for special conservation status. The objectives of the *Caribou and Their Predators Component Study* were to: complete an extensive literature search of studies pertaining to the relevant research and other knowledge of caribou, their predators and their ecology, especially in Newfoundland and Labrador but also in other jurisdictions with similar conditions; develop regional overviews describing the known and likely presence, abundance, and spatial and seasonal distribution of caribou in proximity to the transmission corridor; and develop and present habitat quality mapping for caribou.

Approach and Methods

The study focused primarily on the proposed and alternative HVdc transmission corridors and associated Project components and surrounding area. In Labrador, the herds most likely to overlap with the Study Area are the George River Herd (GRH), the Red Wine Mountains Herd (RWMH) and the Mealy Mountains Herd (MMH), which includes the Joir River subpopulation, while in Newfoundland, the transmission corridor is overlapped by caribou occupancy areas, including various Primary Core areas.

This *Component Study* is based on research completed by the Study Team and others in support of this Project and on relevant surveys and studies completed by others throughout the province, along with other existing and available literature. An extensive literature search was completed that provided a comprehensive listing of the primary sources of information related to the proposed Project, from which an annotated bibliography was compiled detailing relevant studies completed in Newfoundland and Labrador since the 1980s. The most important component of this review was the extensive research and other information compiled by the Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation (NLDEC). Aerial surveys, radio and satellite telemetry collaring and other research have been used to describe existing conditions for this species and inform management decisions. As much of the NLDEC's research is ongoing, the caribou distribution data presented in this report are current, having been updated between 2010 and early 2011.

Based on the findings of the literature review, a description of the available information and existing environmental conditions for caribou was prepared according to the primary sources of information available, existing baseline conditions, habitat associations and distribution, as well as the identification of potential limiting factors. Recent and ongoing research by Nalcor Energy includes general ecological surveys along the transmission corridor in 2008 as part of an Ecological Land Classification (ELC) field program, and intensive reviews of caribou telemetry and location data. ELC-based habitat classifications formed the basis of the caribou habitat potential mapping component of this study. The ELC was completed along a 15 km wide ELC Study Area that encompassed the transmission corridor, including alternative segments, and covered a linear distance of

approximately 1,100 km. Through this initiative, vegetation types and associated habitats were identified, classified and categorized on a regional scale, with a total of 15 Habitat Types and a number of non-vegetated land classes being defined and mapped.

A series of detailed habitat potential maps were generated for caribou for the ELC Study Area, indicating the distribution and abundance of primary, secondary and tertiary caribou habitat. For the purpose of this investigation, primary habitat was defined as habitat that may provide foraging, protection from predation (or other potential limiting factors) and resting habitat, secondary habitat provides an abundance of one or two of the three (or marginal amounts of all) of the critical elements and tertiary habitat provides marginal foraging, protecting or resting opportunities or may only be used during transit.

Habitat potential maps were produced for the 'Southeastern Labrador', 'Northern Peninsula', 'Central and Eastern Newfoundland' and 'Avalon Peninsula' regions, based on the ELC Study Area. Maps were colour-coded to reflect habitat quality and indicate the proportion of potential primary, secondary and tertiary habitat available within each of these geographic regions.

Summary of Key Results and Analysis

In Labrador, the caribou herds most likely to overlap with the transmission corridor are the GRH, RWMH and MMH (including the Joir River herd subpopulation). There are two transmission corridor options in Labrador: one beginning at Gull Island (Option 1) and one at Muskrat Falls (Option 2). Both options occur at the margin of the GRH range, and overlap to varying degrees the edges of the RMWH and MMH ranges. The most recent population estimates for these herds are approximately 74,000 for the GRH (2010), 2,100 for the MMH (2005) and less than 100 for the RWH (2001); the minimum population count for the Joir River subpopulation in 2009 was 110 caribou. Option 1 runs along the northern margin between the range of the Joir River subpopulation and the MMH range. It occurs at the southern margin of the GRH near a portion of the range traditionally used only during the winter. As winter use of the area by GRH caribou has been inconsistent in recent years, overlap is unlikely to occur. However, if there is use of the area by GRH caribou, it will most likely be by small groups of individuals rather than a large proportion of the herd. The linear distance along the centre line of the transmission corridor that will pass through recognized caribou range in Labrador is 182 km (44 percent) for Option 1, or 190 km (49 percent) for Option 2.

In Newfoundland, the transmission corridor overlaps caribou occupancy areas in both the Northern Peninsula and Central and Eastern Newfoundland regions. There has been a recent shift in the NLDECs understanding of caribou distribution in Newfoundland, leading away from the traditionally used 'herd' structure. The current approach defines caribou occupancy areas based on differing amounts of range use by caribou: Primary Core areas (50 percent kernel); Secondary Core areas (80 percent kernel); and Occupancy Areas (100 percent kernel). Primary Core areas are those that receive the highest use while Occupancy Areas include all areas used by caribou regardless of amount. In the Northern Peninsula and Central and Eastern Newfoundland regions, all three levels of occupancy overlap with the transmission corridor. On the Northern Peninsula, 90 percent of the of the linear distance along the centreline of the proposed transmission corridor occurs in caribou Occupancy Areas (213 km), but only 17 percent occurs in Primary Core areas (40 km). In Central and Eastern Newfoundland, 53 percent (152 km) occurs in caribou Occupancy Areas, with only 8 percent (27 km) overlapping Primary Core areas.

In the Southeastern Labrador region of the ELC Study Area, approximately 63 and 66 percent is comprised of potential primary calving / post-calving habitat along the Gull Island and Muskrat Falls options, respectively, while approximately 39 and 45 percent is comprised of potential primary winter habitat along the Gull Island and Muskrat Falls option, respectively. In the Northern Peninsula region of the ELC Study Area, approximately 58 percent is comprised of potential primary calving / post-calving habitat, while approximately 26 percent is comprised of potential primary winter habitat. In the Central and Eastern Newfoundland region of the ELC Study Area, approximately 35 percent is comprised of potential primary calving / post-calving habitat, while approximately 9 percent is comprised of potential primary winter habitat. In the Avalon Peninsula region of the ELC Study Area, approximately 58 percent is comprised of potential primary calving / post-calving habitat, while approximately 13 percent is comprised of potential primary winter habitat.

There are a variety of limiting factors that influence caribou health and abundance in the province. The loss, degradation and fragmentation of habitat vary between Labrador and Newfoundland and by ecotype, herd or aggregation of caribou. In some situations, such as with the GRH, overgrazing has caused a deterioration of seasonal ranges, causing a lowering of fitness and eventual lower abundance. In Labrador, sedentary herds have tended to decline due to predation and over-hunting. In Newfoundland, habitat issues arise more as a result of human activities and in particular, forest harvesting. Legal and illegal hunting, sensory disturbance, as well as collisions with vehicles are other human-induced limiting factors for caribou. The role of predators, such as black bear, wolf, coyote, lynx and others, can also be important in terms of limiting abundance, although it varies between Labrador and Newfoundland, according to the distribution of these species.

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1.0 INTRODUCTION

Nalcor Energy is proposing to develop the *Labrador-Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from Central Labrador to the Island of Newfoundland's Avalon Peninsula. The environmental assessment (EA) of the Project is ongoing, with an Environmental Impact Statement (EIS) currently being completed by Nalcor Energy.

In preparation for and in support of the Project's EA, this *Caribou and Their Predators Component Study* was completed in order to identify, compile, summarize and present information on caribou *(Rangifer tarandus caribou)* in the vicinity of, and which may interact with, the proposed Project as environmental baseline information for use in the EIS.

1.1 Project Overview

The proposed Project involves the construction and operation of transmission infrastructure within and between Labrador and the Island of Newfoundland.

The transmission system, as currently proposed (Figure 1.1), includes the following key components:

- an ac-dc converter station in Central Labrador, on the lower Churchill River (Gull Island or Muskrat Falls) adjacent to the Lower Churchill Hydroelectric Generation Project;
- an HVdc transmission line extending across Southeastern Labrador to the Strait of Belle Isle. The overhead transmission line will be approximately 400 km in length with a cleared right-of-way averaging approximately 60 m wide, and will consist of single galvanized steel lattice towers;
- cable crossings of the Strait of Belle Isle with associated infrastructure, including cables placed under and on the sea floor through various means to provide the required cable protection;
- an HVdc transmission line (similar to that described above) extending from the Strait of Belle Isle across Newfoundland to the Avalon Peninsula, for a distance of approximately 700 km;
- a dc-ac converter station at Soldiers Pond on Newfoundland's Avalon Peninsula; and
- electrodes in Labrador and on the Island, with overhead lines connecting them to their respective converter stations.

Figure 1.1 Labrador-Island Transmission Link: Project Overview

Project planning and design are currently at a stage of having identified a 2 km wide corridor for the on-land portions of the proposed HVdc transmission corridor and 500 m wide corridors for the proposed Strait of Belle Isle cable crossings, as well as various alternative corridor segments in particular areas.

Project planning is in progress and it is anticipated that the Project description will continue to evolve as engineering and design work continue. The EA of the Project will also identify and evaluate alternative means of carrying out the Project that are technically and economically feasible.

In conjunction and concurrent with the EA process, Nalcor Energy will be continuing with its technical and environmental analyses of the corridors in order to identify and select a specific routing for the HVdc transmission line from within these larger corridors. The transmission line will have an on-land right-of-way that will be approximately 60 m in width. The eventual transmission routes and locations will be selected with consideration of technical, environmental and socioeconomic factors.

At the time of the commencement of the EA and these associated environmental studies, the Labrador component of the Project included a proposed converter station facility at Gull Island on the lower Churchill River, as well as a proposed transmission corridor extending from Gull Island to the Strait of Belle Isle. In mid-November 2010, Nalcor Energy advised the provincial and federal governments that it would also be assessing the potential option of locating the Project's Labrador converter station at or near the Muskrat Falls site on the lower Churchill River. If that were to be the case, the Labrador transmission corridor would potentially extend from Muskrat Falls to the Trans Labrador Highway (Phase 3) (TLH-3), and then follow generally along the highway to approximately its southernmost point before meeting and continuing along the previously identified corridor from that location to the Strait of Belle Isle. Both the Gull Island and Muskrat Falls transmission corridor options have been considered in this study.

1.2 Nature, Purpose and Objectives of the Component Study

This *Caribou and Their Predators Component Study* forms one aspect of Nalcor Energy's environmental study program for the Project and its EA. The purpose of this and other such baseline studies has been to gather and present information on key aspects of the environment, and thus, provide an appropriate understanding of the existing environmental conditions within and near the Project area for use in the EIS.

In planning and conducting this environmental study program, the nature of the Project and its potential environmental interactions were important considerations. In carrying out EAs and associated baseline studies for other types of developments - such as mines or hydroelectric projects, which are characterized by more "geographically focused" components and activities with specific "footprints" - the approach is often to conduct one or more field surveys to inventory specific aspects of the environment, typically within a single season. As a result of the nature and geographic scale of this proposed Project and its potential interactions with the environment, it was considered appropriate and necessary to go beyond such a "traditional" approach to environmental baseline studies for the EIS.

Specifically, rather than base the caribou study solely on a snapshot understanding of their presence along the transmission corridor through one or more field surveys at single points in time, a range of methods and information sources were used to provide an appropriate and meaningful understanding of their likely and potential presence, abundance and distribution in and near the Project area. The nature and appropriateness of

this study approach was discussed with various relevant government agencies and stakeholders as part of the planning and design of the Project's environmental study program from 2008 to 2010.

The study approach was to first identify, compile and summarize the existing and available (but widespread) information and datasets related to caribou and their predators in and near the Project. This included literature as well as the results of wildlife studies conducted throughout Newfoundland and Labrador over the past several decades. This information has been compiled and summarized in this *Component Study* to provide an overview of the species across the Project area in each region.

The information has also been used in conjunction with the regional ecological land classification (ELC) mapping work completed for the Project (Stantec Consulting Ltd. 2010, 2011), to assess and map habitat suitability, and thus, the potential use of the Project area, for caribou along and adjacent to the proposed and alternative transmission corridors. Detailed habitat potential mapping is provided in this report.

In summary, the purpose of this *Caribou and Their Predators Component Study* is to identify, gather, analyze, summarize and present information on caribou and their predators in the area of, and which may be affected by, the Project, for use in the EIS. In doing so, the study involved:

- The identification, review and presentation of the results of previous studies conducted in relation to the Project, as well as other relevant surveys and research and the literature that provides information on and insight regarding this species in and near the Project area;
- Based on the above information, the development of regional overviews describing the known and likely presence, abundance, spatial and temporal distribution of caribou across the geographic extent of the transmission corridors; and
- Using the above information, and based on the regional ELC completed for the Project, the development and presentation of habitat potential mapping for caribou across the approximately 15 km wide and 1,100 km long ELC Study Areas.

2.0 APPROACH AND METHODS

This section provides an overview of the Study Area, methodology and Study Team associated with this *Component Study.*

2.1 Regional Context and Study Area

The Project involves the construction and operation of an HVdc transmission system within and between Labrador and the Island of Newfoundland. Given the nature of the Project and its potential interactions with the environment, as well as the rather extensive geographic scale involved, this *Component Study* takes a "regional approach" in identifying and describing the likely presence, abundance and spatial and temporal distribution of caribou along and adjacent to the proposed and alternative transmission corridors and associated Project components (Figure 2.1).

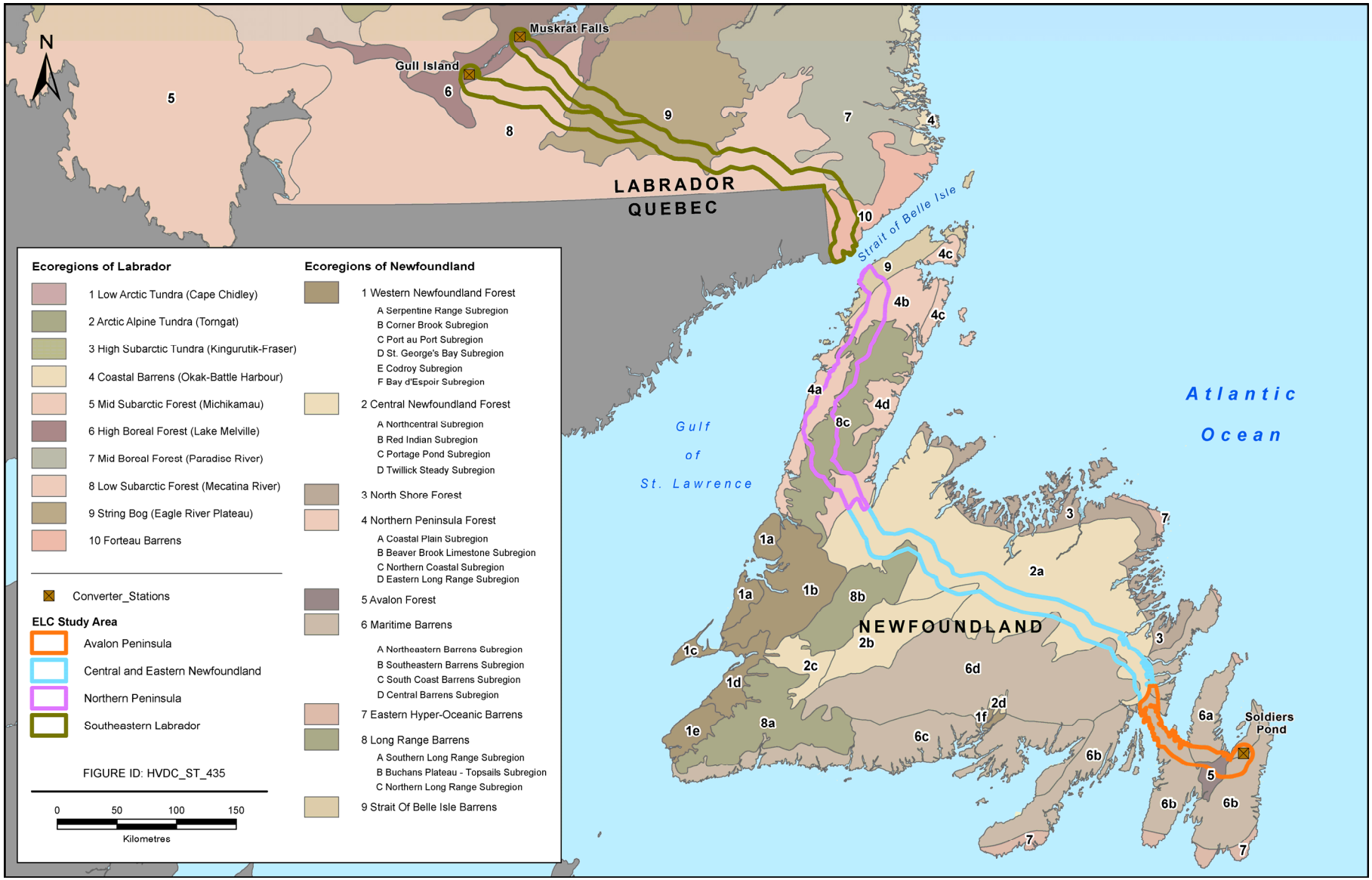
The study focuses primarily on the proposed transmission corridors, as well as an area approximately 15 km wide that encompasses these proposed and alternative transmission corridors from Central Labrador (Muskrat Falls or Gull Island) to Soldiers Pond on the Avalon Peninsula. This corresponds to the Study Area used in the regional ELC (Stantec Consulting Ltd. 2010, 2011) conducted as part of the Project environmental study program. This ELC has also formed the basis for the habitat potential mapping component of this study. The analysis and discussion, in many cases, is influenced by the nature of the existing and available information sources, including the areas covered in previous caribou surveys.

The Project, as described previously, will be approximately 1,100 km in length, and includes a number of associated components. As such, it will extend through a range of natural environments. The description of the natural environments follows the national ecological framework for Canada, a nested hierarchy that describes regional ecological units at multiple scales (Natural Resources Canada 2007). Larger ecological units encompass successively smaller ones. At the top of the hierarchy, Ecozones are defined based on generalized characteristics, and global and continental climate. There are 15 Ecozones delineated for Canada (Natural Resources Canada 2007), of which two overlap the Project: the *Boreal Shield Ecozone* and the *Taiga Shield Ecozone*.

The eastern extent of the *Boreal Shield Ecozone* overlaps Newfoundland, the Churchill River valley and the southeast coast of Labrador. Consisting of a massive rolling plain of ancient bedrock blanketed with gravel, sand and other glacial deposits, its topography is comprised of broadly rolling uplands that form poorly drained depressions covered by lakes, ponds and wetlands. The climate of the *Boreal Shield Ecozone* is generally continental, with long cold winters, short warm summers and abundant precipitation. Cool temperatures and a short growing season along with acidic soils influence plant life in the Ecozone. Most of the area is forested (primarily coniferous species, intermixed with hardwoods) and mixed with bogs, marshes and other wetlands. Lichens and shrubs are common on areas of exposed bedrock.

The *Taiga Shield Ecozone* occurs in the interior of southeastern Labrador, consisting primarily of coniferous taiga forest over bedrock associated with the *Canadian Shield Ecozone* south of the tundra. The terrain is broadly rolling, and the landscape is composed of many lakes and wetlands. The subarctic climate is characterized by short, cool summers and long, cold winters. Precipitation is considered low to moderate. The open, stunted

Figure 2.1 Geographic Regions for the Labrador–Island Transmission Link and Associated Ecoregions of Newfoundland and Labrador



forests are dominated by species such as black spruce, and are mixed with numerous bogs and other wetlands, scattered hardwood stands, and rock outcrops dominated by lichens and low shrubs.

These two Ecozones are further divided into a number of Ecoregions. Ecoregions are smaller land units within Ecozones that have distinctive, recurring patterns of vegetation and soil that are determined and controlled by local climate and geology (Stantec Consulting Ltd. 2010). Ecoregions also differ from each other in their combinations of plant communities, landscapes, geology and other features (Marshall and Schutt 1999; PNAD 2008). There are 19 Ecoregions within the province, nine in Newfoundland (Damman 1983) and ten in Labrador (Meades 1990). The proposed transmission corridor will pass through ten of these Ecoregions (Figure 2.1). A description of the Ecoregions and relevant subregions is presented in Table 2.1Table 2.1. Note, an additional Ecoregion (Mid-Boreal Forest-Paradise River Ecoregion) is included since it marginally intersects with the 15 km wide ELC Study Area.

Table 2.1 Ecoregions Crossed by the Transmission Corridor and ELC Study Area

Ecoregion
LABRADOR
High Boreal Forest-Lake Melville Ecoregion (Boreal Shield Ecozone) - encompasses the Churchill River valley and the coastal plain surrounding Lake Melville. River terraces are composed of coarse-textured, alluvial soils and uplands have shallow, well-drained soils. This region has the warmest climate in Labrador but summers are cool and winters cold. The forests are closed-canopied and relatively productive. Richer slopes are dominated by balsam fir, white birch and trembling aspen. Black spruce is present in most stands, but only dominates in upland areas and lichen woodlands, which occupy river terraces. Ribbed fens occur in upland depressions; plateau bogs occur on coastal plains.
Mid Boreal Forest-Paradise River (Boreal Shield Ecozone) - encompasses coastal areas of southeastern Labrador, from the area surrounding Sandwich Bay and south where it meets the Forteau Barrens Ecoregion. Undulating bedrock with many rock outcrops and fairly productive, closed-crown forests characterize this Ecoregion. The climate is considered boreal and is moister and cooler than the Lake Melville area. Summers are cool to warm and winters are short and cold. Black spruce and balsam fir are dominant tree species; hardwoods are also commonly encountered. Raised bogs are characteristic of valleys in the area.
Low Subarctic Forest-Mecatina River Ecoregion (Taiga Shield Ecozone) - the main portion of this Ecoregion is located in southern Labrador, with two separate areas to the north of Lake Melville and the Red Wine Mountains. Broad river valleys and rolling hills covered by shallow till, drumlins and eskers are characteristic of the region. Summers are cool and winters are long. Somewhat open black spruce forests are the dominant vegetation. String bog-ribbed fen complexes cover extensive areas throughout the region.
String Bog-Eagle River Plateau Ecoregion (Taiga Shield Ecozone) - includes the Eagle River Plateau, which comprises most of this Ecoregion. This upland plateau is composed of extensive string bogs with numerous open pools surrounded by fen vegetation. Bog hummocks are dominated by scrub spruce, Labrador tea and feathermoss. The peatland expanses are occasionally interrupted by only a few conspicuous eskers, which support open, lichen woodland. Alder thickets are common along river banks.
Forteau Barrens Ecoregion (Boreal Shield Ecozone) - is located at the southeastern tip of Labrador, adjacent to the Strait of Belle Isle. Low hills are covered with scrub spruce, crowberry barren and slope bogs. Strong winds and frequent storms occur because of the proximity to the Strait of Belle Isle. Tree growth is limited by a combination of wind, wet soils and a history of repeated burns. Black spruce and larch can reach 10 to 12 m only along rivers, where soils are better drained.
NEWFOUNDLAND
Strait of Belle Isle Barrens Ecoregion - is dominated by almost treeless tundra vegetation. White spruce and balsam fir occurs as krummholz (i.e., stunted forest), interspersed with Arctic-alpine plants near sea level. The soils are generally shallow and outcrops of calcareous bedrock are common throughout. Large stone polygons created by freeze-thaw cycles are common on shallow-exposed mineral soil. Rare and endangered species of calciphillic plants are numerous in these rock barrens.

Ecoregion
Northern Peninsula Forest Ecoregion - differs from most other forested parts of the Island by the shortness of the vegetation season. The frost-free period is similar to other areas and somewhat longer than central Newfoundland. Soils are comparable to those of western Newfoundland, with limestone underlying most of the region. Acidic rock is more common on the eastern side of the peninsula. Balsam fir is the dominant tree in the forest stands, except at high elevations on the eastern side of the peninsula, where it is replaced by black spruce. Limestone barrens are common along the west coast, with dwarf shrub and crowberry barrens on the east coast. Plateau bogs cover extensive areas of the coastal lowlands. ▪ *Coastal Plain Subregion* - includes the western side of the Northern Peninsula to the lower slopes of the Long Range Mountains. Most of the coastal plain is dominated by bogs and scrub forest. The area around Hawkes Bay and the foothills of the mountains are important exceptions to this generalization. ▪ *Beaver Brook Limestone Subregion* - occupies the central lowlands north of the Highlands of St. John on the Northern Peninsula. This sheltered outlier maintains the most productive forests in the Ecoregion. Limestone, shale and sandstone bedrock types occur in this area. The till is formed from sandstone on the western side of the peninsula, east and south of Ten Mile Pond. The landscape is undulating to hilly in the extreme west. The Dryopteris-Balsam Fir and Clintonia-Balsam Fir types are most common on moderate to deep tills. The Pleurozium-Balsam Fir and Black Spruce-Feathermoss on bedrock are dominant on shallow tills. Soil textures in these types are generally sandy loam to loamy sand. ▪ *Eastern Long Range Subregion* - Includes the productive but inaccessible forest on the eastern slopes of the Long Range Mountains up to 450 m in elevation. The forests tend to be somewhat open balsam fir-black spruce mixtures. The tree line decreases towards the northern end of the subregion.
Long Range Barrens Ecoregion - is a discontinuous region of highlands (Southern Long Range, Buchans Plateau-Topsails and Northern Long Range) from the southwest coast to the northern part of the Long Range Mountains. Most of the Ecoregion is characterized by rock barrens, with dwarf shrub heaths, shallow ribbed fens and areas of low, wind-stunted trees. ▪ *Northern Long Range Subregion* - encompasses the mountainous area above the tree line on the Long Range Mountains. Trees occur only as krummholz, which is usually dominated by eastern larch and black spruce; however, sheltered valleys may contain small patches of forest. The vegetation is primarily alpine barren, dominated by Arctic-alpine plants, or crowberry barren. Shallow ribbed fens and slope bogs often cover extensive areas.
Central Newfoundland Forest Ecoregion - has the most continental climate of any part of insular Newfoundland. It has the highest summer and lowest winter temperatures. Because of warm summers and high evapo-transpiration rate, soils in the northern part of this Ecoregion exhibit actual soil-moisture deficiency. The Hylocomium-Balsam Fir forest type is characteristic of this area. Forest fires have played a more important role in this Ecoregion's natural history than in other regions. Thus, much of the Balsam Fir-Feathermoss forest types have been converted to black spruce, and some of the richer site types are dominated by white birch and aspen. In areas that have been burned repeatedly, dwarf shrub (Kalmia) barrens have replaced forest stands. Raised bogs are the characteristic wetland type. ▪ *Northcentral Subregion* - has higher summer maximum temperatures, lower rainfall and higher fire frequency than anywhere else in Newfoundland. The subregion extends from Clarenville in the east to Deer Lake in the west and for the most part has a rolling topography below 200 m. Pure black spruce forests and aspen stands dominate this area because of the prevalence of fire. The high summer temperatures are also thought to stimulate aspen root suckering and contribute to the local success of aspen (Damman 1983). Relatively low moisture, coarse soils and the prevalence of black spruce cover types make this subregion particularly susceptible to regeneration failure. Furthermore, where tree regeneration is lacking, succession to dwarf shrub heath dominated by *Kalmia angustifolia* occurs on the nutrient-poor coarse textured till that is prevalent through much of this area. The rolling to undulating topography is characterized by shallow, medium-quality till, with a soil texture range from sandy loam to loam. Midslopes are dominated by the Hylocomium-Balsam Fir type or Black Spruce-Feathermoss type on gleysols after fire. There are also local areas covered by poor sandy till over glacio-fluvial deposits and outwash deposits along some of the major river systems, such as the Terra Nova, Exploits and Indian rivers. Succession of productive black spruce forest types to ericaceous heath dominated by *Kalmia angustifolia* is most prevalent in these land types.

Ecoregion
Maritime Barrens Ecoregion - extends from east to the west coast of Newfoundland along the south-central portion of the Island. This Ecoregion has the coldest summers, with frequent fog and strong winds. Winters are relatively mild, with intermittent snow cover, particularly near the coastline. The landscape pattern usually consists of stunted balsam fir broken by extensive open Kalmia barren, which developed because of indiscriminate burning by European settlers. Good forest growth is restricted to the long slopes of a few protected valleys. Slope and basin bogs are the most common wetland type. ▪ *Northeastern Barrens Subregion* - this subregion has lower fog frequency and somewhat warmer summers compared to other parts of the Ecoregion. Arctic-alpine species are absent from the heath vegetation and yellow birch is absent from the forest. The landscape is extensively forested with local heath vegetation, particularly along the coast. The tills are generally a shallow, rolling ground moraine with sandy loam to loam texture. The Hylocomium-Balsam Fir type occupies midslopes, and it is usually associated with gleyed podzols or gleysols. ▪ *Southeastern Barrens Subregion* - has landscape dominated by heathlands, with the forest occurring in small acreages that escaped fire. The dominant heath shrub on uplands is *Empetrum nigrum*, with *Kalmia angustifolia* forming a dense cover only in protected valleys. The topography is generally undulating with shallow heavily compacted till and numerous large erratics. The Clintonia-Balsam Fir type is most common where the forest is still present. Good forest growth only occurs in a few large, protected valleys where the Dryopteris-Balsam Fir type dominates the slopes. Good specimens of yellow birch are also found in these stands. ▪ *Central Barrens Subregion* - occurs south of the Central Newfoundland Forest Ecoregion and north of the South Coast Barrens Subregion. Residual forests that have not been destroyed by fire have moderate forest capability. The dwarf shrub heaths are robust and *Rhododendron canadense* is a conspicuous component, suggesting deep snow cover. Arctic-alpine species are poorly represented and yellow birch is absent from the forest.
Avalon Forest Ecoregion - represents a sheltered outlier within the more open and exposed Maritime Barrens Ecoregion. Pure stands of balsam fir with a high mixture of white and yellow birch dominate this region. The Avalon Forest Ecoregion has been spared the ravages of fire that decimated the forests in the surrounding landscape, converting them to open heathland. The very moist climate and ribbed morainal topography give this small (500 km^2) Ecoregion its uniqueness. Raised bogs occur between moraines. The excessive frequency of fog is clearly evidenced by the abundance of pendant, arboreal lichens hanging from the branches of balsam fir.
Notes: Sources: Meades (1990) for Labrador Ecoregions and Damman (1983) for Newfoundland Ecoregions.

Given the geographic scale of the Project and the resulting scope of this *Component Study*, the analysis and discussion that follows is structured according to the following geographic regions (Figure 2.1):

- *Southeastern Labrador* – area encompassing the Project components and activities at and near Gull Island or Muskrat Falls and the HVdc transmission corridor from the lower Churchill River to the Strait of Belle Isle. Ecoregions in the ELC Study Area for the transmission corridor from Gull Island (Option 1) are represented primarily by String Bog (32 percent) and Low Subarctic Forest (48 percent). The Mid Boreal Forest (2 percent), High Boreal Forest (3 percent) and Forteau Barrens (15 percent) Ecoregions are also present, but make up a relatively small portion of the ELC Study Area. In the ELC Study Area for the transmission corridor from Muskrat Falls (Option 2), the predominant Ecoregions are String Bog (35 percent) and Low Subarctic Forest (41 percent). The Mid Boreal Forest (2 percent), High Boreal Forest (6 percent) and Forteau Barrens (16 percent) Ecoregions make up the smaller proportion of the ELC Study Area.

- *Northern Peninsula* – The area encompassing the transmission corridor from the Strait of Belle Isle southwards to the Deer Lake area. Relevant Ecoregions along the Northern Peninsula include the Northern Peninsula Forest (50 percent), the Long Range Barrens (44 percent) and the Strait of Belle Isle Barrens (6 percent).

- *Central and Eastern Newfoundland* – The area encompassing the transmission corridor between approximately Deer Lake and Clarenville. The dominant Ecoregion in this portion of the ELC Study Area is the Central Newfoundland Forest (92 percent), with small amounts of the Long Range Barrens (2 percent) and Maritime Barrens (6 percent) Ecoregions.
- *Avalon Peninsula* – The area encompassing the transmission corridor and associated Project components from Clarenville to Soldiers Pond and near Conception Bay. The Avalon Peninsula ELC Study Area consists of the Avalon Forest (13 percent) and Maritime Barrens (87 percent) Ecoregions.

Management areas for caribou are also crossed by the transmission corridor in Labrador and Newfoundland and are presented in the respective Section of this Report.

2.2 Caribou Presence and Management in Newfoundland and Labrador

Caribou within Newfoundland and Labrador are classified as one of three ecotypes of boreal caribou: 1) sedentary; 2) migratory; or 3) montane (Thomas and Gray 2002; Boulet et al. 2005, 2007; Bergerud et al. 2008). The latter refers to caribou within the vicinity of the Torngat Mountains. Given their distance from the transmission corridor, this ecotype is not examined further in this report. The migratory ecotype is associated primarily with tundra habitats and can undergo extensive migrations between winter and calving grounds, while the sedentary ecotype is forest-dwelling and disperses seasonally (as opposed to migrates) during calving season (Bergerud et al. 2008).

The recognized caribou herds in Labrador and their occurrence by geographic region (as identified from the literature and through consultation with the Newfoundland and Labrador Wildlife Division), are presented in Table 2.2. Within Labrador, the province recognizes the George River Herd (GRH) as a migratory woodland ecotype that winters occasionally in the vicinity of the Study Area in Labrador (such as in 2009-2010). The Red Wine Mountains Herd (RWMH) and Mealy Mountains Herd (MMH) are sedentary woodland herds that overlap the Study Area in Labrador. Recently, the NLDEC determined distribution and range for sedentary caribou in the vicinity of the Joir River (Blake 2011), and have identified this group as a subpopulation of the MMH (I. Schmelzer, pers. comm.; Blake 2011). This group of caribou was first described in the literature as the 'St. Augustin' herd by Bergerud (1958). A second group, affiliated with the RWMH, was also described in the Dominion Lake area (Bergerud 1958). The Joir River subpopulation is linked to the MMH and to the Dominion Lake area (J. Blake, pers. comm.). Unless otherwise noted, in this report discussion of the MMH includes the Joir River subpopulation.

There are two options for the transmission corridor in Labrador: Option 1 (Gull Island to the Strait of Belle Isle); and Option 2 (Muskrat Falls to the Strait of Belle Isle) (see Section 3.2). The placement of these options means that different portions of the caribou herd ranges are overlapped. Option 1, the more southerly option, overlaps the southeastern portion of the RWMH range, runs along the northern edge of the Joir River subpopulation range and overlaps the southern portion of the MMH range. Option 2 overlaps the eastern portion of RWMH range and the southwestern end of the MMH range. Option 2 does not overlap the Joir River subpopulation range, but occurs between this area and the MMH range (see Figure 3.1).

Table 2.2 Caribou Herds in Labrador

Caribou Herd	Southeastern Labrador Region	Elsewhere in Labrador
George River	N	Y - range extends throughout central and northern Labrador
Lac Joseph	N	Y - southwestern Labrador
Leaf River	N	Y - primarily associated with Quebec
Mealy Mountains	Y	N
Red Wine Mountains	Y	Y - central Labrador
Torngat Mountains	N	Y - northern Labrador

Notes:

- Y=Yes, caribou herd occurrence; N=No, no caribou herd occurrence
- Primary sources of information are discussed for each herd in Section 3.0
- Occurrence in a geographic region is based on herd home ranges in Labrador. However, caribou may occur outside of these identified areas in any given year. Similarly, the indicated presence of caribou in any geographic region does not imply overlap with the Study Area

Source: Bergerud et al. 2008

Woodland caribou in Newfoundland are also classified as sedentary (NLDEC 2009a); however, several groups have been observed to undergo seasonal migrations. Understanding these movements is further complicated by the fact that not all individuals within these groups display seasonal migrations (P. Saunders, pers. comm.). The degree to which this occurs has not yet been fully investigated. Ongoing research programs by the Wildlife Division indicate that caribou distribution may not be best described using a 'herd' structure as previously done, but as "occurring throughout the province in various densities" (C. Dyke, pers. comm.). Caribou distribution in Newfoundland has most recently been described through the use of occupancy areas, which include information on intensity of use (Blake 2010, 2011; NLDEC 2011a). Appendix A contains further information on the previously recognized herds in Newfoundland and their overlap with the Study Area. Caribou are often managed according to recognized aggregations or herds in which individuals share common genetic characteristics and interbreed. Where physically isolated by barriers or distances, these herds may also be considered separate populations. In some situations, adjacent herds may belong to a larger metapopulation (Courtois et al. 2003). Metapopulations have been defined as "a collection of subpopulations, each occupying a suitable patch of habitat in a landscape of otherwise unsuitable habitat, forming an interconnected set of subpopulations that function together as a demographic unit" (Turner et al. 2001). Populations are spatially structured into local breeding subpopulations and migrations among subpopulations result in recolonization following local extinctions (Turner et al. 2001).

Note that for the purposes of this *Component Study*, the term 'herd' is retained where traditionally used and 'aggregation' or 'group' is used otherwise. Caribou management areas in Labrador and on the Island of Newfoundland are illustrated in Figure 2.2 and Figure 2.3, respectively. The NLDEC uses both "Zones" and "Areas" to describe caribou hunting areas in the province; for the remainder of this report, the term "Caribou Management Areas" is used. These management areas, as established by NLDEC, do not necessarily reflect the current understanding of caribou distribution on the island and do not necessarily represent caribou overlap with the Study Area (Table 2.2).

Figure 2.2 Caribou Management Zones in Labrador

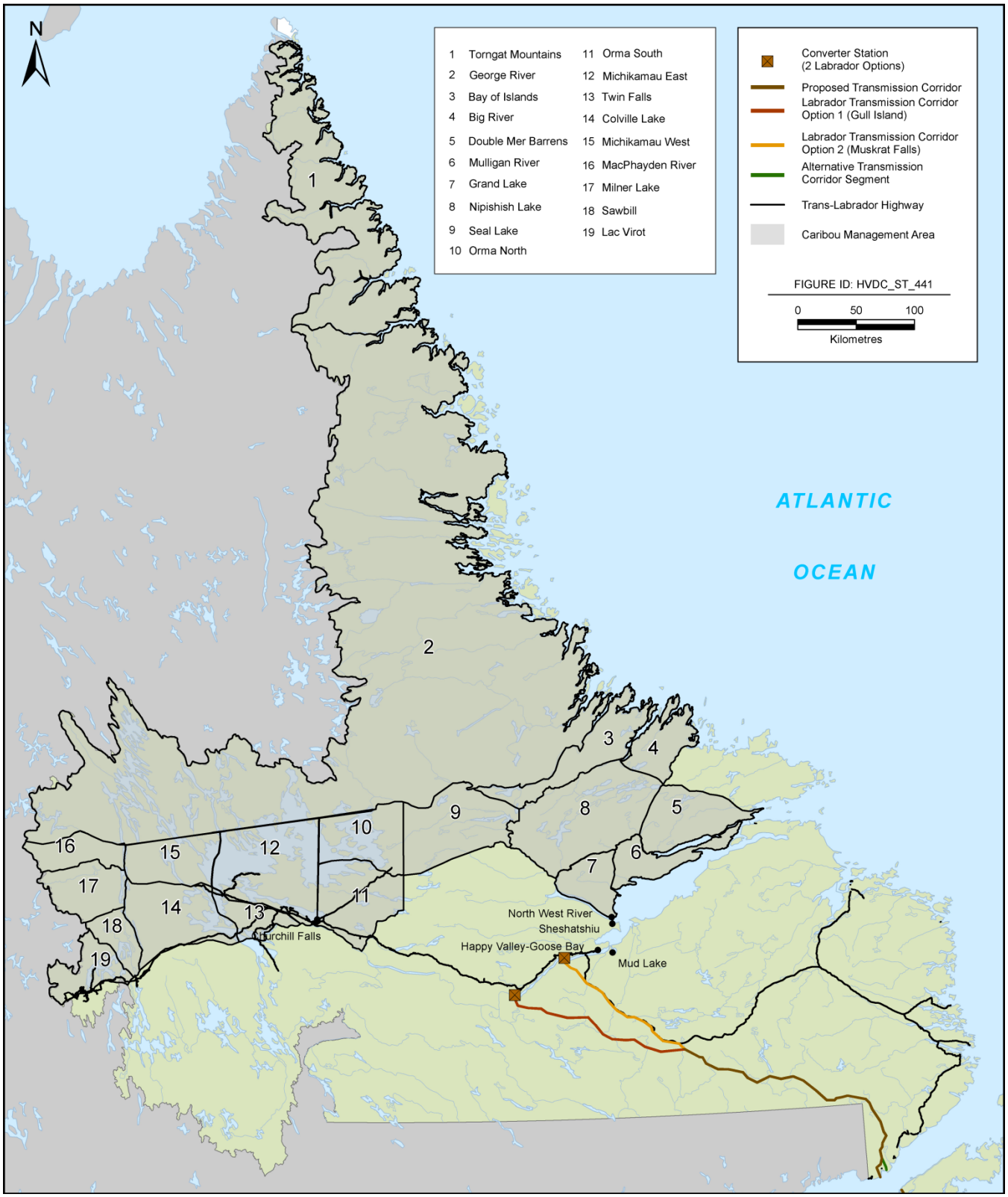
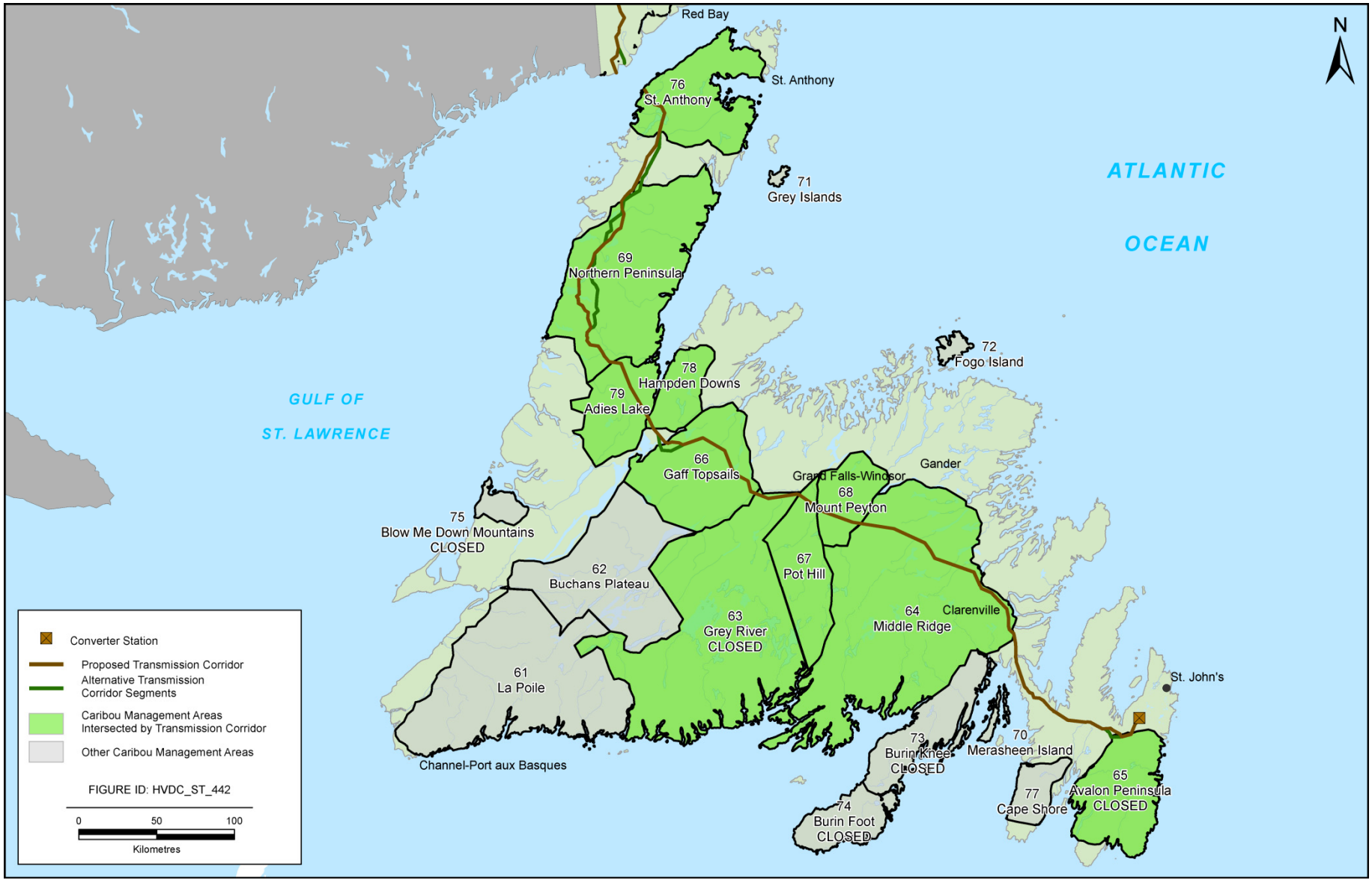


Figure 2.3 Caribou Management Areas in Newfoundland



In Labrador, it is legal to hunt the GRH within the management areas within the seasons defined in the *Newfoundland and Labrador Hunting Guide* (NLDEC 2010a). The RWMH and MMH have been closed to licensed hunting since 1972 and 1976, respectively (with the exception of a single licensed hunt permitted for the MMH in 1989). Hunting by Aboriginal people continued legally on the RWMH until 2002 (Schmelzer et al. 2004).

Both herds are listed as threatened by the Newfoundland and Labrador *Endangered Species Act* (*NLESA*) (NLDEC 2010b), which prohibits disturbing, killing, capturing, possessing or trading these caribou. They are also listed as threatened on Schedule 1 of the federal *Species at Risk Act* (*SARA*) (Species at Risk Public Registry 2010), which prohibits hunting and provides protection in the absence of provincial legislation. A provincial recovery team has been appointed for woodland caribou in Labrador and a strategy was released in 2004 (Schmelzer et al. 2004). In Newfoundland, the Study Area intersects ten management areas, of which some are currently closed to hunting (Figure 2.3).

2.3 Methods

This *Component Study* is based on research completed by the study team in support of this Project as well as on other research completed throughout Newfoundland and Labrador by others. Where relevant, studies from other jurisdictions were considered to supplement the understanding of existing conditions in Newfoundland and Labrador.

Initial meetings between Nalcor Energy and various provincial and federal government departments and stakeholders assisted in and focused the scope of the study by identifying and compiling potential information sources. Caribou are a key focus for the EA because of their occurrence throughout the province, importance as a dominant species in the ecosystem, and from a cultural and economic perspective, and because several herds are provincially and federally listed by *NLESA* and *SARA*, respectively, for special conservation status.

2.3.1 Information Identification, Compilation and Review

Information on caribou was compiled from library and internet searches and obtained through meetings with government departments and other organizations. An annotated bibliography describing relevant caribou studies completed in Newfoundland and Labrador during the past approximately 20 years is provided as Appendix B. Sources include published and unpublished reports, peer-reviewed journal articles, government documents, research theses, books, field guides, other articles and personal communications.

Various agencies and Government departments were contacted to obtain data and information on caribou and their predators with particular attention on the following:

- Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador
- Sustainable Development and Strategic Science, Department of Environment and Conservation, Government of Newfoundland and Labrador

Collected information was categorized and summarized according to:

- Author, date and title;
- Relevance to caribou;

- Status; habitat association; local range; or distribution and limiting factors. Additional information and knowledge regarding potential Project interactions with, and effects on this species, was also identified and retained for eventual use in the EIS.

The NLDEC currently has ongoing caribou research programs in the province. Recent results from this effort suggest possible changes in the understanding of distribution and movement patterns of woodland caribou. As much of this research is ongoing and is undergoing preliminary analysis, extensive discussions were held with NLDEC Biologists (including J. Blake, C. Doucet, I. Schmelzer, C. Dyke, P. Saunders, K. Miller, J. Fenske, G. Luther, K. Morgan, M. Trinidade, J. Weir and S. Mahoney) to help ensure that the NLDEC's latest information and interpretation of caribou distribution and abundance were accurately reflected in this report and the EA. As additional information is continually being collected, the NLDEC's understanding of caribou distribution and movement may change as new data are incorporated.

In addition to these data, several key caribou studies within Newfoundland and Labrador were identified that provide detailed information on several aspects of caribou ecology including:

- historical distribution (Folinsbee 1974, 1979; Pilgrim 1980, 1981; Brown 1986; Bergerud et al. 2008);
- current distribution (Chubbs et al. 2001, Mahoney et al. 2001a; Jeffery 2007a, 2007b, 2007c, 2007d, 2008a, 2008b, 2008c; Bergerud et al. 2008);
- movement patterns (Brown 1986, Mahoney et al. 2001a, Mahoney and Schaefer 2002a, Bergerud et al. 2008);
- demography (Brown 1986; Mahoney et al. 1990; Veitch 1990; Veitch et al. 1993; Snow and Mahoney 1995; Schaefer et al. 1999; Chubbs et al. 2001; Mahoney et al. 2001a; Mahoney and Virgil 2003; Schmelzer et al. 2004; Jeffery 2007a, 2007b, 2007c, 2008a, 2008c; Bergerud et al. 2008; Mahoney et al. 2008; Weir et al. 2010; Mahoney et al. 2011);
- habitat use and selection (Brown 1986; Brown and Theberge 1990; Snow and Mahoney 1995; Mahoney et al. 2001a; Mahoney and Schaefer 2002a; Mahoney and Virgil 2003; Schmelzer and Otto 2003; Bergerud et al. 2008; Mayor et al. 2007; Mayor et al. 2009; Trindade and Mahoney 2011); and
- limiting factors including predators (Brown 1986; Brown and Theberge 1990; Mahoney et al. 1990; Bergerud et al. 2008; Norman et al. 2009; Mumma et al. 2011; Ray et al. 2010; Trindade et al. 2010a, b; Ray et al. 2011).

Summaries of several articles are included in Appendix B. Directly relevant information on caribou within the Study Area from some of these studies is highlighted below.

Recovery Strategy for Three Woodland Caribou Herds (Rangifer tarandus caribou; Boreal population) in Labrador, Canada (Schmelzer et al. 2004) - The Labrador Woodland Caribou Recovery Team (LWCRT) has identified necessary recovery strategies required to protect and recover sedentary woodland caribou in Labrador. Sedentary woodland caribou have been designated as Threatened and listed under Schedule 1 of *SARA*. The primary goal is to prevent the extinction and improve the status of current herds until they are viable and self-sustaining populations. The document examines the historical and potential threats, as well as the ecological and cultural role of caribou in Labrador. The woodland herd ranges presented for Labrador were used as the basis for the comparison with the Study Area in this *Component Study*.

Forest Management Guidelines for Woodland Caribou (*Rangifer tarandus caribou*) for the Island of Newfoundland (Morgan and Doucet 2007) - This report identifies the distributions of caribou in Newfoundland, with respect to calving / post-calving and wintering areas. All available caribou location data, including satellite and GPS collar locations, were compiled from extensive research completed by NLDEC Wildlife Division. Home ranges / areas of concern were generated using GIS software. These polygons were the basis for the comparison of known caribou distribution and the Project as described in this *Component Study*. The provincial forest inventory (updated to 2005) was used to determine the amount of overmature forest in the core, buffer and migration areas. Recommendations were provided for forest management guidelines when working within or near woodland caribou core calving and wintering areas. These included the identification of 10 km buffers of woodland caribou core areas and migration corridors.

2.3.2 Ecological Land Classification Habitat Mapping

An ELC was completed for the Study Area (i.e., an area 15 km wide along the transmission corridor) from Gull Island in Central Labrador to Soldiers Pond on Newfoundland's Avalon Peninsula (Stantec Consulting Ltd. 2010). In addition, with the mid-November 2010 advisement of the Labrador corridor option from Muskrat Falls to the TLH-3, ELC mapping was completed for this corridor option (Stantec Consulting Ltd. 2011). The purpose of the ELC was to identify, categorize and evaluate vegetation types and associated habitats on a regional scale. Satellite imagery (Landsat 7 and Spot 5), forestry vector data (for Newfoundland), air photos, elevation and field survey data served as the foundation for the ELC study. A field survey program was subsequently designed to support a systematic remote-sensing-based mapping program. Based on the hierarchical framework for ELC in Canada (Marshall and Schutt 1999), the ELC study incorporated standard and well-validated methodology for describing ecological units, allowing comparisons of ELCs from other jurisdictions, including in Newfoundland and Labrador (Stantec Consulting Ltd. 2010, 2011).

The field survey program, completed in June and July of 2008, described the vegetation communities / Habitat Types within the ELC Study Area and verified ground information necessary for the remote-sensing mapping algorithms. Field teams consisted of a vegetation ecologist, wildlife ecologist and field technologist. Initial reconnaissance surveys along with existing spatial imagery identified areas that best represented the dominant habitat type within each Ecoregion in the ELC Study Area. Plots were then selected in the field in areas within a homogeneous cover and composition of vegetation, and were spaced as evenly as possible to ensure optimal distribution of ground-verified sites within the Study Area. Each of the 404 plots were approximately 400 m^2.

For each survey plot, vegetation was described for the tree, shrub and ground layers. Presence and abundance of plant species were then used to group the surveyed vegetation communities into Habitat Types. A total of 15 Habitat Types and a number of non-vegetated land classes were defined (Table 2.3). Existing satellite images and aerial photographs of the ELC Study Area were incorporated, along with the location of all surveyed sites, into a computer-based GIS to delineate identified Habitat Types. Maps were produced at scale of 1:50,000 and printed at a scale of 1:75,000. ELC habitat classifications formed the basis for the habitat mapping exercise for caribou herds or aggregations included in this *Component Study*.

Table 2.3 Habitat Types within the ELC Study Area

Habitat Type	Habitat Description	Distribution within ELC Study Area
Alpine Vegetated	Coniferous forest species widely spaced; large variety of shrub and ground cover	Exclusive to Newfoundland portion of the ELC Study Area
Black Spruce and Lichen Forest	*Picea mariana* dominates – these trees are widely spaced; little variety found in shrub or ground layers; *Cladina* sp. dominates ground cover	Exclusive to Labrador portion of the ELC Study Area
Burn	No forest cover; early invader shrub species present; little to no ground cover	Found in both Labrador and Newfoundland portions of the ELC Study Area
Conifer Forest	Coniferous species dominate but some deciduous present; large variety of shrub and ground cover	Found in both Labrador and Newfoundland portions of the ELC Study Area
Conifer Scrub	Stunted coniferous trees; variety of shrub and ground cover	Found in both Labrador and Newfoundland portions of the ELC Study Area
Cutover	A variety of coniferous and hardwood species, shrub and ground cover	Exclusive to Newfoundland portion of the ELC Study Area
Exposed Bedrock	Bedrock exposed; *Cladina* sp., *Trichophorum cespitosum*, *Empetrum nigrum*, and *Vaccinium* sp. make up the little ground vegetation present	Exclusive to Labrador portion of the ELC Study Area
Hardwood Forest	*Betula* spp. dominate but some coniferous species found; variety of species found in shrub layer and ground cover	Exclusive to Labrador portion of the ELC Study Area
Kalmia Lichen / Heathland	*Picea mariana* is dominant tree species; a large variety of shrub and ground cover	Exclusive to Newfoundland portion of the ELC Study Area
Lichen Heathland	No trees present; a large variety of shrub and ground cover	Exclusive to Labrador portion of the ELC Study Area
Mixedwood Forest	Both coniferous and deciduous tree species; *Kalmia angustifolia* is dominant shrub; a large variety of ground cover	Found in both Labrador and Newfoundland portions of the ELC Study Area
Open Conifer Forest	Two dominant coniferous species, widely spaced; variety of shrubs; lichens and mosses dominant ground cover	Found in both Labrador and Newfoundland portions of the ELC Study Area
Rocky Barrens	No forest cover; shrub layer comprised primarily of *Vaccinium* sp.; lichen and other ground cover	Exclusive to Newfoundland portion of the ELC Study Area
Scrub / Heathland / Wetland	Mosaic of Conifer Scrub, Kalmia Heathland and Wetland	Exclusive to Newfoundland portion of the ELC Study Area
Wetland	Three typical tree species (*Betula* spp., *Larix laricina*, *Picea mariana*); a large variety of shrub and ground cover species	Found in both Labrador and Newfoundland portions of the ELC Study Area
Note: Developed by Stantec Consulting Ltd. (2010).		

2.3.3 Data Analysis

Based on the findings of the literature review, a regional overview of the presence, abundance and distribution of caribou has been provided for the geographic regions described in Section 2.1. In terms of spatial overlap with the transmission corridors and ELC Study Area, winter habitat use was considered for migratory caribou while year-round habitat use was considered for sedentary woodland caribou, with particular focus on calving / post-calving and winter periods.

A complete description of the available information and existing environmental conditions for caribou and their predators was prepared according to:

- Primary Sources of Information – research completed within the past approximately 30 years in the province;
- Caribou Distribution in both Labrador and on the Island of Newfoundland:
    - Baseline Conditions – Current status, regional distribution and legislative status of the species within the province;
    - Habitat Association and Distribution – Species distribution and any regional differences, habitat relationships [according to Habitat Types identified by Stantec Consulting Ltd. (2010, 2011)] and extensive habitat mapping. Where they exist, data associated with the proposed transmission corridor were incorporated; and
- Predators and Other Limiting Factors – Hunting, trapping, predation and other factors.

Caribou distribution maps for both Newfoundland and Labrador were obtained from the NLDEC. Although both presented caribou distribution, the type of information obtained differed between Labrador and the Island. For Labrador, the range distribution was provided for the George River, Red Wine Mountains, and Mealy Mountains (including Joir River) herds as minimum convex polygons (MCPs) based on telemetry locations collected from collared caribou. MCPs represent range based on the inclusion of all areas between the furthest caribou collar locations. However, caribou may occur beyond the bounds of the MCPs and the MCPs do not reflect seasonal or annual range use or movements by individuals to adjacent herds (Blake 2011). Additionally, MCPs do not indicate frequency or amounts of use within the range. For Newfoundland, caribou distribution was provided as kernels which indicate areas of differing amounts of use based on telemetry locations from collared caribou. This approach to determining caribou distribution did not distinguish individual herds or groups but included locations from all collared caribou. Three levels of use were determined: Primary Core area, Secondary Core area and Occupancy Areas based on 50, 80 and 100 percent kernels, respectively (Blake 2011).

Based on the literature review and available data, habitat potential was assessed for caribou in Labrador and Newfoundland. Habitat identified in the ELC was qualified as:

- Primary habitat: has an abundance of the structural and compositional elements necessary to provide spatial avoidance from predators during the winter, calving and post-calving periods, as well as providing adequate forage (lichens), particularly during winter, and resting habitat;
- Secondary habitat: provides an abundance of one or two of the three elements (foraging, protection, or resting) or marginal amounts of all of the critical elements; or

- Tertiary habitat: provides marginal foraging, protection or resting opportunities or may only be used during transit.

A series of detailed habitat potential maps were subsequently generated based on the ELC Habitat Types identified by Stantec Consulting Ltd. (2010, 2011) (Table 2.3). Separate maps were produced for the Southeastern Labrador, Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula regions based on the coverage of the ELC. Maps were colour-coded to reflect habitat quality and to indicate the percentage of primary, secondary and tertiary habitat available within each of the larger geographic regions.

This evaluation and mapping of potential caribou habitat suitability is, as a result of the nature and extensive geographic scale of the Project and the regional focus of the ELC upon which it is based, intended to give an overview of the potential for portions of the ELC Study Area to support caribou. The mapping is not intended to indicate definitively whether caribou are currently found in a specific location. Rather, it provides a description of the potential use of an area at a regional scale across the Study Area. In this regard, the caribou habitat potential mapping should be considered in tandem with the information from the literature.

Caribou are a species of special conservation concern under federal (*SARA*) and provincial (*NLESA*) legislation. Where potential habitats are mapped for Labrador and Newfoundland caribou, it should be noted that these habitat ratings are not meant to denote 'critical habitat' or any other habitat definition as specified in *NLESA*, *SARA* or other applicable legislation.

2.4 Study Team

The *Caribou and Their Predators Component Study* for the Project was conducted by Stantec Consulting Ltd. The study team included a project manager, three regional leads and support personnel, data analysts, and administrative support (Table 2.4). Brief biographical statements, highlighting roles, responsibilities, relevant education and employment experience, are provided in Appendix C.

Table 2.4 Study Team and Respective Roles

Role	Responsible Personnel
Project Manager	Perry Trimper
Regional Leads	Perry Trimper
	Tina Newbury
	Elizabeth Way
Lead Report Authors	Karen Rashleigh
	Perry Trimper
	Rebecca Jeffery
	Shawna Peddle
Data Collection Support	John Pennell
	James Loughlin
GIS / Mapping	Stephen Rowe
	Jackie Bowman
	Chris Shupe
	Carolyn Pelley
	Zachary Bartlett
	Amber Frickleton
Senior Review	Rebecca Jeffery
Senior Advisor	Earle Hickey

The NLDEC Wildlife Division generously provided data and insight regarding specific caribou herds or aggregations, as well as shared their initial impressions of recent research in the province. Their contribution and cooperation are very much appreciated.

3.0 RESULTS AND ANALYSIS

An overview of the presence, abundance and distribution of caribou herds found in the vicinity of the transmission corridors and larger ELC Study Area is presented below based on existing literature and results of previous investigations.

3.1 Primary Sources of Information

Bergerud et al. (2008) provide extensive information regarding migratory (predominantly GRH) and sedentary ecotypes of caribou throughout Labrador and northeastern Quebec. Information on caribou within the lower Churchill River watershed is available, including decades of VHF (very high frequency) and satellite telemetry data collected by the NLDEC Wildlife and Sustainable Development and Strategic Science Divisions, Department of National Defence (DND), the Institute of Environmental Monitoring and Research (IEMR) and the province of Quebec, and aerial surveys spanning the 1960s to present (e.g., Bergerud 1963; Folinsbee 1974, 1979; Pilgrim 1981; Brown 1986; Brown and Theberge 1990; Veitch 1990; Veitch et al. 1993; Schaefer et al. 1999; Trimper and Chubbs 2003; Schmelzer et al. 2004; Jeffery 2007a, 2007b, 2007c, 2007d, 2008a, 2008b, 2008c). Surveys of the proposed transmission corridor in Southeastern Labrador in 1980 identified caribou and/or indications of their presence (Northland Associates Limited 1980a, 1980b). Information on herd ranges was provided by the NLDEC in 2011.

The Recovery Strategy prepared for sedentary woodland caribou herds in Labrador provides information on the RWMH and MMH (and the LJH not discussed here), including details on their distribution, herd status and limiting factors (Schmelzer et al. 2004). These are important source documents of research and management effort expended to date on these herds.

In Newfoundland, caribou distribution is based on satellite collar data collected by the NLDEC. Additional information on the biology, distribution and status of woodland caribou was available through various key sources, including Bergerud (1971, 1972), Mahoney et al. (1990), Snow and Mahoney (1995), Mahoney et al. (1998, 2001a, 2001b), Chubbs et al. (2001), Mahoney and Schaefer (2002), Mahoney and Virgil (2003), as well as communications with personnel from the NLDEC Wildlife Division in Corner Brook.

3.2 Caribou Distribution in Labrador

The GRH is representative of the migratory ecotype and the RWMH and MMH are examples of the sedentary ecotype of boreal caribou in Canada. These herds have seasonally or at least have historically overlapped one another in Labrador (Bergerud et al. 2008).

The most recent caribou distribution information for Labrador was provided to Nalcor Energy by NLDEC in early 2011 (Blake 2011). Determined using a Geographic Information System (GIS), the herd ranges are presented as minimum convex polygons (MCPs) based on collected telemetry locations. It is important to note that, due to the nature of the analysis, caribou may occur beyond the bounds of the MCPs and the MCPs do not reflect seasonal or annual range use or movements by individuals to adjacent herds (Blake 2011). The boundaries of these ranges differ than those published in the Recovery Document (Schmelzer et al. 2004), presumably due, in part, to the inclusion of eight years of additional data.

The GRH is the largest caribou herd in the province and at its peak was one of the largest in Canada. The size of the herd was recently estimated at approximately 50,000 caribou in 2011 (NLDEC 2011e). The GRH range covers approximately 900,000 km^2 (Schmelzer and Otto 2003), extending from the Happy Valley-Goose Bay and Hamilton Inlet area and northwards and westwards throughout Labrador and Quebec (Figure 3.1). Calving and rutting occur in the northern portion of the range, with animals migrating southwards to wintering grounds (Bergerud et al. 2008).

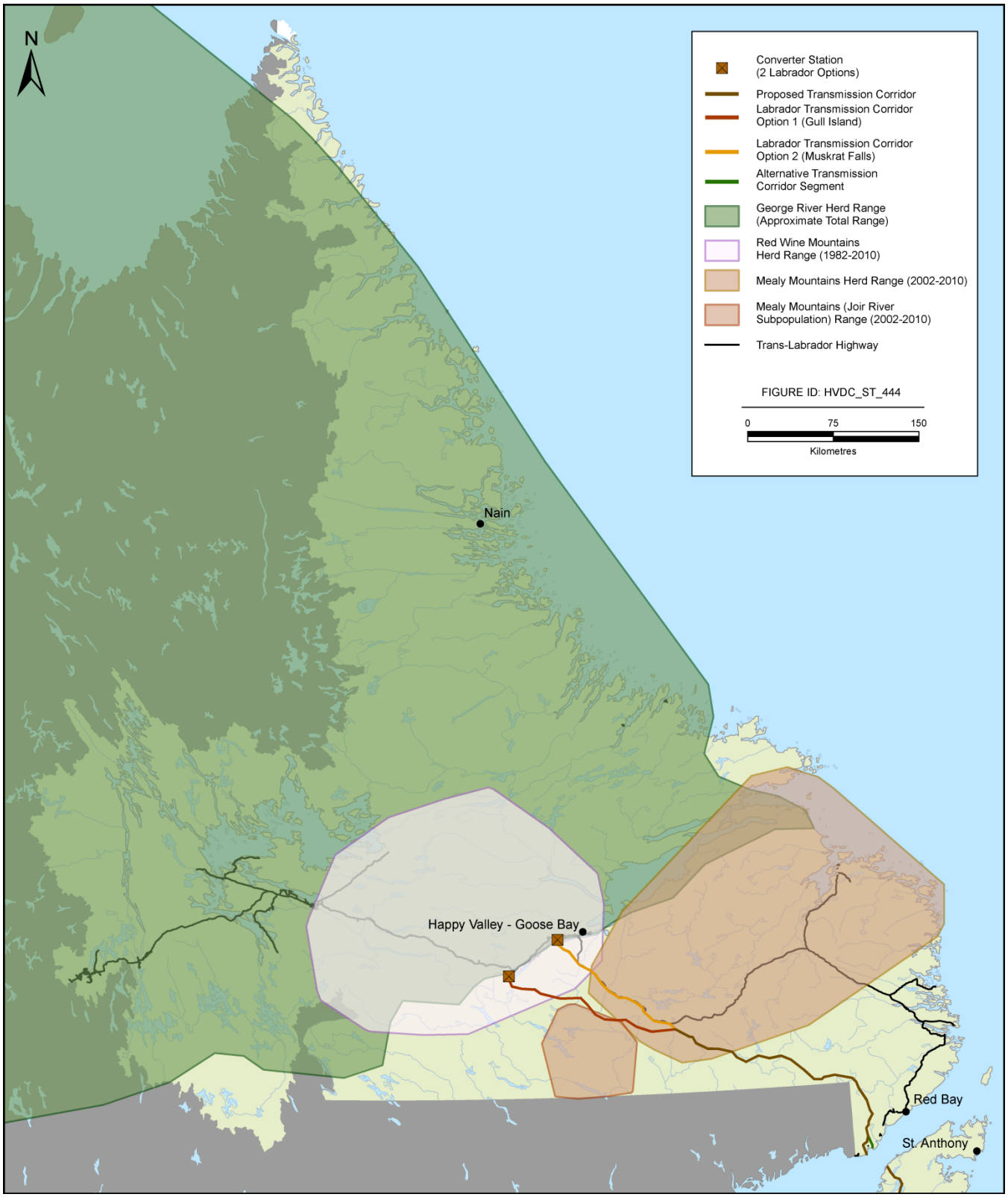
Size estimates for the sedentary herds that overlap the Study Area in Labrador are substantially lower: 97 in the RWMH (2001) and 2,106 in the MMH (not including the Joir River subpopulation) (2005) (Schmelzer et al. 2004; I. Schmelzer, pers. comm.). A minimum count of the Joir River subpopulation in February 2009 identified 110 caribou (J. Blake, pers. comm.).

The RWMH range covers approximately 46,000 km^2 in central Labrador (Schmelzer et al. 2004) (Figure 3.1). The MMH is the most easterly herd in Labrador, covering approximately 24,000 km^2 (Schmelzer et al. 2004) (Figure 3.1). The Joir River subpopulation range (approximately 5,420 km^2), which overlaps the southwest portion of the MMH range, includes the Joir River in the southeast, Minipi Lake in the west, and the Kenamu River in the North. Home ranges of some sedentary caribou herds in Labrador have more recently overlapped with the GRH during winter, resulting in some mixing (Schmelzer et al. 2004) (e.g., LJH and GRH mixing in some winters since the 1980s (Schmelzer et al. 2004), RWMH and GRH mixing in some winters since approximately 2000. In 2004, the Labrador Woodland Caribou Recovery Team released its recovery strategy for the sedentary herds, which outlines specific actions required for their protection (i.e., prevent extinction) and to aid their recovery.

Genetic research has identified a 'weak but significant global genetic differentiation' between the different ecotypes of caribou in Labrador and Quebec (Boulet et al. 2005, 2007). The research suggested the migratory GRH was distinct from the sedentary herds. Although the sedentary herds were not genetically distinct from each other, the amount of differentiation between sedentary herds increased with the distance between them (e.g. the MMH was most different from the LJH) and the MMH was considered the most genetically distinct of the herds evaluated. Other research also found genetic differentiation between sedentary woodland herds was greater with increased distance and suggested that these smaller groups may act as a metapopulation (Courtois et al. 2003). Telemetry data may suggest that there may be little separation between the Lac Joseph, Red Wine Mountains and Mealy Mountains herds as there is some overlap of ranges in during the rut, winter and spring (Couturier et al. 2009).

Boulet et al. (2005, 2007) concluded that the migratory and sedentary herds of northern Quebec and Labrador form a hierarchal metapopulation, with higher gene flow between the migratory herds and lower gene flow between the sedentary herds. Given this, Boulet et al. (2005, 2007) suggest management planning at two scales: (1) a fine-scale level for the sedentary herds, which qualify as management units; and (2) a large-scale level to maintain gene flow between migratory herds and between migratory and sedentary herds. Regarding intermixing between herds, Schaefer et al. (1999) reported 5 of 36 VHF radio-collared females moving from the RWMH to the GRH (although Bergerud et al. (2008) stated that as none of these females remained with this herd or survived until calving, they did not emigrate). Furthermore, the range and movements of the GRH do not overlap sufficiently with the sedentary herds to 'repopulate' any declining herds (NLDEC 2011d).

Figure 3.1 Caribou Herds in Southeastern Labrador



Source: Blake (2011)

Both sedentary and migratory caribou herds winter south of the tree line in areas with low snow cover and access to areas rich in terrestrial 'reindeer' (*Cladonia* spp.) lichens (Bergerud et al. 2008). However, during spring (calving / post-calving), the two ecotypes have developed different strategies to avoid predators: migratory caribou tend to calve in large groups in open areas north of the tree line; and sedentary caribou disperse and calve singly in forested area south of the tree line. The association north or south of the tree line is important, as wolves generally den along this boundary. Caribou calve in areas with the fewest predators, the least alternative prey to attract predators, and less than 75 percent snow cover (where their calves are well camouflaged). South of the tree line, sedentary caribou are widely dispersed during calving, which increases the search time for predators (Bergerud et al. 2008).

Although sedentary woodland caribou in Labrador are protected under the *NLESA* and *SARA,* in recent years there have been caribou hunts (both legal and illegal) in areas where hunting is normally prohibited. On occasion, the GRH is also present in these areas. Without genetic analysis, the exact numbers of MMH or RWMH caribou harvested cannot be ascertained. Annual harvest rates on the GRH between 1957 and 1992 ranged from approximately 3 to 6 percent of the herd (Bergerud et al. 2008). Between 1971 and 1999, the intensity of legal harvest in heavily hunted zones was estimated at 6.98 ± 0.86 caribou / 100 km^2 (based on the annual harvest rate) (Courtois et al. 2004). Currently, licenses to hunt the GRH are available to all residents of Labrador. The NLDEC Wildlife Division has several ongoing research initiatives on caribou in Labrador. As data are obtained, the understanding of caribou distribution is evolving.

The remainder of this section (Section 3.2) focuses on those recognized caribou herds (i.e., GRH, RWMH and MMH) that overlap spatially and temporally with the transmission corridors.

3.2.1 Baseline Conditions

Labrador's sedentary woodland caribou herds (including RWMH and MMH) are currently listed as *Threatened* under the *NLESA* and *SARA.* However, these herds were generally more abundant in the 1960s and historically occurred from Hudson Bay to the Labrador Sea. Now found in more interior locations, Bergerud et al. (2008) suggest that this may be due to the increase in hunting pressure from increased snowmobile availability and transportation networks. The change in range use and movement into Labrador might also be a response to heavy snowfall on wintering grounds in Quebec (Jacques Whitford 1997).

Between 1968 and 1989, estimates of the RWMH varied from less than 100 to 900, with most surveys reporting 600 to 800 animals, and a density of 0.03 caribou / km^2 (Folinsbee 1974, 1979; Pilgrim 1981; Brown 1986; Brown and Theberge 1990; Veitch 1990; Veitch et al. 1993). The 2001 census estimated 97 RWMH caribou remained (Table 3.1). Although recruitment rates (percent calves in a population at a particular age) suggested stability, the herd has declined over the past 20 years (Schmelzer et al. 2004). The most recent estimates (though not based on a complete herd census) indicate 75 RWMH caribou (I. Schmelzer, pers. comm.). In February 2007, 24 RWMH caribou were fitted with satellite collars (Jeffery 2007a). Observations at that time indicated that the majority of RWMH caribou were intermixed with the GRH, with the exception of one group (25 individuals) located south of the GRH (Jeffery 2007a).

Recent analysis indicates that wolf predation is the primary source of mortality of sedentary caribou in Labrador (NLDEC 2011d). When the GRH distribution overlaps that of sedentary woodland caribou, illegal caribou hunts can occur in the RWMH home range which could remove animals. However, the effect of hunting is additive to the mortality due to wolf predation and differed between populations (NLDEC 2011d). Recent recruitment

values are consistent with a stable population (Schmelzer et al. 2004), suggesting that recovery of the herd may be possible if the limiting factors suggested by the Recovery Team (including illegal hunting and predation) could be reduced. As adult female mortality rates are a concern, the future of the RWMH is uncertain (Nalcor Energy 2009). Unless the primary factors attributed to the decline of this herd are addressed (Bergerud et al. 2008), its decline will continue (Nalcor Energy 2009). A complete winter census of the RWMH was planned for 2010 to better understand its current health and status; however, the census could not be completed due to overlap with wintering GRH caribou (I. Schmelzer, pers. comm.).

The most recent estimates of the MMH (2002 and 2005) indicated a stable herd (Table 3.1) (I. Schmelzer, pers. comm.). Although the 2005 estimate (2,106 caribou) was less than the previous estimate (2,585 caribou in 2002), the difference between estimates was not statistically significant (I. Schmelzer, pers. comm.) and did not indicate a decrease in herd size. Recent information indicates that the MMH includes a subpopulation of caribou in the Joir River region (I. Schmelzer, pers. comm.). During a March 2008 survey of the Joir River area, 108 caribou were located (Jeffery 2008a) and a minimum count in February 2009 identified 110 caribou (J. Blake, pers. comm.). Despite the apparent stability in numbers in the MMH, information from satellite collared caribou may be indicating that 'the occupied range of the MMH may be dwindling, particularly in the extreme southern portions of the traditional range' (Schmelzer et al. 2004).

Table 3.1 Status of Caribou Herds in the Southeastern Labrador Region

Herd	Estimate (year)	Status – Increasing or Decreasing (# years[(a)])
Red Wine Mountains[(b)]	97 (72-189) (2001)	Decreasing (-87%, 20 years)
Mealy Mountains[(c)]	2,106 ± 1,341 (2005)	Stable (3 years)
George River	50,000 (2011)	Decreasing (-81%, 10 years)

Notes:

(a) Number of years since previous population estimate.

(b) While a complete census of the RWMH has not been conducted since 2001, the herd was estimated at 87 in 2003 (I. Schmelzer pers. comm.; Schmelzer et al. 2004). Since this time, minimum counts based on groups associated with collared females have been conducted during November (i.e., prior to the seasonal incursion of the migratory GRH) have estimated 80 caribou in 2007 and 75 caribou in 2009 (I. Schmelzer, pers. comm.).

(c) The estimate for the MMH in 2005 was lower than the 2002 estimate of 2,585; however, it did not represent a statistically significant decline. This does not include the Joir River subpopulation.

Table 3.2 Overlap of Caribou Distribution with the Transmission Corridors in Southeastern Labrador

Caribou Distribution by Transmission Corridor Option	Linear Distance (km)[(a)]
Option 1 (Gull Island)	
Red Wine Mountains Herd Range	49 (12%)
Mealy Mountains Herd Range	108 (26%)
Joir River Subpopulation Range	25 (6%)
Total Caribou Range	182 (44%)
Other Area (No Caribou Range)	232 (56%)
Total for Option 1	**414 (100%)**
Option 2 (Muskrat Falls)	
Red Wine Mountains Herd Range	41 (11%)
Mealy Mountains Herd Range	149 (39%)
Joir River Subpopulation Range	-- [(c)]
Total Caribou Range	190 (49%)
Other Area (No Caribou Range)	195 (51%)
Total for Option 2	**385 (100%)**

Note: All values were rounded to the nearest whole number

[(a)] Linear Distance (based on centreline of 2 km wide transmission corridor) indicates the length (km) of corridor that passes through occupancy area

[(b)] Percentages may not add up to 100% because caribou ranges may overlap

[(c)] No caribou range identified in that area

Although greater in numbers than sedentary woodland caribou herds, the GRH has also experienced a decline in recent years. Based on census data, age structure data, tree-root scars and recruitment / mortality statistics, Bergerud et al. (2008) identified an increase in GRH size from 1945 to 1988, followed by a decline during 1988 to 1993. The herd was estimated at 428,000 to 451,000 caribou in June 1993 (Bergerud et al. 2008). Other surveys in the same year estimated between 540,000 and 750,000 caribou (Couturier et al. 1996; Russell et al. 1996).

The June 2001 survey estimated 385,000 George River caribou (Couturier et al. 2004) while the most recent survey (July 2010) estimated 74,131 caribou (NLDEC 2010c). The NLDEC estimated the population at approximately 50,000 in late 2011 (NLDEC 2011e). Bergerud et al. (2008) suggest that it is important to determine whether the decline occurred between 1988 and 1993 or between 1993 and 2001; if the decline occurred in the former period, then "the population is no longer declining and is living more within its means". The GRH has undergone large scale population cycles over lengthy time periods of 40 to 70 years (NLDEC 2010b); this most recent low may not, therefore, be outside the realm of normal fluctuation. The GRH experienced extreme population lows in the mid-1910s [less than 30,000 (Bergerud et al. 2008)] and late 1950s [less than 5,000 (Banfield and Tener 1958)]. After the low in the 1950s, the population increased exponentially to 600,000 in the late 1980s (Bergerud et al. 2008). As the most recent population estimate has just been completed, it may not yet be understood where the GRH is in its population cycle.

In response to the most recent population estimate, there have been changes to the GRH caribou hunting regulations. There is currently no Total Allowable Harvest quota for the GRH (NLDEC 2010b). Prior to November 9, 2010, non-Aboriginal hunters were allowed two GRH caribou per hunter but are now limited to

one (NLDEC 2010d). Also, license transfer to other licensed hunters is no longer permitted and all commercial and non-resident hunting is suspended (NLDEC 2010d).

The provincial Recovery Strategy indicates that the sedentary woodland caribou herds in Labrador will require: the development of an education and stewardship program to nurture local support for caribou; identification and protection of critical habitat; continued population monitoring with focus on recruitment and mortality rates and causes of mortality; and, if necessary, implementation of intensive management and protection programs (Schmelzer et al. 2004). Additional details on the range, habitat features and other aspects of the GRH, MMH and RWMH are provided in relevant sections below.

3.2.2 Habitat Association and Distribution in the Study Area

In Labrador, the migratory GRH occupies habitats both north and south of the tree line, while sedentary caribou herds are associated with habitats south of the tree line. In general, habitats north of the tree line in Labrador are characterized by lichens, mosses and graminoids (Hearn et al. 1990). At lower latitudes, forest tundra and open lichen woodlands are characteristic, where dominant trees and shrubs are black spruce, white spruce (*Picea glauca*), eastern larch, alders (*Alnus* spp.) dwarf birch (*Betula glandulosa*) and willows (Hearn et al. 1990). Within these broad areas, caribou select habitats offering forage and/or protection from predators. In terms of relevance for the proposed Project, habitat discussion for the migratory GRH is limited to the winter period, as this is when the herd is most likely to occur in the Study Area. However, winter, calving and post-calving habitats are considered for the sedentary woodland caribou herds (RWMH and MMH) relevant to the Labrador portion of the Study Area.

3.2.2.1 Calving and Post-Calving Habitat (Sedentary Caribou)

During calving (late May to early June), female caribou of the sedentary ecotype disperse and seek birth sites with low predation risk (Bergerud and Page 1987; Bergerud et al. 2008), independent of lichen cover (Minaskuat Inc. 2009). They typically prefer peatland and mature black spruce forest, which provide refuge from predators (Stuart-Smith et al. 1997; Rettie and Messier 1998; James et al. 2004) and abundant lichen (Dunford 2003). Open water is often used for escape from predators (Bergerud 1985; Bergerud et al. 1990) and as such, habitats with adjacent muskeg are particularly important during calving (Le Hénaff and Hayeur 1983; Paré and Huot 1985; Brown et al. 1986; James et al. 2004; Bergerud et al. 2008).

Coniferous forests are also selected during summer (Chubbs et al. 1993), whether closed or open and with or without lichens (Courtois et al. 2008). However, Hins et al. (2009) found that mature closed forests 50 years of age or older were preferentially selected within individual female home ranges and that open black spruce lichen woodlands were frequented. Minaskuat Inc. (2009) similarly found that woodland caribou in Labrador selected open black spruce scrub habitats. As in winter, areas that support alternative prey would be avoided during summer as they may increase the risk of predation by wolves (e.g., hardwood forests and moose) (Minaskuat Inc. 2009).

3.2.2.2 Winter Habitat (Migratory and Sedentary Caribou)

During late summer and early fall, GRH caribou move south and west in search of fall and winter lichen ‘pastures’ and areas that will offer relief from deep snow (Bergerud et al. 2008; Minaskuat Inc. 2009). Within the Study Area, habitats with sparse trees that are rich in lichens are preferred (Bergerud et al. 2008). Coniferous forests provide arboreal lichens, an important forage item during winter, particularly in areas with deep snow

(Fortin et al. 2008). Terrestrial lichens are also used extensively during winter (Courtois et al. 2004; Fortin et al. 2008); caribou have been documented to dig craters up to 142 cm deep to reach forage (Brown and Theberge 1990). However, Courtois et al. (2003) found that sedentary caribou in Quebec (i.e., Manicouagan Herd) preferred closed conifer stands without terrestrial lichens and open conifer stands with or without terrestrial lichens.

Shallow snow can offer a reduced predation risk by allowing increased mobility (Bergerud et al. 2008). In this regard, frozen lakes and other ice-covered areas (e.g., wetlands, rivers) provide visibility and mobility advantages when wolves are encountered (compared to deep snow in wooded areas), and are often used to access new sources of food (Fortin et al. 2008). Ice-covered open areas are also selected presumably because winds reduce snowfall accumulation (Fortin et al. 2008). Minaskuat Inc. (2009) suggested the observed lack of selection for bogs was indicative of deeper snow conditions in this relatively open habitat, as well as low lichen cover. Known wintering areas occupied by sedentary ecotypes in Labrador (e.g., Red Wine Mountains, Mealy Mountains) are also characterized by low snowfall accumulation (Bergerud et al. 2008).

Areas that support alternative prey (e.g., mixed forests with moose) tend to be avoided as they may increase the risk of predation by wolves (Seip 1992; Fortin et al. 2008). Fortin et al. (2008) also state that woodland caribou avoided early successional forests, including recently burned and harvested forests.

3.2.2.3 Summary of Habitat Quality

Habitat quality of calving / post-calving and winter habitat in the ELC Study Area in Southeastern Labrador is summarized in Table3.3.. As transmission corridor options 1 and 2 differ in length and location, the composition of ELC habitat quality results also differ. For Option 1 (Gull Island), Low Subarctic Forest and String Bog are the predominant Ecoregions, comprising 48 and 32 percent of the ELC Study Area, respectively. The remainder of the Study Area consists of the Forteau Barrens (15 percent), High Boreal Forest (3 percent) and Mid Boreal Forest (2 percent) Ecoregions. During the calving / post-calving period, primary habitat comprises the majority at approximately 62 to 64 percent of the predominant Ecoregions in this portion of the Study Area, and 56 to 89 percent of the other Ecoregions. For the Southeastern Labrador (Option 1) region as a whole, 63 percent is comprised of potential primary calving / post-calving habitat. Secondary habitat comprises almost the remainder at approximately 30 percent of the predominant Ecoregions. Only a small portion is tertiary habitat and represents 6 percent or less of any Ecoregion in the ELC Study Area. During winter, primary habitat occupies between 28 and 56 percent of the Ecoregions in Southeastern Labrador, and 28 to 43 percent of predominant Ecoregions (Figure 3.3). For the Southeastern Labrador (Option 1) region as a whole, 39 percent is comprised of potential primary winter habitat. Secondary quality winter habitat is particularly common in this region, and comprises between 38 and 67 percent of Ecoregions, owing to the downgrading of wetland habitat to secondary quality during winter (Table 3.3, Figure 3.2 and Figure 3.3). The proportion of tertiary winter habitat is similar as for calving / post-calving habitat, forming 6 percent or less of any Ecoregion in Southeastern Labrador (Figure 3.2 and Figure 3.3). Table 3.4 summarizes the amounts of caribou habitat present within the Option 1 (Gull Island) corridor.

Table 3.3 ELC Habitat Type and Quality in Southeastern Labrador

Habitat Type[(a)]	Calving / Post-Calving	Winter	Comments
Black Spruce Lichen Forest	Primary	Primary	Continuous cover of lichens provides a source of food; predator abundance low (Courtois et al. 2004; Fortin et al. 2008)
Burn	Tertiary	Tertiary	No evidence of caribou was documented during 2008 surveys (Stantec Consulting Ltd. 2010)
Conifer Forest	Primary	Primary	As confirmed by Chubbs et al. (1993) and Courtois et al. (2003). One site contained evidence of caribou (tracks, scat) during surveys in 2008 (Stantec Consulting Ltd. 2010)
Conifer Scrub	Primary	Primary	Associated lichens provide forage (Courtois et al. 2003)
Exposed Earth	Tertiary	Tertiary	Non-vegetated
Hardwood Forest	Tertiary	Tertiary	No evidence of caribou was documented during 2008 surveys (Stantec Consulting Ltd. 2010)
Lichen Heathland	Secondary	Secondary	Three sites contained evidence of caribou (scat, tracks, trails) during surveys in 2008 (Stantec Consulting Ltd. 2010)
Mixedwood Forest	Tertiary	Tertiary	No evidence of caribou was documented during 2008 surveys (Stantec Consulting Ltd. 2010)
Open Conifer Forest	Secondary	Secondary	Primarily moss ground cover. One site contained evidence of caribou (trails) during surveys in 2008 (Stantec Consulting Ltd. 2010)
Wetland	Primary	Secondary	Reduced predation risk; in winter, provides refuge from deep snow and thus increases mobility. Three sites contained evidence of caribou (scat) during surveys in 2008 (Stantec Consulting Ltd. 2010)

Note:
[(a)] Habitat Types are described in Table 2.3

Figure 3.2 Caribou Calving / Post-Calving Habitat Quality: Southeastern Labrador – Option 1 (Gull Island)

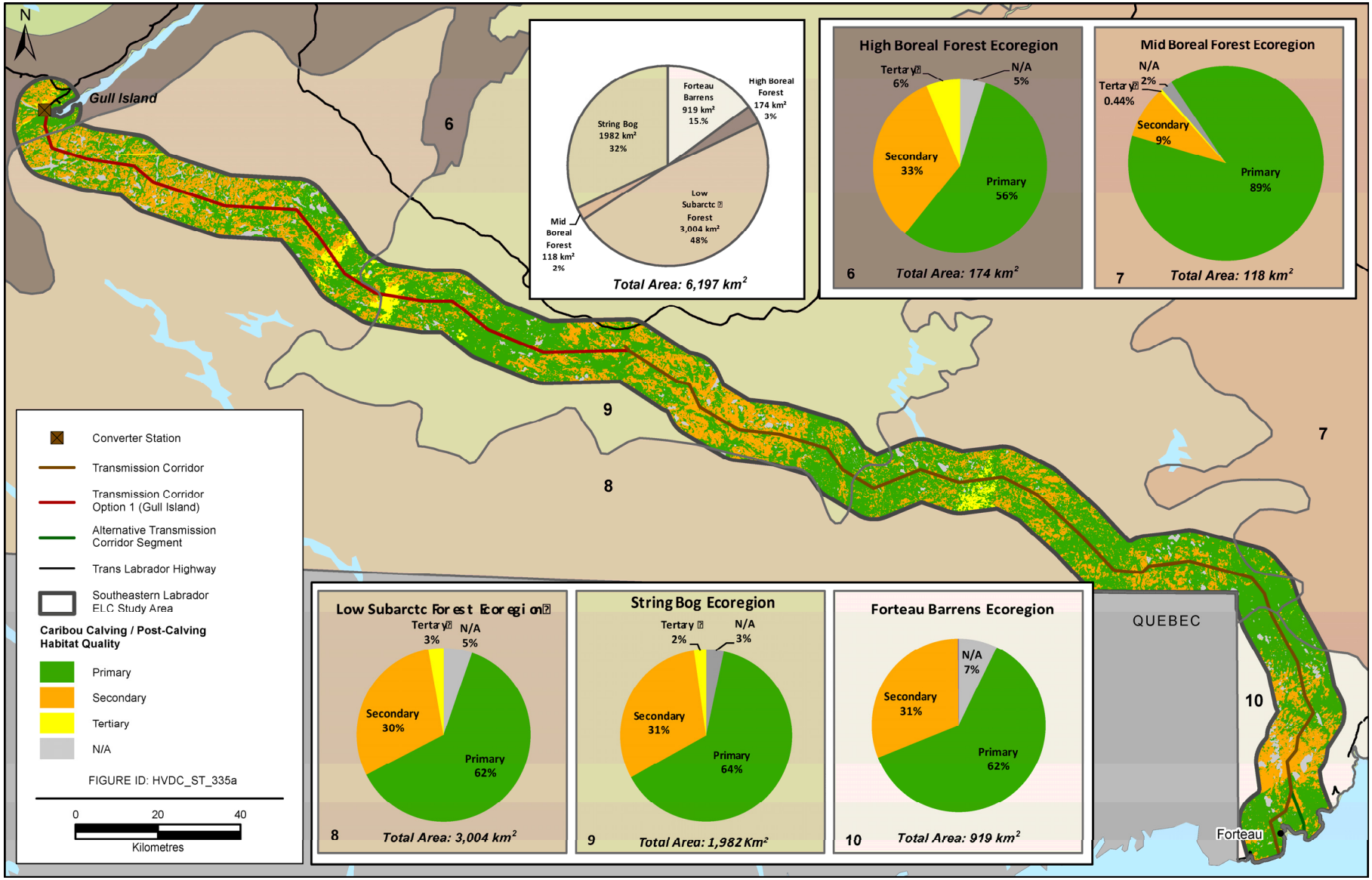


Figure 3.3 Caribou Winter Habitat Quality: Southeastern Labrador - Option 1 (Gull Island)

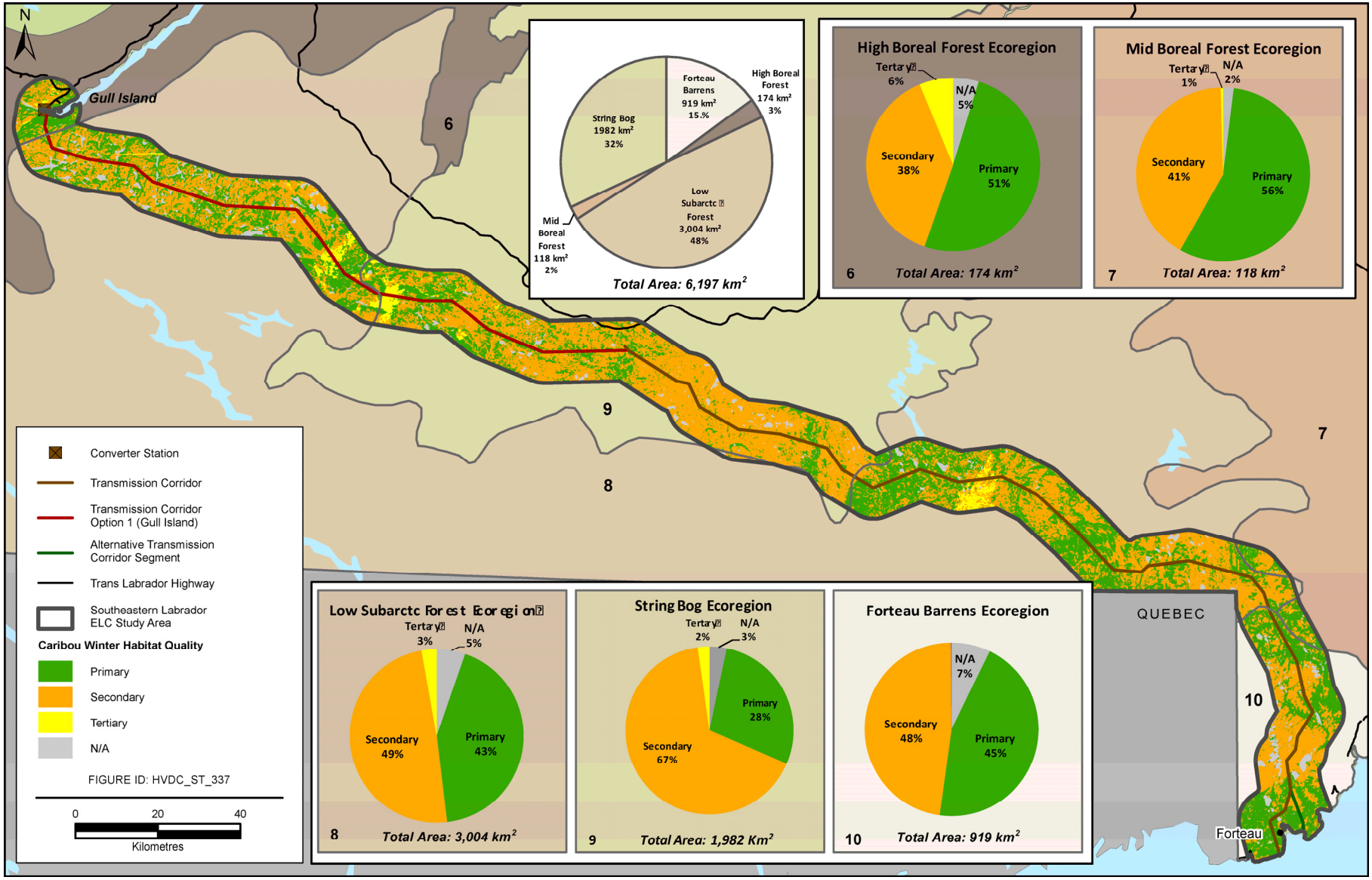


Figure 3.4 Caribou Calving / Post-Calving Habitat Quality: Southeastern Labrador – Option 2 (Muskrat Falls)

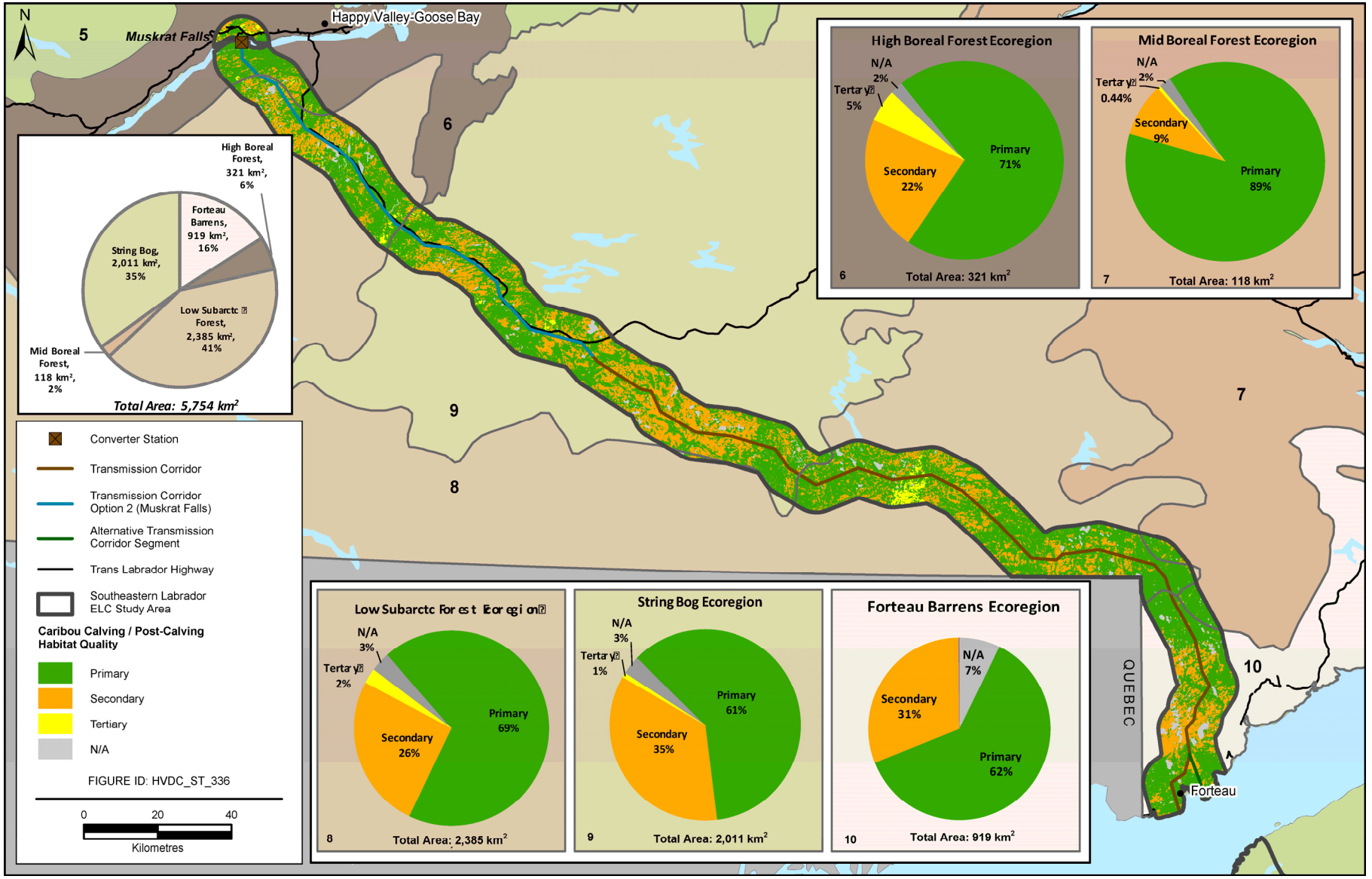

N
5
Muskrat Falls
Happy Valley-Goose Bay
6
9
8
7
10
QUEBEC
Forteau
High Boreal Forest, 321 km², 6%
Forteau Barrens, 919 km², 16%
String Bog, 2,011 km², 35%
Low Subarctic Forest, 2,385 km², 41%
Mid Boreal Forest, 118 km², 2%
Total Area: 5,754 km²
High Boreal Forest Ecoregion
N/A 2%
Tertiary 5%
Secondary 22%
Primary 71%
6
Total Area: 321 km²
Mid Boreal Forest Ecoregion
N/A 2%
Tertiary 0.44%
Secondary 9%
Primary 89%
7
Total Area: 118 km²
Converter Station
Transmission Corridor
Transmission Corridor Option 2 (Muskrat Falls)
Alternative Transmission Corridor Segment
Trans Labrador Highway
Southeastern Labrador ELC Study Area
Caribou Calving / Post-Calving Habitat Quality
Primary
Secondary
Tertiary
N/A
FIGURE ID: HVDC_ST_336
0 20 40
Kilometres
Low Subarctic Forest Ecoregion
N/A 3%
Tertiary 2%
Secondary 26%
Primary 69%
8
Total Area: 2,385 km²
String Bog Ecoregion
N/A 3%
Tertiary 1%
Secondary 35%
Primary 61%
9
Total Area: 2,011 km²
Forteau Barrens Ecoregion
N/A 7%
Secondary 31%
Primary 62%
10
Total Area: 919 km²

Figure 3.5 Caribou Winter Habitat Quality: Southeastern Labrador – Option 2 (Muskrat Falls)

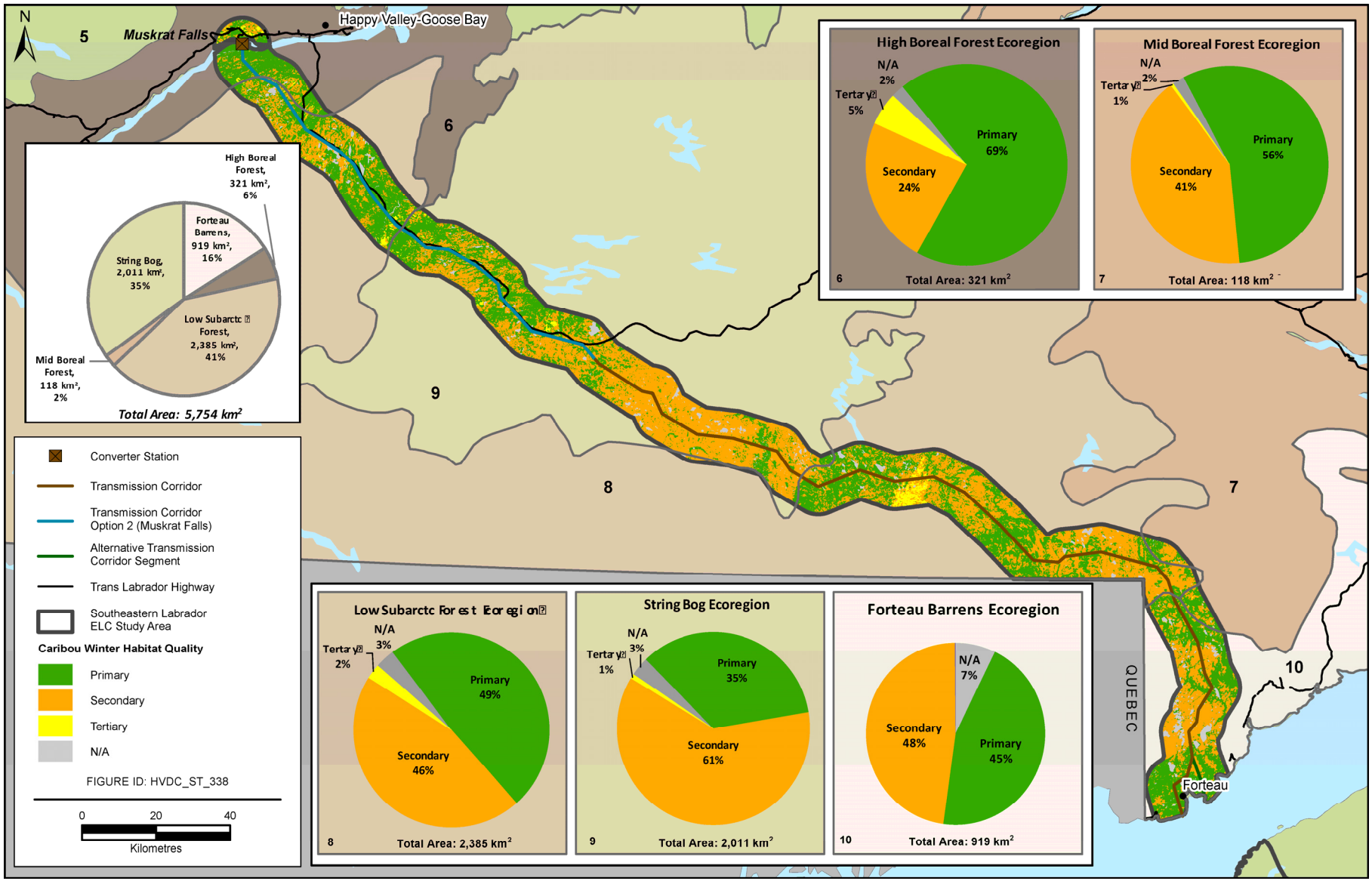


Table 3.4 Ranking of Caribou Habitat Present in the Study Area in Southern Labrador during Calving / Post-Calving and Winter Seasons – Option 1 (Gull Island)

Ecoregion	Amount of Ecoregion within Study Area (km^2)	Primary		Secondary		Tertiary		Non-Habitat Areas[(a)]	
		%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)
Calving / Post-Calving									
High Boreal Forest	174	56	97	33	57	6	10	5	9
Mid Boreal Forest	118	89	105	9	11	<1	<1	2	2
String Bog	1,982	64	1,268	31	614	2	40	3	59
Low Subarctic Forest	3,004	62	1,863	30	901	3	90	5	150
Forteau Barrens	919	62	570	31	285	--[(b)]	--	7	64
Total [(c)]	**6,197**	**63**	**3,903**	**30**	**1,869**	**2**	**141**	**5**	**285**
Winter									
High Boreal Forest	174	51	89	38	66	6	10	5	9
Mid Boreal Forest	118	56	66	41	48	1	1	2	2
String Bog	1,982	67	555	28	1,328	2	40	3	59
Low Subarctic Forest	3,004	43	1,292	49	1,472	3	90	5	150
Forteau Barrens	919	45	415	48	441	--	--	7	64
Total	**6,197**	**39**	**2,415**	**54**	**3,355**	**2**	**141**	**5**	**285**

Notes:

(a) Represents areas classified as Exposed Earth / Anthropogenic / Cutblock; Open Water; Shallow Water with Vegetation; Snow / Ice; Burn; and Cloud / Shadow

(b) No habitat identified within the Ecoregion

(c) All values were rounded to the nearest whole number therefore totals may contain rounding errors

Table 3.5 Ranking of Caribou Habitat Present in the Study Area in Southern Labrador during Calving / Post-Calving and Winter Seasons – Option 2 (Muskrat Falls)

Ecoregion	Amount of Ecoregion within Study Area (km^2)	Primary		Secondary		Tertiary		Non-Habitat Areas[(a)]	
		%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)
Calving / Post-Calving									
High Boreal Forest	321	71	228	22	71	5	16	2	6
Mid Boreal Forest	118	89	105	9	11	<1	<1	2	2
String Bog	2,011	61	1,227	35	704	1	20	3	60
Low Subarctic Forest	2,385	69	1,646	26	620	2	48	3	72
Forteau Barrens	919	62	570	31	285	--	--	7	64
Total [(c)]	**5,754**	**66**	**3,775**	**30**	**1,690**	**1**	**84**	**4**	**205**
Winter									
High Boreal Forest	321	69	221	24	77	5	16	2	6
Mid Boreal Forest	118	56	66	41	48	1	1	2	2
String Bog	2,011	35	704	61	1,227	1	20	3	60
Low Subarctic Forest	2,385	49	1,169	46	1,097	2	48	3	72
Forteau Barrens	919	45	414	48	441	--	--	7	64
Total[(c)]	**5,754**	**45**	**2,574**	**50**	**2,890**	**1**	**85**	**4**	**205**

Notes:

(a) Represents areas classified as Exposed Earth / Anthropogenic / Cutblock; Open Water; Shallow Water with Vegetation; Snow / Ice; Burn; and Cloud / Shadow

(b) No habitat identified within the Ecoregion

(c) All values were rounded to the nearest whole number therefore totals may contain rounding errors

3.2.2.4 George River Caribou Herd

The range of the GRH (Figure 3.1) is approximately 900,000 km^2 (Schmelzer and Otto 2003), encompassing most of northern Quebec and Labrador between 55°N and 60°N (Messier et al. 1988; Schmelzer et al. 2004) and includes tundra, forest-tundra and boreal forest habitat. Current summer ranges are in northern Labrador and Quebec, whereas winter ranges can extend to southern Labrador (Schmelzer and Otto 2003; Couturier et al. 2004). Although GRH caribou are continually on the move, Bergerud et al. (2008) identified an annual cycle of accelerated and decelerated movements that includes calving and post-calving (June and July), breeding (generally October) and an extended winter "pause" (late December to mid-February). The portion of the GRH range that occurs in the Study Area is inconsistently used only during the winter. As well, any use of the area by GRH caribou will be most likely by small groups of individuals rather than a large proportion of the herd.

The GRH calves above the tree line in upland areas with sparse vegetation and where lichens dominate the ground cover (RRCS 1989) in a large area traditionally referred to as 'Caribou House' (RRCS 1989; Bergerud et al. 2008). Tundra provides deciduous shrub for forage, open areas for insect relief and allows for the brown-coloured calves to be camouflaged, reducing predation risk (Bergerud et al. 2008). The open areas also reduce

the risk of predation on calves by providing space to avoid denning wolves (Bergerud et al. 2008). There is also a general scarcity of alternative prey in this habitat that would attract predators (Bergerud et al. 2008; Fortin et al. 2008).

Breeding (rutting) occurs in an area that overlaps both wintering and calving grounds [based on data from 1973 to 1993 (Bergerud et al. 2008)], although specific locations for rutting depend upon the speed and timing of migration from their summer range (RRCS 1989). During this period, males compete for access to females and undergo a dramatic weight loss due to rutting activities (RRCS 1989). If weather conditions are suitable following the rut, females will continue to fatten and the males may recoup some of their losses (RRCS 1989). Following the rut, movement generally increases as the caribou continue the migration to preferred wintering areas (Bergerud et al. 2008).

Winter locations of the GRH are widely spaced both above and below the tree line (Bergerud et al. 2008). Winter ranges are unpredictable for migratory caribou and may shift over time (Schaefer et al. 2000) in response to forage availability (Schmelzer and Otto 2003). In taiga regions, open black spruce lichen forests are frequently used (Bergerud et al. 2008); although areas with little snow (e.g., frozen lakes and wetlands) are also sought after as they reduce predation risk by allowing increased mobility (Bergerud et al. 2008). Caribou tend not to return to areas grazed during the previous winter, but select alternate sites with more abundant lichen (Schmelzer and Otto 2003). Access to winter forage is particularly important for the GRH because it may allow caribou to recuperate physically from the effects of summer forage limitations (Schmelzer and Otto 2003).

The inter-year distances between wintering areas can be up to 450 km (Schaefer et al. 2000) and result in a gradual shift of the winter range over time. In the late 1980s, most of the GRH wintered in black spruce forests in the area from Schefferville and Fermont west to the James Bay area, with some animals wintering in central Labrador (Couturier et al. 1990; Bergerud and Luttich 2003). Between 1984 and 1997, a large number of animals from the GRH wintered in the northern and western portions of the RWMH range (Schaefer et al. 1999). Adult male GRH caribou had a higher mortality rate than females (males - 14.1 to 24.0 percent, females - 5.1 to 17.3 percent) between 1984 and 1993 (Bergerud et al. 2008). The ratio of males to females is similar at the fetus stage, in favour of males up to six months of age, and then shifts to favouring females greater than ten months old, such that males comprise an estimated 38.3 percent of the GRH amongst adults greater than two years of age (Bergerud et al. 2008). Data on pregnancy rates, calf mortality, recruitment and age structure indicate a decline of the GRH after 1988 (Bergerud et al. 2008). One suggested reason for the decline has been the degradation and overgrazing of its summer range (Messier et al. 1988; Hearn et al. 1990; Crête and Huot 1993). Bergerud et al. (2008) also suggest that female body weight may be reduced if poor weather conditions in May (late spring) affect the ability to find food. This may indirectly affect calf survival as female weight is correlated with calf birth weight, which, in turn, affects calf survival (Bergerud et al. 2008). In addition, productivity (number of calves / 100 cows) has been highly variable in recent years and since 1986 has predominantly been below the threshold required for stability of the herd (Couturier et al. 2004).

The occurrence of the GRH in the Study Area is limited to winter and their presence in any given year is influenced by the amount of snow cover and risk of predation. When snow depths are relatively shallow, the majority of the GRH moves south of the tree line. Whereas when snow cover is deep, a large portion of the GRH remains above the tree line (Bergerud and Luttich 2003). Additionally, in heavy snow years, caribou may be more susceptible to predation by wolves and thus favour wind-swept tundra habitats where predation risk may be lower; when snow cover is low, risk of predation may be less and caribou will move into forested areas where lichens are more abundant (Bergerud and Luttich 2003).

3.2.2.5 Red Wine Mountains Caribou Herd

A small portion of the range of the RWMH, southeast of the Churchill River, is overlapped by both proposed transmission corridor options in Labrador. Within the 2 km wide transmission corridor, more RWMH range is overlapped by the Gull Island option than by the Muskrat Falls option; however, in both cases, this represents a small portion of the RWMH range (see Table 3.2).

Bergerud (1963) first reported the existence of the RWMH in 1958. The traditional range of the RWMH encompassed an area 26,000 km^2 in central Labrador (Brown and Theberge 1990) and included several major river valleys, string bogs, upland boreal plateaus and numerous water bodies (Schmelzer et al. 2004). The prominent feature of this range is the Red Wine Mountains, a 2,000 km^2 area at 600 to 900 m above sea level, surrounded by a plateau 400 m in elevation (Schaefer et al. 1999). More recently, the home range of the herd was estimated at 46,000 km^2, based on data from 1982 to 2004 (Schmelzer et al. 2004).

Prior to the 1990s, the RWMH used the forest-wetland matrix of the plateau for most of the year, shifting in late winter to tundra habitat, and then dispersing back onto the plateau in May in a southeasterly direction for the pre-calving dispersal period (Brown 1986; Bergman et al. 2000). However, since the 1980s, there has been an apparent shift away from the northern part of the range and from the Red Wine Mountains (Schaefer et al. 2001; Schmelzer et al. 2004). Caribou are also routinely observed south of the Churchill River, whereas before 1999, this was an unusual occurrence (Schmelzer et al. 2004). Bergerud et al. (2008) question this apparent shift as it is based on radio tracking collared caribou that were captured in different seasons and locations. Schmelzer et al. (2004) note the core area used by the RWMH has remained unchanged since 1993.

Four calving areas have been identified within the home range of the RWMH, the largest occurring between Happy Valley-Goose Bay and Winokapau Lake, covering an area north and south of the Churchill River (Schmelzer et al. 2004). Minaskuat Inc. (2009) modelled possible crossing locations for caribou along the lower Churchill River using telemetry data. Numerous potential crossing locations occurred along the eastern section of the lower Churchill River valley, with a relatively large number between Gull Island and Winokapau Lake. Ice observation surveys in March and April 2006 identified numerous caribou tracks in this area (Minaskuat Inc. 2009). Prior to 1999, few caribou crossed the Churchill River, whereas after this time, up to 50 percent of collared animals moved south across the river at least once yearly between 1999 and 2003 (Minaskuat Inc. 2009). In addition, some collared animals were detected only on the south side of the river between 2000 and 2004, despite being located to the north during previous years (Minaskuat Inc. 2009). These data may suggest that the southern portion of the RWMH range has increased in importance since the 1980s and 1990s (Minaskuat Inc. 2009).

Brown (1986) and Schaefer et al. (2000) found that female RWMH caribou showed strong fidelity to calving sites. Generally, calving areas are comprised of wetland-forest habitat, particularly bog and black spruce scrub stands, while disturbed [e.g., cut-blocks, Trans Labrador Highway (TLH)], young and hardwood dominated stands are avoided (Nalcor Energy 2009). After calving in early June, females and their calves remain dispersed until the rut in October, which usually occurs on wetlands in the southeastern part of the range (Brown 1986). A reduction in the size of the known RWMH calving range has recently been documented, such that the most northern and western portions are no longer being used to the same extent (Schaefer et al. 2001; Schmelzer et al. 2004).

During winter, caribou are typically associated with black spruce scrub habitat and tend to avoid disturbed sites (including burn, cut-blocks, cultural sites and linear features) (Nalcor Energy 2009). However, female caribou

were not found to avoid the TLH corridor during winter, possibly because habitat use at this time is driven more by forage availability than disturbance (Nalcor Energy 2009). When snow depths are particularly extreme, caribou may move towards the tundra and select for eskers and rocky outcrops where forage is more readily available (Nalcor Energy 2009).

Based on radio collared caribou from 1982 to 1988 and 1993 to 1997, Schaefer et al. (2001) found indications of four 'subpopulations' within the identified home range of the RWMH. These caribou occupied northern, southern, western and eastern areas of the range with shared use of some habitats (e.g., Red Wine Mountains). Higher adult female mortality and lower productivity were observed among caribou from the northern and western portions of the herd's range during the 1990s compared to the 1980s, possibly due to increased wolf predation during the periodic overlap with the GRH (Schaefer et al. 1999). Concurrent with this decline, the southern group more than doubled in relative proportion (Schaefer et al. 1999, 2001).

There are limited data on survival of adult female caribou within the RWMH (Nalcor Energy 2009). In a comparison of radio-collared females from 1981 to 1988 and 1993 to 1997, Schaefer et al. (1999) found that the survival rate decreased from 0.801 to 0.701, and the herd size decreased from 751 to 151 caribou between 1981 and 1997. Parturition rate did not vary significantly between the two study periods (74.2 and 71.0 calves / 100 females, respectively), although the rate of recruitment and the sex ratio (number of males / 100 females) decreased (Schaefer et al. 1999).

Recruitment rates for the RWMH have varied from a low of 8.9 percent during 1993 to 1997 to a high of 26.9 percent in 2003. Although this herd has now declined, recruitment data collected over a 22 year period (data from 11 winters) from 1981 (18.5 percent) to 2003 (26.9 percent) indicated a stable and increasing herd in the past (Schmelzer et al. 2004).

Adult female caribou mortality remains high and may be increasing as a result of predation, poaching and other factors, suggesting that recovery of the RWMH is far from certain even with stable recruitment (Schmelzer et al. 2004). Continued high adult female mortality severely limits the potential of the herd to recover and is contributing to their present decline (Schmelzer et al. 2004).

The Labrador Woodland Caribou Recovery Strategy identified the need to quantify high value caribou habitat so that high risk areas could be identified, and potential environmental effects or threats determined (Schmelzer et al. 2004). Monitoring of the RWMH is ongoing and has found that recently, the majority of animals are closely associated with the GRH during winter (Jeffery 2007a, 2008b), suggesting the potential for increased and continued poaching or accidental shooting (potentially unbeknownst to hunters) of animals from the RWMH.

3.2.2.6 Mealy Mountains Caribou Herd

The range of the MMH (Figure 3.1) covers approximately 28,000 km^2 extending from the Kenamu River in southern Labrador, northeast to Double Mer and Groswater Bay and south along the coast as far as the headwaters of the Alexis and St. Augustine Rivers (Schmelzer et al. 2004). Included in this range are offshore islands, coastal areas and the Mealy Mountains (Schmelzer et al. 2004).

Recently released data identify the Joir River group of caribou as a subpopulation of the MMH (Blake 2011; I. Schmelzer, pers. comm.). The range of the Joir River subpopulation, which overlaps the MMH range at its southwest margin, is approximately 5,420 km^2 and encompasses the Joir River and portions of the Kenamu River and Minipi Lake.

Both Labrador transmission corridor options overlap the MMH range. Option 1 (Gull Island) overlaps the northern edge of the range of the Joir River subpopulation and from there crosses through the southernmost portion of the MMH's range. Option 2 from Muskrat Falls does not overlap the Joir River range, nor does it cross between it and the associated MMH. The Muskrat Falls corridor option follows the existing TLH-3 through the southern edge of the MMH's range (Figure 3.1; Table 3.2).

The MMH experienced a decline from 2,400 in 1958 to 833 in 1963 (Bergerud 1967). During this time, hunting mortality was estimated at 26 percent (Bergerud et al. 2008). Between 1963 and 1971 (in the absence of legal hunting), numbers appeared stable until a second decrease was observed, with only 264 animals estimated in 1974 (Bergerud et al. 2008). Surveys between 1975 and 1977 indicated that most of these animals were concentrated in the Mealy Mountains and may have been somewhat protected from illegal hunting that was likely occurring (Bergerud et al. 2008). Beginning in 1975, the herd began to recover and was estimated at 1,371 caribou in the late 1980s (Schmelzer et al. 2004). Following indications of a decline (Chubbs 1994), the MMH was surveyed again in March 1997 (approximately 223 caribou) (Schaefer 1997); however, Schmelzer et al. (2004) suggest that these findings may not have been a reliable indicator of the herd size. Consistent with the decline in abundance since the 1950s, a reduction of the occupied range has also occurred. Although recent estimates (2002) indicate approximately 2,600 animals (Otto 2002) (similar to initial estimates in 1958 and representative of a growth rate of 2 percent annually since 1987), some traditional areas remain unoccupied or support few, compared to the occupied range in 1987 (Schmelzer et al. 2004). The observed reduction in size, both spatially and numerically, has been attributed to overhunting (Bergerud 1967; Schaefer 1997).

Calving / post-calving and winter ranges of the MMH have been calculated based on surveys of collared caribou between 2002 and 2004 (Schmelzer et al. 2004). The distribution of wintering caribou encompasses the Mealy Mountains and surrounding areas, extending southeast beyond Parke Lake (Schmelzer et al. 2004). A separate winter range has been identified that encompasses coastal areas between Groswater Bay and Sandwich Bay (Schmelzer et al. 2004). The Kenemich River marshes, on the south shore of Lake Melville, traditionally supported the MMH during winter; however, this area appears to no longer be used (Schaefer 1997; Schmelzer et al. 2004).

Although calving / post-calving ranges overlap portions of wintering ranges, they are distributed primarily in the areas surrounding the Mealy Mountains (Schmelzer et al. 2004), although some animals may remain in the Mealy Mountains (Hearn and Luttich 1987). The summer distribution of caribou identified by Schmelzer et al. (2004) is similar to data from 1987, with the exception of the area southwest of Parke Lake and east of the Mealy Mountains, where caribou were previously documented.

The distribution of the MMH in any given year is influenced by snowfall and/or other environmental factors, as has been shown with other herds (e.g., Brown and Theberge 1990). During years of heavy snowfall, caribou congregate and move towards higher elevations in the Mealy Mountains or onto bogs near Groswater Bay or those along the shore of Lake Melville (between Carter Basin and Etagaulet Bay) (Bergerud 1967; Hearn and Luttich 1987). With less snowfall, caribou may spread out into forested areas south of the mountains (Bergerud 1967). Recruitment in the MMH has varied considerably since the 1970s, from a low of 14.8 percent observed in 1974 to a high of 28.8 percent in 2002 (Otto 2002).

The TLH-3, which overlaps with the range of the MMH (Figure 3.1), was opened in December 2009 [Newfoundland and Labrador Department of Transportation and Works (NLDWST) 2009a]. Prior to construction, an EIS was completed that included a component study on the MMH (Otto 2002, 2003; NLDWST 2003).

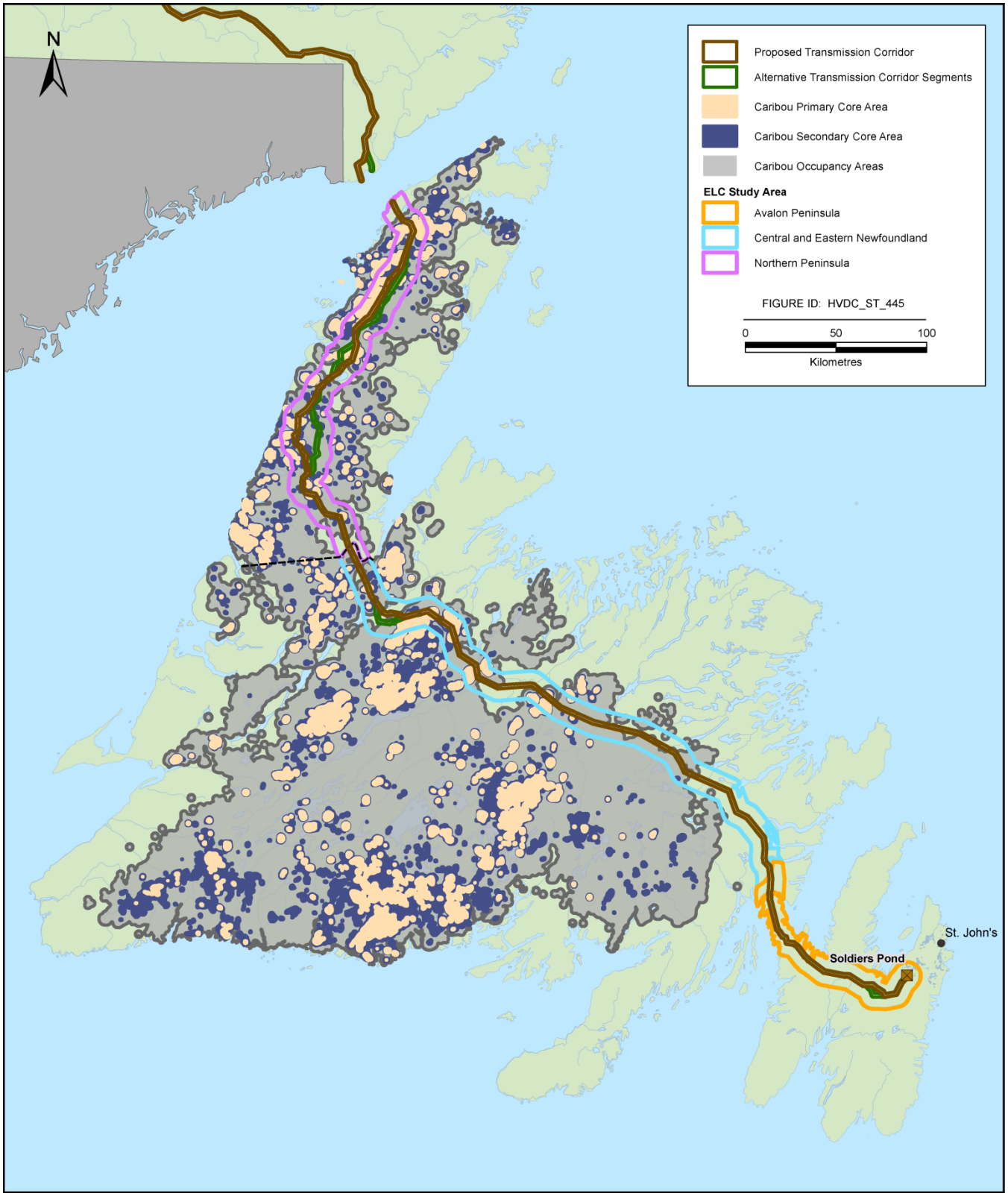
Pre-construction research (a June 2003 block survey of the two highway routing options) observed caribou in the northern option study area, while none were observed in the southern option study area (Otto 2003). The EIS recommended annual demographic surveys to estimate recruitment and survivorship, and a follow-up survey to estimate population size (Otto 2002). Of the two potential options, the NLDWST constructed the southern route (NLDWST 2009b). Results from post-construction monitoring suggest some avoidance of the TLH-3 by MMH caribou (I. Schmelzer, pers. comm.).

3.3 Caribou Distribution on the Island of Newfoundland

Woodland caribou in Newfoundland are part of the Boreal Population, and belong to the sedentary (forest-dwelling) ecotype (NLDEC 2009a), although some herds have traditionally exhibited behaviour similar to migratory caribou herds (C. Dyke, pers. comm.). Caribou are distributed over much of the Island in differing densities. Although certain areas receive considerably higher use than others, the overall home ranges of all herds cover the Northern Peninsula, central and southwestern Newfoundland, as well as the Avalon Peninsula. There has been a marked decrease of 66 percent in the caribou population in Newfoundland since the late 1990s (Soulliere et al. 2010b). NLDEC began research under a comprehensive five year Caribou Strategy in 2008 to better understand the status of the population (NLDEC 2009b).

The most recent information pertaining to woodland caribou distribution on the Island has recently become available (Figure 3.6) (Blake 2011). The NLDEC mapped the distribution of collared caribou in Newfoundland using telemetry locations collected between 2005 and May 2009. Kernel analysis was used in a GIS to determine areas receiving three different amounts of use by caribou (Primary Core area, Secondary Core area and Occupancy Areas based on 50, 80 and 100 percent kernels, respectively) (Figure 3.6) (Blake 2011). The kernels are inclusive, not additive, meaning the Occupancy Areas include the Secondary Core areas, which include the Primary Core areas. Kernel sizes were chosen to include caribou home range sizes; daily, seasonal, and yearly movements; and the distribution of protected area across the landscape and within the range of individual populations (NLDEC 2011a). Rather than designating calving and wintering areas as core areas as had been done in the past (e.g., Morgan and Doucet 2007) the current approach considers all areas of use over all seasons (NLDEC 2011a).

Figure 3.6 Caribou Distribution in Newfoundland based on Locations from Telemetry Collars, 2005-2009



Source: Blake (2011); NLDEC (2011a)

The overlap between caribou distribution and the transmission corridor in the Northern Peninsula and the Central and Eastern Newfoundland Regions is illustrated in Figure 3.7 and Figure 3.8, respectively. Note that there is no caribou distribution overlapping with the proposed transmission corridor in the Avalon Peninsula Region (Figure 3.9). Although the lack of occupancy areas in the Avalon Peninsula is due to the lack of collars currently deployed in this area (NLDEC 2010a; J. Blake, pers. comm.) rather than absence of caribou, the number of caribou in the region has declined greatly, which has led to the closure of that management area to hunting since 2004 (NLDEC 2011b). As the most recent delineation of core areas does not include caribou on the Avalon Peninsula (as there are no collars currently deployed in that area), the Wildlife Division has advised that the Morgan and Doucet (2007) core areas should be used in this region (J. Blake, pers. comm.). However, the core areas delineated using this method do not overlap with the Study Area; therefore, the Avalon Peninsula Region will not be discussed in detail in this report. For more information on the previously used core areas, see Appendix A (i.e., Morgan and Doucet 2007).

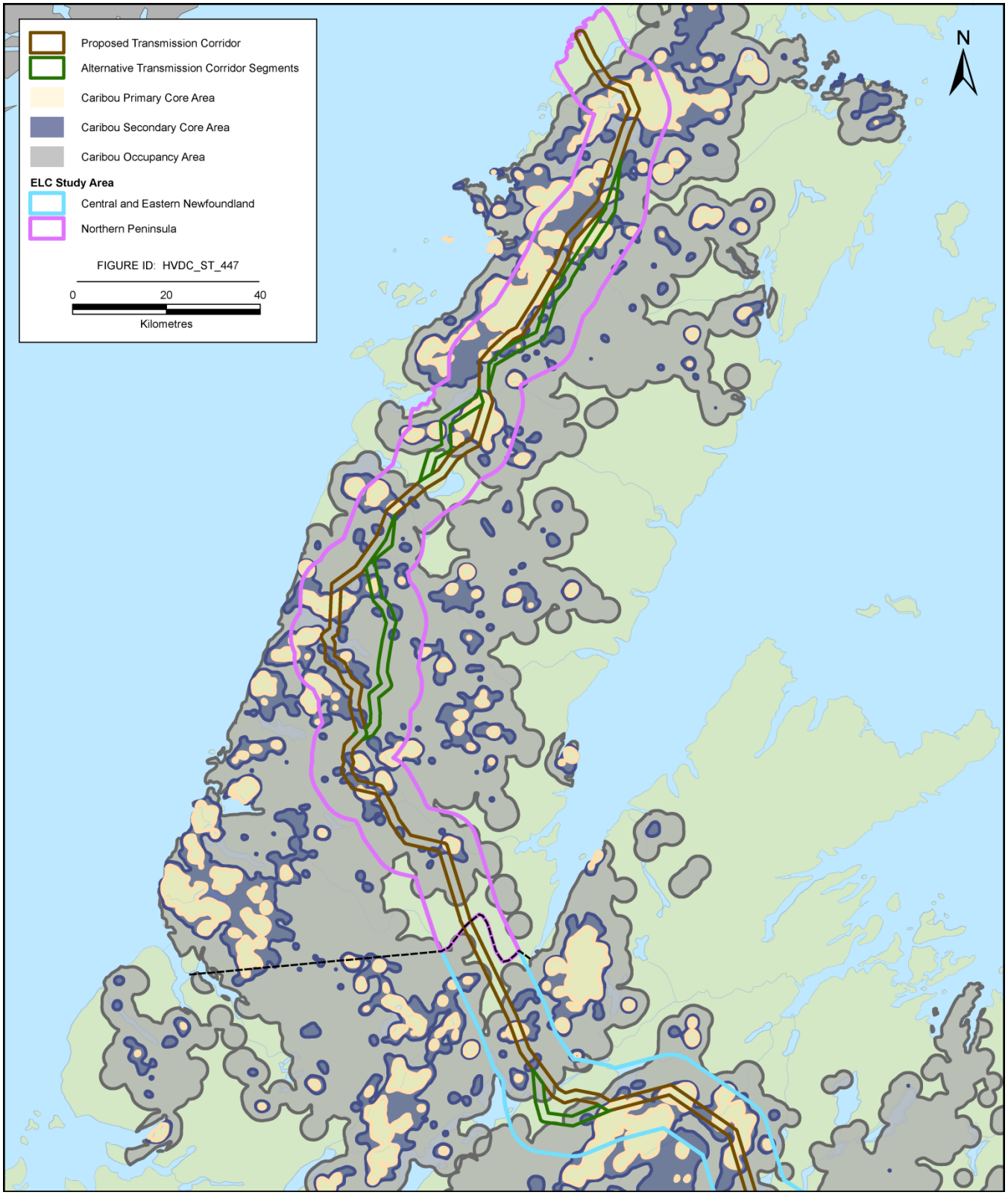
Historically, caribou in Newfoundland were common in the early 1900s, but declined rapidly between 1915 and 1930 (NLDEC 2009a). These herds remained relatively low in abundance until the 1970s, when total numbers increased to approximately 90,000 caribou in the late 1990s (NLDEC 2009a). Since this time, their abundance has again declined to an estimated 34,000 caribou in 2011 (Lewis et al. 2011b), representing a density of approximately 30 caribou/100 km^2 (NLDEC 2009a). In February 2008, the provincial government announced an extensive five-year research program and management strategy for Newfoundland's woodland caribou (NLDEC 2008a).

In contrast to Labrador, where wolves are a major predator of adult caribou and calves, black bear (*Ursus americanus*) and, more recently, coyote (*Canis latrans*), are the dominant predators on the Island. Preliminary research in Newfoundland has indicated that black bears accounted for 30 percent of deaths of radio-collared caribou calves while 15 percent were predated by coyotes (NLDEC 2009a).

Lynx (*Lynx canadensis*) have also been identified as a predator on the Island (Geist 1991; Thomas and Gray 2002). The Government of Newfoundland and Labrador is continuing to research predator-prey dynamics. This is proving difficult, however, due to the relatively large home ranges of both black bear and coyote combined with the expanding range of caribou calving areas in Newfoundland (NLDEC 2009a).

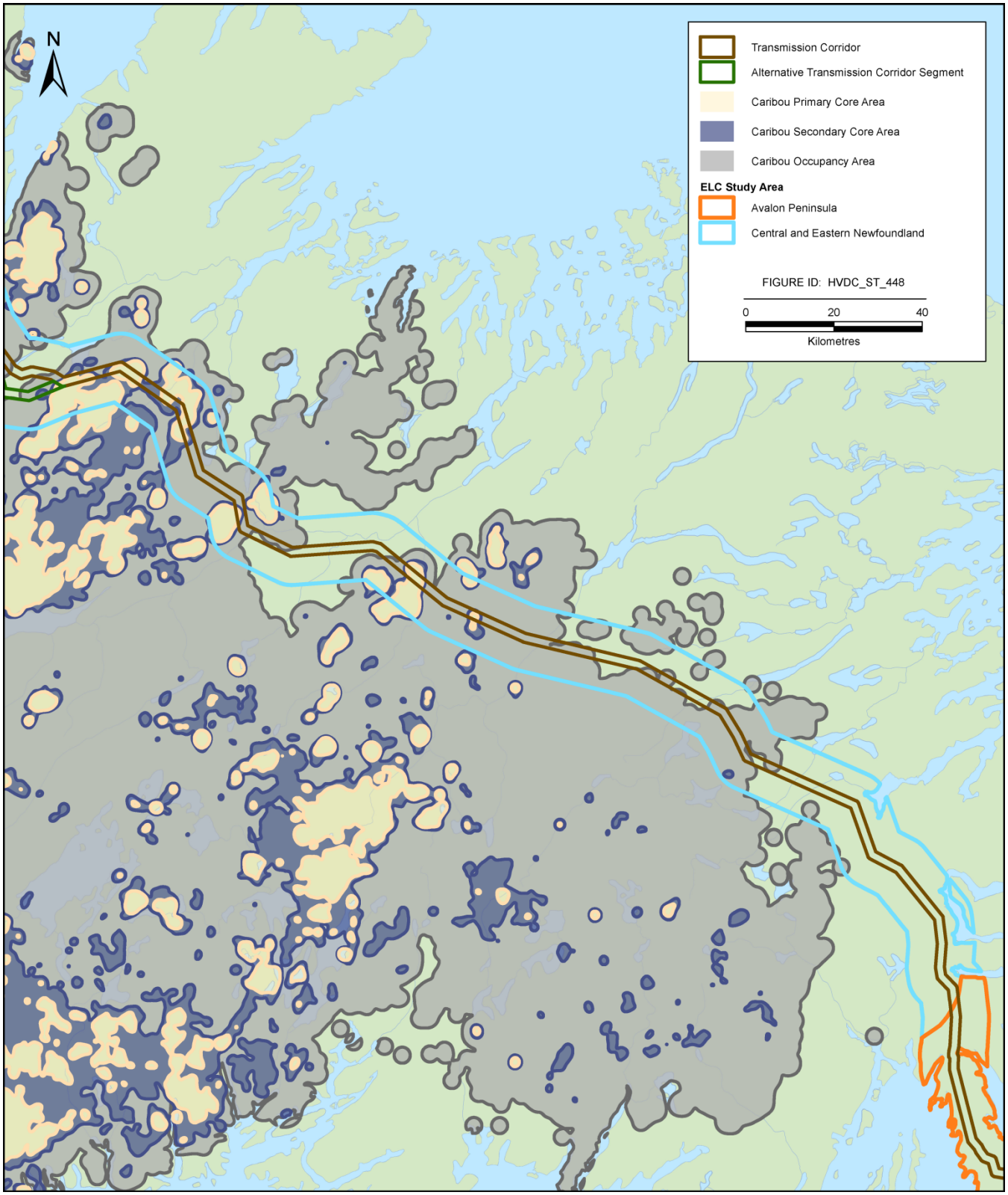
Despite the recent shift in the understanding of caribou in Newfoundland, caribou are still managed by herds as determined by calving areas (NLDEC 2008b). Although not protected under *NLESA* or *SARA*, several management areas are closed to caribou hunting (i.e., Grey River, Avalon Peninsula, Blow Me Down Mountains, Burin Knee and Burin Foot) (see Figure 2.3). Within open management areas, the quota for the 2010-2011 hunting season was 740 (NLDEC 2010a), a decrease of 140 caribou licenses from the previous year (NLDEC 2009b). Due to the recent decreases in caribou populations in Newfoundland since the late 1990s, the quota has been reduced by 6,990 licenses since 2001-2002 (NLDEC 2010a; Newfoundland and Labrador Department of Tourism, Culture and Recreation 2001).

Figure 3.7 Caribou Distribution in the Northern Peninsula Region based on Locations from Telemetry Collars, 2005-2009



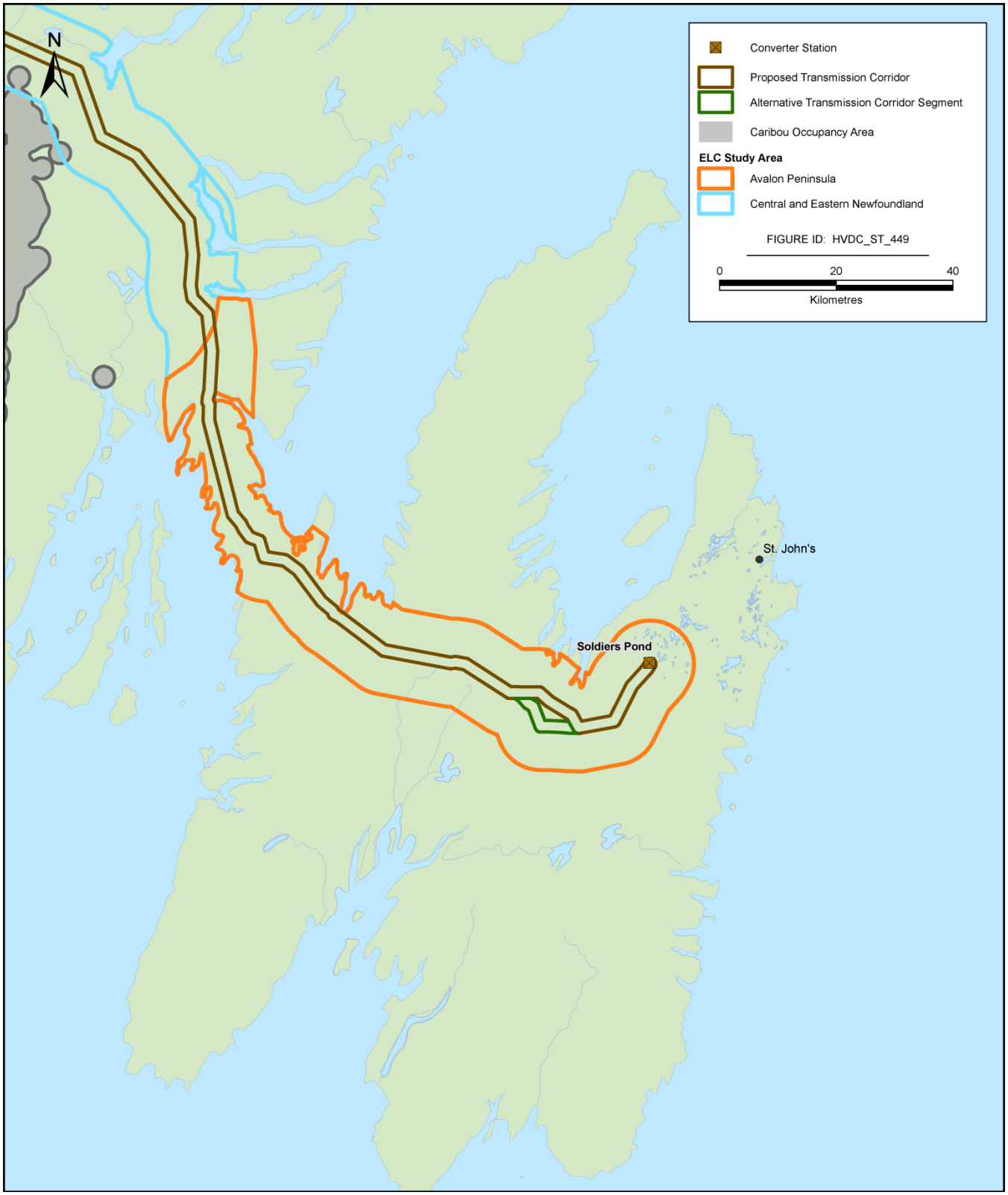
Source: Blake (2011); NLDEC (2011a)

Figure 3.8 Caribou Distribution in the Central and Eastern Newfoundland Region based on Locations from Telemetry Collars, 2005-2009



Source: Blake (2011); NLDEC (2011a)

Figure 3.9 Caribou Distribution in the Avalon Peninsula Region based on Locations from Telemetry Collars, 2005-2009



Source: Blake (2011); NLDEC (2011a)

3.3.1 Baseline Conditions

Unlike Labrador's woodland caribou herds, those in Newfoundland are not listed under *NLESA* or *SARA*, and woodland caribou on the Island do occur at a much higher density than in Labrador (30 caribou / 100 km^2 compared to three caribou / 100 km^2; NLDEC 2009a).

Caribou were considered abundant in Newfoundland during the early 1900s, but declined rapidly between 1915 and 1930 (NLDEC 2009a), possibly as a result of the introduction of a parasite associated with reindeer (Ball et al. 2001). Following this decline, caribou herds became centred in relatively inaccessible parts of their range (Thomas and Gray 2002) and remained in relatively low numbers until about the late 1990s (NLDEC 2009a). By 1995 the population was 116,604 (Trindade et al. 2010a) and by 2002, the range had again expanded (Mahoney and Schaefer 2002a) with densities at an estimated 150 caribou / 100 km^2 (Thomas and Gray 2002). Since that time, numbers have declined to 34,000 caribou (Lewis et al. 2011b) representing a density of approximately 30 caribou / 100 km^2 (NLDEC 2009a) that has led to hunting closures for some herds (Figure 2.3). Although results from recent surveys indicate that the declines may have slowed in certain parts of the island such as Middle Ridge (NLDEC 2010e; Mahoney and Soulliere 2011) and the south coast (NLDEC 2011c; Mahoney and Soulliere 2011), it also indicates that one of the largest issues facing caribou populations in Newfoundland is poor calf survival (Trindade et al. 2010b), and hence poor recruitment rates. Between 1979 and 1997 calf survivorship was approximately 66 percent but decreased to less than 10 percent between 2003 and 2007 in some populations (Mahoney and Weir 2009). However, calf survival rates have generally increased since 2007 (Mahoney and Soulliere 2011). The overall calf survival rate between 2003 and 2009 was approximately 18 percent and the 2010 rate was over 51 percent (Trindade et al. 2010b). The primary cause of calf mortality is predation with 94 percent of calf deaths attributed to predation; however predation rates and trends differ by region and by year (Trindade et al. 2010a). During periods of high population levels, the predation rate on calves was approximately 60 percent (1979 to 1997) but had increased to 83 percent between 2003 and 2007 (Mahoney and Weir 2009). Recent genetic analysis of predated calves is supporting earlier studies which have identified black bears and coyotes as primary predators of calves (Mahoney and Weir 2009; Mumma et al. 2011). Although calf mortality rates have increased, adult survival is high and is comparable to earlier estimates (1979-1997: 86 percent; 2004-2007: 84 percent) (Mahoney et al. 2008; Soulliere et al. 2010a). However, the overall age of the population is increasing (Mahoney 2008). Given the current demographic rates and limiting factors, the caribou population in Newfoundland is predicted to continue to decline (Mahoney 2008). Population models indicate that improved calf survivorship is necessary to increase population size (Trindade et al. 2010a) even with the cessation of hunting (Weir et al. 2010; Mahoney and Soulliere 2011).

Concurrent with recent declines in abundance, wildlife officials have documented changes in caribou behaviour in terms of distribution, migration, calving and wintering locations and occupied habitats (particularly since 2004)(C. Dyke, pers. comm.; P. Saunders, pers. comm.) and decreases in body size (decreases in jawbone size in adults, antler size in males, and calf weights) (Trindade et al. 2010b; Mahoney et al. 2010; Mahoney et al. 2011). While the exact cause of such changes remains unconfirmed, several factors that may be affecting caribou populations in Newfoundland include: increased predation; density-dependant mechanisms and/or changes in distribution; developments; snow and/or other weather conditions; and forest harvesting. Recent work is indicating that reductions in caribou body size may be due to forage-abundance relationships rather than caribou abundance or climate patterns (Mahoney et al. 2011). Research is also indicating that density-dependent competition for forage may be affecting changes in the timing of migration, as some populations spend less time on the summer grounds following periods of high population levels (Mahoney and Schaefer

2002b), and caribou diet, as the composition of the diet following high populations contain decreased amounts of lichen, possibly a result of reduced lichen availability due to overgrazing during peak population periods (Trindade and Mahoney 2011). Currently, however, there is no indication of malnutrition and body condition similar to that in 1997-1998 (Soulliere et al. 2010a).

As indicated previously, recent changes in caribou behaviour on the Island have resulted in changes in management approaches. As a result, estimates are only available for some herds and / or geographic areas.

The distribution of caribou on the Island is divided into areas receiving differing amounts of use by caribou: Primary Core areas (50 percent kernel); Secondary Core areas (80 percent kernel); and Occupancy Areas (100 percent kernel) (see Figure 3.6).The extent of caribou Occupancy Areas in Newfoundland is 57,304 km^2, which includes 14,240 km^2 of Secondary Core areas and 4,947 km^2 of Primary Core areas. The overlap between the proposed transmission corridor and these core and Occupancy Areas in Newfoundland are illustrated in Figure 3.6 to Figure 3.9 and Table 3.6.

Table 3.6 Overlap of Caribou Distribution with the Proposed Transmission Corridor in Newfoundland

Caribou Areas by ELC Study Region	Linear Distance (km)[(a)]
Northern Peninsula	
Primary Core	40 (17%)
Secondary Core	96 (41%)
Occupancy Area	213 (90%)
Other Area (No caribou occupancy)	23 (10%)
Total	**236 (100%[(b)])**
Central and Eastern Newfoundland	
Primary Core	27 (8%)
Secondary Core	53 (16%)
Occupancy Area	175 (53%)
Other Area (No caribou occupancy)	152 (47%)
Total	**327 (100%[(b)])**
Avalon Peninsula	
Primary Core	--[(c)]
Secondary Core	--
Occupancy Area	--
Other Area (No caribou occupancy)	123 (100%)
Total	**123 (100%[(b)])**
Newfoundland	
Primary Core	67 (9%)
Secondary Core	150 (22%)
Occupancy Area	388 (57%)
Other Area (No caribou occupancy)	298 (43%)
Total	**686 (100%[(b)])**

Note: All values were rounded to the nearest whole number

[(a)] Linear Distance (based on centreline of 2 km wide corridor) indicates the length (km) of corridor that passes through Occupancy Area

[(b)] Percentages may not add up to 100% because occupancy areas are inclusive, not additive (i.e., Occupancy Area includes Secondary Core area that includes Primary Core area)

[(c)] Caribou Occupancy Areas did not occur in this area

While caribou in Newfoundland are considered woodland caribou, some herds or aggregations have traditionally exhibited behaviour associated with barren ground or montane caribou. Additionally, there can be considerable overlap between herds or aggregations during winter and calving / post-calving periods, the degree of which has changed in recent years (C. Dyke, pers. comm.). Thus, there is confusion regarding the delineation of caribou herds, aggregations or populations. The concept of a metapopulation of caribou in Newfoundland has been discussed and recent genetic analysis has identified several distinct haplotypes (32) and grouped them into four different clades. Results indicated that, with the exception of the herds on the Avalon Peninsula, there is a lack of genetic differentiation among herds and regions indicating a large amount of genetic exchange, or mixing, among most herds in Newfoundland, especially in the central region (Wilkerson 2010). There is a haplotype present in the St. Anthony herd that is also present in several central herds, but absent from the Northern Peninsula herd, which is located in between (Wilkerson 2010). Additionally, the haplotypes present in the Avalon and Cape Shore herds are distinct from the rest of the island herds (Wilkerson 2010). With the exception of the herds on the Avalon Peninsula, there is a lack of genetic differentiation among herds and regions indicating a large amount of genetic exchange, or mixing, among most herds in Newfoundland, especially in the central region (Wilkerson 2010).

3.3.2 Habitat Association and Distribution

Newfoundland occurs within the *Boreal Shield Ecozone* (Natural Resources Canada 2007). Most of the area is forested (primarily coniferous species, with hardwood species), mixed with bogs, fens, marshes and other wetlands. Lichens and shrubs are common on exposed bedrock. Within Newfoundland, woodland caribou are considered sedentary (NLDEC 2009a), although they undergo seasonal dispersions [as described by Bergerud et al. (2008)], as well as exhibit migratory behaviour, at least historically, between calving and wintering areas (C. Dyke, pers. comm.). While forage and habitat preferences are similar on the Island and in Labrador, there have been several studies focusing particularly on caribou in Newfoundland. Information from these studies is presented in terms of winter, calving and post-calving habitats.

3.3.2.1 Calving / Post-calving Habitat

During spring, caribou in Newfoundland feed preferentially on broad-leaved evergreen (e.g., Empetrum sp., Ledum sp, Kalmia sp., Andromeda sp., and Vaccinium sp.) and deciduous shrubs and sedges and deciduous shrubs, reindeer lichens and fungi in summer (Bergerud 1972). Woodland caribou exhibit a preference for mature coniferous forests during summer (Chubbs et al. 1993), with or without the presence of terrestrial lichens (Courtois et al. 2008). Bergerud (1971) noted that few caribou were observed in Newfoundland during summer as they were generally under trees during the day to escape harassment by flies.

As with woodland caribou elsewhere, female caribou seek calving sites with low predation risk (Bergerud and Page 1987; Bergerud et al. 2008). Mahoney and Virgil (2003) found that adult caribou in western Newfoundland selected rock and heath barrens and virgin and mature forest stands significantly more than other habitats during the calving / post-calving period. Hardwood and softwood scrub were also preferred (Mahoney and Virgil 2003). Recent research suggests that caribou in certain areas of Newfoundland (e.g. Middle Ridge, La Poile and the Northern Peninsula) are selecting areas of low-lying vegetation (Morgan et al. 2010) and barrens and wetlands (McCarthy et al. 2011) for calving while selecting against mixed-forest (McCarthy et al. 2011). Bogs, early climax stands and ponds and lakes were intermediate in their selection value, while recently harvested stands and disturbed sites were used significantly less than other habitats during this period (Mahoney and Virgil 2003). Of the intermediate habitats, bog habitat was more important during summer and fall (Mahoney and Virgil 2003). Open water is also

important as it can be used for escape from predators (Bergerud 1985; Bergerud et al. 1990, 2008). As in winter, areas that support alternative prey (e.g., moose) would be avoided during summer, as they may increase the risk of predation by black bear (Mahoney and Virgil 2003).

3.3.2.2 Winter Habitat

Newfoundland caribou forage primarily on lichens [both terrestrial (*Cladina* spp.) (Mayor et al. 2009) and and arboreal (Bergerud 1972)] and evergreen shrubs during winter (Bergerud 1972). Access to arboreal lichens (that are abundant on trees adjacent to forest edges), is particularly important when snow is deepest (Bergerud 1972; Fortin et al. 2008). Coniferous forest landscapes in particular have been identified as a source of arboreal lichens (Schaefer and Pruitt 1991; Schaefer 1996; O'Brien et al. 2006; Fortin et al. 2008), although Bergerud (1972) found that caribou in Newfoundland would not venture into spruce forests when snow was deep unless there was a crust substantial enough to bear their weight. Additionally, caribou in Newfoundland select for shallow snow conditions (Mayor et al. 2007). Generally, snow in Newfoundland was both deep and soft during January and February but was frequently crusted later in March (between 1957 and 1966) (Bergerud 1972). Terrestrial lichens are also used during winter (Courtois et al. 2004; Mayor et. al 2007; Fortin et al. 2008; Mayor et al. 2009) and it has been observed that caribou will dig craters up to 142 cm deep to reach forage through the snow cover (Brown and Theberge 1990). However, Courtois et al. (2008) found that the presence of terrestrial lichens was less important, as caribou selected closed conifer stands without terrestrial lichens and open conifer stands with or without terrestrial lichens. As in Labrador, shallow snow would offer a reduced predation risk by allowing increased mobility and thus ice-covered habitats (e.g., wetlands, lakes, rivers) would provide visibility and mobility advantages (Bergerud et al. 2008; Fortin et al. 2008).

Mahoney and Virgil (2003) found that adult caribou in western Newfoundland selected rock and heath barrens and virgin and mature forest stands considerably more than other habitats during winter. Bogs, early climax stands and ponds and lakes were intermediate in their selection value, while recently harvested stands and disturbed sites were used measurably less than other habitats during winter. Of the intermediate successional habitats, early climax forest stands were more valuable during winter (Mahoney and Virgil 2003).

Areas that support alternative prey tend to be avoided as they may increase the risk of predation (Seip 1992; Fortin et al. 2008). In Newfoundland, black bear is considered the principal large predator, and moose the alternative prey species (Mahoney and Virgil 2003). Black bears preferentially forage in regenerating stands and will prey on the calves of ungulates (Mahoney and Virgil 2003). Fortin et al. (2008) confirmed that woodland caribou avoided burned and harvested forests.

3.3.2.3 Habitat Quality Summary

Calving / post-calving and winter habitat quality for caribou on the Island is summarized in Table 3.7. Habitat quality along the Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula regions of the ELC Study Area during calving / post-calving and winter are illustrated in Figure 3.10 to Figure 3.15.

Table 3.7 ELC Habitat Type and Quality on the Island of Newfoundland

Habitat Type[(a)]	Calving / Post-Calving	Winter	Comments
Alpine Vegetated	Primary	Secondary	Quality rating based on Mahoney and Virgil (2003); lichen / moss / berry ground cover had seven sites containing caribou, trails, scat and/or evidence of cratering during surveys in 2008 in the Study Area (Stantec Consulting Ltd. 2010)
Burn	Tertiary	Tertiary	Quality rating based on Mahoney and Virgil (2003) and Fortin et al. (2008); caribou and/or evidence of their presence were not identified during surveys in 2008 in this habitat type (Stantec Consulting Ltd. 2010)
Conifer Forest	Primary	Primary	Quality rating based on Schaefer and Pruitt (1991) and Fortin et al. (2008); 16 sites were noted with evidence (scat, trails, hair) of caribou during 2008 surveys (Stantec Consulting Ltd. 2010)
Conifer Scrub	Primary	Primary	Quality rating based on Schaefer and Pruitt (1991) and Fortin et al. (2008); scattered lichens provide some forage; little protection from predators. Eight sites were noted with evidence (trails, scat) of caribou during 2008 surveys (Stantec Consulting Ltd. 2010)
Cutover	Tertiary	Tertiary	Quality rating based on Mahoney and Virgil (2003) and Fortin et al. (2008). Six sites were noted with evidence (scat, trails, forage) of caribou during 2008 surveys (Stantec Consulting Ltd. 2010)
Kalmia Lichen / Heathland	Primary	Primary	Based on Mahoney and Virgil (2003). Two sites were noted with evidence (scat, browse) of caribou during 2008 surveys (Stantec Consulting Ltd. 2010)
Mixedwood Forest	Tertiary	Tertiary	Five sites were noted with caribou or evidence of their presence (scat, trails) during 2008 surveys (Stantec Consulting Ltd. 2010)
Open Conifer Forest	Secondary	Secondary	Quality rating based on Schaefer and Pruitt (1991) and Fortin et al. (2008); primarily moss ground cover. One site contained evidence of caribou (scat, trails) during surveys in 2008 (Stantec Consulting Ltd. 2010)
Rocky Barrens	Primary	Primary	Four sites were noted with caribou or evidence of their presence (scat, tracks) during 2008 surveys (Stantec Consulting Ltd. 2010)
Wetland	Primary	Secondary	22 sites were noted with caribou or evidence of their presence (i.e., tracks, trails, scat, and bones) during 2008 surveys (Stantec Consulting Ltd. 2010)
Scrub / Heathland / Wetland	Primary	Secondary	Based on Stantec Consulting Ltd. (2010)

Notes:
[(a)] Habitat Types are described in Table 2.3.

Figure 3.10 Caribou Calving / Post-Calving Habitat Quality: Northern Peninsula

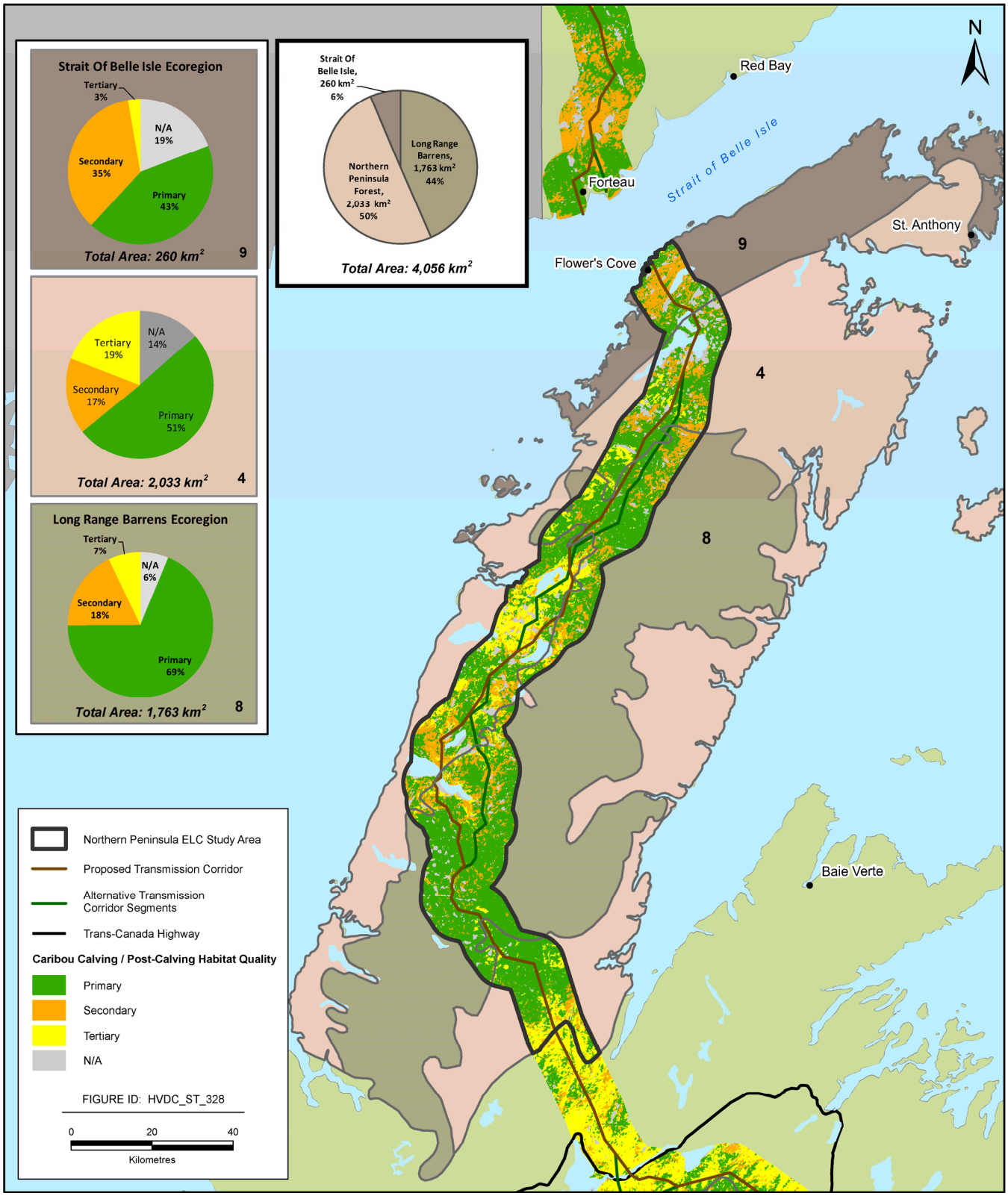


Figure 3.11 Caribou Winter Habitat Quality: Northern Peninsula

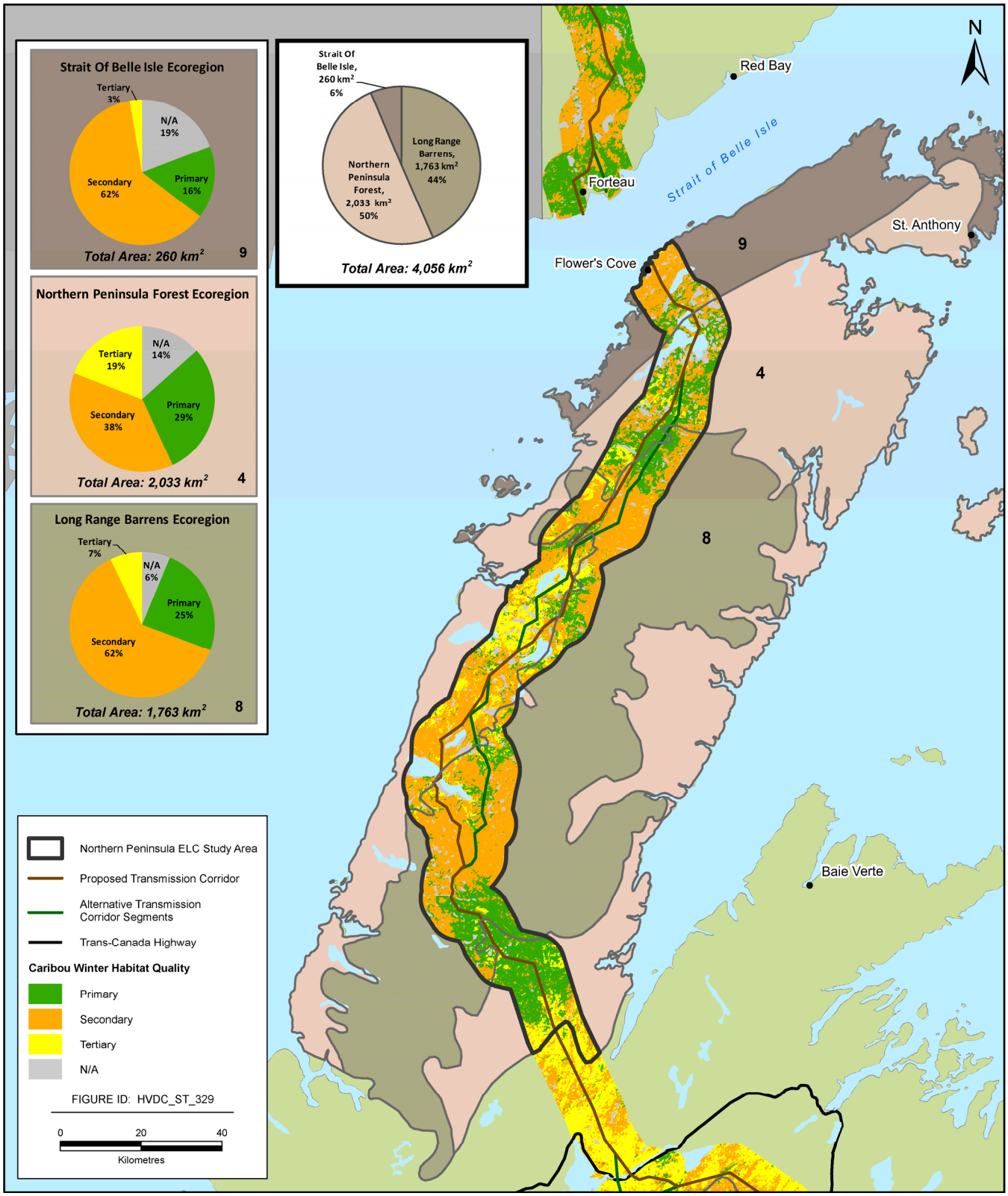


Figure 3.12 Caribou Calving / Post-Calving Habitat Quality: Central and Eastern Newfoundland

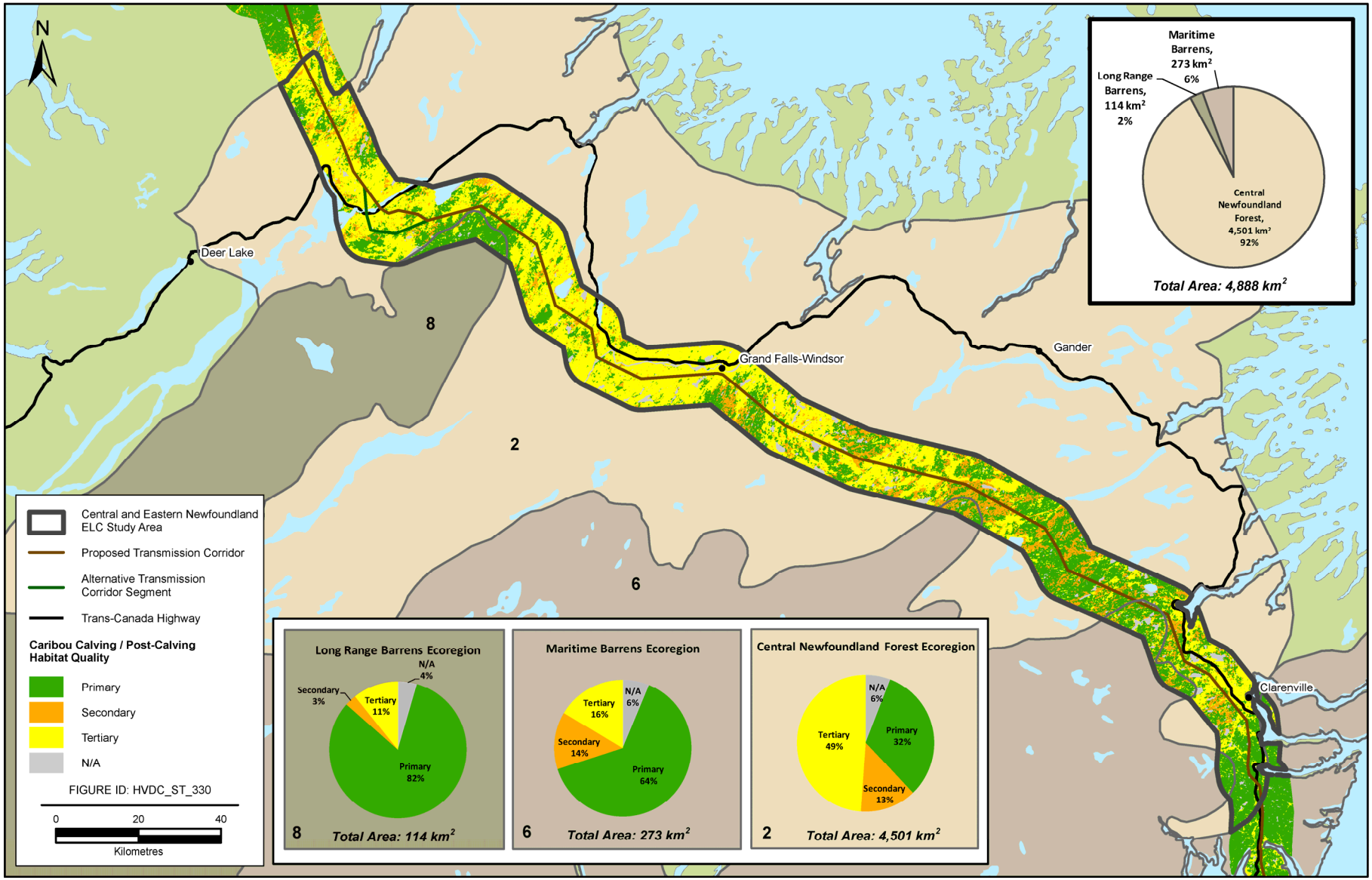


Figure 3.13 Caribou Winter Habitat Quality: Central and Eastern Newfoundland

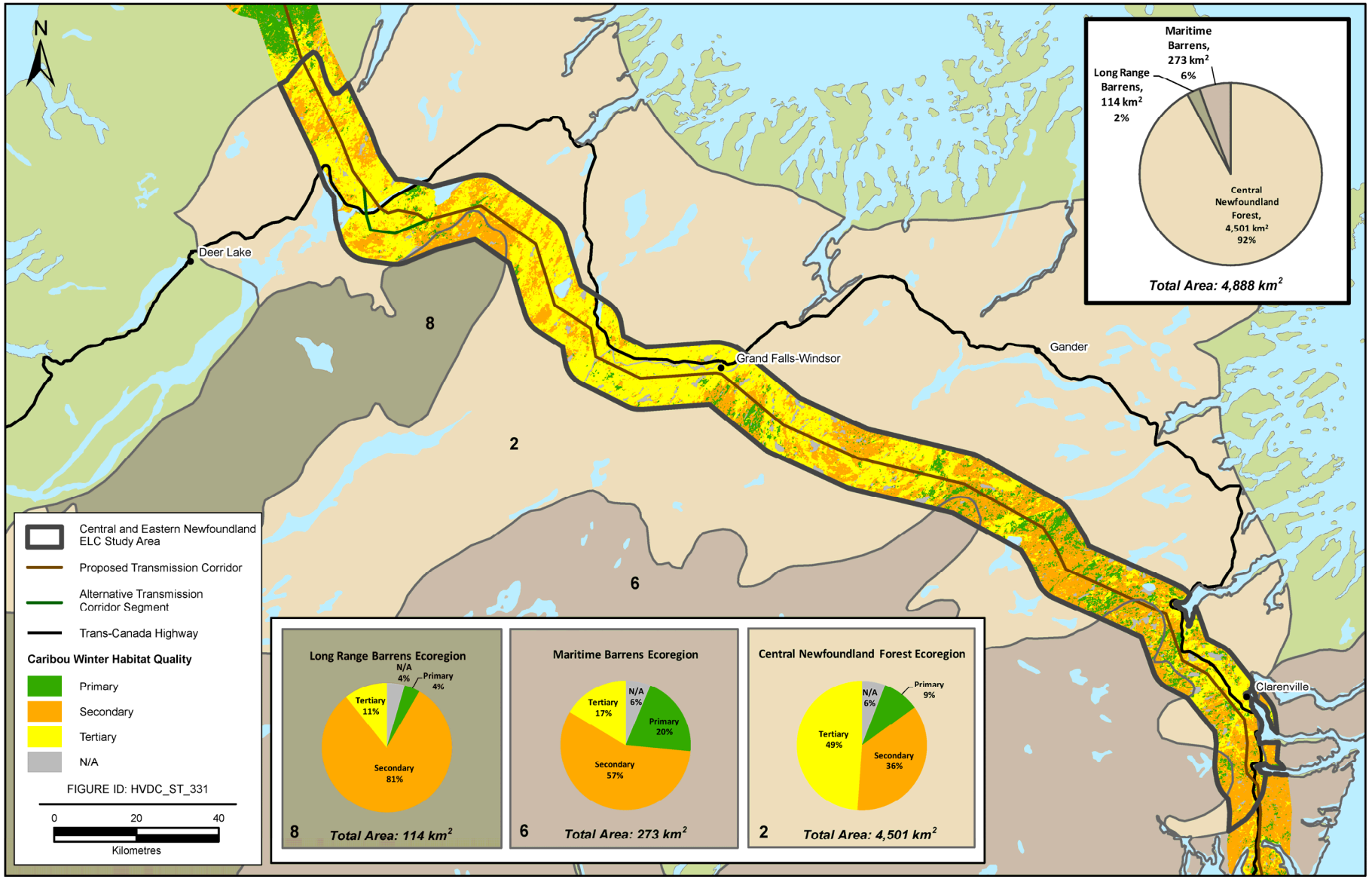


Figure 3.14 Caribou Calving / Post-Calving Habitat Quality: Avalon Peninsula

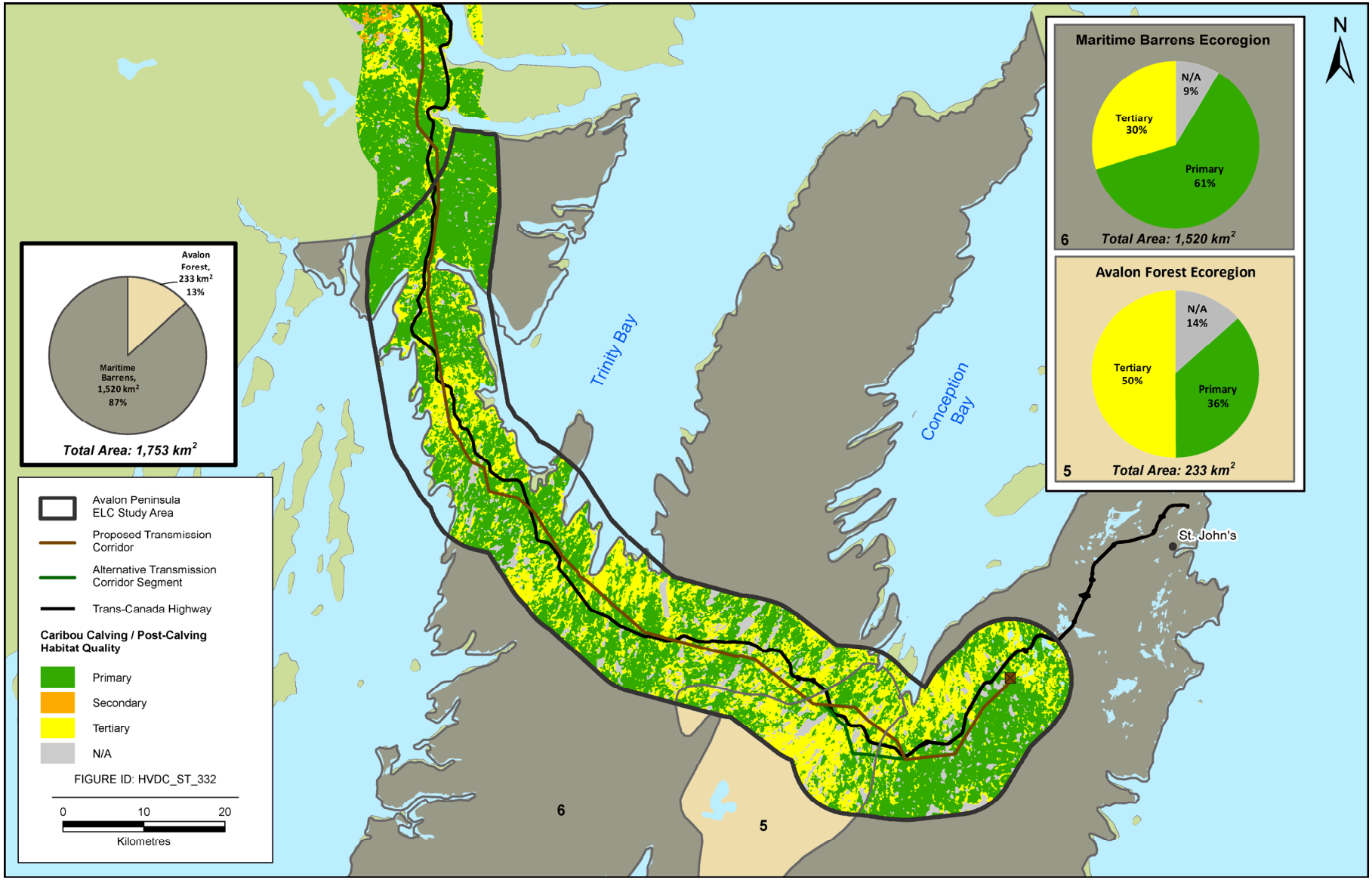
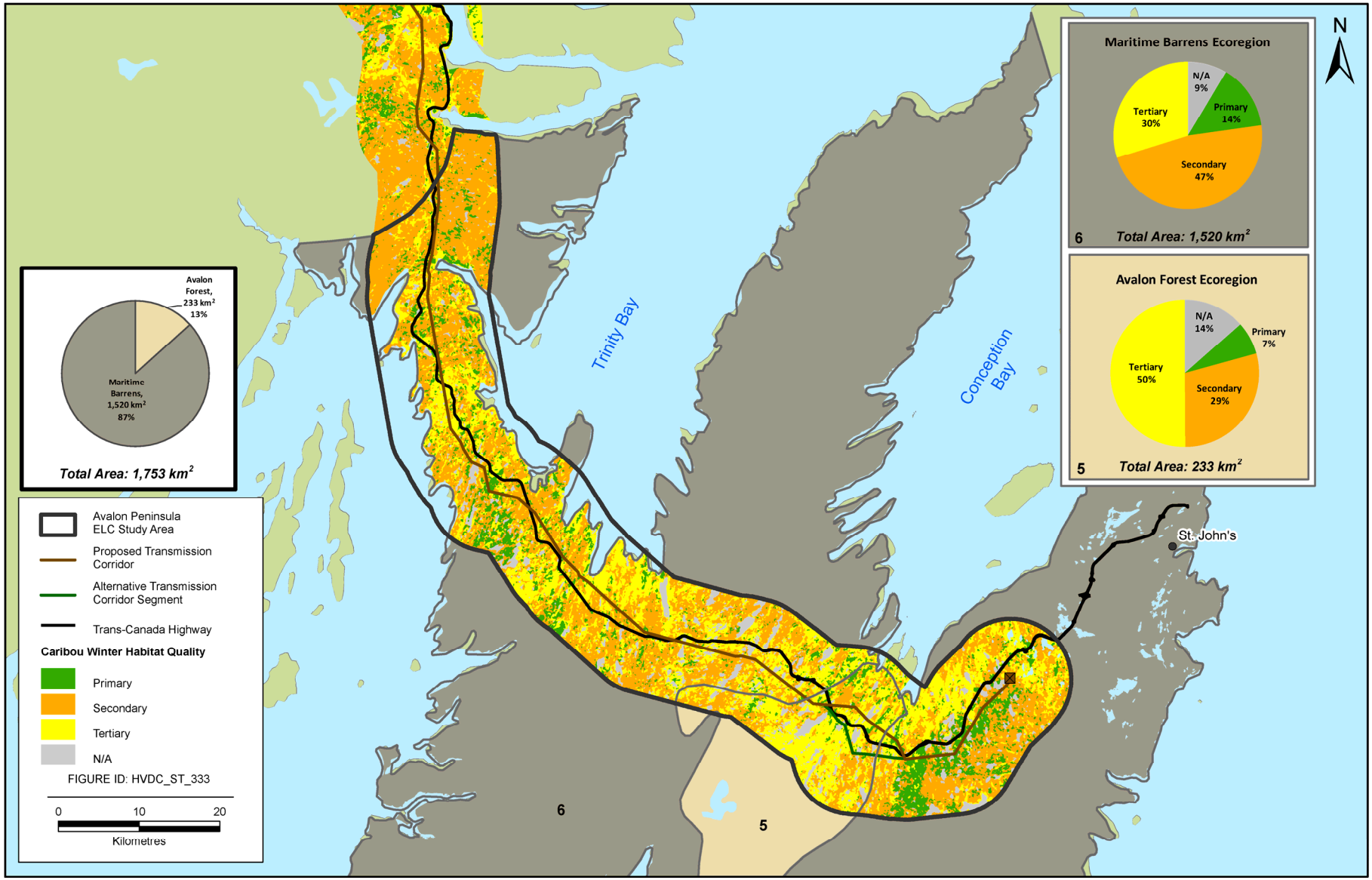


Figure 3.15 Caribou Winter Habitat Quality: Avalon Peninsula



On the Northern Peninsula, the predominant Ecoregions in the ELC Study Area are Northern Peninsula Forest (50 percent) and Long Range Barrens (44 percent), with the Strait of Belle Isle Ecoregion contributing the remaining proportion (6 percent). Primary calving / post-calving habitat is relatively abundant and widely distributed throughout this region of the Study Area (51 to 69 percent for the predominant Northern Peninsula Forest and Long Range Barrens Ecoregions, respectively, and 43 percent for the Strait of Belle Isle Ecoregion (Figure 3.10), but primary winter habitat occurs considerably less (25 to 29 percent for the predominant Ecoregions and 16 percent for the minor Ecoregion) (Figure 3.11), owing to the downgrading of alpine vegetated, wetland and scrub / heathland / wetland habitats to secondary quality (Table 3.7). For the Northern Peninsula region as a whole, approximately 58 percent is comprised of potential primary calving / post-calving habitat and approximately 26 percent is comprised of potential primary winter habitat. Consequently, secondary calving / post-calving habitat ranges from 16 to 18 percent of predominant Ecoregions and 35 percent of the minor Ecoregion and 38 to 62 percent of all represented Ecoregions during winter. Tertiary habitat is found in relatively low abundance (less than or equal to 19 percent of any Ecoregion), regardless of season. The amounts of caribou habitat present in each Ecoregion within the Northern Peninsula are summarized in Table 3.8.

Throughout Central and Eastern Newfoundland, the Central Newfoundland Forest Ecoregion is predominant, constituting 92 percent of the ELC Study Area in this region, with the Maritime Barrens and Long Range Barrens Ecoregions comprising minor proportions (i.e., 6 and 2 percent, respectively), of the Study Area. Primary calving / post-calving habitat is limited to 32 percent of the Central Newfoundland Forest Ecoregion, but comprises 64 to 82 percent of the minor Ecoregions (Figure 3.12). Primary winter habitat is relatively limited and forms only 9 percent of the predominant Central Newfoundland Forest Ecoregion (primary habitat forms 4 and 20 percent of the Long Range Barrens and Maritime Barrens Ecoregions, respectively) (Figure 3.13). For the Central and Eastern Newfoundland region as a whole, approximately 35 percent is comprised of potential primary calving / post-calving habitat and approximately 9 percent is comprised of potential primary winter habitat. Across all Ecoregions, secondary calving / post-calving habitat does not exceed 14 percent, while it comprises up to 81 percent of winter habitat (although only 36 percent of the Central Newfoundland Forest Ecoregion) (Figure 3.12 and Figure 3.13). The availability of tertiary habitat is the same for both calving / post-calving and winter habitat and comprises 11 to 49 percent of Ecoregions in the ELC Study Area. Table 3.8 summarizes the amounts of caribou habitat present within the Central and Eastern region.

On the Avalon Peninsula, the Ecoregions present in the ELC Study Area are Maritime Barrens (87 percent) and Avalon Forest (13 percent). Primary quality calving / post-calving habitat is widely available, comprising 61 percent of the Maritime Barrens Ecoregion and 36 percent of the Avalon Forest Ecoregion (Figure 3.14). The availability of primary winter habitat is limited to only 14 and 7 percent of the Maritime Barrens and Avalon Forest Ecoregions, respectively (Figure 3.15). For the Avalon Peninsula region as a whole, approximately 58 percent is comprised of potential primary calving / post-calving habitat and approximately 13 percent is comprised of potential primary winter habitat. Secondary quality winter habitat only has been identified (Maritime Barrens Ecoregion: 47 percent; Avalon Forest Ecoregion: 29 percent) (Figure 3.15), resulting from the lack of habitat classified as open black spruce forest in this geographic region of the province (Stantec Consulting Ltd. 2010). Tertiary habitat comprises 30 (Maritime Barrens Ecoregion) to 50 (Avalon Forest Ecoregion) percent of Ecoregions for both calving / post-calving and winter habitat (Figure 3.14 and Figure 3.15). The amounts of caribou habitat present within the Avalon Peninsula region are summarized in Table 3.8.

Table 3.8 Ranking of Caribou Habitat Present in the Study Area in Newfoundland during Calving / Post-Calving and Winter Seasons

Ecoregion by Geographic Region	Amount of Ecoregion within Study Area (km^2)	Primary		Secondary		Tertiary		Non-Habitat Areas[(a)]	
		%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)
Calving / Post-Calving Habitat									
Northern Peninsula									
Strait of Belle Isle	260	43	112	35	91	3	8	19	49
Northern Peninsula Forest	2,033	51	1,037	16	325	19	386	14	285
Long Range Barrens	1,763	69	1,216	18	317	7	123	6	106
Total[(c)]	**4,056**	**58**	**2,365**	**19**	**754**	**13**	**518**	**10**	**419**
Central and Eastern Newfoundland									
Long Range Barrens	114	82	93	3	3	11	13	4	5
Maritime Barrens	273	64	175	14	38	16	44	6	16
Central Newfoundland Forest	4,501	32	1,440	13	585	49	2,205	6	270
Total	**4,888**	**35**	**1,708**	**13**	**627**	**46**	**2,262**	**6**	**291**
Avalon Peninsula[(d)]									
Maritime Barrens	1,520	61	927	--[(b)]	--	30	456	9	137
Avalon Forest	223	36	84	--	--	50	117	14	33
Total	**1,753**	**58**	**1,011**	--	--	**33**	**573**	**10**	**169**
Winter Habitat									
Northern Peninsula									
Strait of Belle Isle	260	16	42	62	161	3	8	19	49
Northern Peninsula Forest	2,033	29	590	38	773	19	386	14	285
Long Range Barrens	1,763	25	441	62	1,093	7	123	6	106
Total	**4,056**	**26**	**1,072**	**50**	**2,027**	**13**	**518**	**11**	**440**
Central and Eastern Newfoundland									
Long Range Barrens	114	4	5	81	92	11	13	4	5
Maritime Barrens	273	20	55	57	156	17	46	6	16
Central Newfoundland Forest	4,501	9	405	36	1,620	49	2,205	6	270
Total	**4,888**	**9**	**464**	**38**	**1,868**	**46**	**2,264**	**6**	**291**
Avalon Peninsula									
Maritime Barrens	1,520	14	213	47	714	30	456	9	137
Avalon Forest	223	7	16	29	68	50	117	14	33
Total	**1,753**	**13**	**229**	**45**	**782**	**33**	**573**	**10**	**169**

(a) Represents areas classified as Exposed Earth / Anthropogenic / Cutblock; Open Water; Shallow Water with Vegetation; Snow / Ice; Burn; and Cloud / Shadow

(b) No habitat identified within the Ecoregion

(c) Values were rounded to the nearest whole number therefore rounding errors may occur

(d) Avalon Peninsula region presented for completeness, but not considered further for this Project

Additionally, the amounts of caribou habitat present within each Ecoregion within Newfoundland (i.e. not divided by geographic region) is presented in **Error! Reference source not found.**.

Table 3.9 Ranking of Caribou Habitat Present within each Ecoregion in the Study Area in Newfoundland during Calving / Post-Calving and Winter Seasons

Ecoregion by Geographic Region	Amount of Ecoregion within Study Area (km^2)	Primary		Secondary		Tertiary		Non-Habitat Areas[(a)]	
		%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)
Calving / Post-Calving Habitat									
Strait of Belle Isle	260	43	112	35	91	3	8	19	49
Northern Peninsula Forest	2,033	51	1.037	16	326	19	386	14	285
Long Range Barrens	1,877	70	1,310	17	321	7	136	6	110
Maritime Barrens[(c)]	1,793	62	1,102	2	38	28	500	9	153
Central Newfoundland Forest	4,501	32	1,440	13	585	49	2,205	6	270
Avalon Forest[(c)]	233	36	84	--	--	50	117	14	33
Total[(b)]	**10,697**	**48**	**5,085**	**13**	**1,360**	**31**	**3,352**	**8**	**900**
Winter Habitat									
Strait of Belle Isle	260	16	42	62	161	3	8	19	50
Northern Peninsula Forest	2,033	29	590	38	773	19	386	14	285
Long Range Barrens	1,877	24	445	63	1,185	7	136	6	110
Maritime Barrens	1,793	15	267	49	870	28	502	9	153
Central Newfoundland Forest	4,501	9	405	36	1,620	49	2,205	6	270
Avalon Forest	233	7	16	29	68	50	117	14	33
Total	**10,697**	**17**	**1,765**	**44**	**4,677**	**31**	**3,354**	**8**	**900**

Notes:

(a) Represents areas classified as Exposed Earth / Anthropogenic / Cutblock; Open Water; Shallow Water with Vegetation; Snow / Ice; Burn; and Cloud / Shadow

(b) Values were rounded to the nearest whole number therefore rounding errors may occur

(c) Ecoregions within Avalon Peninsula region presented for completeness, but not considered further for this Project

3.4 Predators and Other Limiting Factors

There are several factors that can affect caribou populations including predation, severe weather, insect harassment, disease, hunting mortality, food limitation and habitat disturbance, destruction or fragmentation (Klein 1991; Seip 1991; Smith et al. 2000, Dyer et al. 2001 and Oberg 2001 in Sorenson et al. 2008). Due to their low reproductive potential, caribou are susceptible to, and recover slowly from, population declines.

Several possible limiting factors have been suggested for caribou populations in Newfoundland and Labrador. Although certain factors may apply only to only one portion of the province (e.g., wolf predation in Labrador), the majority of factors discussed in this section may occur in both Newfoundland and Labrador.

3.4.1 Labrador

Predation is frequently cited as a limiting factor for caribou populations and may play a role in limiting populations in Labrador. For the migratory GRH, wolves are a major predator, contributing to 50 percent of the deaths of collared female caribou between 1984 and 1992, despite the low number of wolves in northern Ungava (Bergerud et al. 2008). Wolves are also responsible for most of the winter calf mortalities, which affects GRH growth considerably (Bergerud et al. 2008). By comparison, herds with low predation experience less than 50 percent calf mortality within their first six months (Bergerud 1985). Older forests tend to be richer in the lichens caribou depend on (than younger forests), and are also less favoured by moose (which are considered alternate prey species of wolf), so there is less attraction for this primary predator of caribou. Although wolves prey on other species in addition to caribou, each wolf requires the food equivalent of 11 to 14 caribou a year (Bergerud 1985). To this end, some wolf packs follow migrating caribou herds from summer to winter range and back. While Messier et al. (1988) did not consider predation a limiting factor of the GRH, the authors acknowledged it could become so if the herd declined. For the sedentary herds, the wolf-caribou interactions are somewhat different than for the GRH. Wolf predation on the RWMH accounted for two-thirds of all deaths during two periods, 1981 to 1988 and 1993 to 1997 (Schaefer et al. 1999). Between 1998 and 2009, wolf predation accounted for 56 percent of mortality in RWMH adult females at rates similar to those during the 1980s (Schmelzer 2011). It is speculated that wolf predation on the RWMH may be associated with the presence of moose and GRH caribou in the RWMH range (Chubbs and Schaefer 1997; Schaefer et al. 1999, 2001; Schmelzer et al. 2004; Bergerud et al. 2008). As the density of forest-dwelling caribou are frequently too low to sustain wolf populations, wolves rely on moose populations to persist. Hence, wolf abundance will increase as moose density increases, which results in a marked increase in predation of caribou (Seip 1991). The decline of the RWMH in the 1990s coincided with both an increase in moose densities in Labrador and frequent incursions of the GRH, which may have led to an increase in wolf density and subsequent predation on the RWMH (Nalcor Energy 2009). Within the MMH range, Schmelzer et al. (2004) did not mention predator threats, but wolves would be common throughout the range.

There are other predators of caribou in Labrador in addition to wolves. Black bears have been documented to prey on GRH caribou (Bergerud et al. 2008) and accounted for 7 of 30 RWMH caribou mortalities (23 percent) documented by Schaefer et al. (1999). Black bear predation accounted for 28 percent of adult female mortalities between 1998 and 2009 (Schmlezer 2011), also similar to rates in the 1980s. Black bears are also present throughout the MMH range.

Hunting can be a limiting factor, especially if the harvest rates are unsustainable. In Labrador, hunting is only permitted on the GRH. The sedentary woodland herds (MMH and RWMH) are all protected by both the *NLESA* and *SARA*, which prohibit hunting. Until 1959, there were no licenses or hunting quotas in Labrador (Bergerud 1967). At the time of their introduction, the hunting season in northern Labrador varied from between September and December to the end of April. Although there were no bag limits initially, in 1963 the limit was set at eight caribou per family, with no limit for Aboriginal hunters (Bergerud 1967). In Quebec, sport hunting of the GRH was first permitted in 1964, with no bag limit (Couturier et al. 1990). In 1983, the quota was two caribou per hunter, after which caribou sport harvest increased by 40 percent until 1987. In Labrador, the GRH is

now only hunted by Aboriginal people and other residents of Labrador as recent changes to hunting regulations now prohibit non-residents through licensed outfitters, and commercial hunting (NLDEC 2010d). The current GRH harvest rates in Labrador are unpublished; however, historical rates are known and it has been suggested that intensive hunting in the mid-1980s (5 to 7 percent harvest rate in 1984 to 1986) combined with low calf recruitment depressed the growth rate of the herd (Messier et al. 1998).

Illegal hunting continues to be a threat for the RWMH (Schmelzer et al. 2004). Between the 1980s and 1990s, three mortalities were attributed to incidental hunting during the licensed GRH hunt (Schaefer et al. 1999). During 2003, poaching accounted for the loss of at least 14 animals, or 15 percent of the herd (Schmelzer et al. 2004). Between 1998 and 2009, hunting accounted for 11 percent of adult female mortalities in the RWMH (Schmelzer 2011). Increased access to the area, via development projects and the introduction and availability of snowmobiles, has contributed to the observed increase in hunting pressure (Bergerud et al. 2008). In recent years, the RWMH has been particularly vulnerable as its range has overlapped with that of the legally hunted GRH that is seasonally accessible via roads in central Labrador.

Hunting mortality has dramatically influenced the size and trend of the MMH (Schmelzer et al. 2004). Hunting has fluctuated with the varying open and closed seasons prior to 1976, since which time the herd has remained closed to hunting (with the exception of single licensed hunt in 1989). However, illegal hunting is still an issue and may limit the recovery or contribute to the decline of the MMH (Schmelzer et al. 2004). Likely the high visibility of winter aggregations along the south shores of Lake Melville and Groswater Bay contribute to the illegal hunt (Schmelzer et al. 2004).

Caribou behaviour can, under certain circumstances, cause mortality or loss to the population. A source of loss proposed for the RWMH is possible emigration to the GRH (Schaefer et al. 1999). Although these caribou may not emigrate permanently (Bergerud et al. 2008), five adult female RWM caribou were documented to have joined GRH between 1993 and 1997 (Schaefer et al. 1999). One rejoined the RWMH after six months, and the remaining females died before the next calving season, possibly from the stresses of using unfamiliar habitat, predation associated with the larger GRH and incidental hunting. It is uncertain whether these animals would have rejoined the RWMH the following year (Schaefer et al. 1999). At this point, however, there have been no cases of sedentary woodland caribou females changing calving sites to those within migratory caribou range, nor of migratory females calving within sedentary woodland caribou calving range (NLDEC 2011d). Other caribou behaviour can have an inherent risk of death. For instance, mortality through accidents such as fighting during the rut (amongst males), during calving (largest cause of death for females), and/or drowning have been reported (Bergerud 1971; Bergerud et al. 2008).

Another important factor regulating the GRH is condition of the summer ranges (Messier et al. 1988; Crête and Huot 1993). The decline of the GRH in the 1980s and 1990s has been attributed to poor foraging conditions on the summer range, which led to complete exhaustion of fat reserves of lactating females and a decrease in calf production and survival (Crête and Huot 1993). Summer foraging habitat for the GRH is considered spatially limited as, in contrast to winter habitat, alternative summer range is not available for colonization following an increase in herd size (Messier et al. 1988). Thus, increasing caribou numbers can lead to summer range deterioration, a decline in female body condition and decreased fecundity and calf survival (Crête and Huot 2003). Although its total range is expansive, deterioration of summer range and the subsequent decline of the GRH suggest that availability of summer habitat is a limiting factor; therefore, loss of this habitat could have an adverse effect on the herd. Similarly, because of the increased importance of winter habitat for GRH caribou (Schmelzer and Otto 2003), loss of extensive areas of winter range could also have adverse effects.

Potential increases in industrial development, commercial forestry and road development in the future may also affect the RWMH, through direct or indirect habitat loss, habitat fragmentation, alteration of movement patterns and dispersion of individuals between herds and/or direct mortality of individuals (e.g., poaching, vehicle collisions) (Schmelzer et al. 2004). Caribou in other areas have been shown to avoid cut-overs (Vors et al. 2007) and infrastructure (Vistnes and Nellemann 2008), and caribou close to altered landscapes may have a higher risk of predation (Seip and Cichowski 1996; James 1999; James and Stuart-Smith 2000). Although focused on Newfoundland, recent work found that one of the factors correlated with calving / post-calving range sizes was the amount of total disturbance present within the calving / post-calving range (McCarthy et al. 2011). Specifically, for every additional square kilometer of total disturbance (defined as natural and anthropogenic disturbances including fires, mining and quarries, agricultural land and power lines), individual female's calving / post-calving ranges increased by approximately 5.4 km^2 (McCarthy et al. 2011). At high levels of avoidance, caribou may abandon entire fragmented areas resulting in small calving / post-calving areas (Joly et al. 2006). At this point the amount of disturbance in Newfoundland and the resulting fragmentation do not appear to be compressing caribou ranges (McCarthy et al. 2011). Additionally, calf requirement rates were found to decrease with increasing amounts of disturbance (McCarthy et al. 2011). Roads may contribute as a limiting factor through caribou and vehicle collisions or by facilitating travel by predators and hunters (Bergerud 1974; James and Stuart-Smith 2000; Fortin et al. 2008). An ELC analysis by Nalcor Energy for the Lower Churchill Hydroelectric Generation Project of the amount of suitable habitat within a portion of the RWMH range (based on available Forest Inventory data) indicated that existing disturbance levels are well below the threshold [identified by Sorensen et al. (2008)] that may trigger declines (Minaskuat Inc. 2009). Although other researchers have cautioned that the Sorensen et al. (2008) model may have low predictive power, over-estimate population growth rates and may not be transferrable to other regions (Sleep and Loehle 2010), the disturbance levels within the RMWH from the Lower Churchill Hydroelectric Generation Project are 4.5 to 7.5 times less than the threshold identified by Sorensen et al. (2008). Threats to the MMH arising from disturbance and development may include habitat loss through forestry developments near Cartwright and the TLH-3 (NLDWST 2009b) that lies adjacent to the southern limit of current calving / post-calving areas. These developments increase accessibility and potential illegal hunting of the MMH (Schmelzer et al. 2004).

The small size of the RWMH may be in of itself a limiting factor for this herd (Schmelzer et al. 2004). Random events such as a major forest fire or severe or unusual weather events (e.g., deep snow or icing over of lichen feeding areas) could reduce herd size below the minimum viable population size (Nalcor Energy 2009). The minimum viable population size for the RWMH has not been identified and remains a knowledge gap in the Recovery Strategy for Labrador Woodland Caribou (Schmelzer et al. 2004).

Parasites can be an important factor limiting caribou populations. The GRH is the only herd in North America infected with the liver fluke *Fascioloides magna*, found in 78 percent of specimens in 2001 (Pollock et al. 2009), a level of incidence higher than noted in the 1980s. Several tapeworms are present in caribou in Labrador, including *Taenia hydatigena*, *T. krabbei* and *Echinococcus granulosus* [Newfoundland and Labrador Department of Natural Resources (NLDNR) 2010a]; larvae were found in the livers of 50 percent of the GRH caribou samples in 2001 (Pollock et al. 2009). Cyst-forming protozoan parasites including *Besnoitia tarandi* and *Sarcocystis* sp. are also found in Labrador. *B. tarandi* was present in nearly 16 percent of GRH caribou samples collected between 2007 and 2008 (Ducroq et al. 2008), while *Sarcocystis* sp. was present in 99 percent of samples from Labrador (Kahn and Evans 2006). Other parasites of caribou in Labrador include the nematode *Parelaphostrongylus andersoni* (Lankester 2001), oestrid fly larvae such as the warble fly *Hypoderma tarandi* and the throat or nose bot, *Cephenemyia trompe* (Toupin et al. 1996; NLDNR 2010b).

Caribou populations in Labrador may be negatively affected by climate change. The temperatures in Labrador are predicted to increase 3°C to 4°C in winter and 2°C to 3°C in the other seasons, while precipitation will increase 10 to 20 percent, including more fall and winter rain (Jacobs and Bell 2008). By the end of the century, there may also be an increase of approximately 25 to 45 growing days (Lines 2008). Possible effects of climate change on caribou could include direct effects (e.g., changes in temperature and moisture, snow and ice conditions, and composition of plant communities), and indirect effects (increases in parasite and insect abundance and distribution, forest fires and predation) (Jeffery 2008d).

As temperatures increase, the composition of plant communities could change, producing vegetation that is less favourable for caribou forage; this could in turn affect caribou population dynamics (Lenart et al. 2002). An increase in forest fire frequency due to increased summer temperatures could reduce the amount of lichen available to caribou (Schaefer and Pruitt 1991; Fortin et al. 2008). Increased winter temperatures in the Arctic have already been associated with reductions in both plant growth and subsequently in reindeer population growth (Aanes et al. 2002). There is the risk of trophic mismatch between the availability of preferred forage on the calving grounds and caribou arrival at their calving sites (Post and Forchammer 2008). Migration paths may change as caribou travel farther to locate forage (Brotton and Wall 1997). Warmer, wetter winters may result in reduced calf weights (Weladji and Holand 2003), which could, in turn, affect the population vital rates through higher calf mortality and reduced calf growth (Reimers 1997). Warmer winter temperatures may lead to an increase in snowfall, while an increase in winter rain could lead to icing, or extremely heavy snow conditions. As caribou crater to reach forage buried under the snow pack (Brown and Theberge 1990), greater snow depth or hard-packed snow conditions may limit caribou accessibility to forage (Mahoney and Virgil 2003).

Caribou predation by wolves may increase in deep snow conditions as wolf predation rates in other ungulate populations have been shown to increase in deep snow (Nelson and Mech 1986). Increased temperature and moisture may also affect populations of insects and parasites that feed / rely on caribou populations. If insect populations increase with temperature and moisture, caribou may spend more time engaged in avoidance activities and less time feeding (Moerschel and Klein 1997; Toupin et al 1996; Weladji et al. 2003). In the Arctic, increased temperatures are leading to faster development and increased larval survival in nematodes (Kutz et al. 2005).

Environmental contaminants have also been identified as possible issues. Elevated cadmium levels were found in kidneys of some caribou from the GRH although overall "…the levels of detected contaminants fell within the reported ranges for caribou in Canada and elsewhere" (Pollock et al. 2009).

3.4.2 Newfoundland

The array of predators in Newfoundland is markedly different than Labrador, as wolves are no longer present on the Island. Predators for caribou in Newfoundland include black bear, coyote, red fox (*Vulpes vulpes*), lynx and large raptors, to which calves are particularly vulnerable (Mahoney et al. 1990; Geist 1991; Snow and Mahoney 1995; Mahoney and Schaefer 2002a; Thomas and Gray 2002; Mahoney and Virgil 2003; Mahoney and Weir 2009; Trindade et al. 2010a; Mumma et al. 2011)..

Predation is the primary cause of caribou calf mortality in Newfoundland with 94% of calf deaths attributed to predation although the predation rates and trends differ between regions and years (Trindade et al. 2010a). The rate during periods of high population levels (1979 to 1997) was approximately 60 percent and increased to 83 percent between 2003 and 2007 (Mahoney and Weir 2009). Recent genetic analysis of predated calves is

supporting earlier studies which have identified black bears and coyotes as primary predators of calves (Mahoney and Weir 2009; Mumma et al. 2011). Other predators include black bear, lynx, golden eagle (*Aquila chrysaetos*) and bald eagle (*Haliaeetus leucocephalus*) (Geist 1991; Mahoney and Schaefer 2002a; Thomas and Gray 2002).

The extent of the coyote's impact as a relatively new predator of caribou in Newfoundland remains undetermined. The Eastern coyote, believed to be a mix of coyote, wolf and wild dog, was first confirmed in Newfoundland in 1987 and by the mid-1990s was confirmed throughout much of the Island (Blake 2006). Preliminary coyote carcass analysis indicates that the coyote in Newfoundland are of similar size to those in Eastern Canada (J. Blake, pers. comm.) and hunt larger prey than coyotes in the western North American population (Blake 2006). Their presence may be unique in terms of the extirpation of wolves and therefore, interactions between coyote and potential prey are likely different than other regions within their range. Preliminary results of the telemetry study on coyote indicate that home range sizes are larger than else wherein North America, consistent with predators that use big game species as their primary food source (J. Blake, pers. comm.). Stomach content analysis indicates that over 80 percent of the diet consists of moose, caribou and snowshoe hare, with moose carrion dominating coyote diet in fall and winter (J. Blake, pers. comm.). , The diet is also supplemented by berries, beaver, squirrels, voles, grouse, ptarmigan and cattle (Blake 2006). On the barrens, however, coyote switch to preying on caribou in winter (J. Blake, pers. comm.). There is some suggestion that coyote prey more heavily on large animals like caribou when snowshoe hare populations are low (Blake 2006), however they may now be switching to snowshoe hare, as they are becoming more abundant (J. Blake, pers. comm.). Current caribou mortality is believed to be similar to historical rates; however, the increase in mortality several years ago was likely related to the introduction and spread of coyote throughout the province (P. Saunders, pers. comm.). Recent research in Newfoundland has indicated coyote accounted for 15 percent of deaths of radio-collared caribou calves (NLDEC 2009a).

Black bear is an important predator of caribou on the Island, especially of calves and young caribou (Mahoney et al. 1990 in Mahoney and Schaefer 2002a; Zager and Beecham 2006) and may have a greater impact on caribou population dynamics than coyote (Blake 2006). Black bears contributed to 33 percent of caribou calves collared in the Middle Ridge and Gaff Topsails herds between 2003 and 2005 (Blake 2006) and account for 20 to 55 percent of the mortality in juvenile caribou on the island (Jennings et al. 2011).

The NLDEC is continuing to research predator-prey dynamics. As of 2011, 82 black bear, 93 coyote and 17 lynx had been fitted with GPS collars in an effort to better understand home range size and distribution and movement patterns and seasonal habitat use (Mahoney and Soulliere 2011). Early results have indicated that both coyote (territorial adults: 19 to 260 km^2) and black bear (adult males: 400 to 1760 km^2; adult females: 38 to 693 km^2) have larger home ranges than reported in other jurisdictions (NLDEC 2010a; Mahoney and Soulliere 2011). Preliminary results from scat detection indicate that the black bear density is 0.05 bears / km^2 in the La Poile region (Mahoney and Soullliere 2011) and 0.09 to 0.18 bears / km^2 in the Middle Ridge area (Lewis et al. 2011). Locational data from collared black bears is indicating that bears that frequent caribou calving areas in one year are likely visit in subsequent years, but not all black bears visit calving areas (Mahoney and Soulliere 2011; Ray et al. 2010; Ray et al. 2011). Early results from diversionary feeding indicate that black bears and coyote responded to bait (e.g., black bear: bakery waste and beaver carcasses; coyote: beaver carcasses) and while bear-specific predation did decrease, results in the treatment areas and effects of calf survival were unclear (Jennings et al. 2011; Mahoney and Soulliere 2011).

Historically, lynx likely preyed upon caribou populations until this predator declined after fur prices increased and snowmobiles enhanced accessibility for trappers (Bergerud 1971; Chubbs et al. 1993). Additional research includes the collection of black bear hair from snag poles to determine density on the Island, and the collection of predator scat (coyote, black bear and lynx) to determine feeding habits (NLDEC 2010a). The provincial government is also considering the feasibility of a predator reduction program in an effort to improve caribou calf survival (NLDEC 2010a).

A great deal of research has been done on the Gros Morne Herd, including on levels of predation, which was documented as the cause of 60 percent of all mortalities in the Gros Morne Herd (Mahoney et al. 2001a). More than 50 percent of calf mortalities, due to predation alone, occurred in the first two weeks; thereafter an abrupt decline in mortality was observed, followed by mortality rates of approximately 20 percent at both four to six weeks and greater than eight weeks post-collaring, with a slight decline at six to eight weeks (greater than 5 percent). In 1993, 5 of 17 (29 percent) radio-collared caribou calves died. Each year black bear predation accounted for the highest proportions of deaths [1993 (40 percent); 1994 (45 percent); 1995 (43 percent); 1997 (83 percent) (Mahoney et al. 2001a)]. Raptor predation accounted for the second highest proportion of caribou deaths in Gros Morne in 1993 (Mahoney et al. 2001a).

Hunting is an important factor in regulating managed wildlife populations. However, if harvest rates are too high, hunting can also jeopardize the sustainability of wildlife populations. The caribou population in Newfoundland has decreased dramatically (66 percent since the late 1990s) (Soulliere et al. 2010b), and as such, the caribou quotas have been reduced. Most recently, the quota was set at 740 caribou for the 2010 to 2011 season (NLDEC 2010a) and as an indication of harvest rates, overall hunter success rates from the last two caribou hunting seasons (2007-2008 and 2008-2009) were 62.1 and 64.7 percent (NLDEC 2009b; 2010a). Previously however, hunter success was 80 to 85 percent in the 1980s (Mahoney et al. 2008). The overall mean harvest rate including both sexes between 1980 and 2003 was 5.6 percent (Trindade et al. 2010c). Investigations of the age structure of the population over time, which have identified a male minority in the population with primarily younger males since 1993, indicate that harvest rates may have affected the population (Trindade et al. 2010c). While illegal hunting and poaching do not seem to be a limiting factor for Newfoundland caribou, one Corner Brook Lakes caribou calf death (n=15) (Mahoney and Virgil 2003) was the result of illegal hunting.

Parasites are also believed to be an important factor limiting caribou in Newfoundland and have been widely studied. Ball et al. (2001) reported that the brain worm (*E. rangiferi*) was prevalent in the Avalon and St. Anthony Caribou Herds but infection has since spread to the rest of the island (Soulliere et al. 2010a). This parasite can cause a debilitating neurologic disease seen primarily in young animals in late winter. An intense pneumonia is also a consequence of this infection (Ronéus and Nordkvist 1962; Polyanskaya 1963; Nordkvist 1971). This parasite is known to occur widely in woodland and barren-ground caribou across Europe (Lankester 2001); however, Newfoundland is the only place in North America where *E. rangiferi* has been found. It took approximately 80 years for *E. rangiferi* to spread from St. Anthony, at the northern tip of Newfoundland, where Norwegian reindeer were first introduced, to the Avalon Peninsula. Despite a predicted future increase in immunocompetence (the ability of the body to produce a normal immune response following exposure), the Avalon herd may never again show the high growth rates noted by Bergerud (1971) and Bergerud et al. (1983). With the establishment of this parasite in what is climatically the best region for transmission in the province, the Avalon herd will likely continue to experience periodic epizootics, primarily involving calves. Other parasites of caribou on the Island include protozoa *Sarcocystis sp.* (Kahn and Evans 2006), oestrids *H. tarandi* and C. *trompe* (NLDNR 2010b) and tapeworms *T. hydatigena*, and *T. krabbei* (NLDNR 2010a). Ticks have recently

become more prevalent in Newfoundland, as evidenced by the first reports of Lyme disease occurring since 2000, although to date, none of the species identified are known to regularly infect caribou (Whitney 2005). However, as ticks are able to persist in Newfoundland, is it possible that ticks that could parasitize caribou may be identified on the Island in the future.

Disturbances such as forest-harvesting are another human-related factor that can lessen available habitat (Snow and Mahoney 1995) and are considered long-term. Caribou in the boreal forest require large tracts of relatively undisturbed, older forest habitat in order to spread out so they are harder for predators and hunters to locate, and to avoid the corridors that predators and hunters use to access prey more easily. Alteration of habitat may also lead to an increase in moose population (inter-specific competition) and black bear or wolf abundance, causing increased predation pressure (Mahoney and Virgil 2003; Fortin et al. 2008). The decline of woodland caribou across Canada may be a result of the reduction in the availability of lichen-rich mature coniferous forests and an increase in access by predators and hunters (James and Stuart-Smith 2000; Smith et al. 2000; Dyer et al. 2001). Other disturbances such as development or noise can affect caribou distribution. Woodland caribou have been shown to actively avoid certain linear features (Mercer et al. 1985; Dyer et al. 2001), as well as noise disturbance (Harrington and Veitch 1991, 1992). Females and calves are most easily disturbed than other cohorts (Wolfe et al. 2000), which would make the calving / post-calving period one of the most sensitive. McCarthy et al. (2011) found that calf recruitment rates decrease and calving / post-calving range size increase with increasing disturbance. Although high levels of fragmentation may cause calving females to shift or compress calving ranges (Joly et al. 2006) the current amount of disturbance in Newfoundland and the resulting fragmentation do not appear to be compressing caribou ranges (McCarthy et al. 2011). However, other research shows that caribou do use transmission lines as movement corridors (Jacques Whitford 1997).

Climate changes in Newfoundland are also likely to affect caribou populations. The Island of Newfoundland is predicted to warm between 1°C and 5°C, and receive an approximately 5 percent increase in precipitation within the next 100 years (Christensen et al. 2007; Lines 2008). There may also be a 25 to 35 day increase in the average number of growing days by the end of the century (Lines 2008). The potential effects of climate change outlined in the Labrador Caribou section would also be possible in Newfoundland.

4.0 SUMMARY

Nalcor Energy is proposing to develop an HVdc transmission system extending from the lower Churchill River (Gull Island or Muskrat Falls) in Central Labrador to Soldiers Pond on the Island of Newfoundland's Avalon Peninsula. The EA of the Project is ongoing, with an EIS currently being completed by Nalcor Energy.

In preparation for and support of the Project's EA, this *Component Study* was completed to identify, compile, summarize and present information on caribou in the area of, and which may interact with, the proposed Project for use in the EIS. This study identifies and describes the occurrence and distribution of caribou herds or aggregations within the Study Area, as well as identifying likely preferred seasonal habitats based primarily on field observations, scientific literature, NLDEC research data, and supported by sources and habitat mapping.

An overview of some of the results of this *Component Study* includes:

- An extensive literature search has been completed providing a comprehensive listing of the primary sources of information relevant to the Project. The annotated bibliography is an important resource that can be accessed for future and/or additional components of this and other projects. In addition to the baseline information presented in this document, literature related to potential Project-related effects on caribou has also been identified and retained to support the EIS.
- Details on the presence of caribou in the Study Area and information on their distribution and relative abundance has been presented based on the available data from NLDEC and the literature on the various herds or aggregations in the province in general, and on observations from key studies relevant to the Project.
- The distribution and abundance of preferred (primary, secondary and tertiary quality) habitats for caribou was mapped for the entire 15 km wide ELC Study Area along the transmission corridor, including corridor options in Labrador from both Gull Island and Muskrat Falls.

Key outcomes of this exercise are the detailed regional overviews of caribou herds or aggregations in the Study Area and the habitat quality mapping products indicating seasonal distribution of primary, secondary and tertiary habitat.

Caribou in the province are native to both Labrador and the Island of Newfoundland. They are part of the Boreal Population of caribou, which is sub-divided into migratory, montane (highland) and sedentary (forest-dwelling) ecotypes. Migratory caribou are found only in Labrador and are represented in the Study Area by the GRH that is typically associated with forest tundra. Montane caribou are also found only in Labrador but occur north of the Study Area in the Torngat Mountains. The sedentary ecotype is found in both Labrador and on the Island and is typically considered forest-dwelling (although many caribou in Newfoundland are associated with open / barren areas and undergo seasonal migrations typical of other ecotypes).

In Labrador, the caribou herds most likely to occur within the Study Area are the GRH, RWMH and MMH (including the Joir River subpopulation). The range of the migratory GRH overlaps with the Study Area in winter only and use of the Study Area has been inconsistent in recent years. Any use of the area by GRH caribou will be most likely by small groups of individuals rather than a large proportion of the herd. The ranges of the sedentary RWMH, MMH and the Joir River subpopulation overlap with the Gull Island transmission corridor option

(Option 1), while only the RWMH and MMH ranges overlap the Muskrat Falls transmission corridor option (Option 2). For Option 1 Study Area (Gull Island), 12 percent, 26 percent and 6 percent of the linear distance along the centreline of the transmission corridor passes through RWMH, MMH and Joir River subpopulation ranges, respectively. For Option 2 (Muskrat Falls), 11 percent and 39 percent of the linear distance along the centreline of the transmission corridor passes through RWMH and MMH ranges, respectively, primarily along the TLH-3 and near the edges of these herds' ranges.

In Newfoundland, the ELC Study Area overlaps caribou occupancy areas in the Northern Peninsula and Central and Eastern Newfoundland regions. In both regions, the occupancy areas, divided by level of use into Primary Core areas (50 percent kernel), Secondary Core areas (80 percent kernel) and Occupancy Areas (100 percent kernel), overlap with the ELC Study Area, although the amount of overlap is different between regions. On the Northern Peninsula, of the linear distance along the centreline of the proposed transmission corridor, 90 percent passes through Occupancy Areas, 41 percent passes through Secondary Core area and 17 percent passes through Primary Core area. The transmission corridor in Central and Eastern Newfoundland overlaps with caribou occupancy areas much less than on the Northern Peninsula, where 53 percent passes through Occupancy Areas, 16 percent passes through Secondary Core area and only 8 percent passes through Primary Core area.

Primary habitat is distributed throughout the ELC Study Area in varying proportions depending on season, with greater proportions of primary quality habitat available during calving / post-calving, owing to the downgrading of several habitat types (Alpine Vegetated, Wetland and Scrub / Heathland / Wetland Habitat Types) from primary during calving / post-calving to secondary during winter.

In the Southeastern Labrador region of the ELC Study Area, approximately 63 and 66 percent is comprised of potential primary calving / post-calving habitat along the Gull Island and Muskrat Falls options, respectively, while approximately 39 and 45 percent is comprised of potential primary winter habitat along the Gull Island and Muskrat Falls options, respectively. In the Northern Peninsula region of the ELC Study Area, approximately 58 percent is comprised of potential primary calving / post-calving habitat, while approximately 26 percent is comprised of potential primary winter habitat. In the Central and Eastern Newfoundland region of the ELC Study Area, approximately 35 percent is comprised of potential primary calving / post-calving habitat, while approximately 9 percent is comprised of potential primary winter habitat. In the Avalon Peninsula region of the ELC Study Area, approximately 58 percent is comprised of potential primary calving / post-calving habitat, while approximately 13 percent is comprised of potential primary winter habitat.

There are a variety of limiting factors that influence caribou health and abundance in the province. The loss, degradation and fragmentation of habitat vary between Labrador and Newfoundland and by ecotype, herd or aggregation of caribou. In some situations, such as with the GRH, overgrazing has caused a deterioration of seasonal ranges, causing a lowering of fitness and eventual lower abundance. In Labrador, sedentary herds have tended to decline due to predation and over-hunting. In Newfoundland, habitat issues arise more as a result of human activities and in particular, forest harvesting. Legal and illegal hunting, sensory disturbance, as well as collisions with vehicles are other human-induced limiting factors for caribou. The role of predators, such as black bear, wolf, coyote, lynx and others, can also be important in terms of limiting abundance, although it varies between Labrador and Newfoundland, according to the distribution of these species.

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APPENDIX A

Former Provincial Perspective on Caribou Distribution
on the Island of Newfoundland

Introduction

In 2010, the NLDEC Wildlife Division released new information on caribou distribution in Newfoundland. This information, which presented caribou distribution as occupancy areas receiving differing amounts of use, was different than the previously used approach, which described caribou distribution as herds. There are many reasons for this shift in perspective, arising from the intensive, ongoing Island-wide caribou research programs being conducted by the NLDEC. This appendix outlines the previously used herd perspective, and some of the reasons the Wildlife Division has moved towards their current model. Discussion of the NLDECs current perspective on occupation areas is available in greater detail in Section 3.0 of the main report.

Although the NLDEC is moving away from using herds to describe caribou distribution in Newfoundland, considering caribou distribution in terms of herds can clarify discussions about distribution and be useful when comparing older information regarding traditional use. The public often refer to caribou or to their distribution in terms of 'herds' and the NLDEC still uses the herd nomenclature to outline their Caribou Management Areas and quotas (NLDEC 2010a) and to discuss survey results (NLDEC 2008b, 2008c, 2011b). In light of the recent observations that have led to changes in understanding, the following section has been organized to reflect the regional occurrence of caribou in Newfoundland (i.e., Northern Peninsula, Central and Eastern Newfoundland, Avalon Peninsula) based on previously recognized herds that overlap the Study Area in each region.

Former Perspective on Caribou Distribution on the Island of Newfoundland

In 2007, the NLDEC developed a definition for determining 'core area' (for greater detail on the NLDEC's current designation of 'Core Area', see Section 3.3 of this report). Determined using a GIS and all caribou locational data available at the time (satellite telemetry data and other sources), these core areas were based on 70 percent of calving / post-calving locations and 50 percent of wintering locations (Figure A.1) (Morgan and Doucet 2007; NLDEC Wildlife Division unpublished data). Areas of use were also delineated for three caribou aggregations on the Island (Corner Brook Lakes, Gregory Lake and Hodge's Hill), based on 95 percent of all locations irrespective of season (Figure A.1) (NLDEC Wildlife Division unpublished data).

Of the previously recognized herds or aggregation, several were most likely to have occurred in the Study Area: Northern Peninsula; St. Anthony; Adies Lake; Gros Morne; Gaff Topsails; Hampden Downs; Hodge's Hill; Mount Peyton and Pot Hill (C. Doucet, pers. comm., Morgan and Doucet 2007, NLDEC Wildlife Division unpublished data) (Table A.1). There were a number of other previously recognized herds that occurred in Newfoundland but may not have occurred in the Study Area (Table A.2). There are not discussed in this appendix. Other 'aggregations' of caribou not defined as herds (indentified by NLDEC Wildlife Division) include those in the vicinity of Corner Brook Lakes, Gregory Plateau, Sandy Lake, Cape Shore and Bay de Verde and Hodge's Hill (P. Saunders, pers. comm., K Miller, pers. comm.) (Table A.2). Of these, only the Hodge's Hill aggregation is included in this appendix, as it potentially overlaps the Study Area (Table A.1).

The following sections discuss the distribution of previously recognized caribou herds based on the definition of 'core areas' described in Morgan and Doucet (2007). As this definition is no longer in use by the NLDEC, please note that all references to 'core areas' are based on the former perspective of the Wildlife Division and are no longer considered current.

Figure A.1 Formerly Recognized Caribou Core Areas in Newfoundland

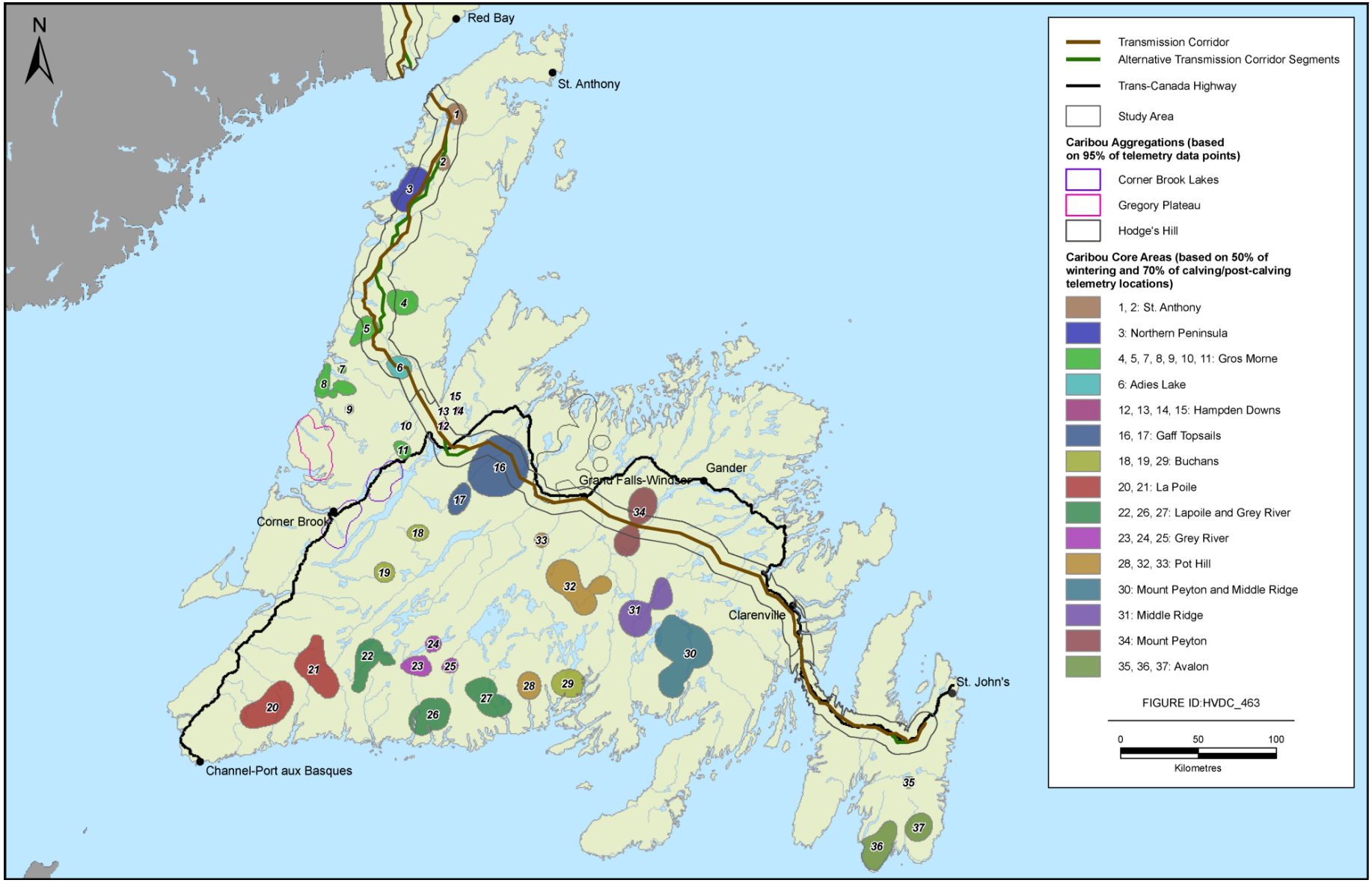

Table A.1 Overlap of Previously Recognized Herds / Aggregations with the Transmission Corridor

Region	Previously Recognized Herd / Aggregation	Overlap with the Study Area
Northern Peninsula	St. Anthony	Range overlaps the Study Area near Ten Mile Lake at the northern portion of the Northern Peninsula
	Northern Peninsula	Majority of the herd's distribution falls within the Study Area. A portion of the range, which occurs 50 km south of St. Anthony between Castor River South and Barr'd Harbour on the west coast of the Northern Peninsula also overlaps the Study Area
	Gros Morne	Herd has several areas of use, some located in the Long Range Mountains and in Gros Morne National Park. The northerly areas of use overlap the Study Area
	Adies Lake	Range occurs in the Long Range Mountains and at the base of the Northern Peninsula
Central and Eastern Newfoundland	Hampden Downs	Several areas of use have been identified, one adjacent to the Study Area
	Gaff Topsails	Several areas of use in west-central Newfoundland near the Mary March river, one of which overlaps the Study Area
	Hodge's Hill[(a)]	Aggregation occupies a large area in central Newfoundland. The distribution extends from the Study Area northward to Notre Dame Bay. It was determined to be an isolated pocket of animals during recent surveys and may be thought of as caribou from other herds that stopped moving with the rest (K. Miller, pers. comm.)
	Mount Peyton	Range overlaps the Study Area. One area of use falls within the Baie du Nord Wilderness Area while the other is between Great Gull River and the Gander Lake. Some winter and calving / post-calving areas are shared with the Middle Ridge herd
	Pot Hill	Several areas of use occurring in central Newfoundland, which overlap Study Area, and the south-central coast

Notes:
[(a)] Aggregation

Table A.2 Caribou Occurrence by Geographic Region within Newfoundland

Previously Recognized Caribou Herd or Aggregation	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula	Elsewhere on the Island
Adies Lake	Y	Y	N	N
Avalon	N	N	Y	N
Bay de Verde	N	N	Y	N
Buchans	N	N	N	Y - southern Newfoundland
Cape Shore	N	N	Y	N
Corner Brook Lakes	N	N	N	Y - western Newfoundland
Gaff Topsails	N	Y	N	N
Grey River	N	N	N	Y - southern Newfoundland
Gregory Plateau	N	N	N	Y - western Newfoundland
Gros Morne	Y	N	N	Y - western Newfoundland
Hampden Downs	Y	Y	N	N
Hodge's Hill	N	Y	N	N
La Poile	N	N	N	Y - southern Newfoundland
Middle Ridge	N	Y	N	N
Mount Peyton	N	Y	N	N
Northern Peninsula	Y	N	N	N
Pot Hill	N	Y	N	Y - southern Newfoundland
Sandy Lake	N	Y	N	Y - southern Newfoundland
St. Anthony	Y	N	N	N

Notes:

1. Y=Yes, previously recognized caribou herd / aggregation occurrence; N=No, no previously recognized caribou herd / aggregation occurrence
2. Geographic regions are presented in Figure 2.1; Primary sources of information are discussed for each previously recognized herd or aggregation in Section 3.0
3. Occurrence in a geographic region is based on previously recognized core calving / post-calving and wintering areas. However, caribou may occur outside of these previously recognized core areas in any given year. Similarly, the indicated presence of caribou in any geographic region does not imply overlap with the Study Area
4. The Corner Brook Lakes, Gregory Plateau and Hodge's Hill caribou represent isolated aggregations of caribou that have been documented in Newfoundland since the publication by Morgan and Doucet (2007). While there may be insufficient information to determine whether these areas or aggregations represent distinct groups (K. Miller, pers. comm.), some studies and publications have recognized them as herds (e.g., Mahoney and Virgil 2003). The Corner Brook Lakes and Gregory Plateau areas are outside the current Study Area; however, the Hodge's Hill aggregation falls within the Central and Eastern Newfoundland region of the Study Area. This latter aggregation will be discussed in relevant sections of the text

Sources: Morgan and Doucet 2007; C. Dyke, pers. comm.; P. Saunders, pers. comm.; K Miller, pers. comm.

Caribou Distribution in the Northern Peninsula Region

Caribou occupancy areas occur on much of the Northern Peninsula. Caribou use of habitat was frequently detected (n=53) at sites visited during ELC surveys (Minaskuat Inc. 2008) and occurred in eight Habitat Types (alpine vegetated, cutover, mixedwood, open conifer, rocky barrens, conifer scrub, conifer forest and wetland). Based on the previously used herd structure, the following herds overlap with the Study Area in this region (Table A.3): St. Anthony; Northern Peninsula; Gros Morne; and Adies Lake.

Table A.3 Population Estimates of Previously Recognized Caribou Herds or Aggregations that Overlap the Transmission Corridor in the Northern Peninsula, Central and Eastern Newfoundland and the Avalon Peninsula Regions

Herd	Estimate (year)	Status – increasing or decreasing (# years[1])
Northern Newfoundland	10,400 (2008)	Not available
St. Anthony	2,162 (2008)	Not available
Northern Peninsula	5,811 (2008)	Decreasing (-29%, 12 years)
Gros Morne	837 (2008)	Decreasing (-71%,11 years)
Adies Lake	608 (2008)	1st census
Hampden Downs	413 (2008)	Decreasing (-52%,14 years)
Hodge's Hill[(a)]	436 (2008)	Not available
Gaff Topsails	2,100 (2007)	Decreasing (-65%, 18 years)
Mount Peyton	650 (2007)	Decreasing (-63%, 13 years)

Notes:
[(a)] Aggregation
1. Number of years since previous population estimate
2. Northern Newfoundland includes all areas north of the Trans-Canada Highway from Corner Brook to Halls Bay and a portion of the area north of Grand Falls-Windsor east to the Bay of Exploits (NLDEC 2008c)
3. Adies Lake, Gros Morne, Northern Peninsula, St. Anthony, Hodge's Hill and Hampden Downs estimates from NLDEC (2008c) and C. Dyke (pers. comm.)
4. Gaff Topsails and Mount Peyton estimates from C. Dyke (pers. comm.)
5. A survey of the Northern Peninsula is planned for 2012 (NLDEC 2011b)

St. Anthony Caribou Herd

The St. Anthony Caribou Herd's core area (core area 1 in Figure A.1) occurs near Ten Mile Lake, located at the northwestern portion of the Northern Peninsula. There is a second, smaller core area (core area 2) for this herd approximately 30 km south of core area 1. This herd was most recently estimated at 2,162 individuals (2008) (NLDEC 2008b).

Approximately 300 Norwegian reindeer (*Rangifer tarandus*) were introduced to the St. Anthony area in the early 1900s. They are believed to have been carrying the brain worm*, Elaphostrongylus rangiferi,* that was transferred to caribou in Newfoundland (Whitney 2004). Of herds sampled by Ball et al. (2001), the occurrence of the *E. rangiferi* was highest in the St. Anthony and Avalon Herds.

Northern Peninsula Caribou Herd

Surveys in 1979 estimated 1,140 adult caribou in the Northern Peninsula Caribou Herd (Fry 1980). This estimate was limited as it was based on the results from an initial phase of a census only. The core area (core area 3 in Figure A.1) occurs along the western edge of the Northern Peninsula, approximately 50 km south of the St. Anthony core area (Morgan and Doucet 2007). The Northern Peninsula Caribou Herd has experienced an estimated rate of decline of 29 percent (over 12 years) and was recently estimated at 5,811 individuals in 2008 (NLDEC 2008b).

Gros Morne Caribou Herd

There are seven core areas identified in Morgan and Doucet (2007) for the Gros Morne Herd (core areas 4 to 5 and 7 to 11 in Figure A.1). Core areas 7, 8 and 9 occur within the Gros Morne National Park boundary. Core areas 7 and 8 are predominantly within the coastal lowland areas, while core area 9 is centred on Gros Morne

Mountain. Core areas 4 and 5 are located to the northwest in the Long Range Mountains. Core areas 10 and 11 are much smaller by comparison and are located at the base of the Northern Peninsula. These two areas occur approximately 25 and 35 km southwest of the Study Area.

The Gros Morne Herd has experienced a decline at an estimated 71 percent since its peak in 1997 following the same trend as all other herds on the Island; the herd increased through the 1970s and 1980s, peaked in the mid to late 1990s, and has followed a steep decline to the present time. The 2008 estimate for the Gros Morne Herd was 837 (NLDEC 2008b).

Adies Lake Caribou Herd

The Adies Lake Caribou Herd core area (core area 6 in Figure A.1) occurs in the Long Range Mountains in the south-central area of the Northern Peninsula (Morgan and Doucet 2007). Caribou from this herd may also range into the Central and Eastern Newfoundland region. The Adies Lake Herd was surveyed for the first time in 2008 and was estimated at 608 individuals (C. Dyke, pers. comm.).

Caribou Distribution in the Central and Eastern Newfoundland Region

Within the central portion of the Island, caribou distribution extends to the southern coast. Caribou use of habitat was detected at 16 of the sites visited during ELC surveys (Stantec Consulting Ltd. 2010) and in six different Habitat Types (cutover, mixedwood, kalmia lichen, conifer scrub, conifer forest and wetland). Use was indicated by the presence of animals, trails, tracks, scats and cratering sites. Based on the previously used herd structure, the following herds overlap with the Study Area in this region: Adies Lake; Gaff Topsails; Hampden Downs; Hodge's Hill; Pot Hills; and Mount Peyton. The Adies Lake Herd, which is more closely associated with the Northern Peninsula Region (and described above), may also occur in this region.

Hampden Downs Caribou Herd

Several areas of use have been identified for the Hampden Downs Herd south of the junction between the Baie Verte and Northern Peninsulas. There is a core area (12 in Figure A.1) adjacent to the Study Area, whereas the rest (core areas 13, 14 and 15 in Figure A.1) occur further north (Morgan and Doucet 2007). The Hampden Downs area, after which this caribou herd is named, is a unique habitat of lichen barrens surrounded by forest. This habitat (a 41,182 hectare area) was identified as a Sensitive Wildlife Area by the provincial government in the 1980s due to its importance to caribou for both forage and as a calving refuge (Kruger Publication Paper 2007). The Hampden Downs Herd, estimated at 413 in 2008, has declined by an estimated 52 percent since its peak in 1994 (C. Dyke, pers. comm.).

Gaff Topsails Caribou Herd

The Gaff Topsail Caribou Herd occupies two core areas (16 and 17 in Figure A.1) in west-central Newfoundland (Morgan and Doucet 2007). Core area 16, the larger of the two core areas, occurs near the Mary March River.

Surveys within the calving area of the Gaff Topsails Herd in 1979 indicated 1,472 ± 548 adult animals (Fry 1980). Between 1985 and 1995, surveys estimated 4,664 caribou (range: 3,894 to 5,813) (Mahoney et al. 1998). The most recent census (2,100 animals) was conducted in 2007 by NLDEC. This represents a decline by an estimated 65 percent over 18 years. A census was not completed during the peak abundance, so the estimated rate of decline was taken from a point in time when the herd was probably still increasing in 1989 (G. Luther, pers. comm.).

Hodge's Hill Caribou Aggregation

The Hodge's Hill aggregation occupies a large area in central Newfoundland extending northward between the Exploits River and Notre Dame Bay. The Hodge's Hill aggregation was determined to be an isolated pocket of animals identified during recent surveys and may be thought of as caribou from other herds that stopped moving with the rest (K. Miller, pers. comm.). The 2008 estimate for the Hodge's Hill aggregation was 436 individuals (C. Dyke, pers. comm.).

Mount Peyton Caribou Herd

The Mount Peyton Caribou Herd is located in central Newfoundland (core areas 30 and 34 in Figure A.1) (Morgan and Doucet 2007). One area of use falls within the Baie du Nord Wilderness Area, while the other is between Great Gull River and the Gander Lake. In 1993, the combined Mount Peyton and Middle Ridge Caribou herds had an estimated 13,000 to 15,000 animals (Chubbs et al. 1993). These herds have been known to use the Northwest Gander-Gull Lake region of east-central Newfoundland (Chubbs et al. 1993). The most recent census of the Mount Peyton Herd was in 2007, with an estimate of 650 individuals. This herd declined by an estimated 63 percent in the 13 years since the peak in 1995 (C. Dyke, pers. comm.).

Caribou Distribution on the Avalon Region

There is one recognized caribou herd on the Avalon Peninsula. Although there is little current data on the distribution of these caribou (P. Saunders, pers. comm.), three core areas (35, 36 and 37 in Figure A.1) are identified on the Avalon Peninsula (Morgan and Doucet 2007). Although these are not near the Study Area, caribou presence was detected in two Habitat Types (mixedwood and wetland) at two sites during ELC surveys in 2008 (Stantec Consulting Ltd. 2010).

Current Perspective on Caribou Distribution on the Island of Newfoundland

Since the late 1990s, there has been a 66 percent decrease in the caribou population in Newfoundland (Soulliere et al. 2010b). In response, the NLDEC began a five year Caribou Strategy in 2008 to better understand the decline in the population (NLDEC 2009b) that includes, in addition to the continued collected of necessary caribou data, the initiation of a predator-caribou ecology study, increased emphasis on habitat assessment, and an assessment of black bear populations on the Island (NLDEC 2008a). The ongoing monitoring program, which includes population censuses, herd composition surveys, health and disease assessment, and the deployment of nearly 400 telemetry collars on adult female caribou (NLDEC 2010a) has returned a large amount of data, some of which has led to changes in the understanding of caribou distribution in Newfoundland.

Historically, a 'herd' approach was used to manage caribou on the island. However, shifts in caribou range and core areas, as well as greater separation between animals during calving (P. Saunders, pers. comm.), have led to a more "ecoregional" approach and an understanding that describes caribou as "occurring throughout the province in various densities" (C. Dyke, pers. comm.). This change in understanding is due to observed changes in the behaviour of caribou on the Island in the past five to six years (C. Dyke, pers. comm.; P. Saunders, pers. comm.; NLDEC 2009b):

- less of a pattern in, and distinction between, the use of different areas and Habitat Types by caribou for specific times and activities;
- more seasonal overlap between traditional herds;
- apparent abandonment of certain calving grounds;
- dispersal during calving to "randomly distributed" locations in forest and open areas;

- changes in traditional fall migration routes; and
- a shift and/or expansion in the distribution of certain herds.

While unconfirmed, several explanations have been proposed for the observed change in behaviour, including density-dependent responses, predation (C. Dyke, pers. comm.; P. Saunders, pers. comm.), caribou health, disease, habitat use and availability and habitat loss, fragmentation and degradation (NLDEC 2009a). Outside of harvest management purposes, where traditional herds labels are still recognized, some researchers are entertaining the idea of a caribou metapopulation on the island (i.e., a group of spatially separated populations of the same species that interact at some level) (C. Dyke, pers. comm.; P. Saunders, pers. comm.). Recent research into the genetic relationships of groups of caribou in Newfoundland have identified several distinct haplotypes (32) and grouped them into four different clades: Clade A, which appears only in the St. Anthony, Hampden Downs and Buchans herds; Clade B, which is present throughout most herds but absent from herds on the Avalon Peninsula; Clade C, which is most prevalent in the western and central herds and decreases in prevalence in eastern herds; and Clade D, which is present in all herds in the island but is the sole clade occurring in the herds on the Avalon Peninsula (Wilkerson 2010). There is a haplotype present in the St. Anthony herd that is also present in several central herds, but absent from the Northern Peninsula herd, which is located in between (Wilkerson 2010). Additionally, the haplotypes present in the Avalon and Cape Shore herds are distinct from the rest of the island herds (Wilkerson 2010). With the exception of the herds on the Avalon Peninsula, there is a lack of genetic differentiation among herds and regions indicating a large amount of genetic exchange, or mixing, among most herds in Newfoundland, especially in the central region (Wilkerson 2010).

These observed changes have led to a reassessment of the previously used definition of 'core area' described in Morgan and Doucet (2007). The core areas used in Morgan and Doucet (2007), while based on the best information available at the time, were based on limited data for some regions and failed to represent others (NLDEC 2011a). Additionally, they were based on calving and winter locations only (Morgan and Doucet 2007). The current occupancy areas, based on locations from 2005 to May 2009, are delineated as Core Areas (50 percent kernel), Secondary Core Areas (80 percent kernel) and Occupancy Areas (100 percent kernel) (Blake 2011). The new process for delineating occupancy areas includes: a mechanism to incorporate not only shifts in calving areas but also movements of some populations to more dispersed calving distributions; the inclusion of important areas that might not receive annual use; home range sizes; and daily, seasonal and yearly movements (NLDEC 2011a).

This shift in the understanding of caribou distribution in Newfoundland is recent and has come about through the analysis of the data obtained through the NLDECs ongoing research programs. As additional data continue to be generated by the five-year Caribou Strategy, the understanding of caribou distribution on the Island may change again as new information is incorporated. However, the approach currently being used by NLDEC (Blake 2010, 2011; NLDEC 2011a) presents the most current perspective of caribou distribution compared to the previously used method (Morgan and Doucet 2007), hence its incorporation in this *Component Study*.

APPENDIX B

SELECTED ANNOTATED BIBLIOGRAPHY

Existing and available information on caribou and their predators through library and internet searches and through discussions with the NLDEC Wildlife Division and other organizations was compiled. The result of this effort was an annotated bibliography that lists and describes relevant caribou studies completed in Newfoundland and Labrador during the past approximately 20 years. Documents related to caribou are presented separately, below. For a complete list of references and literature cited in this *Caribou and Their Predators Component Study,* please refer to Section 5.0.

Bergerud, A.T. and S.N. Luttich. 2003. Predation risk and optimal foraging trade-off in the demography and spacing of the George River herd, 1958 to 1993. *Rangifer Special Issue* 14: 169-191.

The distribution, mobility and energy budgets of the GRH from 1974 to 1993 were studied. The annual cycle was arranged in six phases to examine the priorities of optimal foraging and predation risk between periods. During calving season, risk was more important than foraging for females but males took more risk to optimally forage. In mosquito season, insect avoidance took more priority over risk and foraging. At late summer and fall, optimal foraging took precedent over risk. During winter, localized ranges were restricted as areas of low snow cover were sought to reduce predation risk. Spring migration increased risk for females moving back to tundra to give birth at low risk calving grounds. In May, females sought new vegetation near the tree line to increase risk to provide maximum nutrition to fetuses.

Bergerud, A.T., S.N. Luttich and L. Camps. 2008. The return of caribou to Ungava. McGill-Queen's University Press, *McGill-Queen's Native and Northern Series* 50.

The book is an extensive documentation of research by Dr. Bergerud and others regarding migratory (predominantly George River) and sedentary ecotypes of caribou throughout Labrador and northeastern Quebec from the 1950s until present. Descriptions of the MMH and RWMH are included along with the known history of these herds, associated research, and present status. The document also describes population regulation and management by the Government of Newfoundland and Labrador.

Bergman, C., J.A. Schaefer and S.N. Luttich. 2000. Caribou movement as a correlated random walk. *Oecologia* 123: 364-374.

Correlated random walk models and satellite telemetry were used to investigate long distance movements of caribou. Individual paths of migratory and sedentary female caribou were quantified using measures of mean move length and angle, and net squared displacements at each successive move were compared to predictions from the models. For paths recorded through one annual cycle, the correlated random walk model over-predicted net displacement over time. Paths recorded over shorter intervals delineated by seasonal behavioural changes held an excellent correspondence between model predictions and observations for most periods of both migratory and sedentary caribou. In all cases of over-prediction, there was significant positive autocorrelation in turn direction. In one case of under-prediction, significant negative autocorrelation of sequential turn direction was evident, indicating migratory caribou moved in straightened paths during spring migration.

Boulet, M., S. Couturier, S.D. Cote, R. Otto and L. Bernatchez. 2005. Gene flow patterns between migratory, montane, and sedentary caribou herds of northern Quebec and Labrador: Lessons from satellite tracking, microsatellite genotyping, and population simulations. Ministere des Ressources naturelles et de la Faune, Direction de la recherché sur la faune, QC. 46 pp.

An understanding of gene flow between populations is essential for establishing effective conservation planning. This study combined the use of satellite tracking data (migratory caribou in rutting and calving seasons), micro satellite markers and population simulations to evaluate potential and realized gene flow and understand metapopulation dynamics between seven caribou herds in three ecotypes (two migratory, four sedentary and one montane). Satellite telemetry data indicated an overlap of rutting ranges between the Rivière-George and Rivière-aux-Feuilles migratory herds. In addition, 9.4 percent of satellite tracked females from migratory herds switched calving sites at least once in their lifetime. Some migratory individuals also migrated south into the range of the sedentary herds. The results were reflected in a weak but significant global genetic differentiation among herds (global F_{ST}=0.015). The analysis of gene flow patterns between migratory (e.g., GRH), montane (e.g., Torngat Mountains Caribou Herd, located in northern Labrador), and sedentary herds of northern Québec and Labrador (e.g., RWMH, LJH), indicated that there was 'weak but significant global genetic differentiation' between herds. While there was 'significant differentiation between the sedentary herds' influenced by the geographic distance separating them, they noted that there is gene flow between the sedentary herds and remote migratory herds, such as the RWMH and GRH. The MMH was considered the most distinct of those evaluated.

Brown, W.K. and J.B. Theberge. 1990. The effect of extreme snow cover on feeding site selection by woodland caribou*. Journal of Wildlife Management* 54(1): 161-168.

The depth and hardness of snow cover are important factors affecting caribou feeding strategies. The influence of extreme snow cover conditions on distribution and use of feeding sites was examined. Caribou wintered in areas of mean snow depths of 176.7 cm and dug through snow with mean depths of ≤ 123.1 cm to reach forage.

Burzynski, M., T. Knight, S. Gerrow, J. Hoffman, R. Thompson, P. Deering,, D. Major, S. Taylor, C. Wentzell, A. Simpson and W. Burdett. 2005. State of the Park Report, Gros Morne National Park of Canada: An Assessment of Ecological Integrity.

The ecological health of Gros Morne National Park is described, to assess the effectiveness of management actions aimed at preserving the Park's ecological integrity, and to identify serious gaps in knowledge of the Park. It was found that the caribou herds in Newfoundland are in a decline, with mean population-age increasing; growth of individuals, percentage of males, and fall recruitment decreasing; and juvenile mortality approaching 100 percent in some herds. Changes in caribou distribution have accompanied the decline. Woodland caribou herded in large numbers on the lowland wetlands to feed and rut, but since 2003 they have almost disappeared. This, and continuing damage to the Park's wetlands by snowmobiles, led to an assessment of fair but declining ecological condition.

Courtois, R., A. Gingras, D. Fortin, A. Sebbane, B. Rochette and L. Breton. 2008. Demographic and behavioural response of woodland caribou to forest harvesting. *Canadian Journal of Forest Resources* 38:2837-2849.

The study investigated whether woodland caribou would remain in an area that included large forest blocks linked with wide corridors and cuts were amalgamated in large zones. Five aerial surveys were followed by

telemetry over eight years to evaluate changes in caribou abundance. Caribou selected protected blocks, used corridors in proportion to their availability and avoided logged areas. They preferred closed conifer stands without terrestrial lichens and open conifer stands with or without terrestrial lichens throughout the study. Open habitats (clearcuts and burns), regenerating sites, mixed and deciduous stands and water bodies were avoided. It was concluded that caribou numbers were maintained within the managed area as a result of the presence of protected blocks and uncut continuous forest.

Couturier, S. 2004. Body Condition, Space Use and Demography of Caribou in Québec-Labrador: From Individual to Metapopulation – Some Preliminary Results. Prepared on behalf of the Government of Québec, Québec Société de la faune et des parcs du Québec and Université Laval.

This extensive work on caribou was the result of collaboration between several government organizations and other agencies. Results were presented based on body condition, demography, space use (emigration and survival) and genetic status. Data were collected on the GRH and Leaf River Caribou Herds for comparison.

Couturier, S. 2004. Physical Condition of Migratory Caribou in Québec-Labrador; Summary Assessment of Observations from 2001 to 2003. Prepared for the Institute for Environmental Monitoring and Research by the Société de la faune et des parcs du Québec, Direction de la recherche sur la faune du Québec.

The objective of the study was to provide a better understanding of the ecology of the main populations, subpopulations or groups of caribou in northern Québec and Labrador through the use of spatial analysis, analysis of physical condition and demography and genetics. The study compares the GRH and Leaf River Caribou Herd, which are expected to be genetically similar but differ in their use of space, physical condition and demography. Field measurements were taken on adult females and calves. The preliminary trends similar patterns of change in the demography of both herds. There was an apparent improvement in condition as the GRH population decreased from its peak 775,000 animals (1993) to 440,000 (2001). The Leaf River Herd appeared to deteriorate in condition between 1991 and 2001 during a large population increase. At the same time, the Leaf River Herd's calving range and habitat have changed.

Couturier, S., J. Brunelle, D. Vandal and G. St-Martin. 1990. Changes in the population dynamics of the George River Caribou herd, 1976-1987. *Arctic* 43(1): 9-20.

The recent decrease in the GRH was caused by both increasing calf winter mortality since 1977 and an increase in their summer mortality since 1984. A reduction in the pregnancy rate may also be responsible for the decline. Other probable factors in the decline involve negative effects and interrelation of decline of physical condition of females, habitat deterioration on current calving grounds, an increase in energy expenditures related to more extensive movements, delayed birth dates, increase in density within their range, or increase in wolf populations and exceptionally high snow accumulation during 1980-1981 winter.

Couturier, S., S.D. Côté, J. Huot and R.D. Otto. 2009. Body-condition dynamics in a northern ungulate gaining fat in winter. *Canadian Journal of Zoology* 87: 367-378.

Long-term trends in the condition and productivity of female caribou in two large migratory caribou herds, the Rivière-George and Rivière-aux-Feuilles, were examined. The summer condition of female caribou was better during years of small herd size. Summer nutrition followed the same pattern between herds through time. The spring body condition of females declined during early population growth in 1976 to the mid-1980s. Fall

condition did not change during 1983 and 2002, when the population peaked and then later declined. Pregnancy rates were inversely related to herd size in both herds. Vegetation quality in June was significantly related to body proteins in the fall.

Couturier, S., S.D. Côté, R.D. Otto, R.B. Weladji and J. Huot. 2009. Variation in calf body mass in migratory caribou: The role of habitat, climate and movements. *Journal of Mammalogy* 90(2): 442-452.

The factors influencing variation in body mass of calves of Rivière-aux-Feuilles and Rivière-George migratory caribou at birth and in the autumn were studied. The mass at birth did not differ between herds; however, it was noted birth mass varied with year. Rivière-aux-Feuilles calves were smaller than Rivière-George calves in the autumn. Birth and autumn body mass were influenced positively by habitat quality in June. Previous winter snowfall was negatively related to mass of Rivière-George calves, and summer daily movement rates were negatively correlated with mass of calves of both herds in the autumn. Birth mass was positively related with productivity in October in the Rivière-George herd and also with productivity three to four years later.

Couturier, S., R. Courtois, H. Crépeau, L.-P. Rivest and S. Luttich. 1996. Calving photocensus of the Rivière-George caribou herd and comparison with an independent census. *Rangifer Special Issue* 9: 283-296.

Studies between 1984 and 1990 suggested calving and summer habitats were being deteriorated by the formerly rapid growth of the GRH. In turn, the poor habitat quality has affected physical condition, pregnancy rate and calf survival of the herd. Aerial photographs of the calving grounds have been used to estimate the population of the GRH since 1984. In 1993, a different sampling design was used and compared with the previous technique. The first method determined the number of females from the estimated calves on the photographs and the June female/calf ratio (resulting in an estimate of 775,891 $\pm$ 13.40 percent caribou including calves). The second method used the previous census and based the number of adults on the photos and on the June female/adult ratio (estimate of 823,375 $\pm$ 12.36 percent caribou including calves). The resulting population estimates were compared with an independent census (608,384 adults $\pm$ 14.35 percent).

Couturier, S., D. Jean, R. Otto and S. Rivard. 2004. Demography of the migratory tundra caribou (*Rangifer tarandus*) of the Nord-du-Québec Region and Labrador. Ministere des Ressources naturelles, de la Faune et des Parcs, Direction de l'amenagement de la faune du Nord-du-Québec and Direction de la recherché sur la faune, QC. 68 pp.

Two photographic surveys of post-calving aggregations were conducted in 2001 to estimate the caribou populations. A comparison of results using two statistical methods (Lincoln-Petersen method and the model method) suggested that the two methods were relatively equivalent when smaller groups were excluded. The model method was indicated as less subjective and was used to obtain population estimates. The authors suggested the used of the extrapolated population (October) 385,000 $\pm$ 28 percent as the basis for management of the GRH. The growth rate of 1.12 was reported between 1976 and 2001, the period where the population exceeded 600,000 animals.

Deichmann, K.H. 1990. An Assessment of Environmental Impacts Relating to Past and Present Use of Over-Snow Vehicles within the Boundaries of Gros Morne National Park.

The assessment provides details of observed or reported effects of over-snow vehicles within the national Park. Caribou, which were often in the open, were readily visible and often subject to disturbances. Effects were assessed by setting up line transects at right angles to line of travel in areas of concentrated use. Sites were selected by reference to air photography and topographical maps and flown over by helicopter. Poaching and

harassment of ungulates is easier in winter than other times of year and both moose and caribou are more vulnerable to stress during the winter. Observations during aerial surveys and ground patrols indicated an aversion to over-snow vehicle trails by both moose and caribou.

DND (Department of National Defence). 1994. *An Environmental Impact Statement on Military Flying Activities in Labrador and Quebec.* Ottawa, ON.

This multi-year EA examined the effects of existing and proposed military flight training over a large area of Labrador and northeastern Quebec. Aerial surveys for caribou within this area (i.e., GRH and RWMH) were completed to provide insight regarding seasonal distribution and abundance within the Low-level Training Area. Mitigation measures proposed included spatial exclusion zones when the migratory ecotype was expected and when satellite-collared animals were present.

Ferguson, S.H. and P.C. Elkie. 2004. Habitat requirements of boreal forest caribou during the travel season. *Basic and Applied Ecology* 5: 465-474.

Seasonal differences in migration habitat used by woodland caribou while travelling to and from summer and winter ranges were monitored using radio telemetry from 1995 to 2000. Study results indicated that there were few differences between real travel routes and straight line routes during both high movement periods (post-calving to late winter and later winter to calving). Caribou selected less deciduous forest than available during early winter and spring but did not use more open areas and waterways. Possible migration corridors or habitat used during early winter and spring were not distinguished by one particular habitat type, although caribou were more likely to avoid water and open areas while using more conifer forests. Caribou did not avoid disturbed habitat (e.g., recently burnt or cut areas). Males used deciduous forest more than females.

Ferguson, S.H. and P.C. Elkie. 2005. Use of lake areas in winter by woodland caribou. *Northeastern Naturalist* 12(1): 45-66.

The use of lakes in winter is considered as important for woodland caribou as this habitat provides reduced predation risk and ability to acquire food. The use of ice-covered lakes was compared within a regional study area and within sub-regional landscapes at two spatial levels – seasonal selection of winter ranges and daily locations. In winter range analysis, caribou used areas with more lakes in the 5 to 100 ha size class, including lakes with more perimeter, large area and higher fractal dimensions as compared with the relative distribution of available lakes. These patterns were confirmed at the regional level and sub-regional levels. With regards to daily locations, caribou selected lakes with greater area and perimeter in the west but not the east.

Fortin, D., R. Courtois, P. Etcheverry, C. Dussault and A. Gingras. 2008. Winter selection of landscapes by woodland caribou: Behavioural response to geographical gradients in habitat attributes. *Journal of Applied Ecology* 45:1392-1400.

This study evaluated whether landscape selection by forest-dwelling woodland caribou varied along geographical gradients in habitat attributes. The centroid of track networks made by caribou during the winter was recorded during aerial surveys conducted over 161,920 km^2 of boreal forest. Autologistical models were estimated by comparing the characteristics of landscapes centred on each centroid to an equal number of randomly located landscapes. The availability of habitat attributes varied along longitudinal and latitudinal gradients and caribou altered their landscape selection with respect to those gradients. The probability of occurrence of caribou increased with abundance of conifer forests. This positive response gradually became negative towards the southern portion of the region. The association between caribou and lichens changed from

a negative response on the western study region to being positive in the eastern part. Availability of lichen dominated landscapes decreased from west to east. Caribou generally showed an aversion to areas of high road density, a negative association that became positive in the southern part of the study region.

Hins, C., J-P. Ouellet, C. Dussault and M-H St-Laurent. 2009. Habitat selection by forest-dwelling caribou in managed boreal forest of eastern Canada: Evidence of a landscape configuration effect. *Forest Ecology and Management* 257: 636-643.

Habitat alteration caused by forest harvesting may contribute to the decline of forest-dwelling caribou. The study investigated the hierarchical habitat selection of forest-dwelling caribou in a boreal landscape strongly affected by logging. Telemetry work was conducted over a three year period. Home ranges showed a high proportion of old forests, a low proportion of regenerating forests and a tendency to include a greater proportion of six to 20 yea-old clear cuts. Selection patterns differed between periods. Caribou selected open lichen woodlands throughout the year while mature closed forests were selected uniquely during the summer. Clearcuts were avoided during calving, in summer and during rutting but were selected during the spring. The study suggested that mature forest and open lichen woodlands are highly selected forest cover types by caribou at both spatial scales.

Hoffman, J. 2003. Snowmobile Survey Gros Morne National Park of Canada April 16 and 19, 2003.

This report describes the amount of snowmobile use in Gros Morne National Park during two days in April in 2003. Of relevance, six caribou were observed on 16 April 2003 on Lookout Hills.

James, A.R.C. and A.K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. *The Journal of Wildlife Management* 64(1): 154-159.

Linear corridors were hypothesized to increase human harvest and predation pressure on woodland caribou. The distribution of 2,616 telemetry locations of caribou, 27 caribou mortality sites, 592 telemetry sites of wolves and 76 sites where wolves had preyed on large ungulates relative to linear corridors were examined. Caribou mortalities due to wolf predation were closer to linear corridors than live locations from all caribou (i.e., caribou closer to linear corridors were at higher risk of predation). Caribou mortalities caused by humans were closer to corridors than all live caribou locations but this was not considered significant. It was recommended that the development of new corridors within caribou habitat should be minimized and existing corridors should be made unsuitable as travel routes to reduce industrial development impacts on caribou populations.

Jeffery, R. 2008a. Joir River Woodland Caribou Classification Report. Wildlife Division Report prepared for the IEMR, March 2008.

The NLDEC Wildlife Division and the IEMR partnered to classify the Joir River woodland caribou population. Eight groups of caribou were identified and 108 animals classified. Locations are presented in the report. The portion of calves in 2008 was 24 percent which was considerably higher than in 2007. The proportion of males was lower than in 2007. The 2008 results were more typical of woodland herds, which tend to have fewer males than females.

Jeffery, R. 2008b. Red Wine Woodland Caribou Recollaring, Feb-March 2008. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to replace VHF collars on Red Wine caribou. Ten of fourteen VHF collars on RMWH animals were replaced in February and March 2008. A classification could not be

completed as the RWMH was mixed in with the GRH. Of interest, one RWMH was captured during the Lac Joseph survey in a group of Lac Joseph caribou during a survey of the LJH. This was an important recapture as this animal tends to behave differently than the rest of the Red Wine animals and has a home range beyond the more commonly used core area.

Jeffery, R. 2008c. Lac Joseph Woodland Caribou Classification, March 2008. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to classify the LJH. Satellite collars were used to locate groups of Lac Joseph caribou, which were then classified based on antler shape and size and presence/absence of vulva patch or obvious sex organs. Thirteen groups of caribou totaling 189 were identified and classified. Both the percent calves (18.5) and male to 100 female ratio (48.5) were similar to 2007 results. Demography rates for 2007 and 2008 indicated that the herd could be stable or increasing.

Jeffery, R. 2007a. Joir River Woodland Caribou Project Report, 2006-2007. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to conduct a density distribution survey of the Joir River woodland caribou population, classify the herd, and replace two old collars. Within the high density study area, 75 caribou were observed in nine separate groups. Classification of observed caribou identified 16 percent calves (calf percentage) and 48 calves:100 females. It also yielded 136 stags:100 females. The various analyses showed that the estimated total number of caribou within the survey area varied from 118 to 178 depending on which model was applied.

Jeffery, R. 2007b. Red Wine Woodland Caribou Project Report, 2006-2007. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to classify the RWMH and to replace five collars. The majority of the collared Red Wine caribou were surrounded by hundreds of George River caribou. This meant that apart from the collared animals, it was impossible to identify which were Red Wine animals. The only group of Red Wine animals that was entirely separate was located south of the GRH. There were 25 animals observed in this group including 14 females, seven stags, and four calves. That meant a recruitment rate of 16 percent and a calf:100 female ratio of 28. The male:100 female ratio was 50. These values indicated a healthy herd but there was no way to be certain that this small group was representative of the entire population.

Jeffery, R. 2007c. Lac Joseph Woodland Caribou project report 2006-2007. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to classify the LJH. Twelve groups of caribou totaling 229 animals were identified and classified. The 2007 results indicated that percent calves were somewhat higher compared to 2006 while the males:100 females ratio was lower. This could have been due to the larger sample size in 2007 than in 2001 to 2005. It could also indicate an improvement in calf survival, and subsequent improvement in herd health.

Jeffery, R. 2007d. George River Caribou Project, 2006-2007. Wildlife Division Report prepared for IEMR.

The NLDEC Wildlife Division and the IEMR partnered to deploy seven collars on George River caribou. On 14 February 2007, four female GRH caribou were outfitted with new collars. Thousands of caribou migrated into Nipishish Lake which made the caribou accessible for collaring.

Jung, T.S and C.C. Jones. 2000. Movements and Site Fidelity of Woodland Caribou of the Red Wine Mountains Herd in relation to Low-level Aircraft Training in Labrador. In: M. Baker and G. Beliveau (eds.). *Effects of Noise on Wildlife Conference Proceedings*. Happy Valley-Goose Bay, Labrador. Institute for Environmental Monitoring and Research No. 2.

During 1993 to 1998, location data were obtained for a total of 25 woodland caribou via satellite telemetry. Home range size, movement rates, distance travelled, path tortuosity and site fidelity for each animal, during each of the biological seasons, were calculated. Home range size, movement rates and distance travelled were greater in the spring and fall then in the early summer and late summer periods. Site fidelity was greater in the early summer, late summer and spring than periods during the annual cycle. Reconfiguration of the Military Training Area (MTA), and hence greater exposure to low-level jet overflights, had no effect on home range size, movement rates, distance traveled, path tortuosity or site fidelity of woodland caribou.

Keith, T. 2001. A Natural History and Resource Inventory of the Proposed Mealy Mountains (Akamiuapishku) National Park Study Area, Labrador. Prepared for the Parks Establishment Branch Parks Canada, Hull, QC.

The report describes the species found in the Mealy Mountain National Park Study Area. Of relevance is the MMH, which resides south of Lake Melville in the study area. The caribou was historically one of the most important and characteristic species of the area, but the population has declined dramatically, due largely to overexploitation by humans in the late 1950s, early 1960s and late 1980s. During the winter months this herd has been observed aggregating on the Mealy Mountains and along the Labrador coast, where snow depths are less than in the inland forests.

Jacques Whitford. 1996. Star Lake Hydroelectric Project Environmental Impact Statement. Jacques Whitford Environment Limited report prepared for Abitibi-Price Inc. Grand Falls-Windsor Division. Grand Falls-Windsor, NL.

This document contains information on the habitat requirements and availability, and distribution and abundance of flora and fauna found in the study area including caribou. It also discusses the potential effects that a project like this would have on the flora and fauna in the study area.

Jacques Whitford. 1997a. Environmental Baseline Technical Data Report Caribou. Jacques Whitford Environment Limited report prepared for the Voisey's Bay Mine/Mill Project EIS.

This report describes the caribou found in the study area along with the habitat preferences, seasonal distribution and abundance using various survey methods. This study showed that caribou exhibited extreme variation in terms of seasonal and yearly density and distribution within the project region. In 1996, caribou were present in substantial numbers in the project region only during the winter and during spring migration to the calving area. Many caribou wintering around Voisey's Bay in 1996 crossed the claim block during spring migration to the calving grounds: however, few caribou were present in the area during the winter of 1996-1997 and other seasons.

Jacques Whitford. 1997b. Star Lake Hydroelectric Development Fall 1997 Buchans Plateau Caribou Migration Results of Monitoring. Jacques Whitford Environment Limited report prepared for the Star Lake Mini-Hydro Electric Development.

As part of the Star Lake Hydro Electric Project Environmental Protection Plan (EPP), a caribou monitoring program was developed to ensure that the migration of the Buchans Plateau caribou herd was not disrupted by construction activity in the vicinity of Star Lake. Caribou were observed using corridors such as transmission lines and old skidder trails in addition to the many trails crisscrossing the Star Bog and surrounding area. Changes in the number of caribou observed from one aerial survey to another, particularly during the last week of October, indicated that animals were having no difficulty moving through the area on their migration southward.

Loring, S. 2008. At home in the wilderness: The Mushuau Innu and caribou. Pp. 123-134. In: A.T. Bergerud, S.N. Luttich and L. Camps. 2008. The return of caribou to Ungava. McGill-Queen's University Press, *McGill-Queen's Native and Northern Series* 50.

The author discussed linking together the traditional pursuit of caribou by the Innu through archaeological research and oral traditional and stories. The Mushuau Innu, who lived in the George River country, developed a specialized caribou subsistence lifestyle that predicated on the interception of the migratory GRH. The roles of shaman and spiritual intermediary were thought to be able to influence the movement of the caribou. Fluctuations in the caribou herd size, migration patterns and climatic variations had sometimes resulted in the starvation of some hunting camps. Although the Innu have now abandoned the traditional residence in the country, there continues to be a link between the Innu culture, the country and the caribou.

Mahoney, S.P., K. Mawhinney, C McCarthy and S. Taylor. 2001. Caribou Ecology in Gros Morne National Park. Final Report Draft prepared for Gros Morne National Park of Canada.

The report describes the home range, movement, population, productivity, habitat preferences, survival rates, herd composition, diet, and body condition of caribou in various subregions in and around Gros Morne National Park.

Mahoney, S.P. and J.A. Schaefer. 2002. Hydroelectric development and the disruption of migration in caribou. *Biological Conservation* 107: 147-153.

The study investigated the effects of hydroelectric development on movements and space-use of caribou in west-central Newfoundland. Patterns of range use, site fidelity and timing of migration were compared before, during and after project construction. During the first year of construction, caribou were less likely to be found within 3 km of the site. This persisted for at least two years after construction was completed. They concluded that the development caused a disruption of migration timing during construction and longer-term diminished use of the range surrounding the project site.

Mahoney, S.P. and J.A. Virgil. 2003. Habitat selection and demography of a nonmigratory woodland caribou population in Newfoundland. *Canadian Journal of Zoology* 81: 321-334.

During a four-year period of timber harvesting, the location and status of 24 adults and 46 calves were monitored to determine coarse-scale habitat selection and survival rates of a non-migratory and demographically isolated woodland caribou herd in Newfoundland. Pregnancy and recruitment rates were estimated and potential causes of mortality were determined. Results found that caribou avoided habitats where the likelihood of contact with a predator or alternate prey was high. Population growth rate, calf

recruitment and adult survival rate indicated that the population was stable. Mean pregnancy rate, parturition date and lack of evidence for malnutrition in 22 carcasses suggested that the availability of quality forage was not a key factor limiting population growth. Although predation could not be linked to the death of adult caribou, black bears were responsible for 5 of 15 calf deaths.

Maier, J.A.K, R.G. White, S.M. Murphy and D. Smith. 2001. Effects of Overflights by Jet Aircraft on Activity, Movements, Habitat and Terrain Use of Caribou. In Conference Proceedings, Terra Borealis. Effects of Noise on Wildlife. Happy Valley-Goose Bay, Labrador, August 22-23, 2000. Prepared by the Institute for Environmental Monitoring and Research.

Researchers evaluated responses by caribou to jet aircraft overflights to identify potentially sensitive times of year. Research was conducted in late winter, post-calving and insect season. The objective of the research was to quantify long-term responses of caribou to overflights by subsonic jet aircraft flying at altitudes less than 33 m above ground level. Research included measurement of noise exposure experienced by caribou overflown by jet aircraft, activity cycles and movements of caribou to overflights, responses of caribou to overflights as a function of noise exposure and habitat and terrain use by caribou exposed to overflights. A total of ten caribou were captured – half in the treatment and half in the control areas, and outfitted with a radio collars containing VHF radio transmitters and activity counters. Caribou subjected to overflights in late winter engaged in a greater of resting bouts than caribou not subjected to overflights (p=0.05). Caribou subjected to overflights during post-calving were more active (p=0.03), moved farther (p=0.01) and avoided closed mixed forests compare to caribou not subjected to overflights. Caribou subjected to overflights during insect season were more active (p=0.01) and used higher elevation, more rugged terrain. Caribou responses to overflights by jet aircraft were mild in late winter, intermediate in insect season and strongest during post-calving.

Manseau, M., J. Huot and M. Crête. 1996. Effects of summer grazing by caribou on composition and productivity of vegetation: Community and landscape level. *Journal of Ecology* 84(4): 503-513.

The authors investigated the effect of caribou grazing and trampling on composition and productivity of shrub tundra and stands of dwarf birch. For shrub tundra sites, the lichen mat was absent in grazed sites, and previously lichen occupied sites were bare, covered in fragments of dead lichen/mosses or recolonized by earlier lichen species. Ground cover in the area where shrubs had not been eaten by caribou was lower in grazed sites. Ground cover and leaf biomass was significantly lower in stands of dwarf birch grazed by caribou.

McLoughlin, P.D., J.S. Dunford and S. Boutin. 2005. Relating predation mortality to broad-scale habitat selection. *Journal of Animal Ecology* 74:701-707.

This study related long-term predation-mortality patterns for adult woodland caribou in Alberta (1991 to 2002) with patterns of multivariate habitat selection. A comparison was made of the probability of radio-tracked caribou dying from predation in habitats within the home range, controlling for habitat availability, with that expected from habitat selection probabilities for the same animals during life. A comparison was also made of the survival rates of caribou possessing dissimilar patterns of habitat selections. Patterns in habitat-specific predation mortality differed significantly from expected given probabilities of habitat selection during life (p<0.0001). Cox regression analyses indicated that mortality rates due to predation were affected significantly by and can be predicted from patterns of selection (p=0.02). Results strongly suggested that uplands present caribou with higher than expected levels of predation risk and that caribou can avoid predation by maximizing selection of peatlands.

Minaskuat Inc. 2008. Wildlife Habitat Associations in the Lower Churchill River. Prepared for the Lower Churchill Hydroelectric Generation Project.

This study was effective in collecting evidence and information pertaining to the habitat associations for approximately 13 mammalian species in the survey area. Of relevance are habitat associations concerning caribou. Results showed low evidence of caribou that was relatively consistent across habitat types. This was explained by the nomadic nature of caribou, which may pass through several habitat types on their way to foraging or calving grounds. In winter, caribou typically select areas of high lichen abundance and from spring to fall they use forested and wetland habitat.

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Caribou (*Rangifer tarandus caribou*). Prepared for the Lower Churchill Hydroelectric Generation Project.

Two analytical studies were conducted: a Resource Selection Function analysis and a Least-Cost Pathway analysis to determine caribou habitat selection and possible movement patterns, respectively, in the vicinity of the project. This analysis focused on the RWMH because of probable greater sensitivity to project activities due to its sedentary nature, restricted range and small size. Results were consistent with habitat use patterns of woodland caribou across North America. During all seasons, female RWMH caribou selected black spruce scrub stands. Bog habitats were also favoured during calving, while disturbed, young and hardwood-dominated stands were avoided during the winter and calving seasons.

Morgan, K. and C. Doucet. 2007. Forest Management Guidelines for Woodland Caribou (*Rangifer tarandus caribou*) for the Island of Newfoundland. Department of Environment and Conservation, Wildlife Division.

This report identifies current distributions of caribou in Newfoundland, with respect to calving/post-calving and wintering areas. All available caribou location data, including satellite and GPS collar locations, were compiled from extensive research completed by the NLDEC Wildlife Division. Home ranges/areas of concern were generated using GIS software. Provincial forest inventory (updated to 2005) was used to determine the amount of overmature forest in the core, buffer and migration areas. Recommendations were provided for forest management guidelines when working within or near woodland caribou core calving and wintering areas. These included the identification of woodland caribou 10 km buffer of core areas, and woodland caribou migration corridors.

Newfoundland and Labrador Assembly. 2008. Newfoundland and Labrador Regulation 57/02 – *Endangered Species List Regulations under the Endangered Species* Act. Available at: http://assembly.nl.ca/Legislation/sr/ regulations/rc020057.htm#3.

This lists the species that are designated, special concern, threatened, or endangered. Of relevance is that woodland caribou, LJH, MMH and RWMH are listed as threatened in the Endangered Species List Regulations under the *NLESA*.

Newfoundland and Labrador Department of Works, Services and Transportation. 2003. Trans Labrador Highway - Phase III (Happy Valley-Goose Bay to Cartwright Junction) Environmental Impact Statement and Comprehensive Study. Prepared by Jacques Whitford Environment Limited and Innu Environment Limited Partnership.

This report presents information on the habitat requirements and availability, distribution and abundance of flora and fauna found in the study area for several species including caribou. It also discusses the potential impacts of this project on the flora and fauna in the study area located in Labrador.

NLDEC (Newfoundland and Labrador Department of Environment and Conservation). 2008d. Endangered species and biodiversity. Available at: http://www.env.gov.nl.ca/env/wildlife/endangered.htm

The provincial government website lists the endangered species found in Newfoundland and Labrador along with some general biology of the species and lists the threats to the species. Of relevance are the RWMH, LJH and MMH.

Northland Associates Limited. 1980a. Reservoir and Transmission Line (Labrador) Wildlife Reconnaissance 1980. Prepared for the Lower Churchill Development Corporation.

The document integrated reports on several projects including the Lower Churchill River wildlife reconnaissance, transmission line (Gull Lake to Strait of Belle Isle) wildlife and caribou trail reconnaissance, and identification of fly-in trapping areas used by Sheshatshiu Innu to further assess potential effects of the Lower Churchill development on wildlife and resource use. Aerial surveys indicated that more than 100 caribou winter within 25 km of the north side of the Churchill River but suggested no evidence of significant seasonal movement across the Churchill River. Caribou trails occupied much of the area the will be crossed by the proposed transmission line. Few furbearers or their tracks were observed in the study area. Only one raptor nest was observed along the transmission line route. Interviews with airline companies suggested that most fly-in trapping conducted by the Sheshatshiu Innu was northwest of the community. No sites identified south of the Churchill River were crossed by the proposed transmission line.

Russell, J., S. Couturier, L.G. Sopuck and K. Ovaska. 1996. Post-calving photo-census of the Rivière-George caribou herd in July 1993. *Rangifer Special Issue* No. 9: 319-330.

The objective of this study was to obtain an accurate estimate of size of the GRH. The census procedure consisted of three techniques: 1) location of caribou by satellite and radio telemetry and photography of post-calving aggregations; 2) direct counts from photographs (minimum population size); and 3) estimation of total population using Petersen Index method. Minimum count indicated the population consisted of at least 358,460 adults. The size of the herd in 1993 was estimated to be 540,040 adults within 90 percent confidence limits of $\pm$12.8 percent.

Schaefer, J.A., C.M. Bergman and S.N. Luttich. 2000. Site fidelity of female caribou at multiple spatial scales. *Landscape Ecology* 15: 731-739.

Models were applied to space use of satellite tracked caribou (from sedentary and migratory ecotypes). Distances between consecutive year locations of adult females were compared to expectations based on total range and seasonal range of each population. Sedentary and migratory caribou displayed remarkably similar philopatry between calving to breeding. Ecotypes differed on seasonal range. It was concluded that reproductive

activities delimit the season of fidelity of female caribou of both ecotypes, and scale dependent ecotypic differences in fidelity may reflect different factors of population limitation.

Schaefer, J.A. and W.O. Pruitt. 1991. Fire and woodland caribou in southeastern Manitoba. *Wildlife Monograph*s 116. 39 pp.

The effects of fire on woodland caribou were studied over a two year period. Quality, quantity and accessibility of forage were determined in recently burned habitats and compared to that in intermediate and old growth stands. Current growth of vascular plants and standing crop of lichen (arboreal and terrestrial) were harvested to determine forage productivity. Quality of forage was inferred from the content of fiber and published digestibility studies and accessibility of forage was estimated from the Värriö Snow Index. Deterioration of winter habitat for caribou resulted from loss of lichens in predominant jack pine communities, increase of thickness and hardness of snow cover and accumulation of deadfalls. Caribou winter travel and feeding were significantly skewed towards use of lakes, old growth uplands and bogs and away from burned uplands.

Schaefer, J.A., A.M. Veitch, F.H. Harrington, W.K. Brown, J.B. Theberge and S.N. Luttich. 1999. Demography of decline of the Red Wine Mountains caribou herd. *Journal of Wildlife Management* 63: 580-587.

Population characteristics of the RWMH in central Labrador were compared before (1981 to 88) and during a population decline (1993 to 97). During the 1980s, population estimates were 751 (1981), 736 ± 172 (1983), 610 ± 9 (1987), and 741 ± 165 (1989). By 1997, the herd had declined to 151 animals. The decline was associated with significantly lower recruitment, a greater proportion of females in the greater than one-year-old population, increased mortality of greater than one-year-old females, and emigration to the parapatric GRH. Throughout the study, predation by grey wolves remained the most frequent cause of mortality of greater than one-year-old caribou.

Schaefer, J.A., A.M. Veitch, F.H. Harrington, W.K. Brown, J.B. Theberge and S.N. Luttich. 2001. Fuzzy structure and spatial dynamics of a declining woodland caribou population. *Oecologia* 126: 507-514.

The report investigated the relative spatial and temporal changes in range use and mortality within the RWMH. The results revealed four subpopulations. They also concluded that, as the herd declined, the subpopulations were disproportionately affected. Subpopulations with the greatest range overlap with migratory caribou from the GRH experienced comparative reductions in activity and increased mortality. The subpopulation with the least overlap exhibited the reverse pattern.

Schmelzer, I., J. Brazil, T. Chubbs, S. French, S.B. Hearn, R. Jeffery, L. LeDrew, H. Martin, A. McNeill, R. Otto, F. Phillips, G. Mitchell, G. Pittman, N. Simon and G. Yetman. 2004. Recovery Strategy for Three Woodland Caribou Herds (*Rangifer tarandus caribou;* Boreal population) in Labrador, Canada. Newfoundland and Labrador Department of Environment and Conservation, Corner Brook. 51 pp.

The Labrador Woodland Caribou Recovery Team has prepared the document to identify necessary recovery strategies to protect and recover sedentary woodland caribou in Labrador. Sedentary Woodland caribou have been designated as threatened by COSEWIC and are listed in *SARA*. The primary goal is to prevent the extinction and improve the status of current herds until they are viable and self sustaining populations. The document examines the historical and potential threats, as well as the ecological and cultural role of the caribou in Labrador.

Schmelzer, I. and R. Otto. 2003. Winter range drift in the George River Caribou Herd: A response to summer forage limitation? *Rangifer Special Issue* 14: 113-122.

Space use by the GRH changed in correspondence with migration patterns. Range use was seasonal; however, winter range was more variable. Following the rapid population increase of the GRH, the calving and summer range habitat deteriorated, resulting in a decline in physical condition, poor calf survival and low pregnancy rates. The importance of winter range as a food source compensating for poor summer range quality was assessed via winter range drift and use intensity. It was determined that in spite of a doubling of net range area, annual winter ranges did not increase. As spatial scale decreased, the degree of avoidance of previously used wintering areas increased. Results suggested winter foraging allowed caribou to suspend the effects of density dependant summer forage limitation on herd productivity.

Snow, D. and S. Mahoney. 1995. Habitat Use and Population Ecology of the Corner Brook Lake Caribou Herd. A cooperative Research Project of the Western Newfoundland Model Forest and the Newfoundland and Labrador Wildlife Division, Interim Report June 1993 – March 1995.

During the winter of 1994, 14 adult caribou were radio-collared and during the spring 1994, and nine caribou calves were radio-collared in the Corner Brook Lake area. Results showed that all animals remained resident within the Corner Brook Lake area from March 1993 to March 1994. Average home range size was 70.7 km^2, with no difference between males and females or between females with and without calves. Both males and females selected barren habitats and overmature timber. Population levels are estimated at 350 to 450 caribou with 10 to 11 percent calves. Current timber harvesting has reduced the amount of caribou habitat in the area.

Thomas, D.C. and D.R. Gray. 2002. COSEWIC Assessment and Update Status Report on the Woodland Caribou, *Rangifer tarandus caribou*, in Canada. Pp. 1-98. In *COSEWIC Committee on the Status of Endangered Wildlife in Canada*. Environment Canada, Ottawa, ON.

This document provides an updated status of woodland caribou in Canada at the time as completed by COSEWIC.

Trimper, P.G. and T.E. Chubbs. 2003. Effectiveness of spatial mitigation for the George River Caribou Herd within the Military Training Area of Labrador and Québec. *Rangifer* Special Issue No. 14: 65-72.

Potential disturbance to caribou by military aircraft was mitigated via the reconfiguration of the military low level training area (LLTA) away from the traditional migration routes in 1996 and establishment of closure areas. Seven aerial surveys were conducted in 2000 to 2001 to examine caribou distribution and abundance within the northern portion and adjacent area of the LLTA during four periods of the year. Timing and direction of caribou movement were similar to that observed in the 1990s. Closure areas were based on location of satellite collared caribou and direction of movement.

Vistnes, I. and C. Nelleman. 2001. Avoidance of cabins, roads, and power lines by reindeer during calving. *Journal of Wildlife Management* 65(4): 915-925.

This study investigated the possible avoidance behaviour of calving semi-domesticated reindeer (*Rangifer tarandus tarandus*) near recreational cabins roads and power transmission lines. Within snow-free sites available for grazing, no significant differences occurred in phenological development of cotton grass (*Eriophorum* spp.). Approximately 74 percent of all available forage was located within the avoided 0 to 4 km zones from the resort or the separate power line. Results suggested that power lines may result in substantial

reductions in the use of the foraging areas. Combined actions of power lines, roads and cabins may increase potential avoidance, thus increasing use of remaining undisturbed grazing grounds.

Walsh, N.E., S.G. Fancy, T.R. McCabe and L.F. Pank. 1992. Habitat use by the Porcupine Caribou Herd during predicted insect harassment. *The Journal of Wildlife Management* 56(3): 465-473.

Harassment of female caribou by insects may negatively affect the cows' energy balance during the critical post-calving and lactation period and certain habitats may provide relief from such harassment. Adult female caribou from the Porcupine Caribou Herd were tracked by satellite to determine habitat preferences during periods of predicted harassment by insects. Dry prostrate dwarf scrub vegetation on ridge tops and mountains were preferred during predicted insect harassment (ambient temperature greater than or equal to 13°C and winds less than 6 m/sec). Caribou in the sample set did not show a strong tendency to move to the coastline at the onset of predicted harassment. However, segments of unmarked animals were observed to follow the coastline while moving across the coastal plain.

Weir, J.N., S.P. Mahoney, B. McLaren and S. H. Ferguson. 2007. Effects of mine development on woodland caribou *Rangifer tarandus* distribution. *Wildlife Biology* 13(1): 66-74.

This study examined the impact of the Hope Brook gold mine, southwestern Newfoundland, on the La Poile woodland caribou herd on a section of their year-round range. Results showed that after initiation of the mine construction, caribou abundance increased with distance from the mine site in all seasons, and caribou avoided areas within 4 km of the site in most seasons. Within 6 km of the mine centre, group size and the number of caribou decreased as mine activity progressed in late winter, pre-calving and calving seasons.

Wittmer, H.U., B. N. McLellan, R. Serrouya and C.D. Apps. 2007. Changes in landscape composition influence in the decline of a threatened woodland caribou population. *Journal of Animal Ecology* 76(3): 568-579.

The decline of woodland caribou populations may be precipitated by habitat changes, altering the predator-prey system resulting from timber harvesting. It was indicated that the findings of this study were consistent with predictions from the apparent competition hypothesis and quantify direct fitness consequences for caribou following habitat alterations. It was concluded that apparent competitions may cause rapid population declines and extinction where changes in species composition occur following large scale habitat change.

APPENDIX C

PROFILES OF STUDY TEAM MEMBERS

The project manager for this study was Perry Trimper. In addition to participating in all aspects of this role (including ensuring adherence to the workscope, schedule, and budget), Mr. Trimper served as the regional lead for Labrador. In this capacity, he liaised with government agencies and offices in Labrador as well as collected information relevant to caribou. Regional leads for the Island portion of this study (Corner Brook and St. John's) included Tina Newbury and Elizabeth Way, respectively. Their responsibilities included liaison with regulatory agencies, compilation of literature and data, and report preparation. Additional data collection, research and writing support were provided by Karen Rashleigh, Shawna Peddle, John Pennell and James Loughlin. The GIS team in St. John's was lead by Stephen Rowe, with analytical support from Jackie Bowman, Chris Shupe, Carolyn Pelley, Zachary Bennett and Amber Frickleton. Word Processing was completed by Beverley Best, Karen Williams and Theresa Tobin. Senior review and text support was completed by Rebecca Jeffery. Brief profiles of Study Team members are as follows:

Perry Trimper, B.Sc.F., a Wildlife Ecologist with Stantec Consulting Ltd., served as the Project Manager for the *Component Study*. His 28 years of experience is primarily in northern environments of both Canada and Russia, where areas of specialization include boreal and Arctic wildlife (including caribou and reindeer) research, northern indigenous peoples, EA, and sustainable resource development. He has been involved in every large EA in Labrador since the mid-1980s, all of which have involved research on migratory or sedentary caribou including: Low-level Training at 5 Wing Goose Bay; relocation of Davis Inlet; expansion of Phase I and construction of Phase II and III of the TLH; Voisey's Bay Mine / Mill; Iron Ore Mining near Schefferville; and the Lower Churchill Hydroelectric Generation Project.

Rebecca Jeffery, M.Sc., is a Wildlife Biologist with Stantec Consulting Ltd. with ten years of experience, including seven years in Labrador. Since completing her Masters work in Wildlife Parasitology, she has worked throughout Labrador on a variety of wildlife research and management projects. As the Senior Wildlife Biologist for the Labrador section of the provincial Wildlife Division, she was involved in woodland and migratory caribou herd monitoring, wildlife avoidance monitoring for the Environmental Mitigation Program at 5 Wing Goose Bay, hunting license sales and hunter success monitoring, black bear and polar bear monitoring programs, jawbone and skull collection programs, as well as managing a small staff and routine administrative office affairs. She has also participated in various committees including the Labrador Woodland Caribou Recovery Team and Labrador Wolverine Working Group, the national Polar Bear Technical Committee, as well as the Institute for Environmental Monitoring and Research's Caribou Technical Committee.

Tina Newbury, M.Sc., is a Level III Scientist with Stantec Consulting Ltd. in Corner Brook, NL. Since 2008, Ms. Newbury has assisted in report writing, literature review, data management and field programs for several projects related to the proposed Nalcor Energy transmission line development, Keystone Pipeline, Labrador Iron Mines, Aurora uranium exploration and St Lawrence Wind Turbine projects. She has had extensive experience with forest songbird identification, nest searching, small mammal trapping, radio telemetry and general wildlife surveys. Ms. Newbury worked closely with the NLDEC Wildlife Division during the collection of relevant data and assisted with the text preparation for this document.

Elizabeth Way, M.Sc., is the Team Lead of the Environmental Planning and Permitting Group at Stantec Consulting Ltd. in St. John's, NL. Since 2003, Ms. Way has assisted in report writing, literature review, data management, and field programs for several projects, including the White Rose Habitat Compensation Program and Strategic Environmental Assessments (SEAs) for the Laurentian Sub-Basin and Sydney Basin. She has also gained experience related to EA while working on the environmental and socioeconomic assessment for the

proposed Gateway Pipeline in British Columbia, Pokak Seismic Survey in the North West Territories, the EA of snowmobiling activity in Gros Morne National Park, the socioeconomic baseline study and impact statement for the Long Harbour Commercial Nickel Processing Plant for Vale Inco (formerly VBNC), and the Lower Churchill Hydroelectric Generation Project baseline program and EA.

Karen Rashleigh, M.Sc., was an Environmental Scientist with Stantec Consulting Ltd. based in Happy Valley-Goose Bay, NL. Ms. Rashleigh has a background in conducting biological surveys on a variety of species and their habitats, including birds, fish and mammals. Her responsibilities were primarily to conduct ecological investigations related to resource development in Labrador, in particular studies involving avifauna (waterfowl, raptors and forest songbirds) including all aspects of data analyses and reporting.

Shawna Peddle, M.Sc., is a Senior Project Manager with Stantec Consulting Ltd. in Guelph, ON. She has managed and undertaken large and small-scale EAs in the energy, water and waste, transportation and industrial sectors. She has experience in Ontario and Newfoundland and Labrador provincial and federal EA project development and management, consultant team coordination, public involvement, and report preparation and coordination. Ms. Peddle also has public consultation and communications experience related to risk assessment, mining, oil and gas, transportation, and waste management. She has gained experience in all aspects of EA management and preparation, and has developed and participated in numerous public consultation programs. Her skills include: project management and consultant team coordination; public and stakeholder consultation program development, design and implementation; and EA consultation and preparation.

John Pennell B.Sc., worked with the Biological and Ecological Sciences Group of Stantec Consulting Ltd. in St. John's, NL, specializing in environmental sciences. Mr. Pennell assisted in field programs, report writing, literature review and data management for several projects related to terrestrial studies, including the Lower Churchill Hydroelectric Generation Project. He also assisted in report writing, literature review, data management and field programs for both ELC and rare plant studies for transportation, mining and power development projects. He assisted in report, writing, literature review, data management and field programs for offshore oil and gas, including the Labrador Shelf SEA.

James Loughlin, B.Sc., was a Level II scientist with Stantec Consulting Ltd. in St. John's, NL. Mr. Loughlin assisted in report writing, literature review, data management and field programs for several projects related to offshore oil and gas and fish and fish habitat. He had extensive involvement with the execution of field work in support of the Newfoundland and Labrador sentinel fishery. Programs completed include cod and halibut tagging, Cod Reproductive Potential surveys, July Mobile Sentinel survey, cod stomach, liver, and otolith sampling and collection. Other involvement with fishery related programs include, monitoring vessel and crew activities, identifying, sexing, collecting, measuring, and sampling various fish species in the Bering Sea and the North Atlantic Ocean as part of national fisheries observer program. Mr. Loughlin conducted various environmental screening reports for Fisheries and Oceans Canada, Small Craft Harbours division, for various sites in Newfoundland and Labrador in accordance with the *Canadian Environmental Assessment Act*.

Stephen Rowe, B.Sc., M.GIS (candidate), was a GIS Specialist and Team Leader of the Information Management team with Stantec Consulting Ltd. in St. John's, NL. He has gained over ten years experience as a GIS professional, including working for Parks Canada, Provincial Parks and for a seismic surveying company. His work at Stantec Consulting Ltd. involved in various GIS assignments including ecosystem mapping, linear corridor utility and pipeline projects, wetland and watershed studies, marine geomatics, biophysical assessments,

mapping of environmentally significant areas and species at risk, and a range of wildlife / resource management projects. He has been directly involved with the offshore east coast oil and gas industry, working with Husky Energy, Newfoundland Offshore Industry Association, Canada-Newfoundland Offshore Petroleum Board, Department of Natural Resources (Energy Branch), Nalcor Energy, Newfoundland LNG, Newfoundland and Labrador Refinery Corp. and Irving Oil.

Jackie Bowman, B.Sc., MGIS (candidate), is a scientist and GIS Analyst with Stantec Consulting Ltd. in Darmouth, NS, who has been involved in geomatics related work for the past eight years. This work has been focused on data management, data analysis and mapping presentation for a range of projects across various sectors, including oil and gas, utility and municipal. Since joining the Stantec team, she has been involved in a variety of GIS projects, including vegetation, terrain ecosystem and environmentally sensitive areas mapping, wildlife habitat modeling and mapping, biophysical assessments and high-level cartographic presentations. Ms. Bowman has also been involved in the design, implementation and management of spatial data for large EIS projects. Recently, she was on secondment to Nalcor Energy in association with the environmental hearings for the Lower Churchill Hydroelectric Generation Project.

Chris Shupe, Geomatics / Remote Sensing Analyst with Stantec Consulting Ltd. in Dartmouth, NS, is responsible for preparation, interpretation and analysis of satellite and air photo data to support various disciplines in preparing environmental assessments. He performs land cover identification and land use and disturbance classification to identify the impact of disturbances on the landscape. Before coming to Dartmouth, Chris held the role of senior analyst within Calgary's Geomatics department. As such, he has played a key role in the project planning, spatial analysis and mapping on key projects including Imperial Oil's Mackenzie Gas pipeline, Cold Lake and Kearl Lake SAGD projects and Altalink's Heartland 500 kV transmission line project.

Carolyn Pelley, B.Sc., is a GIS Technician with Stantec Consulting Ltd. in St. John's, NL. Ms. Pelley has been involved in mapping for the Lower Churchill Project, the Newfoundland Liquid Natural Gas project, the Long Harbour Nickel Commercial Processing Plant, the Labrador Shelf SEA, habitat mapping for military properties in Newfoundland and wind power project mapping for Fermeuse, NL.

Zachary Bartlett, B.Sc., is a GIS Technician with the Information Management team at Stantec Consulting Ltd. in St. John's, NL. His experience comes from a combination of public sector GIS positions and work related to his Masters of Science program. Through these various jobs and projects, he has considerable experience with spatial analysis, remote sensing, cartography, data management, and report writing, as well as some experience in object-oriented programming. Since starting with Stantec Consulting Ltd., Zachary has spent time working on Nalcor Energy's proposed Lower Churchill Hydroelectric Generation and Transmission Link Projects, Aurora Waterfowl Surveys, IEMR Waterfowl Surveys and the Hebron Project.

Amber Frickleton, Ad. Dip GIS, B.A., works in the GIS team at Stantec Consulting Ltd. in St. John's, NL with Ms. Pelley and Mr. Bartlett. As part of the GIS team, she may be involved in all aspects including Nomad and Map Folio production, analyses of data, and assistance with report production.

Earle Hickey, M.Sc., has been involved in various elements of environmental management for over 25 years in a wide range of projects. Mr. Hickey is a Principal with Stantec Consulting Ltd. in Dartmouth, NS, and a longtime EIS practitioner having been involved in numerous federal and provincial environmental assessments. His international experience includes work in Brunei, the Caribbean, China, the Middle East and Russia for the Canadian International Development Agency, the World Bank and private sector clients.