Labrador – Island Transmission Link

Moose and Black Bear Component Study

Prepared for:

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EXECUTIVE SUMMARY

Nalcor Energy is proposing to develop the Labrador-Island Transmission Link, a High Voltage Direct Current (HVdc) transmission system extending from Gull Island in central Labrador to Soldiers Pond on the Island of Newfoundland's Avalon Peninsula.

In preparation for and support of the environmental assessment of the Project, a *Moose and Black Bear Component Study* has been completed with the objective to gather, summarize and present information on these large mammal species in the area of, and which may therefore interact with, the proposed Project.

The Study Area comprised the region surrounding the proposed and alternative HVdc transmission corridors and associated Project components. An Ecological Land Classification (ELC) was previously completed along a 15 km wide regional Study Area that encompassed the transmission corridors, covering 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. These ELC-based habitat classifications formed the basis of the wildlife habitat mapping component of this study.

The Component Study is based on research completed by the Study Team and others in support of this Project, as well as relevant large mammal surveys completed by others throughout Newfoundland and Labrador, 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 Labrador-Island Transmission Link, from which an annotated bibliography detailing relevant studies completed in Newfoundland and Labrador since approximately 1987 was compiled.

Recent and previous large mammal baseline studies undertaken in support of the Project include a wildlife reconnaissance along the proposed transmission line in Southeastern Labrador (Northland Associates 1980) and general wildlife surveys along the entire transmission line in 2008 as part of a regional ELC field program, a previous literature review of moose associated with the Churchill River and transmission corridor from Gull Island to Soldiers Pond (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000), as well as winter aerial moose surveys in the general area of proposed electrode corridors in Labrador (Northland Associates and Jacques Whitford 2000). This was supplemented with information from other baseline studies in support of the Lower Churchill Hydroelectric Generation Project (e.g., Minaskuat Inc. 2009a, 2009b, 2009c) or for other proponents (e.g., Jacques Whitford 1997a, 1997b), and other independent research related to moose and black bear on the Island and in Labrador (e.g., Dennis et al. 1996; Chaulk et al. 2005).

Based on the findings of the literature review, a description of the available information and existing environmental conditions for moose and black bear was prepared according to the primary sources of information available, existing baseline conditions, habitat associations and distribution within the Study Area and potential limiting factors. A series of detailed habitat quality maps were generated for each species, indicating the distribution and abundance of primary, secondary and tertiary habitat within the Study Area. For the purpose of this investigation, primary habitat was defined as habitat that provides foraging, protection, and resting habitat, secondary habitat provides an abundance of one or two of the three elements (or marginal

amounts of all) of the critical elements and tertiary habitat provides marginal foraging, protection or resting opportunities or may only be used during transit.

Detailed habitat quality 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 are colour-coded to reflect habitat quality and indicate the percentage of primary, secondary and tertiary habitat available on an ecoregion by ecoregion basis, within each of the larger geographic regions.

Moose occur throughout the Study Area, with densities lowest in Labrador, particularly when compared to Newfoundland which tends to exhibit densities greater than most areas of North America (Jung et al. 2009). The most up-to-date information for moose on the Island ranges in year surveyed from 1987 to 2009, with densities ranging from ≤0.5 (e.g., Moose Management Areas (MMAs) 16, 27 and 42) to highs of between 2.5 and 3.0 moose/km^2 (e.g., MMAs 2, 31, 44 and 45), in MMAs that intercept the proposed transmission corridor (Newfoundland and Labrador Wildlife Division, unpublished data). Comparatively, the most recent census for moose densities in Labrador was conducted in March of 2008 near Double Mer in MMA 55 that resulted in estimates of 0.06 moose/km^2 (Barney, undated). Researchers, including baseline telemetry research completed for Nalcor Energy (Minaskuat 2009c), have documented seasonal patterns in the diet and habitat requirements of moose. Moose yarding or wintering areas are typically associated with river valleys, where there is a source of food and some relief from snow depths. Such habitat, considered as primary fall/winter habitat, comprises 1,270.7 km^2 (19 percent) of the Study Area in Labrador but is approximately twice as common in Newfoundland, where it comprises 4,504.1 km^2 (40 percent) of the Study Area. Wetlands, particularly those that support aquatic plants, are preferred during the summer. Primary spring/summer habitat for moose occupies 1,521.6 km^2 (23 percent) of the Study Area in Labrador and 1,087.7 km^2 (10 percent) of the Study Area in Newfoundland. The seasonal shift in habitat preferences by moose is reflected in the amount of primary quality moose habitat considered available; the distribution and abundance of spring/summer primary habitat is limited compared to the availability of primary fall/winter habitat on the Island, whereas fall/winter primary habitat is comparatively limited in Labrador.

Black bear are also ubiquitous in Newfoundland and Labrador, but tend to be less specialized in terms of habitat preference as compared to moose. While there have been no recent studies designed to estimate population size of black bear in the province (C. Dyke, pers. comm.), a provincial population size of 6,000 to 10,000 black bears is accepted and numbers are believed to be stable (Pelton et al. 1994; C. Dyke, pers. comm.).

Black bear in Newfoundland tend to be distinguishable from other mainland populations in terms of genetic differentiation, and tend to be larger (Mahoney et al. 2001). As is true for black bears found in the eastern United States (Lee and Vaughn 2003), male bears in both Labrador and Newfoundland have much larger home range sizes than females (Dennis et al. 1996; Minaskuat Inc. 2009c). Typical home range sizes in Labrador range from 19 to 902 km^2 in the lower Churchill River watershed (Minaskuat Inc. 2009c) and 20 to 193 km^2 in the Voisey's Bay area (Jacques Whitford 1997b). Solitary animals through most of their lives, mating occurs in June/July of each year, beginning as late as the eighth year of life (Chaulk et al. 2005). Although not true hibernators, this species spends winter dormant in dens (approximately November through April). During the non-denning season, diet and subsequent habitat use by this species varies seasonally; forage items such as plant material and insects are selected in the early spring and summer, with berries preferred in late summer and fall. Bears also prey upon moose calves, and are a prominent predator of caribou calves in Newfoundland (Mahoney and Virgl 2003). Primary spring/early summer black bear habitat occupies 3,017.1 km^2 (46 percent) of the Study Area in Labrador and 1,905.4 km^2 (44 percent) in Newfoundland. Primary late summer/fall habitat occupies 3,154.7 km^2 (48 percent) of the Study Area in Labrador and 2,250.1 km^2 (52 percent) in Newfoundland. The larger availability of late summer/fall primary black bear habitat results from the addition of burn, hardwood and mixedwood habitats to this habitat quality category during this season. The seasonal shift in the availability of primary habitat is most obvious in the Central and Eastern Newfoundland and the Avalon Peninsula regions.

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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 Gull Island in central Labrador to Soldiers Pond on the Island of Newfoundland's Avalon Peninsula. The Project's environmental assessment (EA) is ongoing, with an Environmental Impact Statement (EIS) currently being prepared by Nalcor Energy.

In preparation for and in support of the Project's EA, this *Moose and Black Bear Component Study* was completed in order to identify, compile, summarize and present information on these large mammals in the area 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 proposed transmission system, as currently planned, will include the following key components:

- an ac-dc converter station at Gull Island in central Labrador, on the north side of the Churchill River adjacent to the switchyard for the Lower Churchill Hydroelectric Generation Project;
- an HVdc transmission line extending from Gull Island across southeastern Labrador to the Strait of Belle Isle. The overhead transmission line will be approximately 407 km in length with a cleared right-of-way averaging 60 m wide, and consist of single galvanized steel lattice towers;
- submarine cable crossings of the Strait of Belle Isle with associated infrastructure, including three to five cables placed under the seafloor across the Strait 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 the Island of Newfoundland to the Avalon Peninsula, for a distance of approximately 688 km;
- a dc-ac converter station at Soldiers Pond on the Island of Newfoundland's Avalon Peninsula; and
- electrodes at each end of the HVdc transmission corridor in Labrador and on the Island, with overhead lines connecting them to their respective converter stations.

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. Potential on-land corridors and study areas have also been identified for various potential (alternative) locations for the proposed electrodes, although the nature, type and location of these electrodes are the subject of ongoing analysis and engineering. It is these proposed and potential transmission corridors and components that were the subject of Nalcor Energy's environmental baseline study program for the Project's EA. 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 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.

1.2 Nature, Purpose and Objectives of the Moose and Black Bear Study

This *Moose and Black Bear Component Study* forms one aspect of Nalcor Energy's environmental study program in relation to the proposed Project. 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 in 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 the proposed transmission link 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 this EIS.

Specifically, rather than base the large mammals study solely on a "snap shot" understanding of moose (*Alces alces*) and black bear (*Ursus americanus*) presence along the transmission corridor through one or more field surveys at single points in time, a range of methods and information sources were utilized 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 generally discussed with various relevant government agencies and stakeholders as part of the planning and design of the Project's environmental study program in 2008 and 2009.

The study approach was to first identify, compile and summarize the existing and available (but somewhat widespread) information related to moose and black bear in and near the proposed transmission project. This included the literature, as well as the results of wildlife studies throughout Newfoundland and Labrador by the Study Team and others over the past two decades. This information has been compiled and summarized in this report to provide an overview of these species across the Project area.

The information has also been used in conjunction with the regional Ecological Land Classification (ELC) completed for the Project, to assess and map habitat quality – and thus, the likely and potential use of the Project area - for moose and black bear along and adjacent to the proposed and alterative transmission corridors. Detailed habitat mapping is provided in this report.

In summary, the objective of this *Moose and Black Bear Component Study* is to identify, gather, analyze, summarize and present information on large mammal species in the area of, and which may potentially be affected by, the proposed 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 moose and black bear surveys and the literature that provided information on and insight regarding these species in and near the Project area;
- based on the above information, the development of regional overviews describing the known and likely presence, abundance and spatial and temporal distribution of moose and black bear across the geographic extent of the proposed transmission line, followed by detailed discussion and analyses for these species; and
- using the above information, and based on the regional ELC completed for the Project, the development and presentation of habitat quality mapping for moose and black bear across the transmission corridor and surrounding area.

2.0 APPROACH AND METHODS

The following sections provide an overview of the Study Area, methodology and Study Team for this *Moose and Black Bear Component Study.*

2.1 Regional Context and Study Area

The proposed 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 moose and black bear along and adjacent to the proposed and alternative transmission corridor and associated Project components (Figure 2-1).

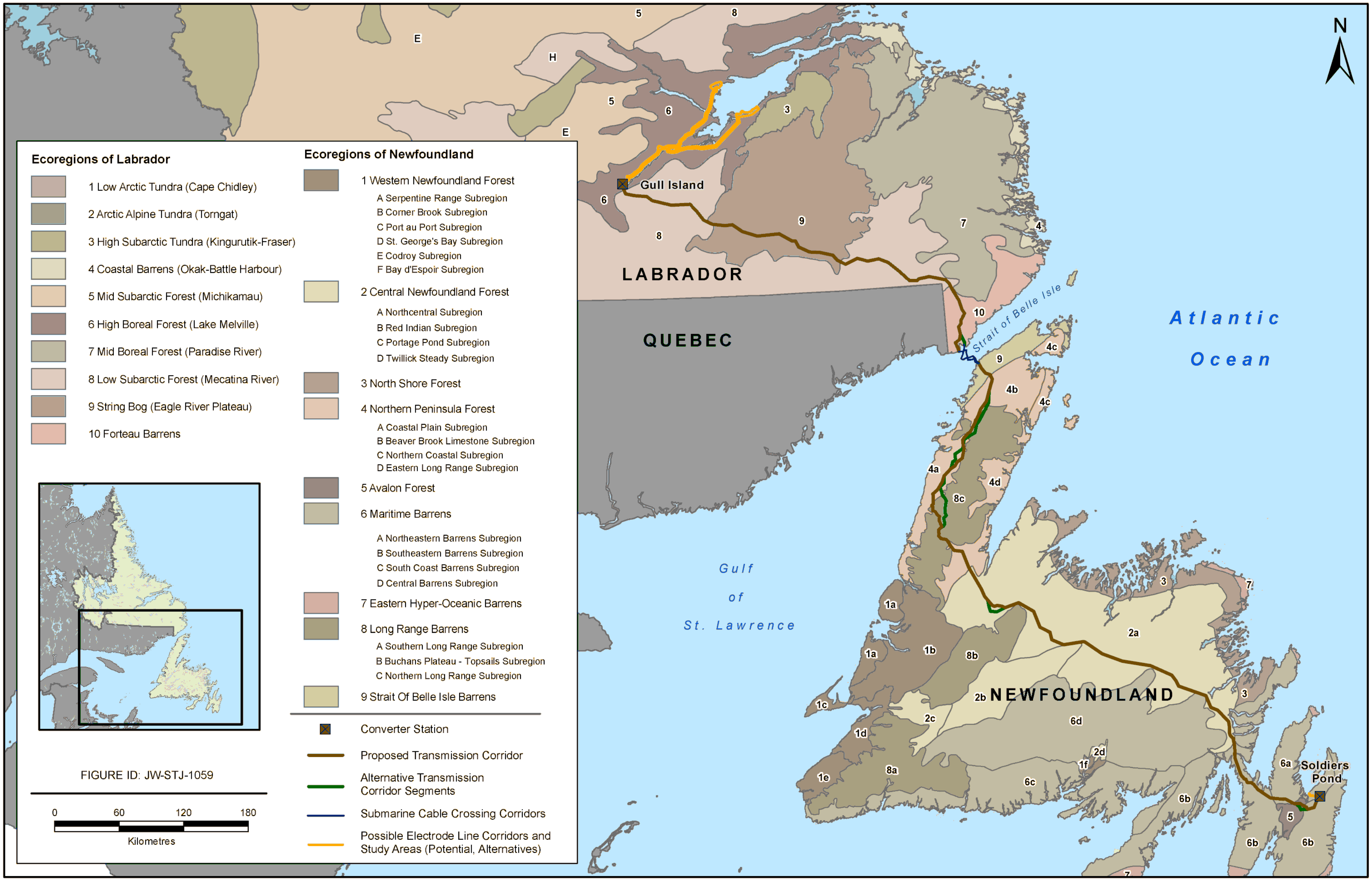
For the HVdc transmission corridor, the study focuses primarily on a regional Study Area, generally comprising an approximately 15 km wide area that encompasses the proposed and alternative transmission corridors from Gull Island to Soldiers Pond. This corresponds to the Study Area utilized in the regional ELC carried out as part of the Project environmental study program, which has also formed the basis for the habitat quality mapping component of this study. For other Project components, such as the potential electrode lines, the study focuses on the general areas involved (such as the lower Churchill River valley and Lake Melville). In many cases, the analyses and discussion are influenced by the nature of the existing and available information sources, including the areas covered by the previously cited moose and black bear surveys.

The proposed transmission line will, as described previously, be approximately 1,100 km in length, and include a number of associated components. As such, it will extend across a considerable portion of Newfoundland and Labrador, and thus, through a range of natural environments.

The national ecological framework for Canada is a nested hierarchy that describes regional ecological units at multiple scales, in which larger ecological units encompass successively smaller ones. At the top of the hierarchy, Ecozones are defined on the basis of generalized characteristics and global and continental climate. There are 15 Ecozones (Natural Resources Canada 2007) delineated for Canada, with the Project crossing two of these: the *Boreal Shield Ecozone* and the *Taiga Shield Ecozone*.

1. *Boreal Shield Ecozone*: The Island of Newfoundland and the Churchill River valley and southeast coast of Labrador form the eastern extent of this region. 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 is generally continental with long, cold winters, short, warm summers and abundant precipitation. Cool temperatures and a short growing season along with acidic soils challenge plant life in the Ecozone, although most of the area is forested (primarily coniferous species, intermixed with hardwoods), which is mixed with bogs, marshes and other wetlands. Lichens and shrubs are common on areas of exposed bedrock.

Figure 2-1 The Labrador – Island Transmission Link and Associated Ecoregions and Subregions in Newfoundland and Labrador



2. *Taiga Shield Ecozone*: The interior of southeastern Labrador is within this Ecozone, which consists of the taiga forest and the Canadian Shield, a primarily coniferous forest area located 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, and precipitation is low to moderate. The open, stunted forests are dominated by species such as black spruce, and are intermixed 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. Ecoregions also differs from each other in their combination 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 10 in Labrador (Meades 1990). The proposed transmission corridor will pass through 10 of these Ecoregions (Figure 2-1). A description of the Ecoregions and relevant subregions crossed by the transmission corridor and ELC study is presented in Table 2-1. Note, an additional Ecoregion (Mid-Boreal Forest-Paradise River Ecoregion) is included since it marginally intersects with the 15 km wide Study Area of the ELC, but is not intersected by the 2 km wide transmission corridor.

Table 2-1 Ecoregions and Subregions of Newfoundland and Labrador Crossed by the Transmission Corridor and ELC Study Area

Ecoregions and Subregions
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 most favorable climate in Labrador. Summers are cool and winters cold. The forests are closed-canopied and highly 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 Ecoregion (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.

Ecoregions and Subregions
Forteau Barrens Ecoregion (Boreal Shield Ecozone) - 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.
ISLAND OF NEWFOUNDLAND
Strait of Belle Isle Barrens Ecoregion – is dominated by almost treeless tundra vegetation. White spruce and balsam fir occurs as krummholz, interspersed with Arctic–alpine plants even near sea level. The soils are generally very 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.
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 treeline decreases towards the northern end of the subregion.
Long Range Barrens Ecoregion - 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 (i.e., stunted forest), 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.

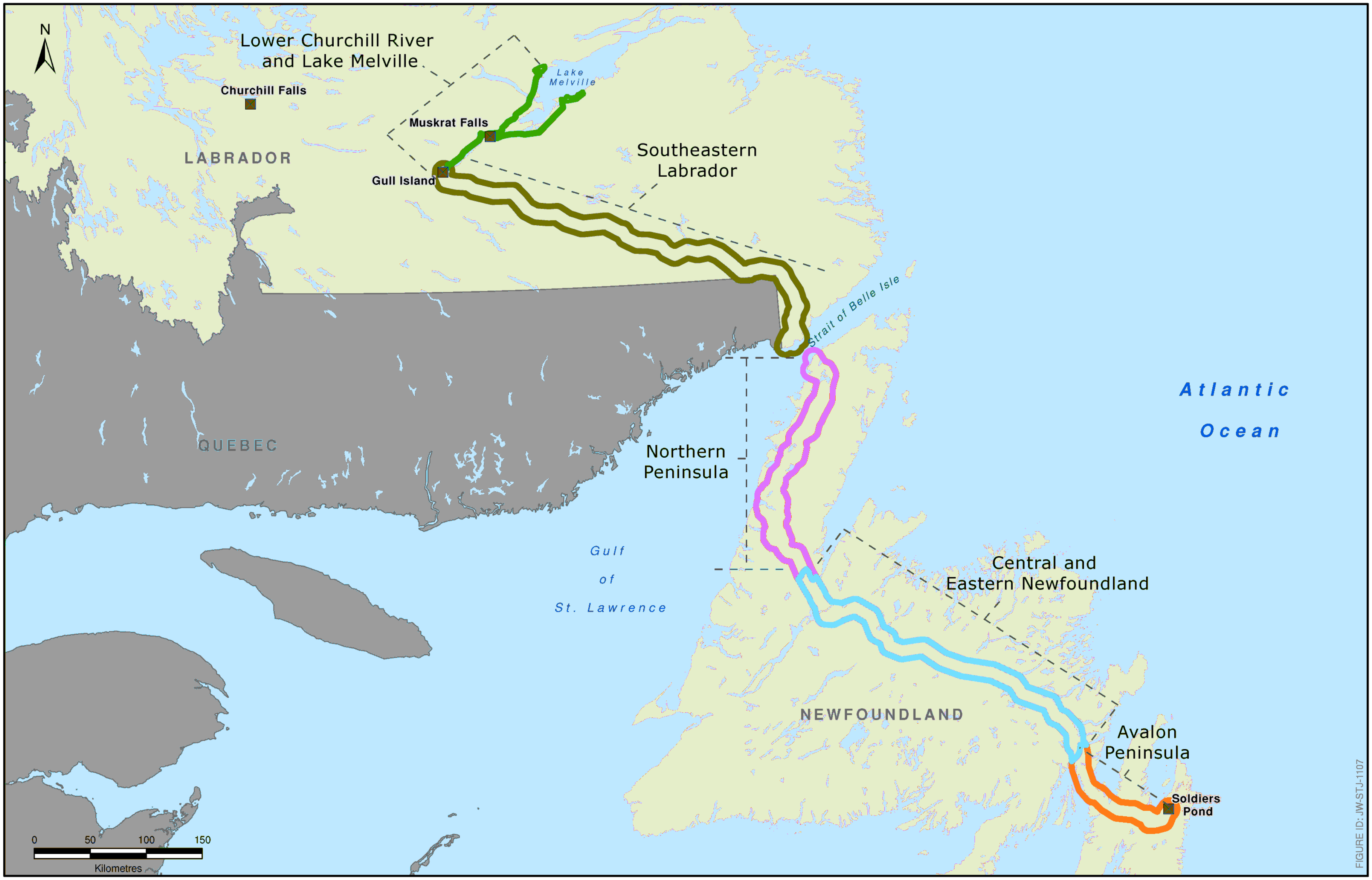
Ecoregions and Subregions
▪ *Northcentral Subregion* - has higher summer maximum temperatures, lower rainfall and higher fire frequency than anywhere else in Newfoundland. The subregion extends from Clarenville in the east to Deer Lake in the west and for the most part has a rolling topography below 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 seepage 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.
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 which 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 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.
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 *Moose and Black Bear Component Study*, the analysis and discussion that follows is generally structured according to the following geographic regions (Figure 2-2):

- *Lower Churchill River and Lake Melville:* The general area encompassing the Project components and activities at and near Gull Island, as well as the potential alternative electrode corridors to Lake Melville identified in the Project's EA Registration (January 2009). The dominant Ecoregion in this area is the High Boreal Forest-Lake Melville Ecoregion.
- *Southeastern Labrador:* The area encompassing the HVdc transmission corridor from Gull Island to the Strait of Belle Isle. Ecoregions in this portion of the Study Area are represented primarily by the Forteau Barrens (15 percent), the Low Subarctic Forest (48 percent) and the Eagle River Plateau (32 percent). The High and Mid Boreal Forest Ecoregions are also present, but make up a relatively small portion (5 percent) of the Study Area.
- *Northern Peninsula:* The area encompassing the HVdc 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 HVdc transmission corridor between approximately Deer Lake and Clarenville. The dominant Ecoregion in this 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 HVdc transmission corridor and associated Project components from Clarenville to Soldiers Pond and Conception Bay. The Avalon Peninsula Study Area consists of the Avalon Forest (13 percent) and Maritime Barrens (87 percent) Ecoregions.

Where applicable and appropriate, such as where specific information was not available or meaningful for a particular region, existing conditions and status for moose and black bear are discussed more generally within a larger geography (i.e., Labrador, Island of Newfoundland, or the province as a whole).

Figure 2-2 Geographic Regions of the Study Area



2.2 Methods

This *Moose and Black Bear Component Study* is based on research completed by the Study Team and others in support of this Project, as well as other relevant and available research completed throughout Newfoundland and Labrador in recent years. Where relevant, information from elsewhere in the range of these species has been used to supplement the understanding of existing conditions.

Initial meetings with Nalcor Energy and various provincial and federal government departments and stakeholders served to focus the scope of the study by identifying and compiling potential information sources including (but not limited to) relevant documents and data prepared for this Project and Lower Churchill Hydroelectric Generation Project by Nalcor Energy as well as existing scientific literature. The two species included in this component study occur throughout the Study Area, are dominant species in the ecosystem, and are important from a recreational and therefore socioeconomic perspective.

2.2.1 Literature Review

Existing and available information on moose and black bear was compiled through library and internet searches and meetings with government departments and other organizations. This resulted in the development of an annotated bibliography listing and describing relevant large mammal studies completed in Newfoundland and Labrador during the past approximately 20 years (Appendix A). Sources included published and unpublished reports, peer-reviewed journal articles, government documents, research theses, books, field guides and other articles.

This information was categorized and summarized according to:

- author, date and title;
- relevance to moose or black bear;
- a summary of the information included within, with emphasis on one or more of the following topics: population status; habitat association; local range; or distribution and limiting factors. Additional information and knowledge regarding potential Project interactions with and effects on these species was also identified and stored for eventual use in the EIS.

2.2.2 Previous Wildlife Surveys for or Relevant to the Transmission Link

Although environmental baseline studies in support of the Project have not included specific field programs dedicated to moose or black bear, several key studies were identified that provide relevant information on these species in the Study Area. Relevant findings and observations from these earlier investigations were incorporated into this *Moose and Black Bear Component Study.*

Labrador-Island Transmission Link Ecological Land Classification (Minaskuat Inc. 2009a)

As part of the ELC for the proposed transmission corridor (described below), selected wildlife species, including moose and black bear and evidence of their presence (e.g., tracks, scat, browse) were recorded by a wildlife biologist during field surveys in July and August 2008, in selected plots in Labrador (67 plots) and on the Island of Newfoundland (337 plots). Potential habitat for these species was classified, where appropriate, according to primary, secondary or tertiary habitat potential (as described in Section 2.2.4). Results of this survey provide an indication of the relative levels of use between habitat types in the Study Area, rather than an estimate of abundance. Some caution must be exhibited interpreting these data as they are heavily dependent on the amount of effort, observer skill and time of year and day and, as such, there is some inherent variability in the species-specific data that were collected. Observations were non-independent, as preferred habitat in which one or more animals remained and were present for an extended period yielded more evidence of wildlife presence (e.g., browse, droppings) than poor quality habitat in which wildlife would only be transient.

As these data were not presented in Minaskuat Inc. (2009a), information from these surveys, where relevant, has been fully incorporated in this Component Study.

Moose and the Proposed Lower Churchill Project: A Literature Review (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000)

This desktop exercise involved an extensive literature review of the ecology, distribution, population biology and harvest statistics of moose in Labrador and on the Island of Newfoundland, within the Lower Churchill Hydroelectric Generation Project Study Area. Specifically, the objectives of this study were to:

- compile and review existing information on moose abundance, distribution and habitat use (e.g., seasonal movements, important wintering areas) in Newfoundland and Labrador; and
- identify and describe the potential effects of hydroelectric development (e.g., construction and operations of transmission lines) on moose and moose habitat use.

The Study Area for this review included the Churchill River and adjacent areas that would be flooded by the Lower Churchill Hydroelectric Generation Project (Atikonak Lake and the Lac Brule area), as well as proposed transmission infrastructure from Gull Island to Soldiers Pond.

The relevant results of this previous work have been fully included and incorporated into this current Component Study. The initial report itself has been submitted as part of the EA process for the Lower Churchill Hydroelectric Generation Project and is thus available publicly. It has therefore not been entirely reproduced or resubmitted as part of the Transmission Project's EA.

Winter Moose Survey (Northland Associates and Jacques Whitford 2000)

Northland Associates (1995) Limited and Jacques Whitford conducted a late winter moose survey in March 1999 along the Churchill River, Atikonak Lake area and the Petit Mecatina and Goose River watersheds. Survey grids established in the Goose River area, and along some areas of the lower Churchill River, provide insight into moose presence, densities and habitat use along the potential (alternative) electrode corridors.

Aerial (helicopter) strip transect surveys were conducted over a total linear distance of 482 km and subsequent block surveys within seventeen 10.5 km^2 (3 x 3.5 km) survey blocks, following peer reviewed and accepted procedures (Trimper et al. 1996). The field team consisted of one field lead, two rear observers and a pilot experienced in conducting wildlife surveys. Transect locations, blocks, observed moose, and old and fresh tracks were recorded on topographical maps with the aid of a GPS. Habitat quality was assessed, with areas of highest potential exhibiting attributes important for wintering moose such as areas of forage (re-generating softwood, willow, birch) interspersed with shelter (mature softwood stands).

All strip transects were completed in a single day to avoid complications associated with tracks and the number of days since the last snowfall. Surveys were used to determine the distribution of moose and their sign along the Atikonak Lake/Lac Brule area and newly selected sections of the Churchill and Goose Rivers, for which little information on moose previously existed. Transects focused primarily along lines 250 m from rivers or large bodies of water and avoided slopes and large wetland complexes. An area of approximately 250 m on each side of the helicopter was scanned intensively for the presence of moose and/or their sign. Transects were flown at a groundspeed of 100 km/h and at an altitude of 100 m above ground level (agl).

Based on the results of the strip transect surveys, 10 percent of transects were resurveyed by overlapping blocks, in areas of higher quality habitat for moose. This included 10 previously surveyed blocks (established by the Department of National Defence) and seven new blocks. All blocks were searched at approximately 20 to 30 m agl and at a groundspeed of 70 to 80 km/h, and followed a combination of overlapping transects at 250 m intervals. Key terrain/habitat features were surveyed with greater intensity. Densities of moose were calculated based only on the number of animals observed (i.e., did not include tracks or other sign).

This study concluded that the availability of suitable forage influence moose wintering areas and that the Churchill River valley and associated valleys provide important wintering habitat for moose. In terms of population status, results suggested that moose abundance was relatively unchanged in the Churchill River between 1995 and 1999. In Labrador, factors such as illegal harvest, wolf predation, marginal habitat, or some combination of these may limit further population growth.

Again, the relevant results of this previous work have been fully included and incorporated into this current Component Study. The initial report itself has been submitted as part of the EA process for the Lower Churchill Hydroelectric Generation Project and is thus available publicly. It has therefore not been entirely reproduced or resubmitted as part of the Transmission Project's EA.

Transmission Line Wildlife Reconnaissance: Gull Lake – Strait of Belle Isle (Northland Associates Limited 1980)

This study by Northland Associates Limited investigated wildlife use along the proposed transmission corridor from Gull Lake to Point Amour on the Strait of Belle Isle, with particular emphasis on other species of wildlife, although observations of moose or black bear were recorded. Wildlife activity along the study corridor was determined based on aerial observations of animals and/or tracks, as well as local (expert) knowledge.

Aerial surveys were completed over two days, on 15 and 16 February and 15 April, 1980. A Cessna 185 aircraft was flown at an altitude of approximately 100 m agl and at speeds of approximately 160 km/h. One navigator and lead observer with one additional observer, plus the pilot, conducted the surveys, recording all observations within approximately 500 m on either side of the aircraft. Survey lines consisted of an outbound flight from the Churchill River to the Strait of Belle Isle and an inbound/return flight. Conditions were ideal for February surveys (i.e., recent snowfall, moderate wind and temperatures and good visibility). However, poor weather conditions thereafter resulted in only one and a half of the original six lines proposed being surveyed. These are referred to as Line 1 East and West Legs (consisting of only the north portion of these legs) and Line 2 West Leg (consisting of the most westerly leg of Line 2, on the southwest side of the transmission line).

Overall, track numbers and densities were low along the surveyed lines. Five moose tracks were recorded (along Line 2), indicating a density of 0.01 tracks per linear km surveyed. Black bear were not mentioned in this report.

The majority of moose and moose tracks were located in the western section of the transmission line corridor in Labrador, and generally restricted to areas of mixedwood habitat often associated with river valleys in the Study

Area. Information on moose activity in the study corridor and adjacent area was supplemented by ungulate observations provided through the Wildlife Division and from Audet (1979). These data indicated an area of moose activity near the St. Augustin and Little Mecatina Rivers, immediately south of the transmission line.

Other Data Sources

Additional data sources included results of previous investigations along the Churchill River in support of the Lower Churchill Hydroelectric Generation Project dedicated to moose (Minaskuat Inc. 2009b), black bear (Minaskuat Inc. 2009c) and incidental sightings from other studies, as well as baseline studies in support of other EAs in the province (e.g., Jacques Whitford 1997a, 1997b).

In addition to these data sources, various other published and unpublished reports related to moose and black bear in the province were accessed and incorporated into this report. These are referenced throughout the document.

2.2.3 Ecological Land Classification Habitat Mapping

An ELC was completed in 2008 along the Study Area (i.e., 15 km wide area along the proposed transmission corridor) from Gull Island in Labrador to Soldiers Pond on Newfoundland's Avalon Peninsula, covering a linear distance of approximately 1,100 km. The purpose of the ELC was to identify, categorize and evaluate vegetation types and associated habitats on a regional scale within the Study Area. Satellite imagery (Landsat 7 and Spot 5), forestry vector data (for the Island of 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 described by Marshall and Schutt (1999), the ELC incorporated a standard and well-validated methodology for describing ecological units, allowing comparisons of ELCs undertaken in other jurisdictions, including others in Newfoundland and Labrador (Minaskuat Inc. 2009a).

The field survey program was carried out in June and July of 2008, to describe the vegetation communities/habitat types within the Study Area and to verify 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 were used to identify areas that best represented the dominant habitat type within each Ecoregion in the Study Area. Plots were selected in the field in areas within a homogenous cover and composition of vegetation, and were spaced as evenly as possible to ensure optimal distribution of ground-verified sites within the Study Area. A total of 404 plots were surveyed, including 67 plots in Labrador and 337 in Newfoundland.

At each survey plot, a vegetation inventory was conducted for the tree, shrub and ground layers within an area of approximately 400 m^2. Plant species presence and abundance (expressed as a percentage of ground area covered by the 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 2-2). Existing satellite images and aerial photographs of the Study Area were incorporated, along with the location of all surveyed sites, into a computer-based geographic information system (GIS) and used to delineate identified habitat types that were subsequently produced at scale of 1:50,000 (but printed at a scale of 1:75,000). ELC habitat classifications formed the basis for the habitat mapping exercise for moose and black bear in the Study Area.

Table 2-2 Habitat Types within the Study Area, Newfoundland and Labrador

Habitat Type	Habitat Description	Distribution
Alpine Vegetated	Coniferous forest species widely spaced; large variety of shrub and ground cover.	Exclusive to the Newfoundland portion of the 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 the Labrador portion of the Study Area.
Burn	No forest cover; early invader shrub species present; little to no ground cover.	Found in the Labrador and Newfoundland portions of the Study Area.
Conifer Forest	Coniferous species dominate but some deciduous present; Large variety of shrub and ground cover.	Found in the Labrador and Newfoundland portions of the Study Area.
Conifer Scrub	Stunted coniferous trees; variety of shrub and ground cover.	Found in the Labrador and Newfoundland portions of the Study Area.
Cutover	A variety of coniferous and hardwood species, shrub and ground cover.	Exclusive to the Newfoundland portions of the Study Area.
Exposed Bedrock	Bedrock exposed; *Cladina* sp., *Trichophorum cespitosum*, *Empetrum nigrum*, and *Vaccinium* sp. make up the little ground vegetation present.	Exclusive to the Labrador portion of the Study Area.
Hardwood Forest	*Betula* species dominate but some coniferous species found; variety of species found in shrub layer and ground cover.	Exclusive to the Labrador portion of the Study Area.
Kalmia Lichen/Heathland	*Picea mariana* is dominant tree species, a large variety of shrub and ground cover.	Exclusive to the Newfoundland portion of the Study Area.
Lichen Heathland	No trees present; a large variety of shrub and ground cover.	Exclusive to the Labrador portion of the Study Area.
Mixedwood Forest	Both coniferous and deciduous tree species, *Kalmia angustifolia* as dominant shrub; a large variety of ground cover.	Found in the Labrador and Newfoundland portions of the Study Area.
Open Conifer Forest	Two dominant coniferous species, widely spaced; variety of shrubs; lichens and mosses dominant ground cover.	Found in the Labrador and Newfoundland portions of the Study Area.
Rocky Barrens	No forest cover, shrub layer comprised primarily of *Vaccinium* species; lichen and other ground cover.	Exclusive to the Newfoundland portion of the Study Area.
Scrub/Heathland/Wetland	Mosaic of Conifer Scrub, Kalmia Heathland and Wetland.	Exclusive to the Newfoundland portion of the Study Area.
Wetland	Three typical tree species *(Betula* sp., *Larix laricina*, *Picea mariana)*, a large variety of shrub and ground cover species.	Found in the Labrador and Newfoundland portions of the Study Area.
Note: Developed by Minaskuat Inc. 2009a.		

2.2.4 Data Analysis

Based on the findings of the literature review, a regional overview of the presence, abundance and distribution of moose and black bear in the Study Area has been provided for the geographic regions described in Section 2.1. In terms of spatial overlap with the Study Area, year-round habitat use has been considered, with particular focus on habitat use during the breeding season. However, any other seasonal sensitivities (e.g., moose wintering areas) were also identified and discussed.

A complete description of the available information and existing environmental conditions of moose and black bear was prepared according to:

- Primary Sources of Information – An overview of the relevant and available information and research completed within the past approximately 20 years in the province;
- Existing Conditions and Status – Information on the distribution and population status of the species in the province, where available;
- Habitat Association and Distribution in the Study Area – Species distribution and any regional differences, habitat relationships [according to habitat types identified by Minaskuat Inc. (2009a)] and extensive habitat mapping. Where they exist, data associated with the proposed transmission corridor were incorporated;
- Limiting Factors – Natural or human factors which may be affecting the status of a species in the region (e.g., hunting, trapping, predation and other disturbances).

A summary of the presence of moose and black bear within the regions of the Study Area is presented in Table 2-3.

Table 2-3 Species Occurrence by Region

Species	Lower Churchill River and Lake Melville	Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Moose	✓	✓	✓	✓	✓
Black Bear	✓	✓	✓	✓	✓

Notes:
1. Geographic Regions are defined in Section 2.1.
2. Primary sources of information are discussed for each species in Section 3.

Based on the literature review and available data, habitat quality was assessed for moose and black bear. Habitat quality was classified as:

- primary habitat – has an abundance of the structural and compositional elements to provide foraging, protection and resting habitat during fall-winter for moose, and during either spring-early summer or late summer-fall for black bear;
- secondary habitat – provides an abundance of one or more (or marginal amounts of all) of the critical elements (i.e., foraging, protection and resting); and
- tertiary habitat – provides marginal foraging, protection or resting opportunities or may only be used during transit.

A series of detailed habitat quality maps were subsequently generated based on the habitats types identified by Minaskuat Inc. (2009a) (Table 2-2). 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 indicate the percentage of primary, secondary and tertiary habitat available on an Ecoregion basis, within each of the larger geographic regions.

This evaluation and mapping of potential moose and black bear 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 Study Area to support moose and black bear. The mapping is therefore not intended to indicate definitively whether a particular species is 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 moose and black bear habitat potential mapping should be considered along with the survey data and information from the literature that precedes it.

2.3 Study Team

The *Moose and Black Bear Component Study* was conducted on behalf of Nalcor Energy by Jacques Whitford Stantec Limited. The Study Team included a project manager/regional lead in Labrador supported by two additional regional leads (Corner Brook and St. John's), who were responsible for liaison with regulatory agencies in their respective areas. Additional team members included personnel responsible for supporting data collection and administrative support. The Study Team and their respective roles are presented in Table 2-4. Brief biographical statements, highlighting roles and responsibilities and relevant education and employment experience, are provided in Appendix B.

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
	Shawna Peddle
Data Collection Support	John Pennell
	James Loughlin
GIS/Mapping	Stephen Rowe
	Jackie Bowman
	Erin Marshall
Senior Review	Earle Hickey
Senior Advisor	Colleen Leeder

3.0 RESULTS AND ANALYSIS

A general overview of the presence, abundance and distribution of moose and black bear in the Study Area is presented, based on existing literature and results of previous investigations in the Study Area. Both moose and black bear have a widespread distribution pattern in the province, with a relatively limited proportion of their population confined to any given area (although moose tend to concentrate in select areas during winter). They are also important economically (i.e., outfitters and other commercial hunting), as well as provide sustenance to aboriginal and other residents of Newfoundland and Labrador.

3.1 Moose

Moose, a large ungulate and member of the deer family, are found in boreal forests throughout northern North America (Snyder 1991). They are a generalist species, adapting to the relative abundance of available habitat and forage (Jackson et al. 1991; Osko et al. 2004). Largely influenced by the availability of feeding opportunities, as well as the need for shelter in winter, the habitat preferences of moose shift seasonally (Bowyer et al. 2003). Open wetlands and other riparian zones are generally an important component of summer habitat (Peek 1997) and moose typically stay away from mature forest for most of the year (Cederlund and Okarma 1988), with the exception of open areas (canopy gaps) with young vegetation (Stelfox et al. 1995).

Moose were introduced to the Island of Newfoundland in the late 1800s and to Labrador in the 1950s (Mercer and Kitchen 1968; Chubbs and Schaefer 1997; Nalcor Energy 2009). The distribution and abundance of this large ungulate has since expanded in both regions of the province, where it often exists in sufficient abundance to sustain an annual harvest. Recent estimates (2000 and 2001) of moose in central Labrador show that densities are generally low, ranging from 0.016 to 0.03 moose/km^2, although this number is based on studies in relatively low quality habitats (Jung et al. 2009). Estimates of moose density in 2008 near Double Mer were similarly low, indicating a density of 0.6 moose/km^2. In comparison, moose populations are high on the Island, with estimates of more than 120,000 moose (Government of Newfoundland and Labrador, undated (a)) and densities ranging from 0.11 moose/km^2 in Moose Management Area (MMA) 19 along the south coast to 6.82 moose/km^2 in MMA 43 on the Port-au-Port Peninsula.

Figures 3-1 and 3-2 show MMAs (alternatively referred to as Moose Management Units (MMUs) in various publications; hereafter collectively referred to as MMAs) for Labrador and the Island of Newfoundland, respectively. In Labrador, the transmission and electrode corridors pass through five MMAs (Figure 3-1; Table 3-1). On the Island, the Project (including proposed and alternative transmission corridors) intersects 21 MMAs (Figure 3-2; Table 3-1). Table 3-1 summarizes moose quotas in the province, recent changes in quotas and hunting success for the 26 MMAs that the Study Area overlaps.

Figure 3-1 Moose Management Areas in Labrador

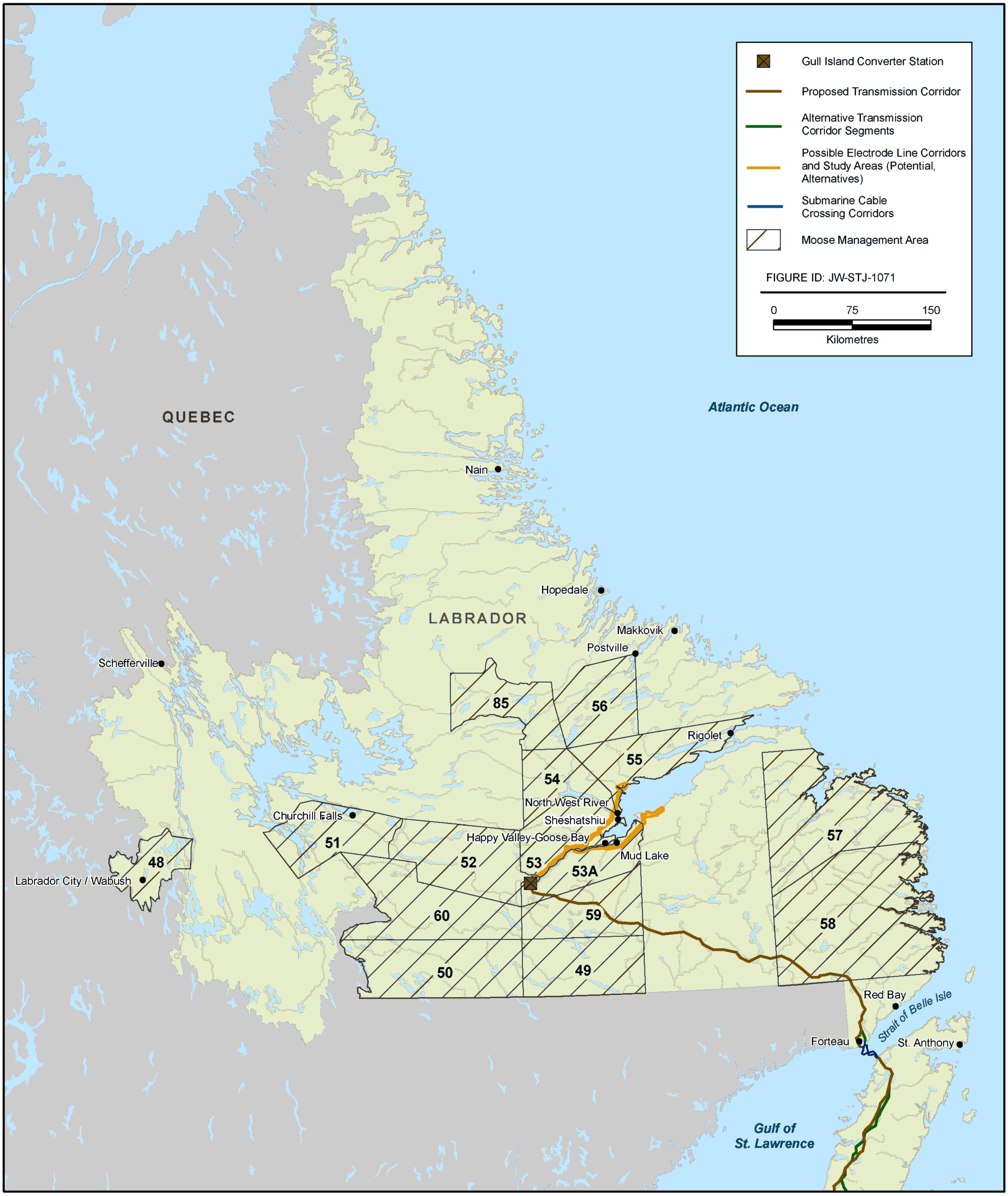


Figure 3-2 Moose and Black Bear Management Areas in Newfoundland

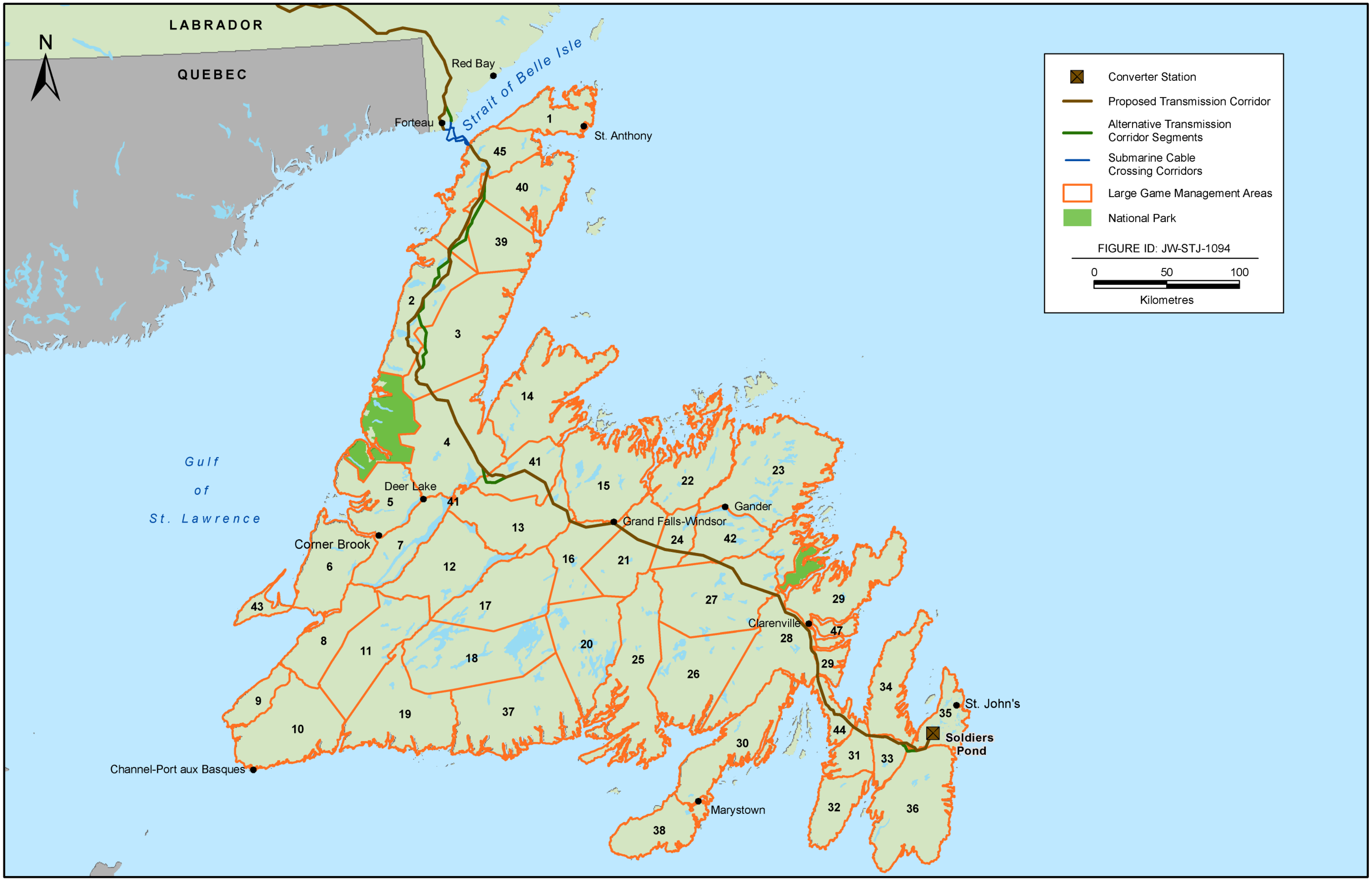


Table 3-1 2009 to 2010 Provincial Moose Quotas in Newfoundland and Labrador MMAs that Intersect Proposed and Alternative Project Infrastructure

Moose Management Area		Total Quota	Quota Change from 2008 to 2009	Overall Success (%) 2007 to 2008
Labrador				
53	Upper Muskrat Falls	25	No change	Not available
53A	Lower Muskrat Falls	5	No change	Not available
54	Grand Lake	30	No change	Not available
55	Double Mer	25 (+ 11 licenses through the Nunatsiavut Government license allocation)	No change	Not available
58	Alexis River	5	No change	Not available
Newfoundland				
2	Portland Creek	1,650	No change	78.6
3	Harbour Deep	1,250	No change	50.4
4	Taylor's Brook	900	No change	69.2
13	Gaff Topsails	450	No change	58.3
16	Sandy Badger	200	No change	58.3
21	Rattling Brook	400	No change	64.8
24	North West Gander	250	No change	52.4
27	Terra Nova	200	No change	75.8
28	Black River	425	+25	68.1
29	Bonavista Peninsula	900	No change	81.4
31	Placentia	550	No change	56.1
33	Salmonier	450	No change	64.9
34	Bay De Verde	550	-50	71.0
35	St. John's	475	+50	71.8
36	Southern Shore	1,100	+100	78.5
39	Cloud River	500	No change	48.1
40	Conche	1,250	No change	76.8
41	Sheffield Lake	450	No change	71.6
42	Gambo	200	No change	61.6
44	Bellevue	200	No change	74.2
45	Ten Mile Lake	1,600	+100	76.5

Notes:
1. Reproduced from the 2009 to 2010 Hunting and Trapping Guide (Government of Newfoundland and Labrador 2009).
2. Overall success based on 2007 license returns.

3.1.1 Primary Sources of Information

Four studies have been completed previously for moose in association with this Project and proposed development of the lower Churchill River. The first was completed by Northland and Associates (1980), documenting the occurrence of wintering moose (and other wildlife) along the Southeastern Labrador portion of the proposed transmission corridor. Aerial helicopter surveys were also completed during winter, in survey blocks along the lower Churchill River and proposed electrode corridors in Labrador (Northland Associates and Jacques Whitford 2000). Recently, evidence of the presence of moose and assessment of habitat quality was documented along the entire transmission corridor during ELC surveys in 2008. Nalcor Energy also completed a moose capture and aerial telemetry study along the Churchill River of Labrador from 2006 to 2009 (Minaskuat

Inc. 2009b). A literature review of the ecology, distribution, population biology and harvest statistics of moose in Labrador and on the Island of Newfoundland, within the lower Churchill River Power Project Study Area was completed by Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. (2000). The Study Area for this review included the Churchill River and adjacent areas that would be flooded by the Project (Atikonak Lake and the Lac Brule area), as well as the proposed transmission infrastructure from Gull Island to Soldiers Pond.

Additional research includes: a study investigating moose populations in MMA 57 and MMA 58 that was carried out in 1998, prior to the construction of the Trans Labrador Highway (TLH) from Red Bay to Cartwright (Found 1998); surveys of potential moose wintering areas within the military Low Level Training Area in 1995, 1997 and 1999 (Trimper et al. 1996; Jacques Whitford 1997a; Northland Associates and Jacques Whitford 2000); an examination of the distribution, population growth, population structure and hunter returns of moose in Labrador (Chubbs and Schaeffer 1997); and moose surveys in MMA 55 in 2008 conducted jointly by the province and Nunatsiavut Government (Barney, undated).

On the Island, Mawhinney and Mahoney (1994) studied moose in the Western Newfoundland Model Forest (WNMF) (MMA 5), the Corner Brook area (MMA 6) and near South Brook (MMA 7). Burzynski et al. (2005) looked at moose population dynamics in Gros Morne National Park in western Newfoundland and Gosse et al. (2002) conducted similar studies in Terra Nova National Park in eastern Newfoundland. Moose habitat associations were studied by Thompson et al. (1992), McLaren et al. (2000) and Newbury et al. (2007). Earlier studies also examined moose in relation to forest harvesting practices on the Island (Parker and Morton 1978).

3.1.2 Existing Conditions and Status

Moose populations are increasing both on the Island and in Labrador. In Labrador, the species is relatively new, resulting from the introduction of 12 animals on the south coast in the 1950s and from the range expansion of herds coming east from Québec (Chubbs and Schaeffer 1997). By 1961, this species had reached the lower Churchill River watershed near the Minipi River (Mercer and Kitchen 1968). Licensed hunting began in 1977, once population numbers had reached levels able to sustain the hunt (Chubbs and Schaeffer 1997). Concurrently, forestry practices over the past 50 years may have allowed for increases in population numbers due to prevalence of willow and birch stands and associated high quality forage and shelter (Newbury et al. 2007).

Densities in Labrador remain relatively low compared to other areas near the northern extent of this species range (Brassard et al. 1974; Fryxell et al. 1988; Boer 1992; Chubbs and Schaeffer 1997; Minaskuat Inc. 2009b), possibly associated with an overall low abundance of willow and alder (*Alnus* sp.) browse (Jacques Whitford 1997a). Estimated densities were 0.168 moose/km^2 in the Muskrat Falls MMA (population estimate of 677 ± 359) and 0.085 moose/km^2 in the Grand Lake MMA (population estimate of 321 ± 218) during the late 1980s and early 1990s (Chubbs and Schaeffer 1997). In 1986, Dalton (1986) counted 75 moose in the Grand Falls MMA, 65 moose in the Grand River MMA, 218 in the Muskrat Falls MMA and 326 in the Grand Lake MMA. An overall population size of 5,000 individuals in Labrador was estimated in 1990 (Karns 1997).

Studies conducted in 1995 indicated that the highest concentration of moose in central Labrador occurred along the Churchill River (Trimper et al. 1996). Comparison of these data with subsequent field surveys in 1997 (Jacques Whitford 1997a), in 1999 (Northland Associates and Jacques Whitford 2000) and in 2007 (Minaskuat Inc. 2009b), reveal no obvious trends in population data other than consistently low densities (less than four observed in any given survey plot, throughout sampling years). Densities along coastal Labrador are even lower than in central Labrador, with Found (1998) reporting densities of 0.00035 moose/km^2 in MMA 57 and 0.0091 moose/km^2 in MMA 58 (the latter of which overlaps with the proposed transmission corridor), along the then-proposed TLHL from Cartwright to Red Bay. The highest densities of 1.7 moose/km^2 were reported in south-central Labrador (Trimper et al. 1996).

More recently in Labrador (in March 2008), moose density and population size were estimated in MMA 55 during aerial surveys conducted jointly by the province's Wildlife Division and Nunatsiavut Government (Barney, undated). Results from this survey indicate densities of 0.06 moose/km^2 and a population size of 314 ± 80 animals, representing a four-fold increase in animals since 1980.

Moose densities on the Island of Newfoundland are higher than in Labrador, with densities ranging from a low of 0.61 moose/km^2 in MMA 17 to 6.8 moose/km^2 in Gros Morne National Park (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000 and references therein). With a total of an estimated 125,000 animals in 2004, Newfoundland has a disproportionate amount of the continental population (greater than 10 percent), even though available habitat for moose represents less than 2 percent of that available throughout North America (McLaren et al. 2004).

Moose have been present on the Island since introductions of male/female pairs in 1878 at Gander Bay in northeastern Newfoundland and in 1904 near Howley in western Newfoundland (Northcott 1974; Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000). By 1935, moose occupied much of the Island [Government of Newfoundland and Labrador, undated (a)], largely due to low rates of competition from other ungulate species and low predation (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000). The first regulated hunting season opened in 1930 [Government of Newfoundland and Labrador, undated (b)], and currently over 25,000 moose licenses are issued annually (Government of Newfoundland and Labrador 2009).

Between 1966 and 1973, moose populations were considerably reduced on the Island primarily as a result of hunting, with harvest rates in some areas between 24 percent and 55 percent annually (Fryxell et al. 1988). Subsequent reductions in license quotas in the mid-1970s have resulted in population rebounds throughout the province.

Surveys conducted in 1993 and 1994 on the Island found 123 moose in the Trout River area (MMA 5), 407 moose in the Corner Brook area (MMA 6) and 215 moose in the South Brook area (MMA 7) (Mawhinney and Mahoney 1994). Based on these numbers, the population of moose was estimated at 3,258 ± 489 animals in MMA 5, 4,330 ± 1,015 animals in MMA 6 and 2,054 ± 218 animals in MMA 7, for a total estimated population of 9,642 animals (Mawhinney and Mahoney 1994). Estimates of densities in these management units ranged from 1.2 to 2.1 moose/km^2 which is comparable to densities of 0.38 to 2.3 moose/km^2 reported in other eastern boreal forests (Mawhinney and Mahoney 1994).

Mawhinney and Mahoney (1994) also investigated the total moose population in the management areas of the WMNF, where an estimated 10,000 individuals are found. Densities in the WMNF range from approximately 1.42 to 2.08 moose/km^2 (Mawhinney and Mahoney 1994). Elsewhere on the Island, S. Fudge and Associates (1989) estimated moose densities at 0.33 to 0.46 moose/km^2 in association with a proposed base metals mine in Central Newfoundland (Tally Brook).

Densities are highest in the province in Gros Morne National Park, where densities have reached as high as 7 moose/km^2 (McLaren et al. 2000). For comparison, density in Terra Nova National Park was only 0.75 moose/km^2 around the same time period (Gosse et al. 2002).

The most recent moose census data available for the Island have been provided by the provincial Wildlife Department and is presented in Table 3-2. Note that similar data were not available for Labrador.

Table 3-2 Most Recent Density and Population Estimates of Moose in Newfoundland

MMA	Year Surveyed	Population Estimate	Density Estimate (moose/km^2)	Adjusted Density - Forest and Scrub Habitat (moose/km^2)
1	2006	4,165	3.11	5.27
2	**2008**	**6,045**	**2.63**	**4.00**
3	**2009**	**4,626**	**1.26**	**1.87**
3A	1993	756	2.17	2.55
4	**2004**	**2,543**	**0.69**	**0.99**
5	2005	5,338	2.68	3.79
6	2007	7,522	3.39	4.52
7	2006	1,913	1.39	1.59
8	1987	3,781	2.16	3.04
9	1996	1,214	1.53	2.10
10	2000	2,868	0.97	2.31
11	1998	3,048	1.01	2.25
12	2007	1,227	0.47	0.84
13	**1997**	**1,800**	**0.70**	**1.16**
14	1997	4,304	1.21	1.24
15	2004	4,207	1.33	1.88
16	**2008**	**761**	**0.46**	**0.65**
16A	1994	902	3.09	
17	2005	2,151	0.81	1.08
18	1994	1,708	0.47	1.26
19	1997	340	0.11	0.51
20	1995	572	0.21	0.41
21	**2004**	**2,584**	**1.24**	**1.81**
22	2004	3,767	1.91	2.44
22A	1994	1,302	3.97	4.46
23	2003	4,107	0.91	1.54
24	**1997**	**1,202**	**1.42**	**1.82**
25	1995	3,816	1.01	2.12
26	2007	1,633	0.48	1.51
27	**2009**	**1,844**	**0.51**	**0.88**
28	**1997**	**3,090**	**0.87**	**1.70**
29	**1989**	**3,452**	**1.52**	**1.82**
30	1997	1,400	0.54	1.98
31	**1996**	**2,250**	**2.94**	**5.33**
32	1997	734	0.61	1.13
33	**2005**	**683**	**1.13**	**1.87**
34	**1997**	**2,770**	**1.59**	**3.00**
35	**2005**	**759**	**0.70**	**1.31**

MMA	Year Surveyed	Population Estimate	Density Estimate (moose/km^2)	Adjusted Density - Forest and Scrub Habitat (moose/km^2)
36	**1995**	**3,358**	**0.96**	**3.09**
37	2008	1,629	0.41	2.01
38	1997	352	0.22	0.79
39/39A	**2006**	**2,649**	**1.54**	**3.17**
40	**2004**	**3,500**	**1.74**	**3.24**
41	**2009**	**1,412**	**0.88**	**1.73**
42	**2009**	**752**	**0.51**	**0.64**
43	1999	2,702	6.82	13.93
44	**1997**	**1,656**	**2.79**	**5.41**
45	**2005**	**6,435**	**2.71**	**5.42**
47	1997	798	3.18	4.48

Notes:
1. Data provided by the Newfoundland and Labrador Wildlife Division.
2. MMAs are the same as Bear Management Areas.
3. MMAs that overlap the transmission line corridor are indicated in **bold.**
4. Some MMAs indicated above are historical and currently not recognized for management purposes (MMAs 3A, 22A, 16A). Estimates for MMAs 2A and 5A have not been separated in these data.
5. Population size is estimated using a standard correction factor (2.0) applied to the raw data (C. Dyke, pers. comm.; Barney, undated).

3.1.3 Habitat Association and Distribution in the Study Area

Moose use a variety of habitat types throughout the year in Newfoundland and Labrador, reflective of seasonal preferences. In the lower Churchill River valley, moose show a general seasonal pattern of occupying the lower reaches of the river valley during winter and typically move to higher elevations outside the river valley during spring and summer (Minaskuat Inc. 2009b).

At a landscape scale, wintering moose typically select areas relatively sheltered from snow and adjacent to abundant food sources (Forbes and Thebérge 1993; Dussault et al. 2005). Dense forests with canopy gaps are often preferred, to avoid deep snow, hard ice crusts and predation, as well as to take advantage of available forage. Willow, birch and alder are the preferred winter browse (Bowyer et al. 2003; Newbury et al. 2007) although conifers are sometimes used as a supplementary food source (Bowyer et al. 2003). Habitats typically selected during winter include riparian and willow/alder habitats, deciduous dominated forests, coniferous/deciduous mixedwood forests and deciduous scrub habitats (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000; Sikumiut Environmental Ltd. 2007; Minaskuat Inc. 2009b). Moose may also use cutover and coniferous dominated forest (spruce-balsam fir) communities (Dodds 1960; Irwin 1985; Schwab and Pitt 1991; Newbury et al. 2007; Minaskuat Inc. 2009b), the latter likely dependent on the amount of balsam fir present (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000). Other important habitats indentified include coniferous forest and cutovers, as they provide good cover and forage. Twenty and thirty year old regenerating stands are preferentially selected compared with recently clearcut stands (5 and 10 years old) or mature forests (>150 years old) (Newbury et al. 2007).

Habitats such as black spruce forest/scrub and recent burns tend to be avoided during winter (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000), although black spruce dominated forests were frequently used by GPS collared moose in the lower Churchill River valley, possibly as shelter, to access adjacent preferred forage (Minaskuat Inc. 2009b), or as a supplementary food source (Bowyer et al. 2003). Similarly, RRCS and Fudge (1988) identified 30 percent use of black spruce forest habitats in central Labrador (compared with 30 percent in riparian habitat, 25 percent in mixedwood habitat, and less than 10 percent in each of deciduous and lake habitats), although their use of black spruce habitats was considered much less than what was available (as cited in Northland Associates and Jacques Whitford 2000).

Moose often congregate during winter in 'yarding areas' that are indicative of high quality habitat (Northland Associates and Jacques Whitford 2000). These areas often contain high forage availability and/or low snow accumulation (Conor Pacific Environmental Technologies Inc. and Westworth Associates Ltd. 2000 and references therein) (though note that moose also tend to avoid areas of lowest snow cover, to evade wolves and reduce predation risk (Dussault et al. 2005)). Moose in northern Labrador do not tend to aggregate during the winter, compared to populations on the Island (Chubbs and Schaeffer 1997), possibly due to low moose densities and a limited availability of high quality winter browsing areas (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000). On the Island, winter yards have been reported in some management areas and Ecoregions that overlap the Study Area, including MMA 3, MMA 28, MMA 33, MMA 36 and the Maritime Barrens Ecoregion (Conor Pacific Environmental Technologies Inc. and Westworth Associates Ltd. 2000 and references therein).

During early summer, moose tend to seek out nutrient-rich forage in open and aquatic areas (Peek 1997). Summer diets are comprised primarily of young leaves and shoots of deciduous species, as well as sedges, grasses and aquatic plants (Newbury et al. 2007 and references therein). The latter provide an important source of sodium and are more digestible than other terrestrial vegetation (MacCracken et al. 1993). Important habitat types during summer include coniferous forests, cutovers, wetlands and mixedwood and hardwood forests (Dodds 1960; Bergerud and Manuel 1968; Irwin 1985; Schwab and Pitt 1991; McLaren et al. 2000; Courtois et al. 2002; Minaskuat Inc. 2009b). Burns may provide increased forage from regenerating conifers (Rempel et al. 1997) in some locations, whereas other open sites, such as alpine vegetated habitat, provides neither good cover nor forage.

Calving (typically the May-June period) generally occurs on small islands or other secluded areas adjacent to water (Nalcor Energy 2009). Home range size of females can be almost twice as large in summer compared to winter (Cederlund and Okarma 1988). In general, both sexes are tolerant of each other and home ranges tend to overlap, particularly those of females (Dussault et al. 2005).

Table 3-3 summarizes observations and/or evidence of moose collected during ELC surveys along the transmission corridor in 2008, in relation to habitat classification. This information provides an indication of the relative use of habitat types within the Study Area, throughout multiple seasons (i.e., spring/summer and fall/winter). Relatively high proportions of cutover (89 percent), mixedwood (85 percent), wetland (47 to 76 percent), conifer forest (33 to 74 percent), burn (33 to 80 percent), lichen heathland (80 percent) and hardwood (100 percent) habitats were observed, though note that the latter two habitats are based on a small sample size. Observations of live animals occurred only in alpine vegetated, conifer forest and wetland habitats, providing some indication of their use during summer (July/August).

Table 3-3 Observations and/or Evidence of Moose in Relation to Habitat Type Along the Transmission Corridor, in 2008

Habitat Type	# Sites with Observations (% of Sites)	Abundance Rating	Comments
Labrador			
Burn	4 (80%)	2-3	Scat and tracks
Conifer Forest	7 (39%)	1-3	Animals observed, scat and tracks
Conifer Scrub	0 (0%)	0	-
Hardwood Forest	2 (100%)	Not indicated	Scat and browse
Lichen Heathland	4 (80%)	2-3	Scat and tracks
Open Conifer Forest	3 (33%)	1-3	Browse, scat and tracks
Wetland	9 (47%)	1-3	Animals observed, browse and tracks
Newfoundland			
Alpine Vegetated	2 (14%)	2-3	Animals observed, scat, trail
Burn	1 (33%)	2	-
Conifer Forest	64 (74%)	1-3	Browse, scat and tracks
Conifer Scrub	15 (63%)	1-2	Browse, scat, trail and tracks
Cutover	16 (89%)	1-3	Browse, scat trail and tracks
Kalmia Lichen	15 (58%)	1-3	Scat, trails and tracks
Mixedwood Forest	22 (85%)	1-3	Browse, scat and tracks
Open Conifer Forest	6 (60%)	1-3	Bedding area, scat, trails and tracks
Rocky Barrens	4 (50%)	1-2	Scat, trail
Wetland	42 (76%)	1-3	Browse, bedding area, scat and tracks

Notes:
1. Abundance rating: 0=non-existent; 1=trace; 2=common; and 3= abundant.
2. Observations of scat may represent winter or summer habitat use, browse would likely indicate winter use, and trails and tracks would likely represent spring/summer habitat use (Minaskuat Inc. 2008a).

Table 3-4 summarizes primary, secondary and tertiary habitat quality for moose during winter and summer, respectively. Primary spring/summer habitat consists of wetland and hardwood forest habitats and comprises 1,521.6 km^2 (23 percent) of the Study Area in Labrador and 1,087.7 km^2 (10 percent) of the Study Area in Newfoundland. During fall/winter, wetlands lose their importance as they are no longer accessible as a food source (Allen et al. 1987; Peek 1997). Mixedwood and conifer forests are considered primary habitat during fall/winter, as well as cutover habitat on the Island. Primary fall/winter habitat comprises 1,270.7 km^2 (19 percent) of the Study Area in Labrador and 4,504.1 km^2 (40 percent) of the Study Area in Newfoundland.

Table 3-4 ELC Habitat Type and Relative Quality for Moose Use Along the Transmission Corridor

Habitat Type/Habitat Description	Spring / Summer Importance	Fall / Winter Importance	Notes
Alpine Vegetated	Tertiary	Tertiary	Lack of forage and cover available but early regeneration *Abies balsamea* may attract moose. Only 14 percent of alpine sites sampled in 2008 had moose sign.
Black Spruce Lichen Forest	Tertiary	Tertiary	May provide cover.
Burn	Tertiary	Tertiary	Lack of forage and cover available, although 5 of 8 burn habitats sampled in 2008 had evidence of moose.

Habitat Type/Habitat Description	Spring / Summer Importance	Fall / Winter Importance	Notes
Conifer Forest	Secondary	Primary	Forage and cover available. Approximately 82 percent of conifer forest sampled in 2008 had moose sign, with stronger relationships found on the Island.
Conifer Scrub	Secondary	Tertiary	Some forage available seasonally. 52 percent of sampled habitats showed evidence of moose in 2008.
Cutover	Secondary	Primary	Moose use of cutover sites is well-documented where the presence of *Betula* sp. can be an important food source. Approximately 89 percent of sampled cutover habitats in Newfoundland in 2008 had moose sign.
Exposed Earth	Tertiary	Tertiary	Lack of forage and cover available. No evidence of moose recorded in 2008 surveys.
Hardwood Forest	Primary	Secondary	Provides food, protection and shelter primarily in spring and fall. Little cover during the winter. 100 percent of hardwood habitat sampled in 2008 had moose sign.
Lichen Heathland	Secondary	Tertiary	Some forage available.
Mixedwood Forest	Secondary	Primary	Deciduous component an important food source and also provides shelter. 85 percent of mixedwood habitat sampled in 2008 had moose sign.
Open Conifer Forest	Tertiary	Tertiary	Early regeneration *Abies balsamea* may attract moose (McLaren et al. 2000). 53 percent of open conifer habitat sampled in 2008 had moose sign.
Rocky Barrens	Tertiary	Tertiary	Lack of forage and cover available, although 50 percent of sampled sites in Newfoundland in 2008 had evidence of moose.
Kalmia Lichen/Heathland	Secondary	Secondary	Some forage available. Depending on snow depth, can be used in winter. Of the 25 habitats sampled in 2008, 15 (or 60 percent) had moose sign.
Wetland	Primary	Tertiary	Primary source of aquatic vegetation that is critical during spring/summer. 69 percent of wetland habitats sampled in 2008 had moose sign, with higher percentage use on the Island (76 percent) compared to Labrador (47 percent).
Scrub/Heathland/ Wetland	Secondary	Secondary	May provide some aquatic vegetation and other food sources seasonally.

Notes:
1. 2008 surveys refer to wildlife observations collected as part of the ELC field program.
2. Though not included at the scale of the ELC (Minaskuat Inc. 2009a), riparian habitats are considered secondary habitat quality for moose, during both spring/summer and fall/winter.

Secondary moose habitat in Labrador includes conifer forest, conifer scrub, cutover, lichen heathland, mixedwood forest, kalmia lichen/heathland and scrub/heathland/wetland during spring/summer and hardwood forest, kalmia lichen/heathland and scrub/heathland/wetland habitats during fall/winter (Table 3-4). All other habitat types in Table 3-4 were considered tertiary, based on limited protection, resting or feeding opportunities.

Lower Churchill River and Lake Melville

Moose are present in the Churchill River and Lake Melville region in low densities, often in association with river valleys. Relevant findings of research in support of the current Project and/or for other proponents that provide information on moose in the Churchill River and Lake Melville region include the following:

- As part of the mitigation program regarding military flight training over the Québec-Labrador Peninsula, aerial surveys of potential wintering areas were completed in 1995, 1997 and 2008 to identify potential sensitivities and implement possible spatial closures (Trimper et al. 1996; Jacques Whitford 1997a; LGL Limited 2008). The greatest concentrations of moose and/or areas of optimal moose winter habitat were found along large river valleys with reduced snow depth and that had a greater availability of browse.
- Trimper et al. (1996) conducted strip-transect and block surveys during March 1995 over 2,210 km throughout the Churchill, Petit Mecatina, Olomane, and Natashquan River valleys and found that moose were often absent from areas of apparently suitable habitat. Estimated densities were between 0 and 0.1 moose/km^2, well below densities elsewhere in Canada.
- Twenty-one moose were recorded throughout the Churchill River system in 1999, with densities ranging between 0.10 and 0.57 moose/km^2 (average 0.25 moose/km^2) (Northland Associates and Jacques Whitford 2000). Higher densities were found in the Churchill River valley, where favourable winter habitat with adequate forage and shelter were found. These densities were similar to other estimates in Labrador but lower than moose densities in the boreal forest system of eastern North America. The male : female sex ratio was 1 : 1.25 and the male : female : calf distribution was 38 percent : 38 percent : 9.5 percent, which were also similar to previous studies in the region (although Chubbs and Schaefer (1997) reported calf proportions of 17 percent in some management areas in Labrador).
- In 2007 surveys conducted in support of the Lower Churchill Hydroelectric Generation Project (Minaskuat Inc. 2009b), moose were found in several riparian areas and islands within the lower Churchill River valley during winter, but moved out of the valley to higher elevations and wetland areas during the summer (Minaskuat Inc. 2008a). Animals were also generally found in proximity to tributaries (along areas of confluence with the lower Churchill River), and/or other water bodies in the Survey Area.
- In the Churchill River watershed, moose appear to utilize all habitat types for foraging, shelter, transit or other movement (Minaskuat Inc. 2009b).
- In MMA 53 (Goose River), incidental observations of moose were primarily associated with riparian habitats of the Goose River, Penas River and Gosling Creek (LGL Limited 2008). The estimated density of moose in MMA 53 was 0.047 moose/km^2, and represented a decline in numbers since initial surveys 14 years prior.
- Chubbs and Schaefer (1997) studied moose in the High Boreal Forest (Lake Melville) Ecoregion in Labrador and found that although moose have increased in numbers and expanded their range in Labrador, densities remain low. Rates of increase were estimated at 1.10 between 1986 and 1994. Moose have been recorded as far north as Hebron Fiord.

Southeastern Labrador

Moose are present in the Southeastern Labrador Study Area, but also in relatively low densities compared to the Island and other boreal regions elsewhere in Canada (Brassard et al. 1974; Fryxell et al. 1988; Boer 1992; Chubbs and Schaeffer 1997; Jacques Whitford 1997a; Minaskuat Inc. 2009b). Moose populations in MMAs 57 and 58 were examined in 1998, prior to construction of the TLH (Phase II - Cartwright to Red Bay), and numbers were found to be low (<0.01 moose/km^2) in both management areas (Found 1998). However, the moderate percentage of cows and the presence of twinning amongst adult cows indicated that the population was stable despite low densities (Found 1998).

Primary and secondary spring/summer moose habitat is abundant, with primary habitat comprising between 17 and 36 percent of the major Ecoregions (i.e., contributing to a larger percentage of the Study Area within that region) in Southeastern Labrador, with an additional 22 to 76 percent secondary habitat available (Figure 3-3). However, during fall/winter, the majority of the Study Area in this region is comprised of tertiary habitat, which ranges from 65 percent in the Low Subarctic Forest Ecoregion to 87 percent in the Eagle River Plateau Ecoregion (Figure 3-4). This shift to a reduced availability of preferred habitats during fall/winter is also evident in the other relatively minor Ecoregions (i.e., that make up only a small percentage of the Study Area in this region).

Northern Peninsula

Moose are found throughout the Northern Peninsula region on the Island of Newfoundland. Within the WNMF (including a portion of the Northern Peninsula), 213 moose were counted and classified in 1994 in the Trout River Area (MMA 5), 407 in the Corner Brook Area (MMA 6) and 215 in the South Brook area (MMA 7) (Mawhinney and Mahoney 1994).

Densities on the Northern Peninsula have been estimated between 0.93 and 3.00 moose/km^2 in sampled MMAs in this region, with lowest population estimates in MMA 39 (2,207 animals) and highest numbers in MMA 40 (6,474 animals) (Conor Pacific Technologies Inc. and Westworth Associates Environmental Ltd. 2000).

South of the Study Area, moose are particularly abundant in Gros Morne National Park. McLaren et al. (2000) found densities of 14.6 and 6.1 moose/km^2 in two areas within Gros Morne National Park, where they were first reported in the late 1940s, and it is believed that there are approximately 7,700 moose within the Park's boundaries. Such high moose densities have been found to negatively affect the regeneration potential of vegetation communities in the park (Burzynski et al. 2005).

Primary spring/summer habitat is relatively limiting, covering only six percent of the major Ecoregions (i.e., Long Range Barrens and Northern Peninsula Forest Ecoregions) on the Northern Peninsula (Figure 3-5). However, during fall/winter, primary habitat peaks at 46 percent within the Northern Peninsula Forest Ecoregion, with between 15 and 27 percent in the remaining Ecoregions (Figure 3-6). Secondary habitat is widely distributed, particularly during spring/summer, when it comprises 66 percent of the Long Range Barrens and 63 percent of the Northern Peninsula Forest Ecoregions, representing 94 percent of the Study Area for this region (Figure 3-5).

Figure 3-3 Moose Spring/Summer Habitat Quality: Southeastern Labrador

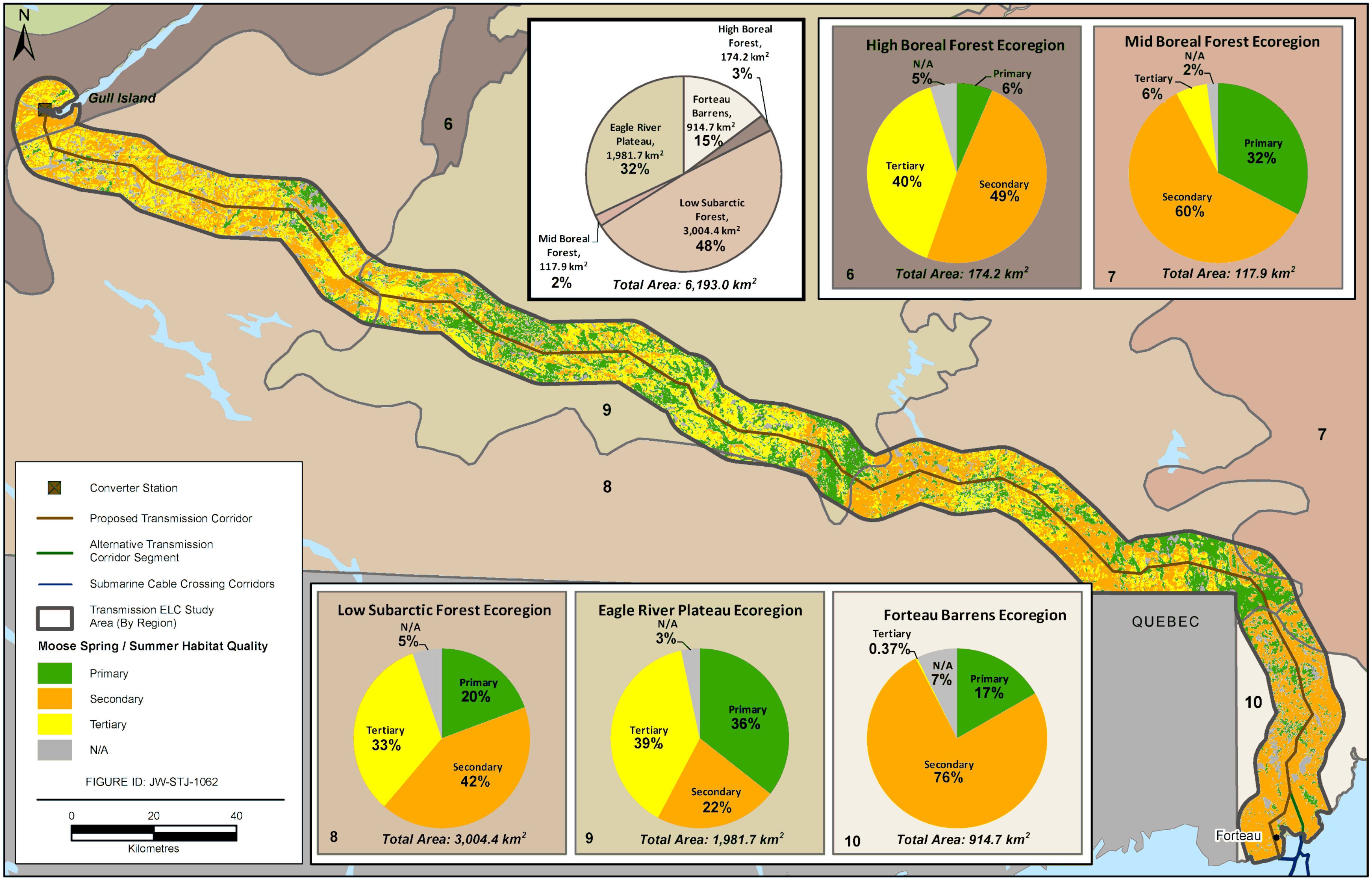


Figure 3-4 Moose Fall/Winter Habitat Quality: Southeastern Labrador

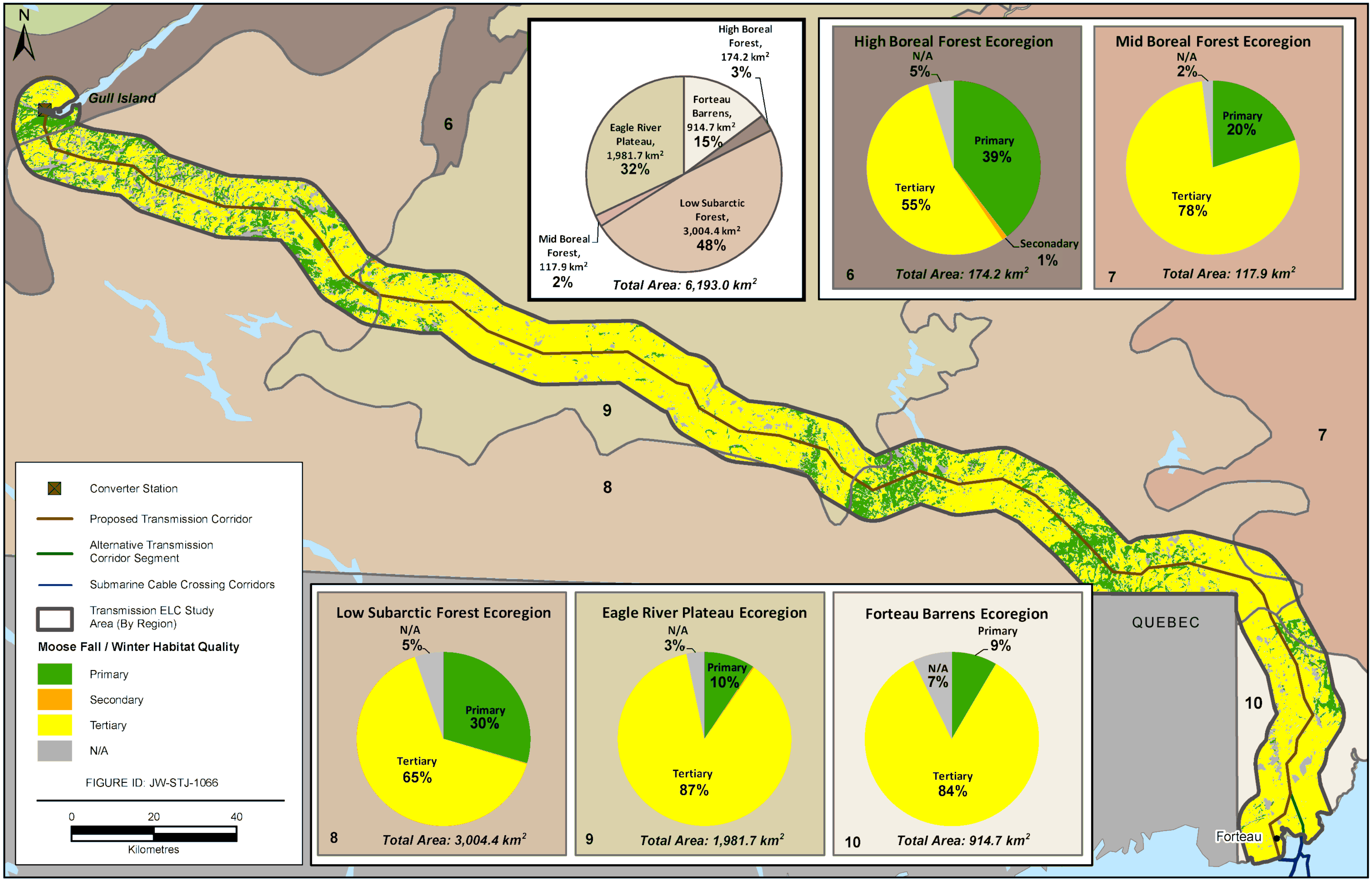


Figure 3-5 Moose Spring/Summer Habitat Quality: Northern Peninsula

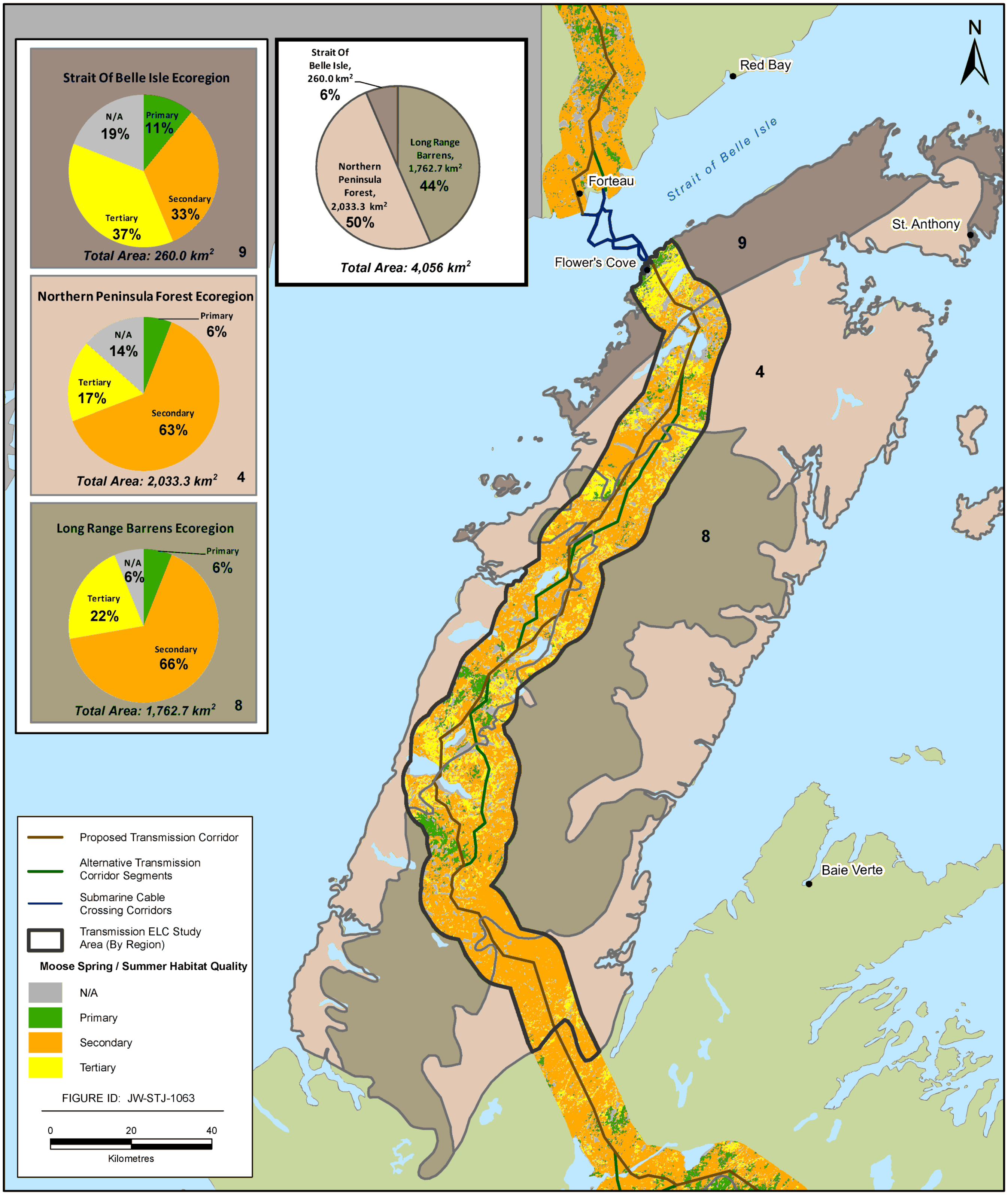
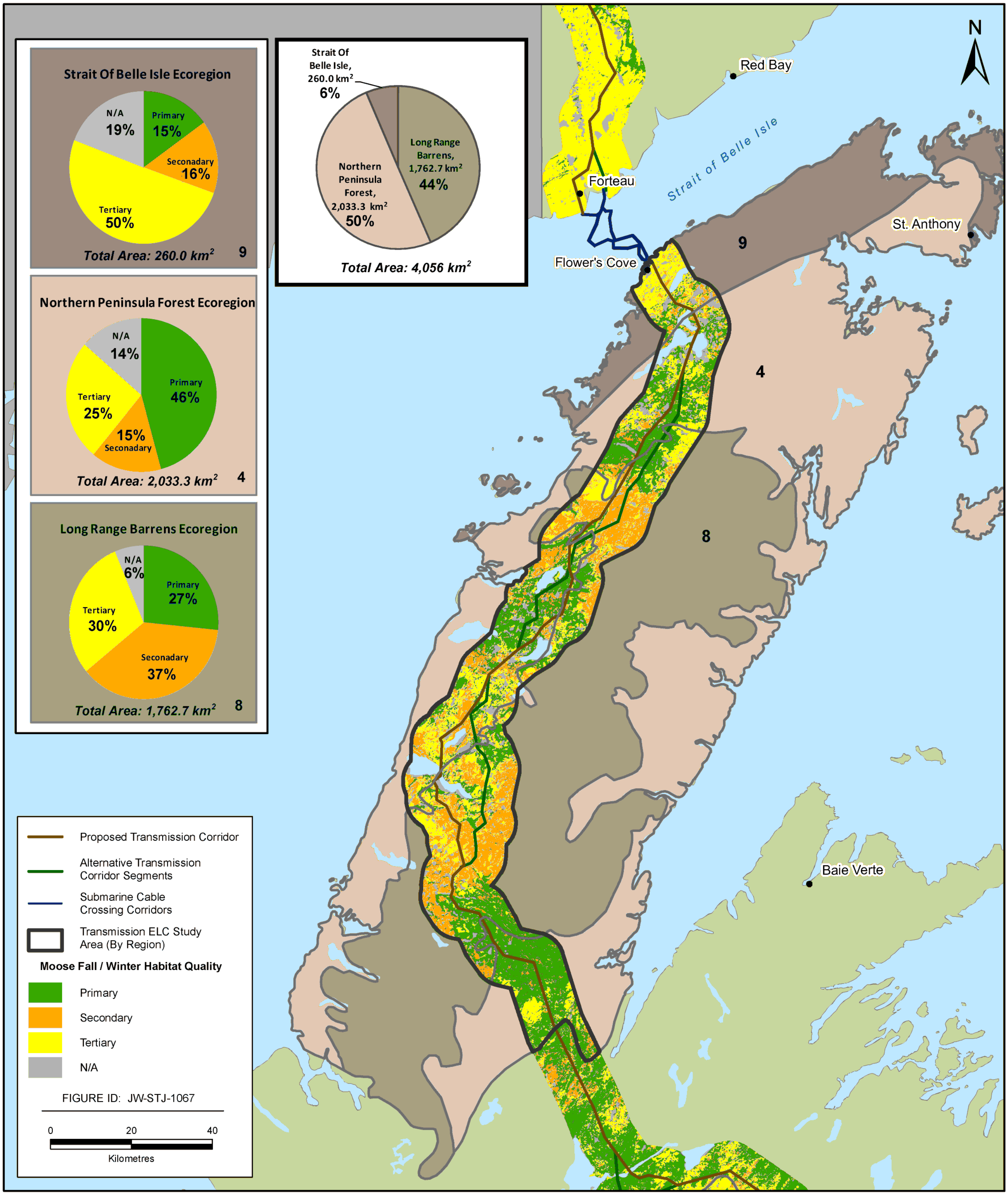


Figure 3-6 Moose Fall/Winter Habitat Quality: Northern Peninsula



Central and Eastern Newfoundland

Moose are also found throughout the Central and Eastern Newfoundland region. The Badger area in particular has historically supported relatively high densities of moose in this region (Parker and Morton 1978). Forests in this area are some of the most productive in insular Newfoundland and the focus of historic and current logging activities in the coniferous forests (Parker and Morton 1978). Bogs, muskegs, lakes and rivers are also present, providing aquatic vegetation and riparian areas (Parker and Morton 1978).

In Terra Nova National Park, immediately adjacent to the Study Area, Gosse et al. (2002) studied moose within the Park and adjacent MMA 27. Mean densities of moose in these areas were 0.75 and 0.59 moose/km^2, respectively. Earlier studies indicated densities of 0.43 moose/km^2 and population estimates of 170 animals (Briggs and Hicks 1993; cited in Conor Pacific Technologies Inc. and Westworth Associates Environmental Ltd. 2000).

Densities in other MMAs in the Central and Eastern Newfoundland region have been estimated between 0.70 and 3.32 moose/km^2 in MMAs in this region (Conor Pacific Technologies Inc. and Westworth Associates Environmental Ltd. 2000). The highest densities were found in MMA 42 (Triton Brook, Southwest Gander) and densities were also relatively high along the Isthmus Barrens (MMA 44) (Conor Pacific Technologies Inc. and Westworth Associates Environmental Ltd. 2000). McLaren et al. (2000) examined population densities at MMA 15A, north of the Study Area. Population estimates of 568 to 1,167 individuals were recorded, with an average of 433 moose seen each year (McLaren et al. 2000).

Spring/summer moose habitat in the Central and Eastern Newfoundland region is dominated by secondary quality habitat, with the exception of the relatively minor Long Range Barrens Ecoregion that is comprised largely of primary spring/summer habitat (74 percent of the 113.9 km^2 area) (Figure 3-7). Primary habitat in the main Central Newfoundland Forest Ecoregion is estimated at only 13 percent. In comparison, primary fall/winter habitat is generally abundant in this region, ranging from 4 to 53 percent within Ecoregions. The highest availability of primary fall/winter habitat (53 percent) is associated with the Central Newfoundland Forest Ecoregion (covering 92 percent of the Study Area) (Figure 3-8).

Figure 3-7 Moose Spring/Summer Habitat Quality: Central and Eastern Newfoundland

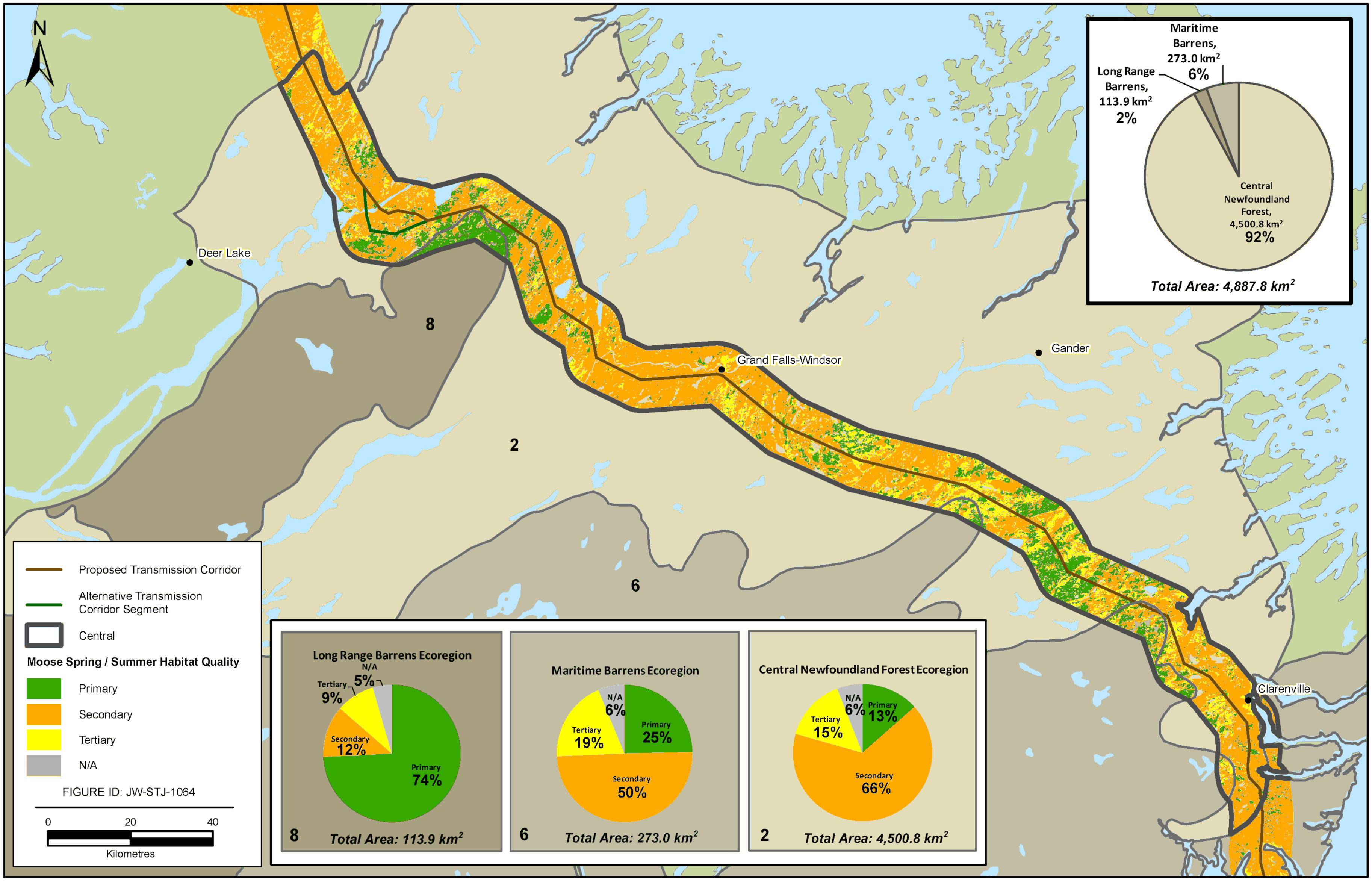
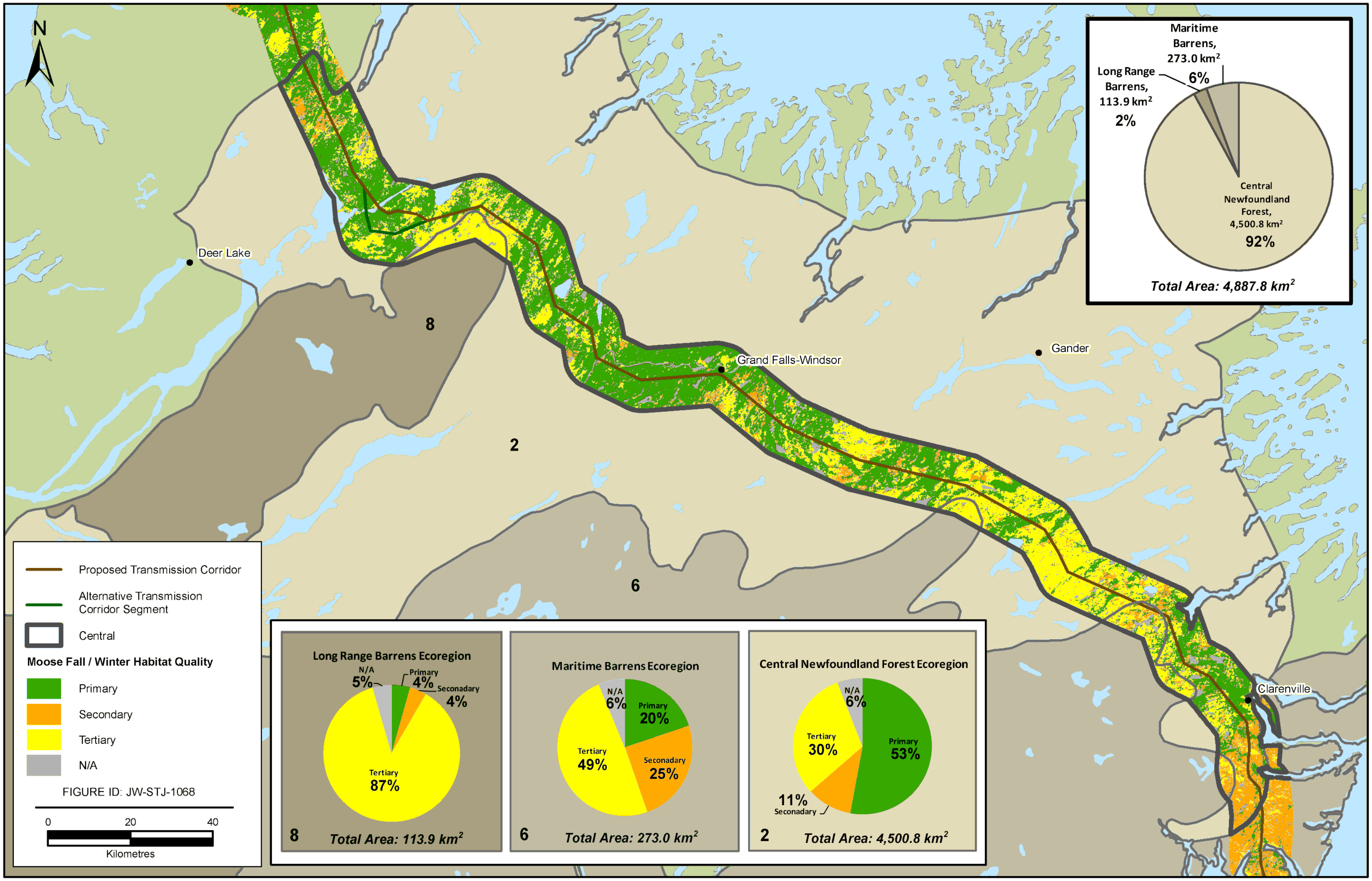


Figure 3-8 Moose Fall/Winter Habitat Quality: Central and Eastern Newfoundland



Avalon Peninsula

Moose are found throughout the Avalon Peninsula, having arrived several decades after their introduction in the late 1800s and early 1900s (McLaren and Mercer 2005). This delay in their arrival is believed to have resulted from a slower migration across the narrow isthmus that connects the Avalon Peninsula to the rest of Newfoundland (Broders et al. 1999). It is also worth noting that the Avalon Peninsula population is genetically distinguishable from those in Central Newfoundland and the Northern Peninsula (Broders et al. 1999).

Densities on the Avalon Peninsula have been estimated between 0.97 and 2.86 moose/km^2 in MMAs in this region (Conor Pacific Technologies Inc. and Westworth Associates Environmental Ltd. 2000), indicative of a minimum population estimate of 7,100 animals.

Primary spring/summer moose habitat is limited on the Avalon Peninsula, forming less than 5 percent of the Study Area in that region (Figure 3-9). Primary fall/winter habitat reaches 29 percent in the larger Maritime Barrens Ecoregion, covering 87 percent of the Study Area and 56 percent in the Avalon Forest Ecoregion (Figure 3-10). Secondary habitat is readily available during all seasons (particularly spring/summer), with percentages of 84 and 78 percent for the Avalon Forest and Maritime Barrens Ecoregions, respectively (Figures 3-9 and 3-10). For the fall/winter, the Ecoregion that represents 87 percent of the Study Area has 48 percent secondary habitat (Figure 3-10).

3.1.4 Limiting Factors

Evidence shows that population growth of moose is limited due to illegal harvests, wolf and/or bear predation, marginal habitat, parasites, disease, food availability, climate or a combination of these factors (Dalton 1986; Chubbs and Schaeffer 1997; Northland Associates and Jacques Whitford 2000; Dussault et al. 2005). Snow depth over 60 cm also limits populations, as it decreases food availability and increases energy output in transportation (Dussault et al. 2005; Newbury et al. 2007). Increased road access to hunters due to mining and forest operations and management measures to protect pre-commercially thinned forest stands can also conflict with moose population dynamics. In Labrador in particular, suboptimal habitat and an inadequate supply of willow and alder browse may limit the species (Jacques Whitford 1997a).

The availability of habitat, the availability of alternate foods created by agriculture, management of hunting and the presence of natural predators all affect moose populations and their growth (Crete and Daigle 1999, cited in McLaren et al. 2004).

Figure 3-9 Moose Spring/Summer Habitat Quality: Avalon Peninsula

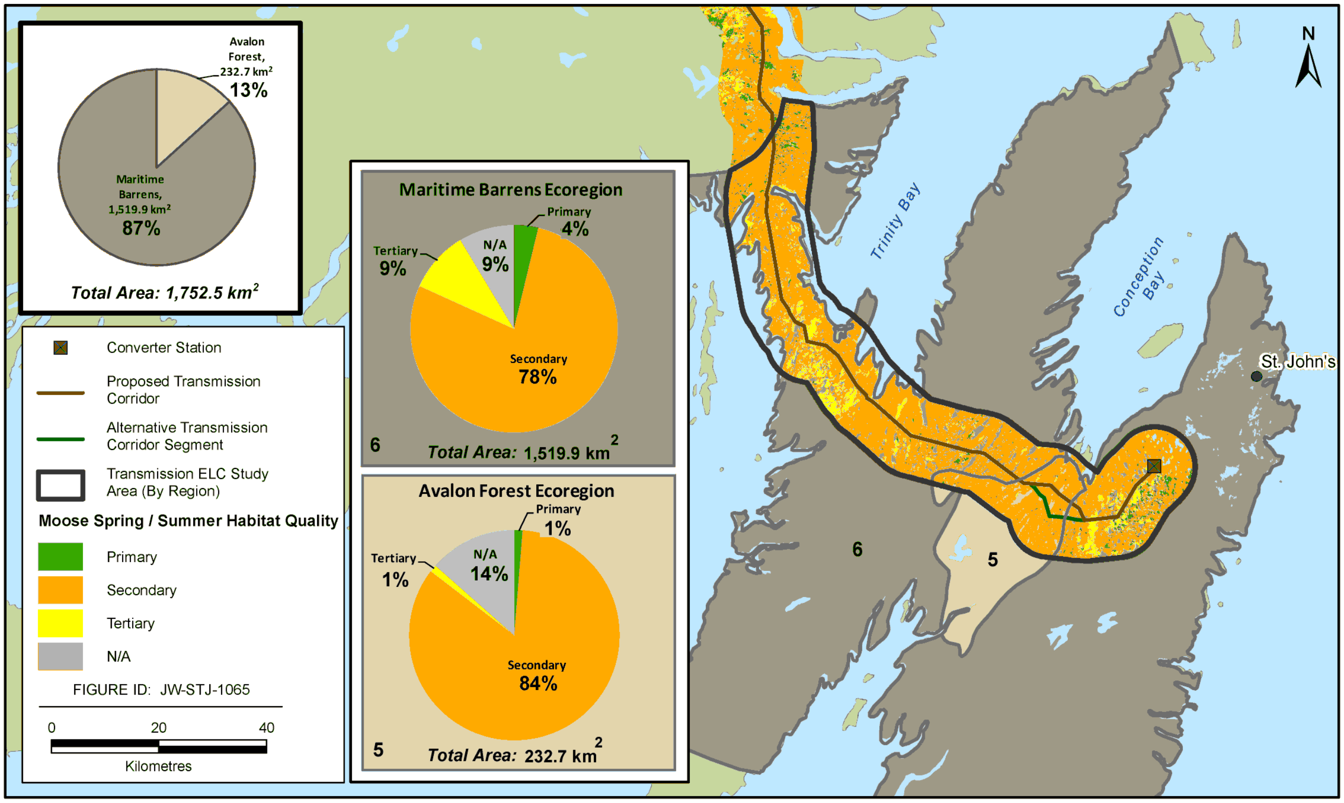
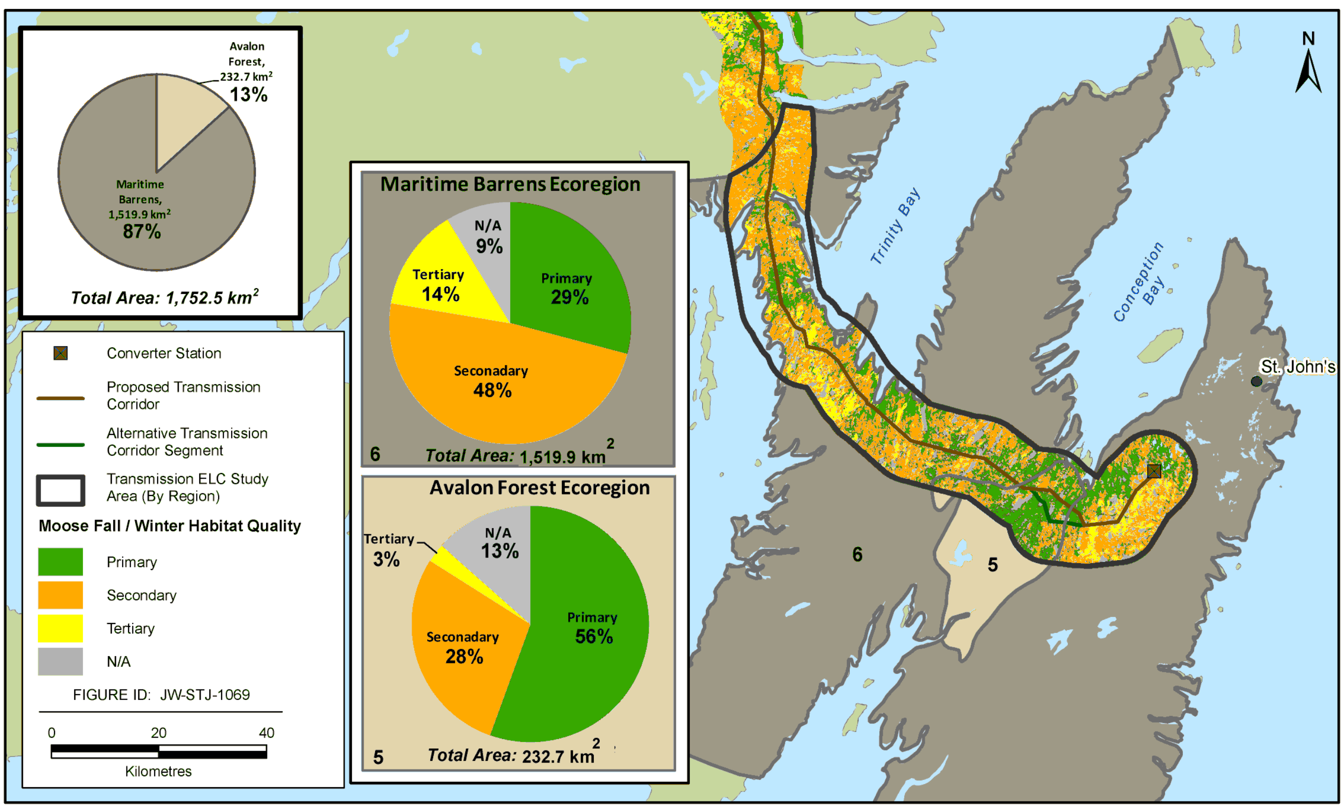


Figure 3-10 Moose Fall/Winter Habitat Quality: Avalon Peninsula



3.2 Black Bear

The Black Bear is a large (70 to 135 kg on mainland; 101 to 179 kg on Island of Newfoundland (Mahoney et al. 2001)) omnivorous mammal found historically throughout Canada, Alaska, isolated pockets in the United States of America and southerly into Mexico (although this species presently occupies only 60 percent of this historical range, no longer occurring throughout the southern part of the continent or throughout southern parts of Canada) (Kolenosky and Samson 2007).

This opportunistic forager eats a large variety of food (e.g., insects, fish, small mammals, birds and newborn ungulates (Mahoney and Virgl 2003)) but the diet is largely plant-based, especially in late summer and early fall when berries and nuts are plentiful. Solitary animals through most of their lives, mating occurs in June/ July of each year beginning in the third to fifth year. Although not true hibernators, this species dens each fall and through the winter months. This species experiences delayed implantation and young (generally two) are born in January/February. The young will remain with the female for 16 to 17 months. The lifespan of a wild black bear is up to 10 years.

Black bear are found throughout Labrador and the Island of Newfoundland. They are large omnivores, feeding on berries, carrion, other mammals (including caribou and moose), garbage and other human food (Government of Newfoundland and Labrador, undated (c)).

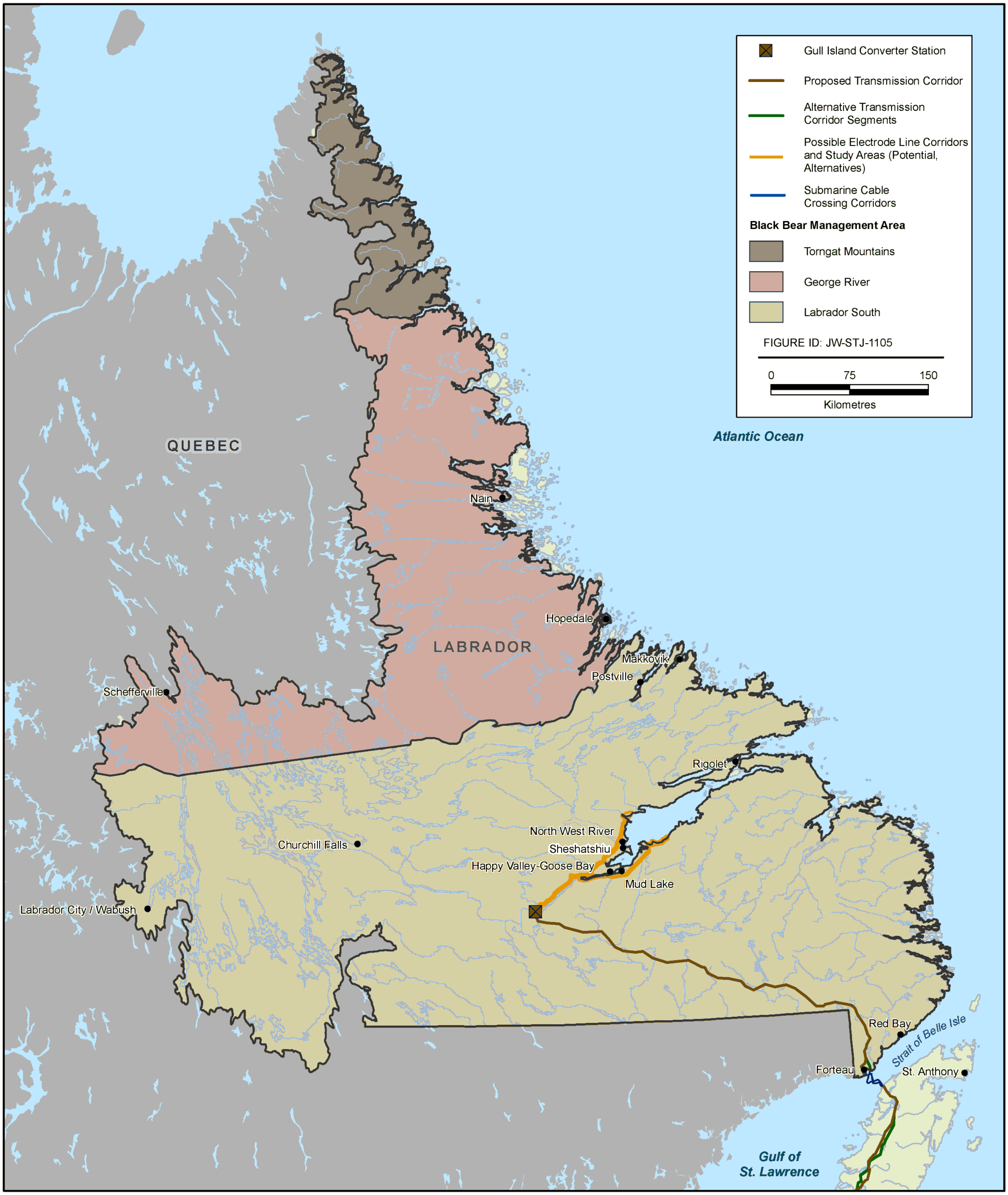
There are two black Bear Management Areas in Labrador (Figure 3-11): the George River Area; and the Labrador South Area. Black Bear Management Areas on the Island of Newfoundland are the same as those for moose (Figure 3-2). In Labrador, the proposed transmission corridor passes through only the Labrador South Bear Management Area (Figure 3-11). On the Island, the Project (including proposed and alternative transmission corridors) intersects 21 Bear Management Areas (Figure 3-2 and are the same as those indicated in bold in Table 3-2 regarding moose). The quota for resident and non-residents is two bears (either sex) in all open management areas (Government of Newfoundland and Labrador 2009).

3.2.1 Primary Sources of Information

Along the entire transmission corridor Study Area, evidence of black bear and indications of habitat quality were documented in 2008, as part of the ELC baseline investigations, and are documented in this report. Aside from this, little work has been done historically for black bear in the Study Area in general. Primary sources of information in Labrador stems from baseline radio telemetry studies completed previously for the Lower Churchill Hydroelectric Generation Project (Minaskuat Inc. 2009c) and research undertaken for the Voisey's Bay Nickel Company (Jacques Whitford 1997b; Chaulk et al. 2005).

On the Island, Dennis et al. (1996) studied the ecology and habitat use of black bears in Western Newfoundland, between 1993 and 1994. Several other studies on the Island were designed primarily to compare black bear populations on the Island to mainland populations elsewhere in North America (e.g., Paetkau and Strobeck 1994; Mahoney et al. 2001; Miller et al. 2009).

Figure 3-11 Black Bear Management Areas in Labrador



3.2.2 Existing Conditions and Status

Black bears have been the subject of limited study in Newfoundland and Labrador. They are considered widespread across the province but not particularly abundant (Parks Canada 2009). While there have been no recent assessments of population size (C. Dyke, pers. comm.), the provincial population of black bear has been roughly estimated at 6,000 to 10,000 animals and is considered to be stable (Pelton et al. 1994; C. Dyke, pers. comm.). Recently in 2009, the province's Wildlife Division initiated a program that will use genetic analysis on strands of black bear fur to estimate the number of bears living on the Island (Dyke 2009). At the time of writing (February 2010), results from this initiative have not been published nor were available through consultation with the Wildlife Division (C. Dyke, pers. comm.).

Densities of black bear near Voisey's Bay (northern Labrador) range from 0.45 to 0.52 bears/km^2 in forested areas to 0.05 bears/km^2 in non-forested regions (VBNC 1997). These densities are relatively high compared to other similar areas, which may result from an attraction to human activity (and associated wastes) at the work camps (Jacques Whitford 1997b). The sex ratio for black bears at Voisey's Bay was 1 : 1, similar to other areas of Canada (Jacques Whitford 1997b).

For northern areas in general, mating season typically lasts from mid-May to early July (Schwartz and Franzmann 1991), and females typically first breed at an average of eight years of age – much later than in other areas further south, such as Massachusetts (3.7 years) and Minnesota (6.3 years) (Chaulk et al. 2005). The average litter size of females in western Newfoundland was 1.7, with females following a two-year reproductive cycle (Dennis et al. 1996).

3.2.3 Habitat Association and Distribution in the Study Area

Black bears in general are forest-dwellers, but have also been found on sea ice and on coastal islands and barrens (Veitch and Krizan 1996; Jacques Whitford 1997b; VBNC 1997; Chaulk et al. 2005). Meades (1990) describes this species as ubiquitous and occurring in most habitat types throughout the province.

In Labrador, the primary food source in spring is berries of blueberry and crowberry and cranberry bush species, as well as occasional hunts and scavenged moose, caribou or other carcasses (Nalcor Energy 2009). During summer, bears feed upon emergent vegetation, including sedges and grasses, until berries emerge in August (Jacques Whitford 1997b; VNBC 1997). On the Island, berry crops and insects (such as bees, wasps and ants) are particularly important during midsummer (Beeman and Pelton 1980, cited in Dennis et al. 1996) and bears spend time in search of rotting logs and snags where these are concentrated (Dennis et al. 1996). Predation is also relatively high on neonatal moose and caribou on the Island, as well as on adult caribou (Dennis et al. 1996 and references therein).

Home range size of black bear in the province varies according to sex, location, local resources and conditions, as in other regions (e.g., Dennis et al. 1996; Moyer et al. 2006). Resource abundance and gender combined are likely to have the greatest effects on black bear dispersal patterns (e.g., Lee and Vaughan 2003; Moyer et al. 2006). Results of the telemetry study completed for Nalcor Energy (Minaskuat Inc. 2009c) demonstrated seasonal shifting among habitats. In addition, these bears demonstrated dramatic differences in the size of home ranges between males and females, with males occupying an area up to 250 times that of females (237 to 5,105 km^2 compared with 19 to 24 km^2, respectively). Similar studies in Newfoundland also found males to have larger home ranges than females (Dennis et al. 1996). This is consistent with the findings of Lee and Vaughan

(2003), who found that adult males generally roam over larger areas than adult females, and may defend their territories. Studies have shown that both genders may occupy the same spatial distribution from year to year (Powell 2000) and findings from Minaskuat Inc. (2009c) indicate an overlap in home range between males and females, as well as between adjacent males. Overlapping home ranges was also demonstrated during previous research (Jacques Whitford 1997b), but there is often temporal separation in such cases (Moyer et al. 2006). Estimated home ranges were 20 to 193 km^2 in the Voisey's Bay area (Jacques Whitford 1997b) and approximately 19 to 902 km^2 in the lower Churchill River watershed (Minaskuat Inc. 2009c).

Black bears generally den between November and April (Dennis et al. 1996; Jacques Whitford 1997b; Nalcor Energy 2009), although they may den as early as October and emerge as late as May (Chaulk et al. 2005), depending on their geographic location. Habitats selected for denning include white spruce forests, shrub thickets and on barrens, typically in excavated areas under stumps, tree roots, fallen logs, or hollowed-out areas in trees and under boulders (Jacques Whitford 1997b).

Upon emergence from dens, bears require easily digestible foods, typically emergent aquatic vegetation, which may limit den location and activities for approximately two weeks after emergence (Garneau et al. 2007). Throughout much of the remainder of the non-denning season, black bears are typically associated with coniferous forest habitats (Minaskuat Inc. 2009c). Black bears in the lower Churchill River watershed consistently used coniferous forest habitat types (including sparse, open and dense coniferous forests) (Minaskuat Inc. 2009c). Forest habitat was also dominant in home ranges identified for black bears at Voisey's Bay (Jacques Whitford 1997b). Adults, sub-adults, females and males all used forest habitats slightly more than barrens, although family groups were observed on barren areas (Jacques Whitford 1997b). However, observations by Chaulk et al. (2005) suggested that barren areas were used nearly as much as forested habitats and habitat classified as exposed land also comprised a relatively high percentage of occupied habitat in the lower Churchill River valley for some individuals (Minaskuat Inc. 2009c). The use of barrens by bears may be due to the high residual berry crop on the barrens during the spring and the large berry crop during the late summer and early fall (Jacques Whitford 1997b). Bears are generally not found in recently burned areas, where food would not be as plentiful (Nalcor Energy 2009).

In Newfoundland, Dennis et al. (1996) found that habitat use is related to forage availability, but not in proportion to habitat availability. Within the Study Area, habitat use varied between individual bears and also varied seasonally; mature forests were used during spring and early summer, when bears were feeding predominantly on ants and grasses, while clearcuts and other open areas (e.g., scrub habitats) were used in late summer, as ripening berries became available (Dennis et al. 1996).

Table 3-5 summarizes observations and/or evidence of black bear collected during ELC surveys along the transmission corridor in 2008, in relation to habitat classification. This information provides an indication of the relative use of habitat types within the Study Area, during the non-denning season. Results indicate that evidence of habitat use was found throughout habitat types, generally in the range of 10 to 25 percent of sample sites, with the exception of a few habitats that indicated a higher proportion of use (e.g., hardwood and lichen heathland) but were based on a relatively small sample size. As well, evidence of black bear was found in 80 percent of burn habitats sampled in Labrador, but in none of the sites sampled on the Island.

Table 3-5 Observations and/or Evidence of Black Bear in Relation to Habitat Type Along the Transmission Corridor, in 2008

Habitat Type	# Sites with Observations (% of Sites)	Abundance Rating	Notes
Labrador			
Burn	4 (80%)	2	Animals observed, ground disturbance, scat and tracks
Conifer Forest	4 (22%)	2-3	Scat
Conifer Scrub	1 (20%)	2	-
Hardwood Forest	1 (50%)	2	-
Lichen Heathland	2 (40%)	2	Animals observed, scat and tracks
Open Conifer Forest	1 (11%)	-	Scat (old)
Wetland	1 (5%)	2	Scat and tracks
Newfoundland			
Alpine Vegetated	4 (29%)	1-2	Forage, scat
Burn	0 (0%)	0	-
Conifer Forest	19 (22%)	1-3	Forage, scat and tracks
Conifer Scrub	5 (21%)	2-3	Scat
Cutover	3 (17%)	1-3	Scat
Kalmia Lichen	4 (15%)	1-3	Ground disturbance, scat, tracks
Mixedwood Forest	3 (12%)	2-3	Tree rub, scat, ground disturbance
Open Conifer Forest	2 (20%)	1-2	Foraging signs
Rocky Barrens	2 (25%)	1-2	Browse and scat
Wetland	5 (9%)	1-3	Forage, scat and tracks

Notes:
1. Abundance rating: 0=non-existent; 1=trace; 2=common; and 3= abundant.
2. Evidence of black bears indicates habitat use during the non-denning season (i.e., spring/early summer and late summer/fall).

Table 3-6 summarizes primary, secondary and tertiary breeding habitat quality for black bear in the Study Area. Due to the omnivorous diet of black bear and its adaptability to a wide variety of environments, most natural terrestrial environments are either primary or secondary, with the exception of exposed earth habitats. Primary spring/early summer habitat consists of black spruce lichen forest, conifer forest, cutover and open conifer habitats (Table 3-6) and comprises 3,017.1 km^2 (46 percent) of the Study Area in Labrador and 1,905.4 km^2 (44 percent) in Newfoundland. These same habitats are preferred during late summer/fall, in addition to hardwood, mixedwood and burn habitats, and account for 3,154.7 km^2 (48 percent) of the Study Area in Labrador and 2,250.1 km^2 (52 percent) in Newfoundland during this season.

Secondary habitat is represented by alpine vegetated, conifer scrub, lichen heathland, rocky barrens, kalmia lichen/heathland, wetland and scrub/heathland/wetland habitats during both seasons, and burn, hardwood and mixedwood habitats during spring/early summer only.

Table 3-6 ELC Habitat Type and Relative Quality for Black Bear Use Along the Transmission Corridor

Habitat Type/ Habitat Description	Spring/Early Summer Importance	Late Summer/Fall Importance	Notes
Alpine Vegetated	Secondary	Secondary	May provide some forage. None of the alpine sites sampled in 2008 had evidence of bear[1].
Black Spruce Lichen Forest	Primary	Primary	Provides foraging and shelter requirements. Only one site sampled represented this habitat type during 2008 surveys and there was no indication of bear.
Burn	Secondary	Primary	May provide good forage but less commonly shelter. 50 percent of sites sampled in 2008 had evidence of bear.
Conifer Forest	Primary	Primary	Provides foraging and shelter options. 28 percent of sites sampled in 2008 had evidence of bear.
Conifer Scrub	Secondary	Secondary	Provides seasonal foraging opportunities. 21 percent of sites sampled in 2008 had evidence of bear.
Cutover	Primary	Primary	Provides seasonal foraging opportunities. 17 percent of sites sampled in 2008 had evidence of bear.
Exposed Earth	Tertiary	Tertiary	Limited foraging and shelter options.
Hardwood Forest	Secondary	Primary	Increased importance in late summer and fall due to maturing of food resources. One of two sites sampled in 2008 had evidence of bear.
Lichen Heathland	Secondary	Secondary	Provides foraging opportunities. Two of five sites sampled in 2008 had evidence of bear.
Mixedwood Forest	Secondary	Primary	Increased importance in late summer and fall due to maturing of food resources. None of the 27 sites sampled in 2008 had evidence of bear.
Open Conifer Forest	Primary	Primary	Provides foraging and shelter. One of nineteen sites sampled in 2008 had evidence of bear.
Rocky Barrens	Secondary	Secondary	Provides some foraging opportunities. Two of eight sites sampled in 2008 had evidence of bear.
Kalmia Lichen/Heathland	Secondary	Secondary	Provides some foraging opportunities. 8 percent of sites sampled in 2008 had evidence of bear.
Wetland	Secondary	Secondary	Provides foraging opportunities. 8 percent of sites sampled in 2008 had evidence of bear.
Scrub/Heathland/ Wetland	Secondary	Secondary	Provides foraging opportunities.

Notes:
1. 2008 surveys refer to wildlife observations collected as part of the ELC field program (Minaskuat Inc. 2009a).
2. Though not included at the scale of the ELC, riparian habitats are considered primary habitat quality in spring/early summer and secondary habitat quality in late summer/fall.

Central and Southeastern Labrador

Black bear are found throughout Labrador. Northernmost populations are referred to as barren ground bears, southern populations are forest-dwelling bears, and bears located between these geographic locations are intermediary between the two morphs (Chaulk et al. 2005). Black bears in the vicinity of the Study Area are forest-dwelling bears.

The black bear baseline study in support of the Lower Churchill Hydroelectric Generation Project from 2006 to 2009 provides the most comprehensive overview of this species in central Labrador (Minaskuat Inc. 2009c). Results of this initiative indicated that black bears are relatively common in central Labrador, given the frequency of bear sign encountered and the short duration of the capture program. Recurrent use of the river valley was evident, although the home range of bears extended beyond the lower Churchill River watershed (and particularly in association with the landfill in Happy Valley-Goose Bay) (Minaskuat Inc. 2009c).

Both primary and secondary habitats are distributed throughout the Southeastern Labrador region of the Study Area, with little change in the distribution and abundance of these seasonally. Primary habitat is particularly abundant in the Low Subarctic (60 and 63 percent for spring/early summer and late summer/fall, respectively), Eagle River Plateau (46 and 49 percent for spring/early summer and late summer/fall, respectively) and High Boreal Forest (74 and 78 percent for spring/early summer and late summer/fall, respectively) Ecoregions, although the latter forms only 3 percent of the Study Area in this region (Figures 3-12 and 3-13).

Island of Newfoundland

Black bear are found throughout the Island; however, relatively few published studies of black bear were available and of those that were, most were focused on morphology and/or genetic distinctions between black bears on the Island compared to other areas in North America. In general, black bear on the Island are larger than their mainland counterparts (Mahoney et al. 2001) and may be genetically distinguishable (Cameron 1956; Paetkau and Strobek 1996, cited in Virgl et al. 2003).

One study in the Serpentine Lake area of western Newfoundland (Serpentine Lake to Georges Lake, south of Corner Brook and south of the Study Area) showed home ranges of 130.1 and 465.8 km^2 for two males and 103.2 and 61.3 km^2 for two females, with a large amount of overlap between ranges (Dennis et al. 1996). A preliminary density of 0.11 to 0.15 bears/km^2 was determined for the Serpentine Lake Study Area (Dennis et al. 1996).

Specific key habitats and/or locations of bears on the Island were not identified; however, previous research has demonstrated relationships between black bears and caribou calving areas in Newfoundland (Manohey et al. 1990, as cited in Dennis et al. 1996; Mahoney and Virgl 2003).

As in Labrador, primary and secondary habitats are distributed throughout the Island. On the Northern Peninsula, primary habitat is most abundant in the Northern Peninsula Forest Ecoregion (49 for spring/early summer and 62 percent for late summer/fall) (Figures 3-14 and 3-15). Tertiary habitat forms less than 2 percent of any Ecoregion, regardless of season (Figures 3-14 and 3-15).

In Central and Eastern Newfoundland, where the Central Newfoundland Forest comprises 92 percent of the Study Area, primary spring/early summer habitat comprises 35 percent (Figure 3-16) of this Ecoregion and almost doubles, as late summer/fall habitat peaks at 66 percent of this Ecoregion (Figure 3-17). Tertiary habitat comprises 6 percent or less of the landmass within any Ecoregion in the Central and Eastern Newfoundland Study Area.

On the Avalon Peninsula, primary spring/early summer habitat is reduced to 9 and 18 percent (Figure 3-18). Primary late summer/fall habitat is similarly abundant, where it forms between 29 and 56 percent of the Study Area in that region (Figure 3-19). During both periods, primary habitat is greater in the Avalon Forest Ecoregion (13 percent) and the Maritime Barrens Ecoregion (87 percent). Tertiary habitat forms 5 percent or less of either Ecoregion during all seasons.

Figure 3-12 Black Bear Spring/Early Summer Habitat Quality: Southeastern Labrador

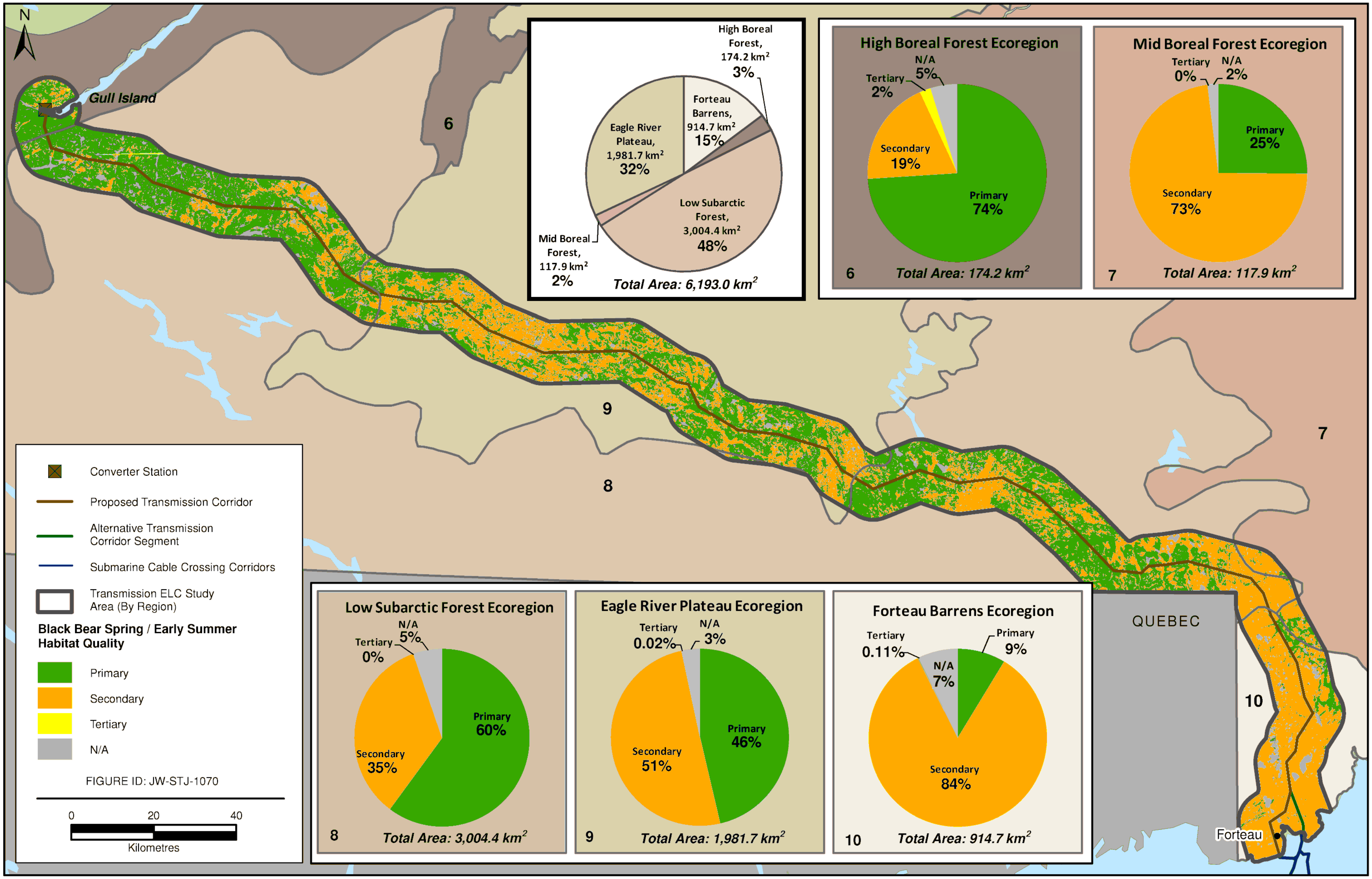


Figure 3-13 Black Bear Late Summer/Fall Habitat Quality: Southeastern Labrador

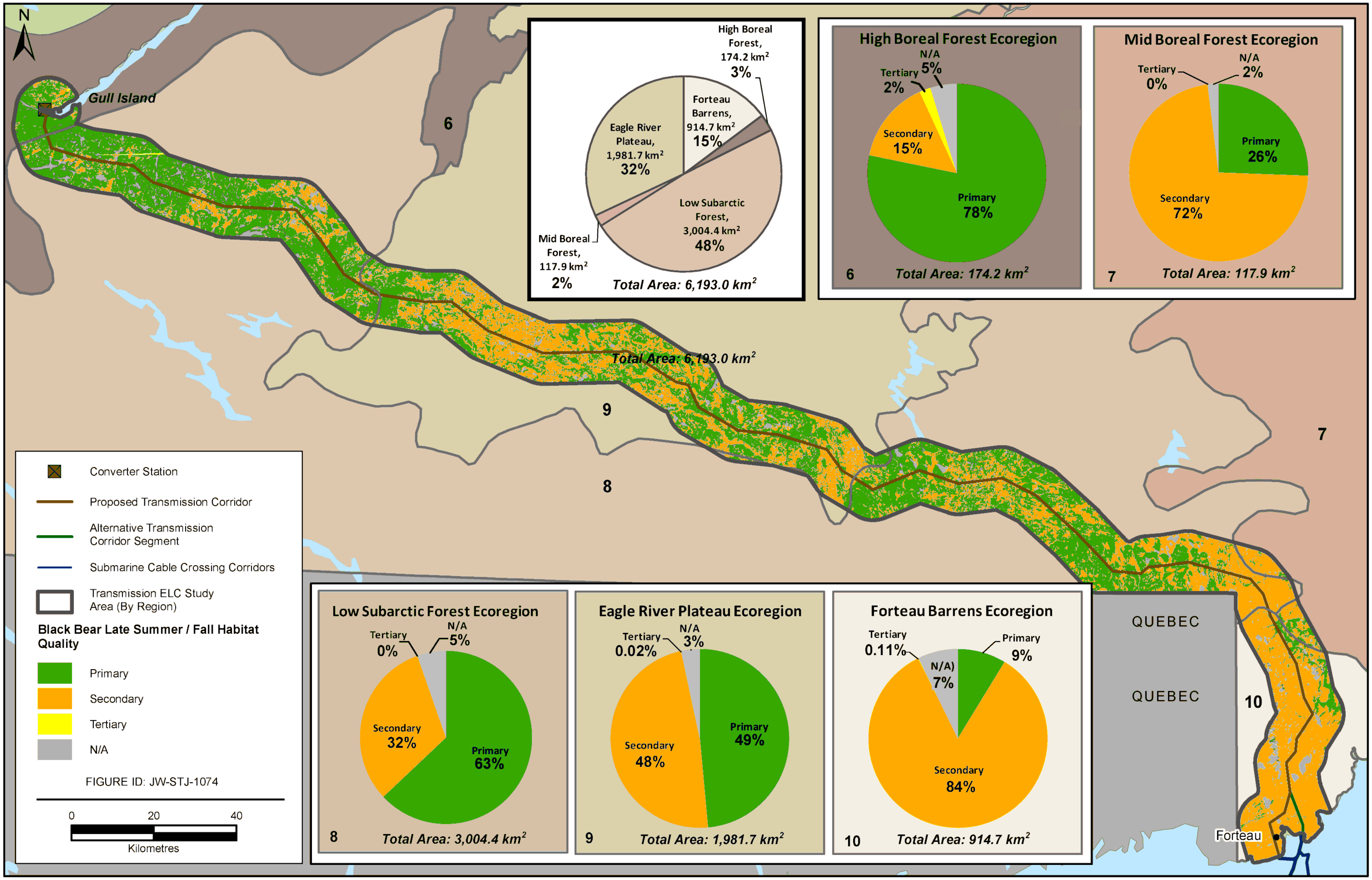


Figure 3-14 Black Bear Spring/Early Summer Habitat Quality: Northern Peninsula

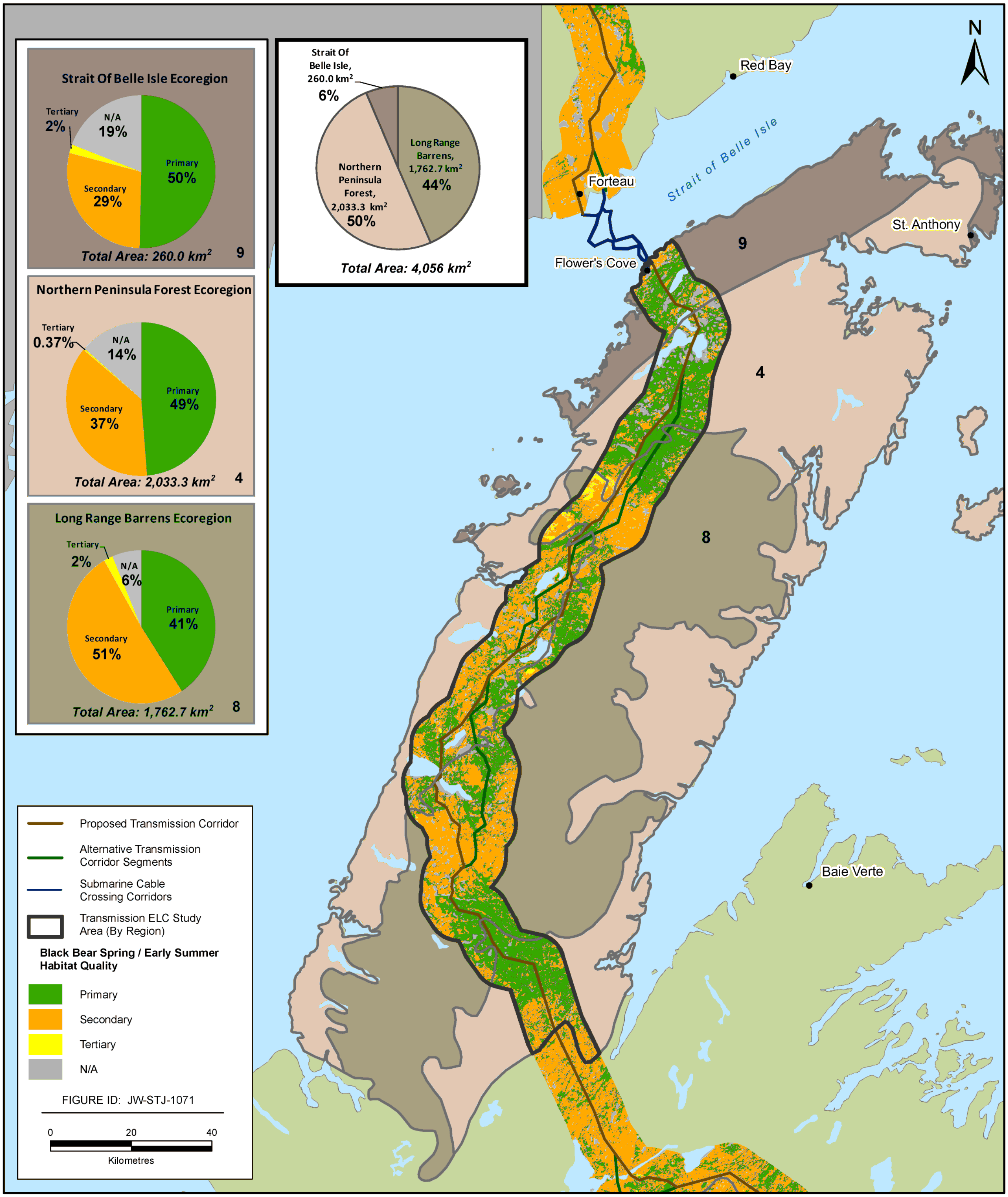


Figure 3-15 Black Bear Late Summer/Fall Habitat Quality: Northern Peninsula

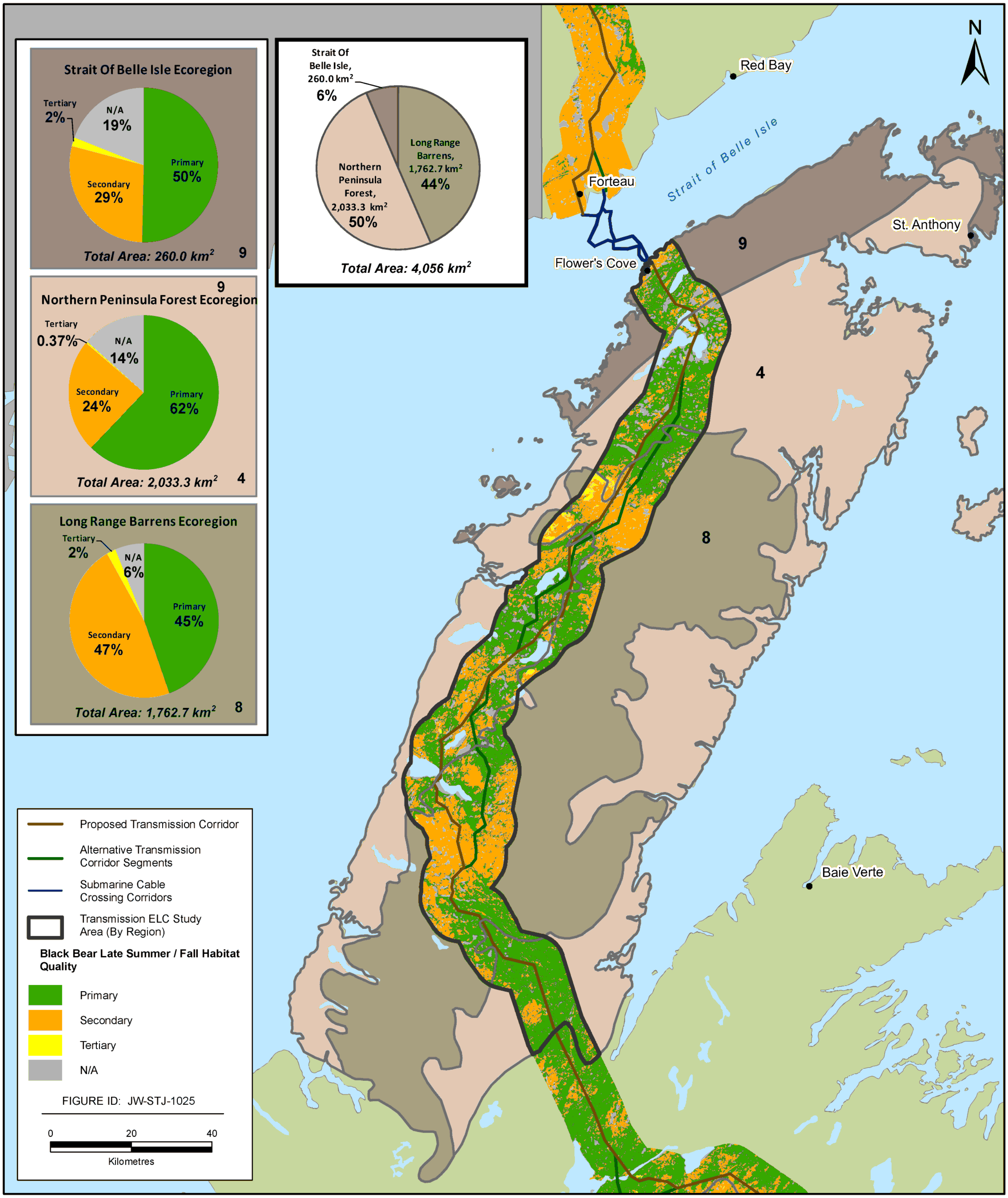


Figure 3-16 Black Bear Spring/Early Summer Habitat Quality: Central and Eastern Newfoundland

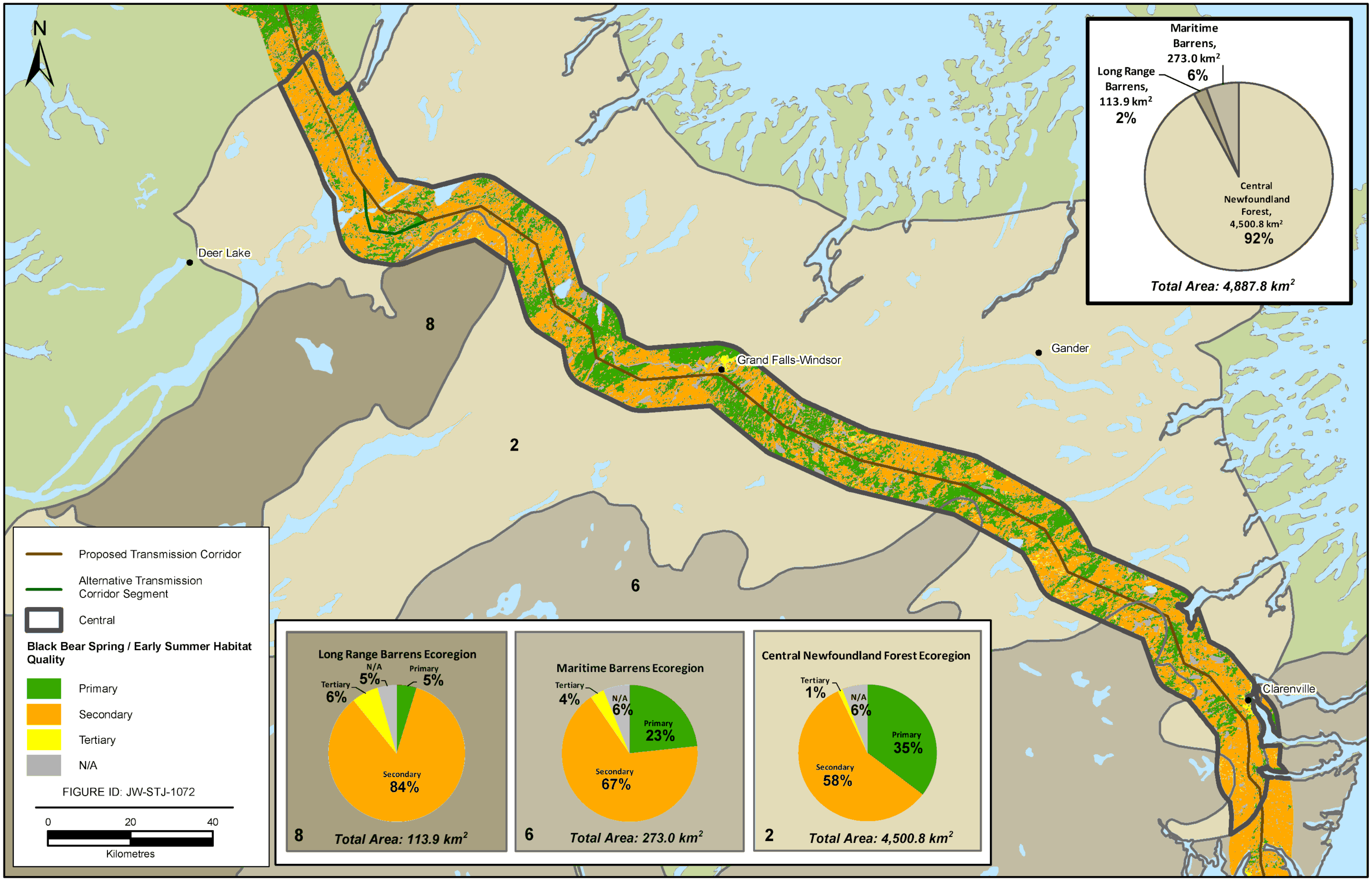


Figure 3-17 Black Bear Late Summer/Fall Habitat Quality: Central and Eastern Newfoundland

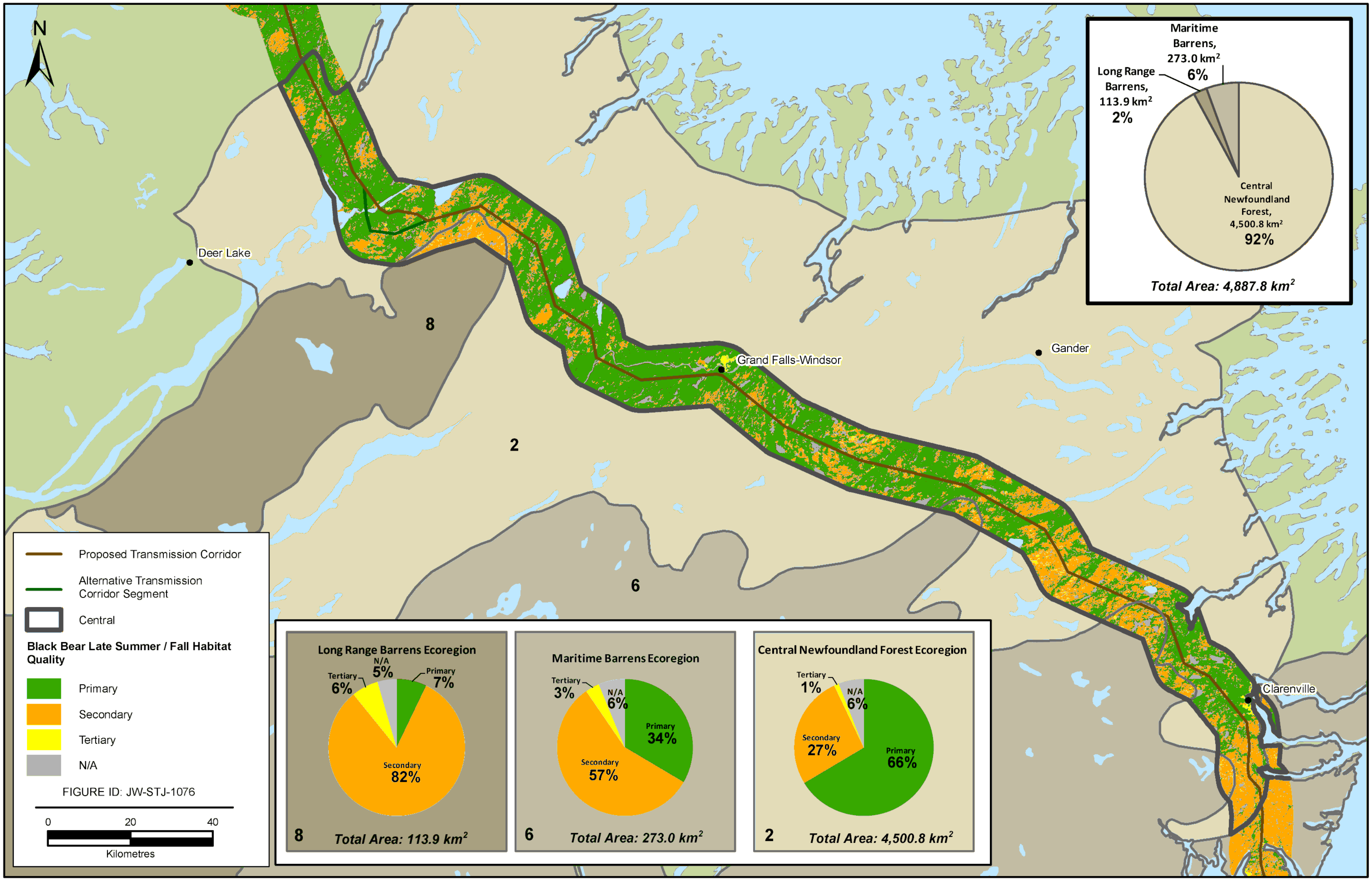


Figure 3-18 Black Bear Spring/Early Summer Habitat Quality: Avalon Peninsula

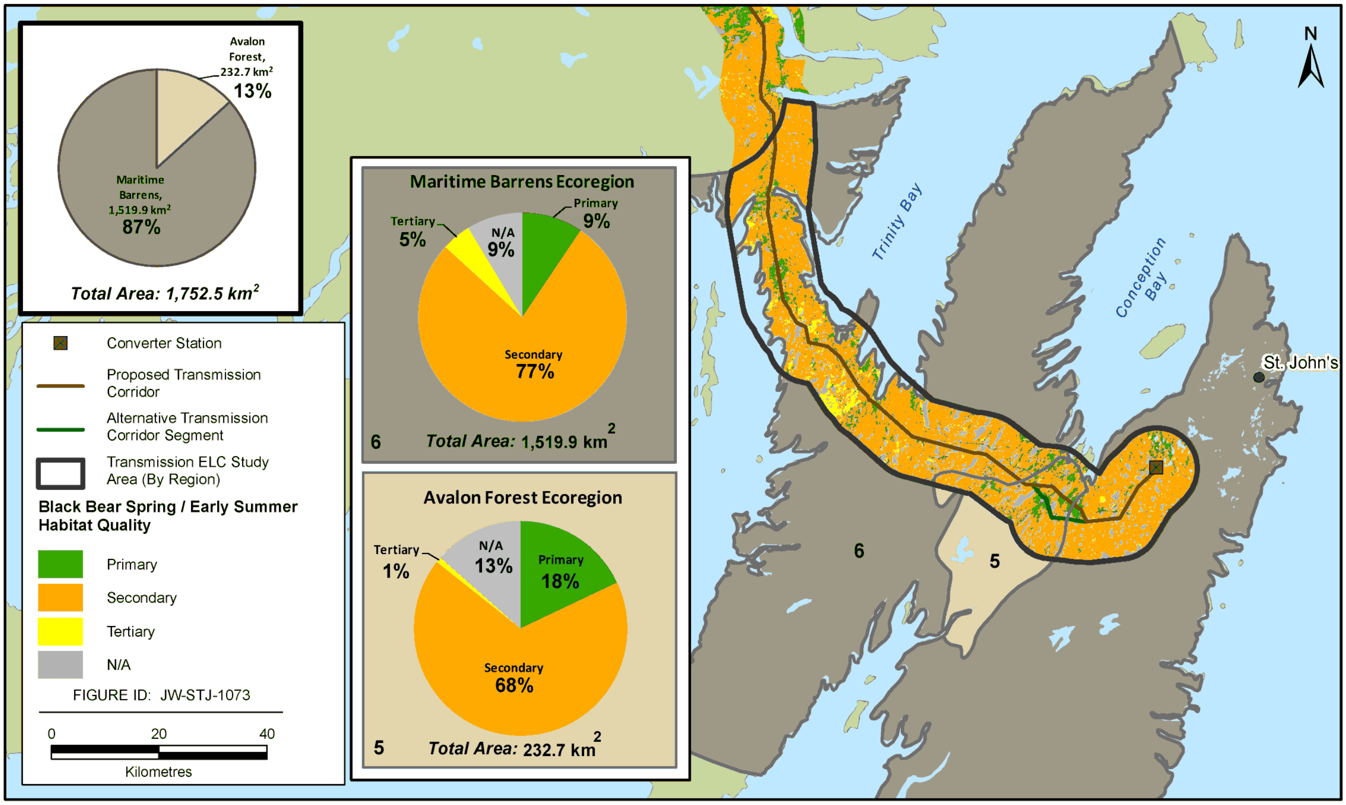
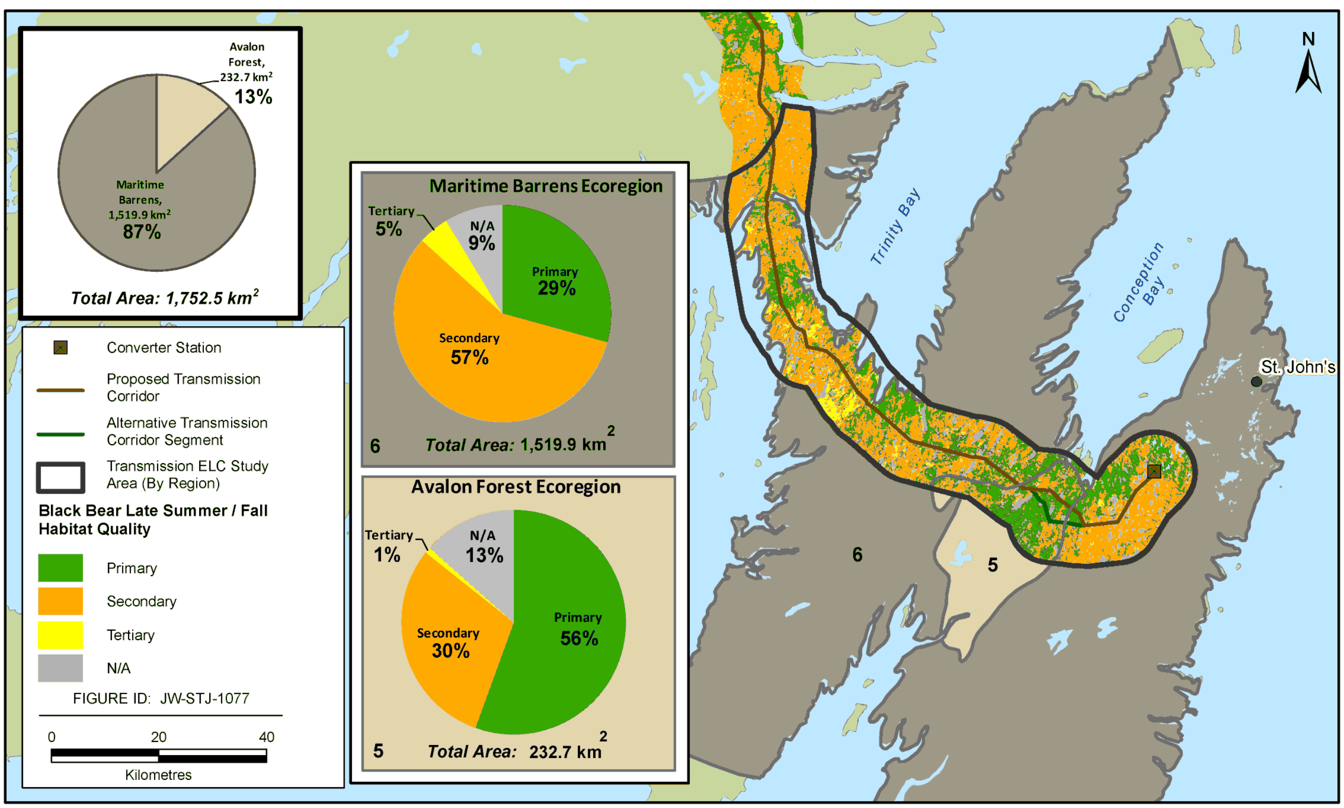


Figure 3-19 Black Bear Late Summer/Fall Habitat Quality: Avalon Peninsula



3.2.4 Limiting Factors

Black bears have few natural predators. Parasites and diseases are common, but rarely fatal (Kolenosky and Samson 2007). Hunting and vehicle collisions may also be major factors contributing to black bear mortality in boreal forests, though this is not common in the Study Area. Forestry operations directly affect availability and quality of primary habitat, increase exposure to, and avoidance of, humans, and increase road access and hunting potential (Dennis et al. 1996).

Reproductive success is dependent on food quality and availability (Schwartz and Franzmann 1991; Dennis et al. 1996) and cubs can be subject to cannibalism and starvation, as well as deaths related to being orphaned when mothers are killed by hunters (Schwartz and Franzmann 1991). Low reproductive rates in general, delays in sexual maturity/reproduction and high juvenile mortality rates are also limiting factors (Dennis et al. 1996).

4.0 DISCUSSION AND SUMMARY

Nalcor Energy is proposing to develop the Project, a HVdc transmission system extending from Gull Island 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 in order to identify, compile, summarize and present information on moose and black bear in the area of, and which may interact with, the proposed Project for use in the EIS.

This Component Study identified and described the occurrence and distribution of these species within the Study Area, as well as mapped preferred seasonal habitats based on field observations, literary sources and habitat mapping provided by the ELC for the Project (Minaskuat Inc. 2009a).

An overview of some of the key results of this Component Study is provided below:

- An extensive literature search has been completed providing a comprehensive listing of the primary sources of information relevant to the proposed 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 moose and black bear has also been identified and retained to support the EA.
- Details on the presence of moose and black bear in the Study Area and information on their distribution and relative abundance has been presented based on the available literature on these species in the province in general and on observations from key studies relevant to the proposed Project.
- The distribution and abundance of preferred (primary, secondary and tertiary quality) habitats for both moose and black bear was mapped for the entire 15 km wide Study Area along the transmission corridor.

Key outcomes of this exercise are the detailed regional overviews of moose and black bear in the Study Area and the habitat quality mapping products indicating areas of primary, secondary and tertiary habitat for each species.

4.1 Moose and Black Bear in the Study Area

The following sections summarize the findings of this Component Study.

4.1.1 Moose

In Labrador, moose are a relatively new species, resulting from the introduction of 12 animals on the south coast in the 1950s and from the range expansion of herds coming east from Québec (Chubbs and Schaeffer 1997). Despite further expansion since this time and apparent population growth, densities in Labrador remain relatively low compared to other areas near the northern extent of this species range and to densities reported on the Island (Brassard et al. 1974; Fryxell et al. 1988; Boer 1992; Chubbs and Schaeffer 1997; Minaskuat Inc.

2009b). Research has indicated that the highest concentration of moose in central Labrador occurs along the Churchill River (Trimper et al. 1996) and some of the lowest densities of moose are found in southeastern Labrador (Found 1998).

Moose were also introduced on the Island of Newfoundland in 1878 (Gander Bay) and in 1904 (near Howley) (Northcott 1974; Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000), and quickly expanded their distribution (with the exception of a delayed arrival on the Avalon Peninsula), largely due to low rates of competition from other ungulate species and low predation (Conor Pacific Environmental Technologies Inc. and Westworth Associates Environmental Ltd. 2000). The moose population on the Island of Newfoundland was estimated at 125,000 animals in 2004, indicating that Newfoundland had a disproportionate amount of the continental population (greater than 10 percent), even though available habitat for moose represents less than two percent of that available throughout North America (McLaren et al. 2004). The highest densities on the Island are found in Gros Morne National Park on the Northern Peninsula (McLaren et al. 2000) and the area near Badger in Central Newfoundland has also historically supported high numbers of moose (Parker and Morton 1978).

Moose use a variety of habitat types throughout the year in Newfoundland and Labrador, reflective of seasonal preferences. Moose tend to congregate in river valleys during winter. Dense forests with canopy gaps are often preferred, to avoid deep snow, hard ice crusts and predation, as well as to take advantage of available forage (preferentially, willow, birch and alder, as well as some conifers). During early summer, moose tend to seek out nutrient-rich forage in open and aquatic areas (Peek 1997) that are critical for this species. Summer diets are comprised primarily of young leaves and shoots of deciduous species, as well as sedges, grasses and aquatic plants (Newbury et al. 2007 and references therein). The latter provide an important source of sodium and are more digestible than other terrestrial vegetation (MacCracken et al. 1993).

Researchers, including baseline telemetry research completed for Nalcor Energy (Minaskuat 2009c), have documented seasonal patterns in the diet and habitat requirements of moose. Primary habitat for moose is found in all Ecoregions, but is particularly abundant on the Island compared to Labrador, and during the fall/winter period compared to spring/summer. Wetlands and particularly those that support aquatic plants are preferred during the summer. Habitat for moose during this period occupies 1,521.6 km^2 (23 percent) of the Study Area in Labrador and 1,087.7 km^2 (10 percent) of the Study Area in Newfoundland. The seasonal shift in availability of primary habitat is reflective of a shift towards preferential use of wetland and hardwood habitats during spring/summer compared to preferred fall/winter habitats (i.e., mixedwood, conifer forest, cutover). As a result of this shift, primary habitat is most abundant during spring/summer in Southeastern Labrador versus during fall/winter on the Island. Moose yarding or wintering areas are typically associated with river valleys, where there is a source of food and some relief from snow depths. Such habitat, considered primary fall/winter habitat, comprises 1,270.7 km^2 (19 percent) of the Study Area in Labrador but is approximately twice as common in Newfoundland, where it comprises 4,504.1 km^2 (40 percent) of the Study Area.

4.1.2 Black Bear

Like moose, black bear are also ubiquitous in the province but tend to be less specialized in terms of habitat preferences. This species is native to both Labrador and the Island of Newfoundland. The provincial population of black bear has not been recently assessed (C. Dyke, pers. comm.), but has been estimated at 6,000 to 10,000 animals and is considered to be stable (Pelton et al. 1994). In Labrador, the northern-most populations are referred to as barren ground bears and southern populations are forest-dwelling bears, and those located between these geographic locations are intermediary between the two morphs (Chaulk et. al 2005). Black bear in Newfoundland are genetically distinguishable from their mainland counterparts and also tend to be larger (Mahoney et al. 2001).

Black bear are considered relatively common in central and southeastern Labrador (Minaskuat 2009c) and are found throughout the Island of Newfoundland, although little data have been found on black bear densities in this region.

Black bears are, in general, forest-dwellers but have been found in a variety of habitats, including sea ice and on coastal islands and barrens (Veitch and Krizan 1996; VBNC 1997; Jacques Whitford 1997b; Chaulk et al. 2005). The opportunistic feeding habitats of this species may account for some of this unpredictable distribution, as their diet consists of emergent vegetation (including sedges and grasses in spring), berries (in late summer/fall), insects (such as bees, wasps and ants, particularly during midsummer); black bear occasionally hunt and scavenge moose, caribou or other carcasses (Mahoney et al. 2001).

Black bears generally den between November and April (Dennis et al. 1996; Jacques Whitford 1997b), although they may begin denning as early as October and emerge as late as May (Chaulk et al. 2005), depending on their geographic location. Upon emergence from dens, bears require easily digestible foods, typically emergent aquatic vegetation, which may limit den location and activities for approximately two weeks after emergence (Garneau et al. 2007). Throughout much of the remainder of the non-denning season, black bears are typically associated with coniferous forest habitats, cutovers and scrub habitats, and in some locations barren habitats (Dennis et al. 1996; Chaulk et al. 2005; Minaskuat Inc. 2009c). Riparian areas are also used for feeding, travel and resting (Minaskuat Inc. 2009c). Several authors also note an association between black bears and caribou calving areas in Newfoundland (Mahoney et al. 1990; Mahoney and Virgl 2003).

Given that black bears are omnivorous and have opportunistic feeding behaviours, all habitats in the Study Area are considered either primary or secondary, with the single exception of exposed earth habitat. Primary habitat for black bear is found in all Ecoregions of the Study Area and there is a general shift towards a greater availability of primary habitat during late summer/fall, owing to the addition of burn, hardwood and mixedwood habitats to this habitat quality category during this season. Primary habitat during late summer/fall occupies 3,154.7 km^2 (48 percent) of the Study Area in Labrador and 2,250.1 km^2 (52 percent) in Newfoundland. During spring/early summer, primary habitat occupies 3,017.1 km^2 (46 percent) of the Study Area in Labrador and 1,905.4 km^2 (44 percent) in Newfoundland. The seasonal shift in the availability of primary habitat is most obvious in the Central and Eastern Newfoundland and the Avalon Peninsula regions.

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APPENDIX A

Select Annotated Bibliography

APPENDIX A

Existing and available information on moose and black bear was compiled through library and internet searches and through meetings with government departments and other organizations. The result of these efforts was an annotated bibliography that lists and describes relevant large mammal studies completed in Newfoundland and Labrador during the past approximately 20 years. Documents related to moose and black bear are presented separately, below.

For a complete list of literature cited in this *Moose and Black Bear Component Study* please refer to Section 5.0.

MOOSE

Burzynski, M., T. Knight, S. Gerrow, J. Hoffman, R. Thompson, P. Deering,, D. Major, S. Taylor, C. Wentzell, A. Simpson & W. Burdett. 2005. State of the Park Report, Gros Morne National Park of Canada an assessment of ecological integrity.

The Park's ecological health 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 condition and trend of the forest ecosystem is poor and declining, respectively - due to the over-population of moose within the Park. The extreme moose density is affecting regeneration of vegetation.

Chubbs, T.E. and J.A. Schaeffer. 1997. Population growth of moose, *Alces alces*, in Labrador. Canadian Field-Naturalist. 111(2): 238-242.

These authors examined the distribution, population growth, population structure and hunter returns of moose in Labrador. The distribution of moose introduced in the 1950s in southern Labrador and from range expansion from Québec in the west, expanded along the Labrador Ungava Peninsula northward to the 58° parallel. By 1980, moose had been observed as far north as Nain and in 1995, two moose were observed as far north as Ikinet River, west of Okak Bay. This expansion occurred at a rate of 8 km/yr since 1980. Observations showed that moose in this region do not tend to aggregate during the winter (compared to Newfoundland for example). Densities of moose in Labrador remain relatively low, but several indicators reveal an expanding population. An estimated density of 0.168 moose/km^2 was found in the Muskrat Falls MMA, and a density of 0.085 moose/km^2 was found for the Grand Lake MMA. Evidence shows that population growth of moose in Labrador is limited due to illegal harvest, wolf predation, marginal habitat, or a combination of these factors. In the Grand Lake area, adult bull : cow ratio was 47 : 53, and 40 : 60 in the Muskrat Falls area. There was no evidence of twinning during the 1994 census in the Grand Lake area, while Muskrat Falls area had a low twinning rate of 11 percent, which is much lower than what was found in the Northwest Territories (31 percent). Hunter success rates ranged from a low of 37 percent in 1877 to a high of 77 percent in 1993, suggesting that the moose population has increased.

Courtois, R., C. Dussault, F. Potvin and G. Daigle. 2002. Habitat selection by moose (*Alces alces*) in clear-cut landscapes. Alces 38: 177-192.

This four-year study looked at moose habitat selection in clear-cut habitats in northwestern Québec. At the landscape scale (location of home range within a landscape) habitat selection was not influenced by the presence of clear-cuts. At the home range scale (animal locations within their home range), moose preferred habitats with mixed stands in all seasons, mature conifer stands in summer and early winter, and young conifer stands in late winter. Clearcuts were generally avoided except in early winter. This study demonstrated differences in habitat selection by moose, depending on scale; clear-cuts did not appear to influence home range location, but adaptations to minimize their impact operated at finer scales. The authors suggest that habitat selection at the landscape scale was likely linked to a trade-off between predator avoidance and browse availability, and habitat selection at the home range scale suggests that moose exhibit behavioural adaptations that tend to maximize energy gain and counteract predation and other adverse environmental conditions.

Dussault, C., J.-P. Ouellet, R. Courtois, J. Huot, L. Breton and H. Jolicoeur. 2005. Linking moose habitat selection to limiting factors. Ecography 28: 619-628.

The objective of this field program was to assess moose habitat selection in relation to predation risk, food availability and snow. Moose were found to be selective in their choice of habitat at the landscape and home range scale. At a landscape scale, moose spatially segregated from wolves by avoiding areas that receive the lowest snowfall and often concentrated in areas with harsh snow conditions. Moose also selected areas with increased food availability that were interspersed with habitats that provided shelter from snowfall. At the home range scale, moose avoided areas of deep snow and high predation risk, often making tradeoffs with food availability. Solitary males mainly avoided snow, whereas females with calves selected habitats with reduced predation.

Ferguson, S.H., A.R. Bisset and F. Messier. 2000. The influence of density on growth and reproduction in moose *Alces alces*. Wildlife Biology 6: 31-39.

This study was designed to assess whether high moose densities resulted in smaller moose, slower growth rates, lower reproductive rates and more variable annual population size. Fifteen moose populations were assessed, including eleven in Newfoundland and four in Ontario. Findings of this study indicate that density negatively affects growth rate, reproductive rate and recruitment. Specifically, in Newfoundland, where populations are not limited by natural predators and where there is low primary productivity (percent forest cover), moose have decreased body growth rates, decreased reproduction and decreased recruitment. Newfoundland moose populations may also experience unpredictable year-to-year variations in population size, relatively high densities, and variable food availability, due to climatic effects.

Found, C. 1998. Moose population survey of Moose Management Areas 57 and 58, Labrador. Newfoundland-Labrador Wildlife Division. Goose Bay, Newfoundland and Labrador.

The main objective was to obtain a baseline estimate of moose densities before the construction of the TLH (Phase II) between Cartwright and Red Bay. Results suggest that the number of moose in MMAs 57 and 58 was low, although the moderate percentage of calves in the population, and the presence of twinning among adult cows, suggests a stable, although low-density, population. Management recommendations included monitoring of moose in the area, no increase in hunting quotas, as well as a follow-up survey after the construction of the road was recommended.

Forbes, G.J. and J.B. Théberge. 1993. Multiple landscape scales and winter distribution of moose, *Alces alces*, in a forest ecotone. Canadian Field-Naturalist 107: 201-207.

Moose distribution and abundance were studied in Algonquin Park, Ontario. In particular, this study looked distribution and abundance during winter in relation to habitat use and habitat disturbance at local and regional scales, using 13 years of aerial survey data supplemented by spring pellet surveys. Results indicate that at a local scale, moose selected closed-canopy habitats with a preference for hemlock (*Tsuga Canadensis*). At the regional scale, moose selected areas of canopy disturbance, specifically: plots with >33 percent of the area impacted by logging; areas heavily impacted by spruce budworm (*Choristoneura fumiferana*); or areas moderately affected by spruce budworm with greater logging activity.

Garneau, D.E., E. Post, T. Boudreau, M. Keech and P. Valkenburg. 2007. Spatio-temporal patterns of predation among three sympatric predators in a single-prey system. Wildlife Biology 13: 186-194.

The objective of this Alaskan field program was to analyze relationships between female moose density and distribution during winter and habitat heterogeneity. This study looked at vegetation type, topography, distance to rivers and towns, occurrence and timing of fire and landscape metrics. Results indicate that the densest populations of moose were closer to towns, at moderate elevations, near rivers, in areas where fire occurred between 11 and 30 years ago, and in areas with large compact patches of varied habitat, but tended to avoid variable terrain and non-vegetated areas. Moose tend to respond to the environment variables within a few kilometres of their location.

Gosse, J., B. McLaren and E. Eberhardt. 2002. Comparison of fixed-wing and helicopter searches for moose in a mid-winter habitat-based survey. Alces 38: 47-53.

These surveys were completed in Terra Nova National Park and an adjacent harvesting area (MMA 27) using forest inventory mapping to define blocks. Mean moose densities in these areas were 0.75 and 0.59 animals/km^2, respectively. Helicopter surveys identified 78 percent more animals and represented the best technique for accuracy and classification.

Jacques Whitford. 1996. Star Lake Hydroelectric Project Environmental Impact Statement. Prepared for Abitibi-Price Inc. Grand Falls-Windsor Division. Grand Falls-Windsor, Newfoundland.

This study presents information on the habitat requirements and availability, distribution and abundance of flora and fauna found in the Study Area for several species including moose and black bear. The report also discusses the potential impacts of the Star Lake Hydroelectric Project on the flora and fauna in the Study Area located in Central Newfoundland.

Jacques Whitford. 1997. Distribution of Wintering Moose Within the Low-Level Training Area of Labrador and Northeastern Québec, 1997. Jacques Whitford Environment Ltd. report prepared for PMO Goose Bay, National Defence Headquarters, Ottawa, Ontario.

The 1995 moose survey determined that estimated moose densities for all survey blocks were below the mitigation criterion of 0.5 moose/km^2 (regarding military flight training activity). Based on moose densities determined during the 1997 moose study, five areas approached or exceeded 0.5 moose/km^2 over an area of 10 km^2 (and were recommended for seasonal closure to military flight training): Blocks 4 and 5 of the Snegamook survey area with densities of 1.7 and 0.95/km^2, respectively; Block 8 in the Mecatina survey area with a density of 0.48/km^2; Block 10 in the Lac Fourmont survey area with an observed density of 0.38/km^2, but an estimated density of 0.5/km^2; and at the western end of the Winokapau Lake where six moose were recorded in a 3 km section of shoreline.

Mawhinney, K., and S.P. Mahoney. 1994. Aerial moose census of management units 5, 6, 7 in the Western Newfoundland Model Forest, 1993 and 1994. Prepared for Western Newfoundland Model Forest. Corner Brook, NL.

A total of 213 moose were counted and classified in Trout River area (MMA 5), and 407 and 215 moose were counted and classified in the Corner Brook area (MMA 6) and South Brook area (MMA 7), respectively. The population of moose was estimated at 3,258 ±489 (MMA 5), 4,330 ±1,015 (MMA 6) and 2,054 ±218 (MMA 7) for a total estimated population of 9,642 animals. Net recruitment (percent calves) ranged from 20 to 25 percent in the WNMF. The estimated density within these areas have increased and/or maintained relatively stable and currently range between 1.2 to 2.1 moose/km^2.

McLaren, B.E., S.P. Mahoney, T.S. Porter and S.M. Oosenbrug. 2000. Spatial and temporal patterns of use by moose of pre-commercially thinned, naturally-regenerating stands of balsam fir in central Newfoundland. Forest Ecology and Management 133: 179-196.

A study of use and damage of pre-commercially thinned forest stands containing balsam fir by moose in central Newfoundland was undertaken to determine how potentially conflicting resource management goals such as wood yield optimization and provision of stable moose populations could be achieved. The study found that a stable moose population was achieved over five years, through the issue of licenses for a management sub-area designed to coincide with ongoing pre-commercial thinning. Good road access ensured high success for hunters in this sub-area, and this management option eventually allowed for declines in moose density and in browsing of crop trees in pre-commercially thinned stands.

McLaren, B.E., B. A. Roberts, N. Djan-Chékar and K. P. Lewis. 2004. Effects of overabundant moose on the Newfoundland Landscape. Alces. http://findarticles.com/p/articles/mi_hb006/is_40/ai_n29153404/pg_13/?tag=content;col1.

This study presents how moose are significantly influencing several aspects of some ecosystems in Newfoundland (e.g., forest succession, forest composition, soils and other wildlife). This has been due, in part, to the absence of wolves on the island, which allows for local irruptions in moose populations. The paper provides a discussion of the effects of moose on the forest ecosystem, monitoring of moose overabundance, and provides some management recommendations.

Messier, F. and D.O. Joly. 2000. Regulation of moose populations by wolf predation. Canadian Journal of Zoology 78: 506-510.

This discussion was prepared as a response to an earlier publication (Eberhardt 1997). Canadian Journal of Zoology 75: 1940-1944), who suggested that the killing rate of moose by wolves was constant, wolf population size was proportional to prey density, and that predation by wolves regulated ungulate prey numbers. These authors provide argument that there is density dependence in both functional and numerical response of wolf and prey densities and that predation by wolves is density-dependant at low moose densities (and possibly higher densities). As such, wolf predation can act as a regulatory factor.

Following this publication, Eberhardt (2000. Canadian Journal of Zoology 78: 511-513) responded indicating that different modelling approaches were incorporated into these studies; Messier and Joly's approach assumed equilibrium between wolf abundance and prey abundance, while Eberhardt's model depicted non-equilibrium conditions.

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

Evidence and information pertaining to the habitat associations for 13 mammalian species were collected in the lower Churchill River watershed. Of relevance were habitat associations concerning moose. Moose also appeared to utilize all habitat types for foraging, shelter, transit or other movement. Observations were most pronounced in mixed coniferous-deciduous forests, and to a lesser extent riparian areas, within the river valley, as this species is known to prefer willow, birch and alder as a food source.

Minaskuat Inc. 2008. Wetland Assessment and Evaluation. Report prepared for the Lower Churchill Hydroelectric Generation Project.

Wetlands were identified, characterized and classified to address gaps in the ELC report by Beak and Hunter Associates (1978). Wetland form, function and wildlife use was linked and used to complement the terrestrial habitat information previously gathered from project-related field studies. Of relevance was the seasonal use by moose in wetland areas. Moose or moose sign was documented at a moderate level, with moderate to high use of marshes and wetlands with a swamp component. Moose habitat potential was lowest in shallow-water wetlands.

Minaskuat Inc. 2009. The Lower Churchill Hydroelectric Generation Project Environmental Baseline Report: Moose *(Alces alces)*. Report prepared for the Lower Churchill Hydroelectric Generation Project.

During the course of this project, four male and four female adult moose were captured from six locations in the survey area and then tracked using remotely-accessed GPS technology. The study showed that moose remained in the lower Churchill River valley immediately post-capture (in April 2007), but moved out of the valley to higher elevations (as far as 40 km from capture locations) throughout the summer and fall, returning to the river valley by the start of winter. The total area occupied by captured moose ranged from 23.5 to 331.2 km^2. In this area, moose were found in association with coniferous habitat types, particularly black spruce or spruce-fir combinations, and to a lesser extent hardwood, riparian and gravel bar habitats. Animals were also found in proximity to tributaries and/or water bodies in the survey area.

Newbury, T.L., Simon, N.P.P. and T.E. Chubbs. 2007. Moose, *Alces alces*, Winter Browse Use in Central Labrador. Canadian Field-Naturalist 121 (4): 359-363.

Moose browse was recorded along four 250 m transects in five forest regeneration ages. Browse was greater on 20 and 30 year old regenerating stands as compared with recently clearcut stands (5 and 10 years old) or mature forests (>150 years old). Willow followed by white birch had the highest proportion of browsing by moose.

Northland and Jacques Whitford. 2000. Winter Moose Survey. Northland Associates (1995) Ltd and Jacques Whitford Environment Limited report prepared for Churchill River Power Project - 1999 Environmental Studies, LHP 99-25.

Two aerial (helicopter) survey techniques (strip transect and block) were used to assess habitat capability for moose throughout central Labrador and northeastern Québec. Habitat compatibility was considered to be moderate to high in most of the areas surveyed, except along the northern half of Atikonak Lake and north to the east end of Ossokmanuan Lake, where the predominant vegetation was scrub spruce. Elsewhere, a mix of black spruce stands for shelter and balsam fir/deciduous trees/shrubs for forage provided relatively good habitat for overwintering moose. The blocks which contained moose or moose tracks were distributed throughout the Churchill River system. Moose densities ranged from 0.10 to 0.57 moose/km^2.

Potvin, F. and R. Courtois. 2004. Winter presence of moose in clear-cut black spruce landscapes: Related to spatial pattern or to vegetation? Alces 40: 61-70.

This field program involved aerial winter surveys of moose in clearcuts (aged three to nine years) in southcentral Québec. Moose densities were 0.20 moose/10 km^2, which were 50 percent lower than in other areas within the same hunting zone and with a similar forest composition. The authors concluded that the presence of moose in clearcut black spruce landscapes is related to vegetation characteristics and not the spatial pattern of the forest. Moose yards were found to have denser shrub layers and more available browse, than other sites in the same landscape.

Schwab, F.E. and M.D. Pitt. 1991. Moose selection of canopy cover types related to operative temperature, forage, and snow depth. Canadian Journal of Zoology 69: 3071-3077.

This paper presents a statistical analysis of the contribution of temperature, forage and snow depth to moose selection of canopy cover types. The number of hours at which operative temperature exceeded the thermal limit to cause panting significantly influenced cover selection during summer (1 June to 15 September) and late winter (16 January to 15 April). During early winter, moose apparently suffered little heat stress, and habitats that provided relatively high forage were selected. Forage influenced cover selection during early winter (16 November to 15 January) and somewhat during late winter. Snow depth contributed to cover selection in early winter only.

S. Fudge and Associates Limited. 1989. Late winter moose survey Tally Pond Newfoundland. Prepared for the Tally-Pond Duck Pond Mining Project.

An extensive strip-transect survey using helicopter was completed in the vicinity (306 km^2) of a proposed base metals mine in central Newfoundland during March 1989. Moose densities were estimated at 0.33 to 0.46 moose/km^2. Concentrations occurred in association with recent cutovers along Harpoon Brook, Noel Paul's Brook, and elsewhere.

Thompson, I.D., W.J. Curran, J.A. Hancock and C.E. Butler. 1992. Influence of moose browsing on successional forest growth on black spruce sites in Newfoundland. Forest Ecology and Management 47: 29-37.

This paper presented the results of an 11-year (1976 to 1987) establishment of enclosures in Newfoundland to eliminate browsing by moose. Tree growth and density and species composition within the enclosures were assessed and it was found that the densities of balsam fir, pin cherry (*Prunus pensylvanica*) and high-bush cranberry (*Viburnum trilobum*) were higher inside the enclosures versus outside. Additional findings include a recovery of balsam fir inside the enclosure that had been browsed and these trees were taller and had higher growth rates than balsam fir on the outside. White birch was also taller inside the enclosure.

Trimper, P.G., E.A. Young and T.E. Chubbs. 1996. Distribution of wintering moose in south central Labrador and northeastern Québec. Alces 32: 41-49.

As part of the mitigation program regarding military flight training over the Québec-Labrador Peninsula, aerial surveys of potential wintering areas were completed to identify potential sensitivities and implement possible spatial closures. Strip-transect and block surveys were completed during March 1995 over 2,210 km throughout the Churchill, Petit Mecatina, Olomane, and Natashquan River valleys. Moose were often absent from areas of apparently suitable habitat. Results of 17 block surveys over areas of greatest activity indicated densities of 0 to 0.1 animals/km^2, well below densities elsewhere in Canada.

BLACK BEAR

Chaulk, K., S. Bondrup-Nielsen and F. Harrington. 2005. Black bear, *Ursus americanus*, ecology on the northeast coast of Labrador. Canadian Field-Naturalist 119(2): 164-174.

Twenty-three black bears were captured, 20 were measured, marked and/or radio collared in northeastern Labrador during 1996 and 1997. Findings included: bears used sea ice for travel; coastal islands for denning; hunted adult caribou; and were possible causes of moose calf mortality. In addition, this study found that the body sizes of bears studied was small. The sex ratio for captured subjects was 1:1 and four of six females captured gave birth during the winter of 1997. The reproductive histories of females suggested delayed sexual maturity. During the study, bears entered dens between October and December 1996, with spring emergence from April to May 1997 (i.e., estimated denning time of 148 to 222 days). Observations suggested that barren areas were used nearly as much as forested areas in the Study Area.

Dennis, W., S. Mahoney, and D. Snow. 1996. Ecology and habitat use of black bears in the Serpentine Lake area of Western Newfoundland: A cooperative study of the Western Newfoundland Model Forest and the Newfoundland and Labrador Wildlife Division. Interim Report June 1993 – August 1996.

The Study Area comprised mixed conifer forest interspersed with bog and barren areas. In 1993 and 1994, radio collars were placed on eight bears, to determine home ranges and habitat use. Baseline information on food habits, reproduction, denning, and sources of mortality was collected on collared and uncollared bears.

Garneau, D.E., T. Boudreau, M. Keech and E. Post. 2008. Black bear movements and habitat use during a critical period for moose calves. Mammalian Biology 73: 85-92.

This study was designed to test the hypothesis that black bears movement patterns and habitat use are deliberate and result in greater energy acquisition, given that they hibernate and are thus active for shorter periods annually. Results from six GPS collared bears suggest that bears moved closer to probable moose calving sites from up to three weeks prior to parturition. However, whether recently emerged bears were for the most nutritious and digestible plants (e.g., *Equisetum*) that are the same as that used by parturient moose, or selecting for moose calves could not be determined.

Jacques Whitford. 1996. Star Lake Hydroelectric Project Environmental Impact Statement. Prepared for Abitibi-Price Inc. Grand Falls-Windsor Division. Grand Falls-Windsor, Newfoundland.

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 moose and black bear. It also discusses the potential impacts of Star Lake Hydroelectric project on the flora and fauna in the Study Area located in central Newfoundland.

Jacques Whitford. 1997. Voisey's Bay 1996 Environmental Baseline Technical Data Report: Black Bear. Voisey's Bay Nickel Company Limited, St. John's, NL.

From 1995 to 1997, Jacques Whitford conducted field surveys during an environmental baseline characterization in the area of a proposed mine and mill project for VBNC. The study found a relatively high density (0.45 to 0.52 bears/km^2) compared to other similar areas, which may have been a result of attraction to human activity at the work camps. Sex ratio for black bears was found to be 1:1, similar to other areas of Canada. Bears were in good physical shape, although they tended to be smaller than black bears elsewhere. Many family group observations occurred on the barrens. This may reflect family group habitat selection, but may also be due to increased visibility and observer bias. The largest home range documented in 1996 was 193 km^2, although there was a high degree of home range overlap between radio-collared black bears in the 1996 study. Forest was the major habitat type in each home range calculated. Adults, sub-adults, females and males all used forest slightly more than barrens. The use of barrens by bears may be due to the high residual berry crop on the barrens during the spring and the large berry crop during the late summer and early fall. Berries were the main diet of the black bears in the Study Area during spring, summer and fall. Dens in the area were found in three habitat types: white spruce forests, shrub thickets and on the barrens. All dens had the entrance facing south or southwest and were found on slightly elevated areas.

McBurney, S., A.M. Veitch and P.Y. Daoust. 2000. Bacterial valvular endocarditis in a black bear from Labrador. Journal of Wildlife Diseases 36(4): 788-791.

In fall 1991, a radio-collared black bear in northern Labrador died from valvular endocarditis, with widespread dissemination of the infection to other organs shortly before death. This was the first reported case of bacterial valvular endocarditis in a wild black bear.

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

Evidence and information pertaining to the habitat associations for 13 mammalian species were collected in the lower Churchill River watershed. Of relevance were habitat associations concerning black bear. Black bear were distributed throughout Labrador in various habitat types. They exhibited no distinct habitat preferences and evidence was found consistently in all habitat types. During the spring and early summer, black bears occupied different habitat types such as coniferous forests and wetlands in search of food, primarily berry crops. During late summer and fall, coniferous forest was used for foraging, shelter, and building fat reserves for winter.

Minaskuat Inc. 2009. Black Bear *(Ursus americanus)* Study in the Lower Churchill River Watershed. Interim Report prepared for the Lower Churchill Hydroelectric Generation Project.

During the course of this study, 13 capture events occurred, with 11 bears captured, and eight GPS telemetry collars deployed, six on males, and two on females. Multiple Convex Polygons and kernel estimators were generated. The Multiple Convex Polygons for bears ranged from 18 to 1,220 km^2. A preference was demonstrated for sparse coniferous, dense coniferous and open coniferous habitat.

Schwartz, C. C. and A.W. Franzmann. 1991. Interrelationship of black bears to moose and forest succession in the northern coniferous forest. Wildlife Monographs 113: 58 pp.

Black bears living in middle-aged (1947) and recent (1969) burns in Alaska were compared. Densities of bears in both burns were similar as well as sex ratios, but there were significantly more females in both areas. Higher cub production and survival was evident in the 1969 burn area. Other differences noted were greater consumption of lowbush cranberry (*Vaccinium vitis-idaea*) in 1947 burns and consumption of approximately four times more moose calves per individual in the 1969 burn. The greater growth and reproduction of black bears in the 1969 burn was attributed to greater consumption of moose calves.

Schooley, R.L., C.R. McLaughlin, G.J. Matula Jr. and W.B. Krohn. 1994. Denning chronology of female black bears: Effects of food, weather, and reproduction. Journal of Mammalogy 75 (2): 466-477.

This study looked at 104 female black bears in Maine, USA. Den entry dates were found to be associated with the abundance of beechnuts (*Fagus grandifolia*), such that in years when nuts were scarce, bears entered dens earlier (mid to late October) and when nuts were abundant, they entered dens later (mid to late November). Bears also used hardwood forests more often in falls when nuts were abundant. Where beech trees were less abundant, den entry and habitat use varied less between years. Pregnant females denned earlier than other bears and did not show strong associations with the availability of nuts.

Veitch, A.M. and P.K. Krizan. 1996. Black bear predation on vertebrates in northern Labrador. Journal of Wildlife Research. 1: 193-194.

Between 1989 and 1991, 22 black bears were caught and equipped with telemetry collars in the area above the tree line, 200 km north of Nain. This three-year field program provided insight into barren ground bears in terms of seasonal habitat use, food items, movements, and home range size, based on resighting or traditional telemetry triangulation techniques.

APPENDIX B

Profiles of Study Team Members

APPENDIX B

The project manager for this study was Mr. 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 moose and black bear. Regional leads for the Island portion of this study (Corner Brook and St. John's) included Ms. Tina Newbury and Ms. Elizabeth Way, respectively. Their responsibilities included liaison with local regulatory agencies, compilation of literature and data and report preparation. Additional data collection, research and writing support were provided by Ms. Karen Rashleigh, Ms. Shawna Peddle, Mr. John Pennell and Mr. James Loughlin. The GIS team in St. John's was led by Mr. Stephen Rowe, with analytical support from Ms. Jackie Bowman and Mr. Erin Marshall. Word Processing was completed by Ms. Beverley Best and Ms. Tracy Osmond. Senior review of all draft and final reports was completed by Mr. Earle Hickey.

Brief profiles of Study Team members are as follows:

Perry Trimper, B.Sc.F, served as the Project Manager for the *Moose and Black Bear Component Study*. His 24 years of experience is primarily in northern environments of both Canada and Russia where his areas of specialization include boreal and Arctic wildlife research, northern indigenous peoples, environmental assessment and sustainable resource development. He has been involved in every large environmental assessment in Labrador over the last two decades. Relevant projects related to aspects of hydroelectric development or northern issues include: various wildlife programs and preliminary assessment of the proposed hydroelectric development on the Churchill River of Labrador; and registration and environmental assessment of hydroelectric projects in Newfoundland and Labrador.

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 Ltd. and a longtime EIS practitioner having been involved in numerous federal and provincial EISs. 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.

Tina Newbury, M.Sc., is a Level III scientist with Stantec Ltd.'s Corner Brook, NL office. Since 2008, Ms. Newbury has assisted in report writing, literature review, data management and field programs for several projects related to the proposed Nalcor transmission line development, Keystone Pipeline, Labrador Iron Mines, Aurora uranium exploration and St. Lawrence Wind Turbine projects. She has extensive experience with forest songbird identification, nest searching, small mammal trapping, radio telemetry and general wildlife surveys. Ms. Newbury also has involvement with an ongoing contract with Environment Canada that has led to experience with marine water quality sampling.

Elizabeth Way, M.Sc., is the Team Lead for the Environmental Management Group of Stantec Consulting Ltd., in St. John's. Since 2002, 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 for the Laurentian Sub-Basin and Sydney Basin. She has also gained experience related to environmental assessment while working on the Environmental and Socioeconomic Assessment for the proposed Gateway Pipeline in British Columbia, Pokak Seismic Survey in the Northwest Territories, the environmental assessment 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 environmental assessment.

Karen Rashleigh, M.Sc., is an Environmental Scientist 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 are primarily to conduct ecological investigations related to resource development in Labrador, in particular, studies involving terrestrial wildlife (e.g., avifauna, small and large mammals) including all aspects of data analyses and reporting.

Shawna Peddle, M.Sc., is a Senior Project Manager with Stantec in Guelph, Ontario. She is experienced in managing and undertaking large and small-scale environmental assessments in the energy, water and waste, transportation and industrial sectors. She is skilled at interacting with diverse Study Teams, sub-consultants, clients, agencies and the public. She has experience in Ontario and Newfoundland provincial and federal environmental assessment project development and management, consultant team coordination, public involvement and report preparation and coordination. She also has extensive public consultation and communications experience related to risk assessment, mining, oil and gas, transportation and waste management. Ms. Peddle 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 environmental assessment consultation and preparation.

John Pennell B.Sc., was a member of the Environmental Management Group in St. John's, 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 Power Project. He has also gained experience related to Socioeconomic Assessment for the lower Churchill Power project. He has also assisted in report writing, literature review, data management and field programs for both ecological land classification 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 Strategic Environmental Assessment.

James Loughlin, B.Sc., was a member of the Environmental Management Group in St. John's. 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 has 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), is a GIS Specialist and Team Leader of the Information Management team with Stantec Ltd. in St. John's, Newfoundland. Since graduating with a Bachelor of Science degree in Geography in 1998, he has gained over 10 years experience as a GIS professional, including working for Parks Canada, Provincial Parks and for a seismic surveying company. He has been 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.

Jackie Bowman, **B.Sc., M.GIS (candidate),** is a GIS Analyst and 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 Stantec Consulting Ltd., 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. She has also been involved in the design, implementation and management of spatial data for large EIS projects.

Erin Marshall, **B.Sc.,** is a GIS Analyst in the Geomatics Department within Stantec Consulting Ltd. (St. John's, NL). Mr. Marshall has been involved in the Geomatics industry for the past seven years, where he has accumulated a diverse background and work experience. Mr. Marshall has conducted ecological classifications, 3D visualization models, wildlife and terrain models, site assessments and regional and site mapping, for clients including government departments and agencies (domestic and foreign), First Nation groups, oil and gas companies, forestry organizations and information technology groups. Mr. Marshall is skilled in land and marine survey data collection and interpretation using GPS, bathymetry data, satellite and LiDAR imagery.

Labrador – Island Transmission Link

Moose and Black Bear Supplementary Report

Labrador Transmission Corridor Option: Muskrat Falls to the Strait of Belle Isle

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1.0 INTRODUCTION

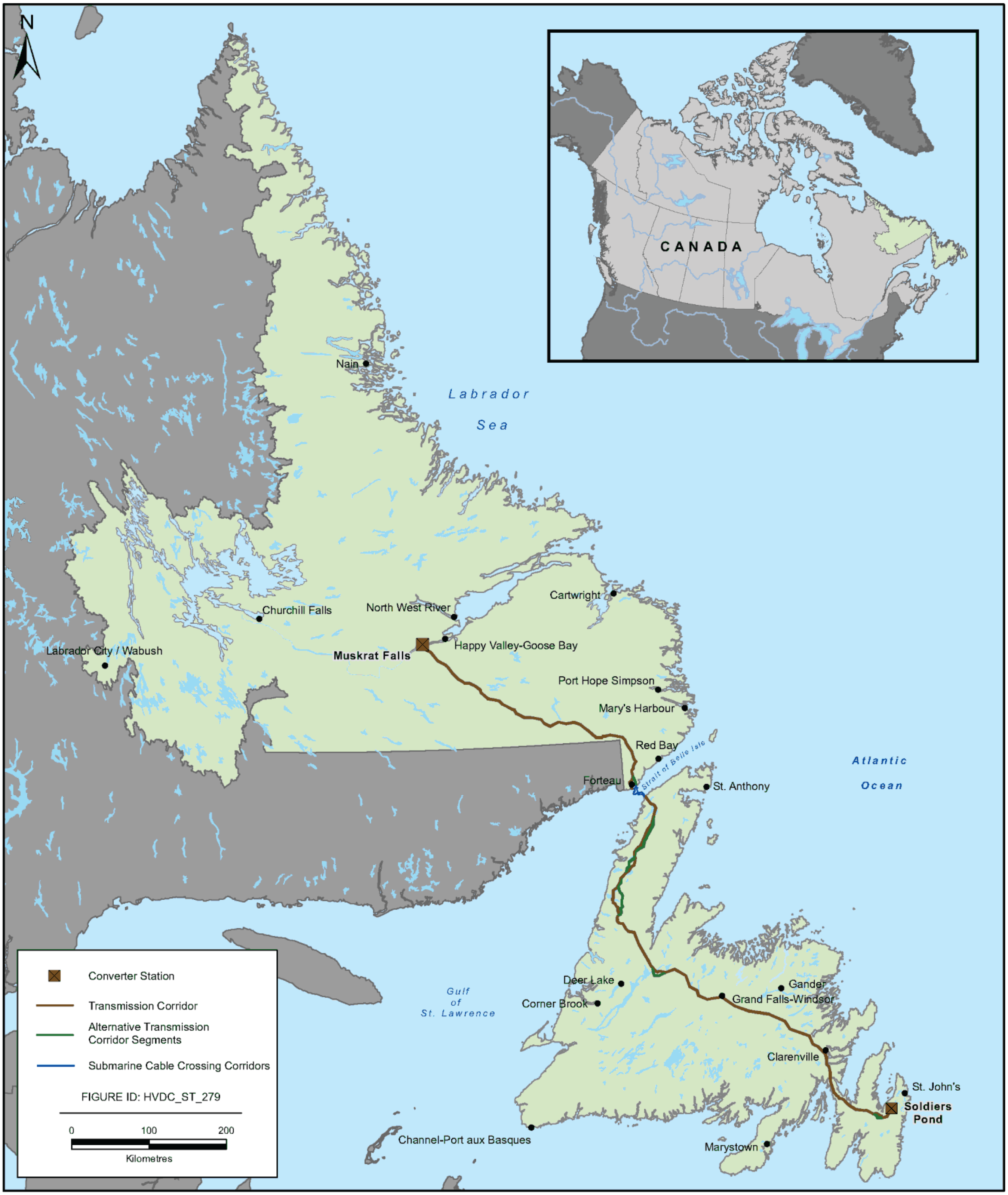
Nalcor Energy is proposing to develop the *Labrador – Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from Central Labrador to the Island of Newfoundland's Avalon Peninsula.

The environmental assessment (EA) process for the Project was initiated in January 2009 and is in progress. An Environmental Impact Statement (EIS) is being prepared by Nalcor Energy, which will be submitted for review by governments, Aboriginal and stakeholder groups and the public. In preparation for and support of the Project's EA, a series of environmental studies have been completed to provide information on the existing biophysical and socioeconomic environments in and near the Project area.

At the time of the commencement of the EA and these associated environmental studies, the Labrador component of the Project included a 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 south side of 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 (Figure 1.1).

The purpose of this Supplementary Report is to expand and update the scope of the *Moose and Black Bear Study* completed for the EA to provide similar environmental information for this additional transmission corridor option, for eventual use in Project planning and in the EIS.

Figure 1.1 Labrador - Island Transmission Link (Muskrat Falls Corridor Option)



2.0 APPROACH AND METHODS

The study involved the compilation and review of existing and available information on moose and black bear and their known and potential habitats in the area of the proposed Project, including the identified 2 km wide transmission corridor, as well as a larger regional Study Area that comprises an area approximately 15 km wide surrounding the corridor. The information and analysis provided herein focuses primarily upon the new 135 km long transmission corridor segment from Muskrat Falls, to and along a portion of the TLH-3, to the point where that corridor option joins the previously identified transmission corridor to the Strait of Belle Isle (see Figure 1.1). For completeness and consistency, however, the associated habitat quality mapping includes the entire transmission corridor and larger Study Area from Muskrat Falls to the Strait of Belle Isle.

2.1 Review of Relevant Studies

Information regarding use of the Study Area by moose and black bear was obtained by reviewing previous studies. In addition to those reports previously summarized in the initial *Moose and Black Bear Study* (Stantec 2010a), the TLH-3 EIS (Department of Works, Services and Transportation 2003) and associated reports were reviewed to provide additional information on moose and black bear within relevant portions of the corridor and Study Area.

2.2 Ecological Land Classification Habitat Mapping

An Ecological Land Classification (ELC), previously prepared for the Project (Stantec 2010b), has been applied to the Study Area (Stantec 2011). Through this initiative, vegetation types and associated habitats were identified, classified and categorized on a regional scale, with nine habitat types being identified and mapped for Southeastern Labrador. These ELC-based classifications formed the basis of the wildlife habitat mapping component of this supplementary report. Based on interpretation of the ELC units, as outlined by Stantec (2010a) and presented in Tables 2.1 and 2.2, moose and black bear habitat quality maps were produced for the Study Area. Maps were colour-coded to reflect habitat quality and indicate the percentage of primary, secondary and tertiary habitat available within specific ecoregions and for the Study Area as a whole.

Table 2.1 ELC Habitat Types and Relative Quality for Moose Habitat in the Study Area

ELC Habitat Type[1]	Habitat Quality[2]	
	Spring / Summer[3]	**Fall / Winter[3]**
Black Spruce Lichen Forest	Tertiary	Tertiary
Burn	Tertiary	Tertiary
Conifer Forest	Secondary	Primary
Conifer Scrub	Secondary	Tertiary
Hardwood Forest	Primary	Secondary
Lichen Heathland	Secondary	Tertiary
Mixedwood Forest	Secondary	Primary
Open Conifer Forest	Tertiary	Tertiary
Wetland	Primary	Tertiary

[1] Descriptions for habitat types provided in the ELC for the Project (Stantec 2010b)
[2] Descriptions for habitat quality provided in the initial *Moose and Black Bear Study* for the Project (Stantec 2010a)
[3] Though not included at the scale of the ELC, riparian habitats are considered secondary habitat for moose, during both spring / summer and fall / winter.

Table 2.2 ELC Habitat Types and Relative Quality for Black Bear Habitat in the Study Area

ELC Habitat Type[1]	Habitat Quality[2]	
	Spring / Early Summer[3]	**Late Summer / Fall[3]**
Black Spruce Lichen Forest	Primary	Primary
Burn	Secondary	Primary
Conifer Forest	Primary	Primary
Conifer Scrub	Secondary	Secondary
Hardwood Forest	Secondary	Primary
Lichen Heathland	Secondary	Secondary
Mixedwood Forest	Secondary	Primary
Open Conifer Forest	Primary	Primary
Wetland	Secondary	Secondary

[1] Descriptions for habitat types provided in the ELC for the Project (Stantec 2010b)
[2] Descriptions for habitat quality provided in the initial *Moose and Black Bear Study* for the Project (Stantec 2010a)
[3] Though not included at the scale of the ELC, riparian habitats are considered primary habitat for black bear in spring / early summer and secondary habitat quality in late summer /fall.

3.0 RESULTS AND ANALYSIS

The Study Area encompasses five ecoregions. The Low Subarctic Forest (Mecatina River) and String Bog (Eagle River Plateau) Ecoregions are dominant, comprising approximately 41 percent and 35 percent of the Study Area, respectively. The Forteau Barrens Ecoregion comprises 16 percent of the Study Area, whereas the High Boreal Forest (Lake Melville) and Mid Boreal Forest (Paradise River) Ecoregions are relatively minor, accounting for approximately 6 percent and 2 percent, respectively.

3.1 Moose

Moose are present in the Study Area but in relatively low densities compared to the Island and other boreal regions elsewhere in Canada (Brassard et al. 1974; Fryxell et al. 1988; Boer 1992; Chubbs and Schaeffer 1997; Jacques Whitford 1997; Minaskuat Inc. 2009a). The Study Area overlaps three Moose Management Areas (MMAs): 53A, 58 and 59 (Figure 3.1). Although specific data are not available for MMAs 53A, and MMAs 59, 57 and 58 were examined in 1998 prior to construction of Phase II of the TLH (Cartwright to Red Bay) and numbers were found to be low (<0.01 moose/km^2) in both management zones (Found 1998). However, the moderate percentage of cows and the presence of twinning amongst adult cows indicated that the population was stable despite low densities (Found 1998). A review of the TLH-3 EIS and its associated reports did not provide any detailed data or information pertaining to the distribution or abundance of moose within the Study Area.

Results of the ELC-based habitat model indicate that potential moose habitat is found throughout the Study Area. During the spring / summer, hardwood forests and wetlands (particularly those that support aquatic plants) provide particularly important moose habitat. Such primary habitat accounts for 21 percent (1,204.7 km^2) of the Study Area, and is primarily provided by wetlands. Secondary spring / summer moose habitat is also common and comprises 49 percent (2,805.8 km^2) of the Study Area. The major ecoregions of the Study Area (Subarctic Forest and String Bog Ecoregions) contain between 20 and 26 percent primary spring / summer moose habitat and 33 to 48 percent secondary habitat (Figures 3.2 and 3.3).

During the fall / winter, moose yarding and wintering areas are typically associated with habitats that provide a source of food and some relief from snow depths; such are often found in forested river valleys. Conifer and mixedwood forests provide such opportunities, and were therefore considered as primary habitat in the model. Although the Study Area is primarily comprised of tertiary habitat during the fall / winter (71 percent, 4,072.0 km^2), primary habitat does account for 25 percent of its area (1,461.7 km^2). However, secondary fall / winter habitat is relatively scarce, accounting for <1 percent of the Study Area. Although the shift to a reduced availability of preferred habitats during fall / winter is evident for the most of the ecoregions, the majority of the High Boreal Forest Ecoregion (62 percent) is identified as primary moose habitat during this period.

Figure 3.1 Moose Management Areas

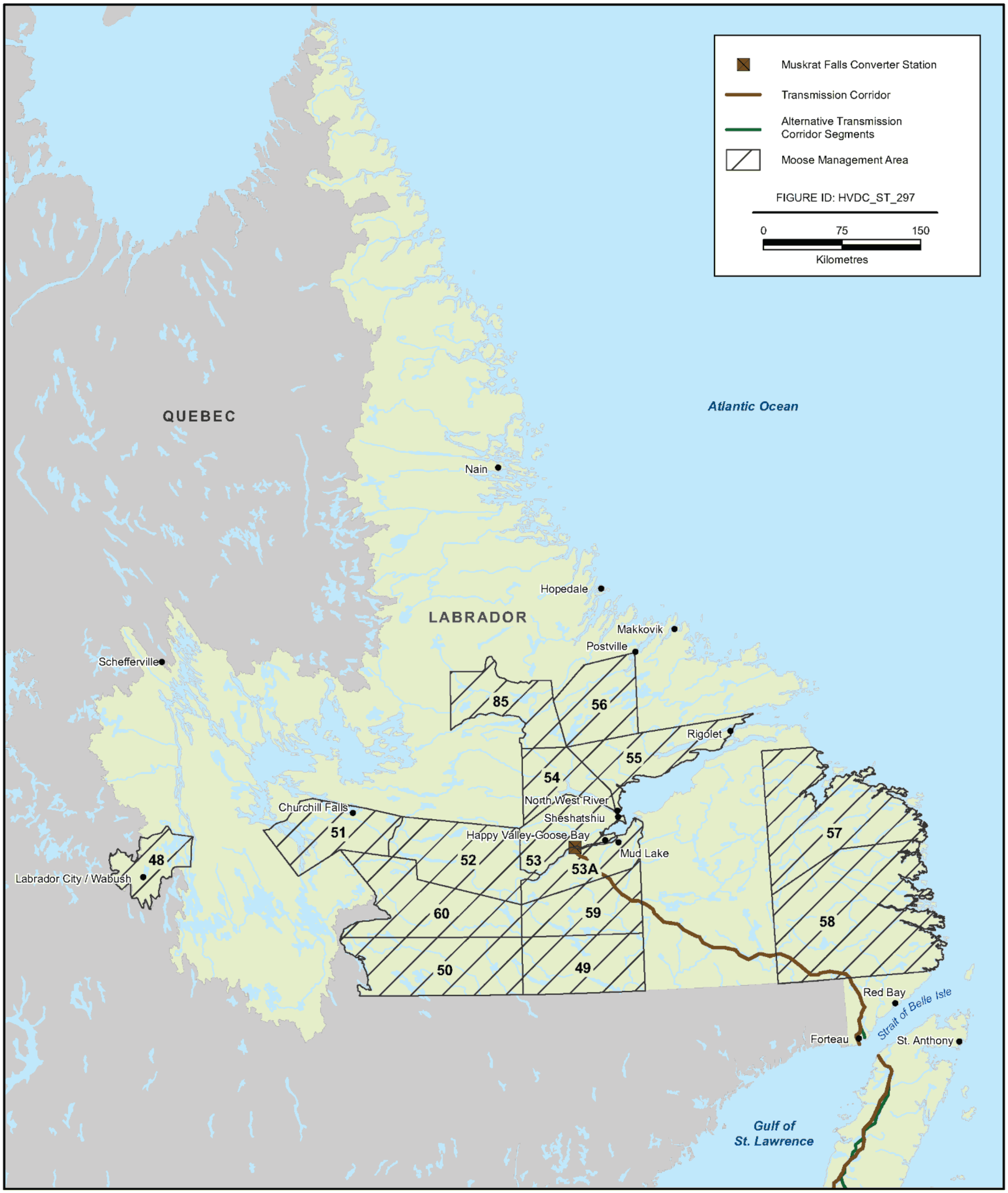


Figure 3.2 Moose Spring / Summer Habitat Quality in the Study Area

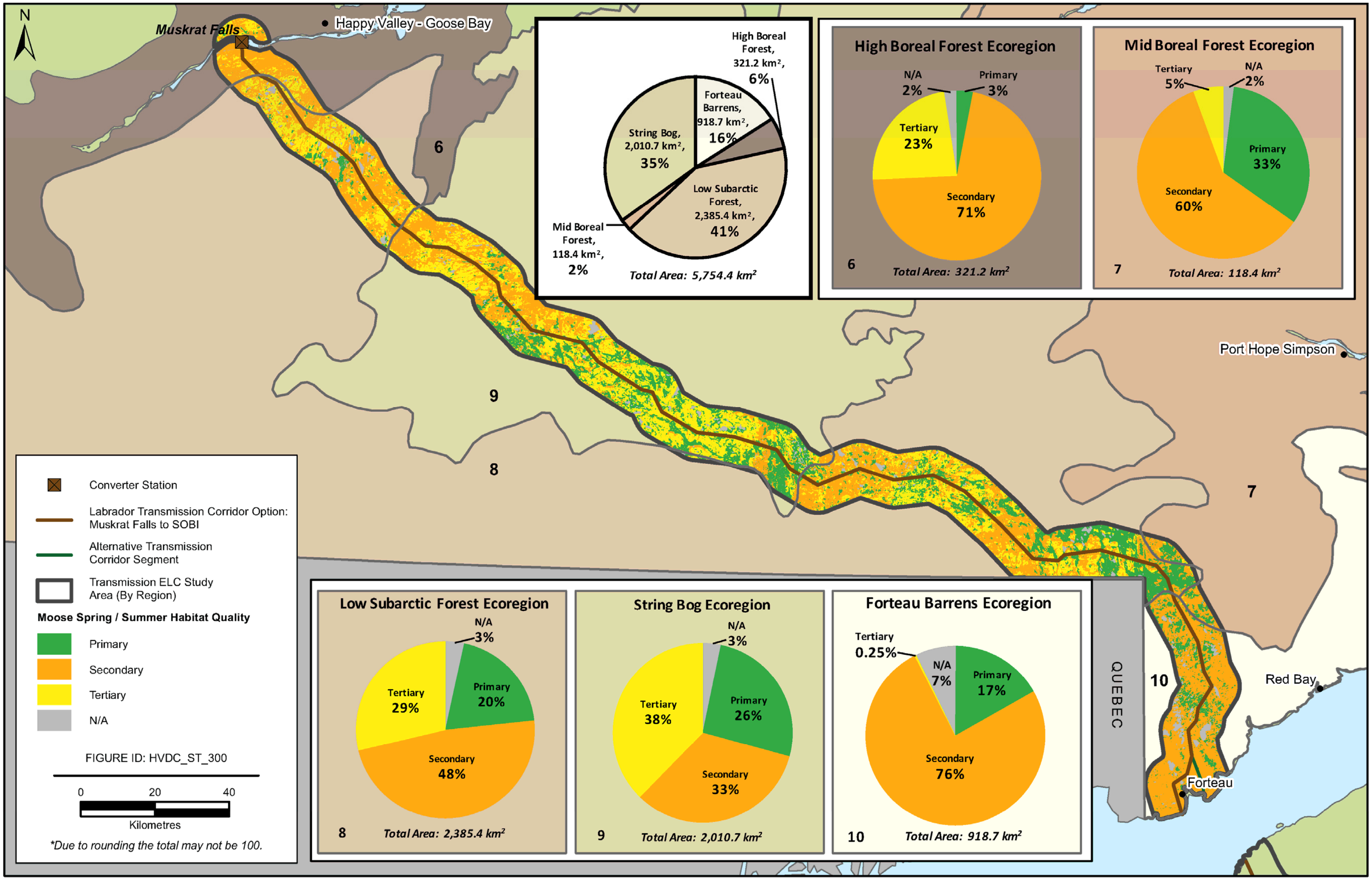
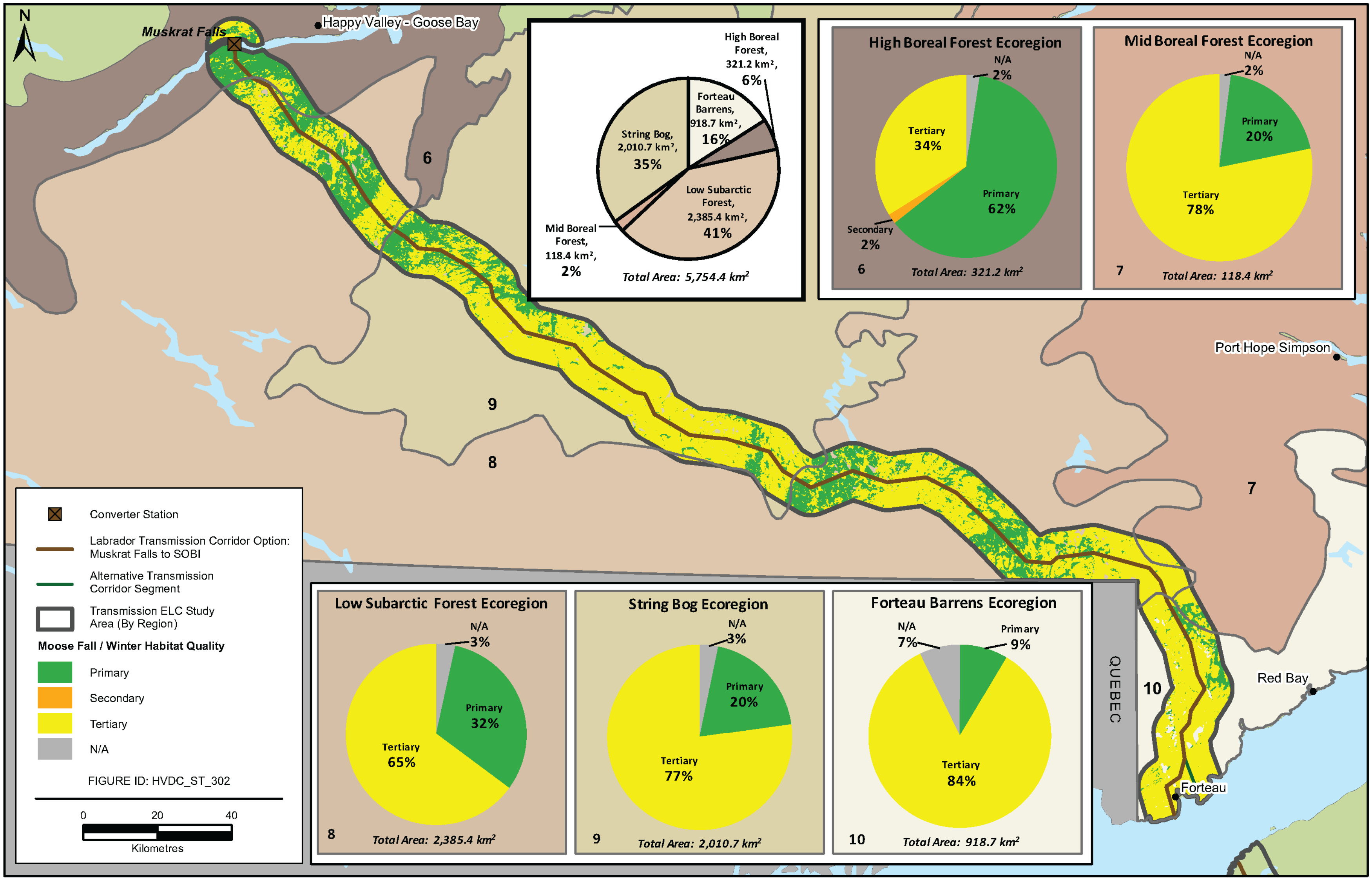


Figure 3.3 Moose Fall / Winter Habitat Quality in the Study Area



3.2 Black Bear

Black bear are known to be distributed throughout the Study Area, which is located within the Labrador South Black Bear Management Area (Figure 3.4). The black bear baseline study in support of the Lower Churchill Hydroelectric Generation Project from 2006 to 2009 provides the most comprehensive overview of this species in the region (Minaskuat Inc. 2009b) and indicated that black bear are relatively common in central Labrador. Recurrent use of the river valley was evident, although the home range of bears extended beyond the lower Churchill River watershed (particularly in association with the landfill in Happy Valley-Goose Bay) (Minaskuat Inc. 2009b). Although the black bear is noted as present within Southeastern Labrador by the TLH-3 EIS, neither this document or its associated reports provide any detailed data pertaining to its distribution or use with respect to the Study Area.

Results of the ELC-based habitat model indicate that both primary and secondary black bear habitat are distributed throughout the Study Area, with little seasonal change in the distribution and abundance. Given that black bear are omnivorous and have opportunistic feeding behaviors, all habitats in the Study Area were considered either primary or secondary. During spring / early summer, primary black bear habitat occupies 50 percent (2,905.2 km^2) of the Study Area, whereas in the late summer / fall, it accounts for 52 percent (2,992.8 km^2). Primary habitat is particularly abundant in the Low Subarctic (58 and 61 percent for spring / early summer and late summer / fall, respectively), String Bog (57 percent for both the spring / early summer and late summer / fall) and High Boreal Forest (82 and 87 percent for spring / early summer and late summer / fall, respectively) Ecoregions, although the latter forms only 6 percent of the Study Area (Figures 3.5 and 3.6). Secondary black bear habitat occupies for 46 percent (2,644.1 km^2) of the Study Area, whereas in the late summer / fall, it comprises 44 percent (2,556.5 km^2) of the area.

Figure 3.4 Black Bear Management Areas

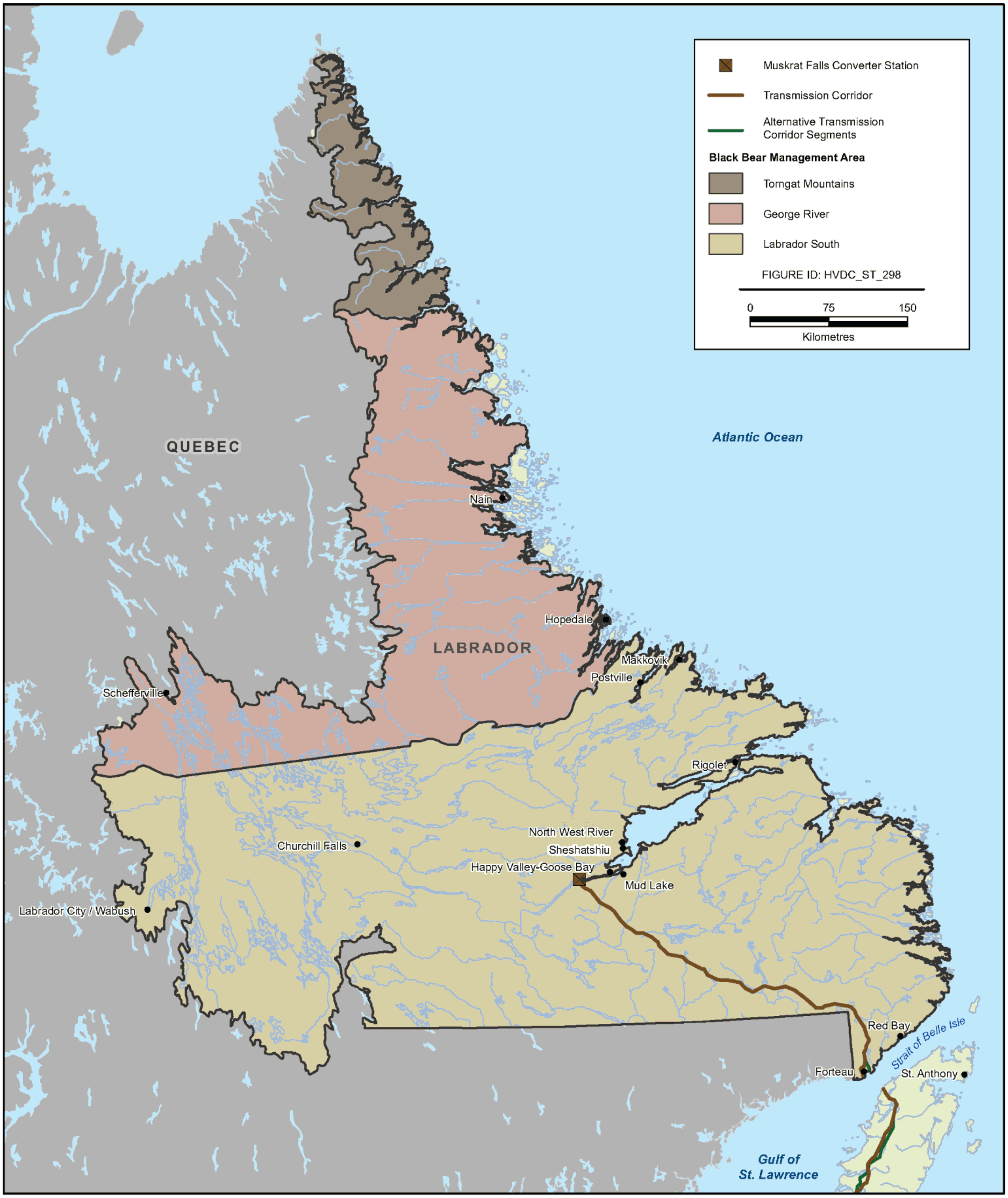


Figure 3.5 Black Bear Spring / Early Summer Habitat Quality in the Study Area

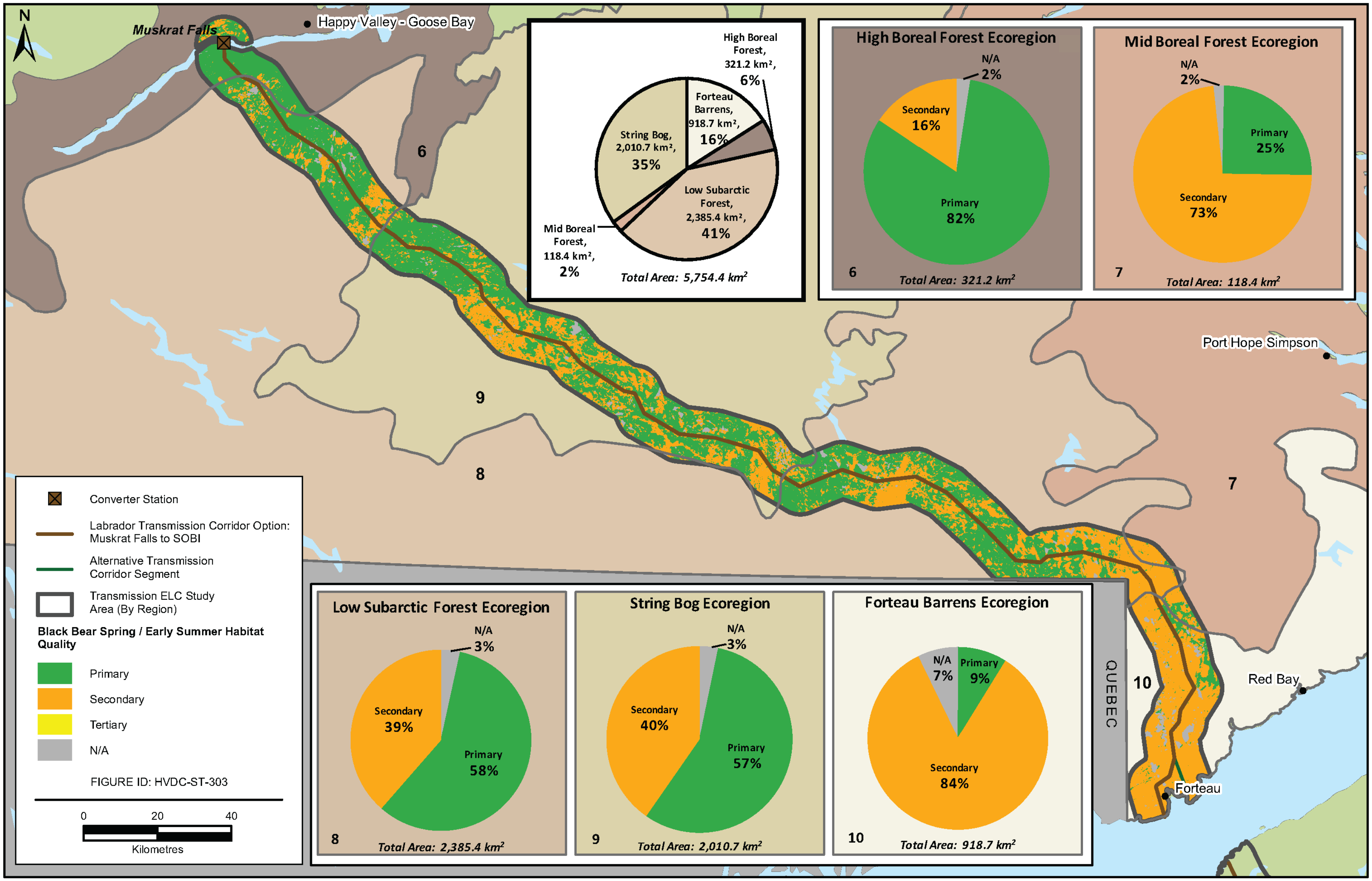
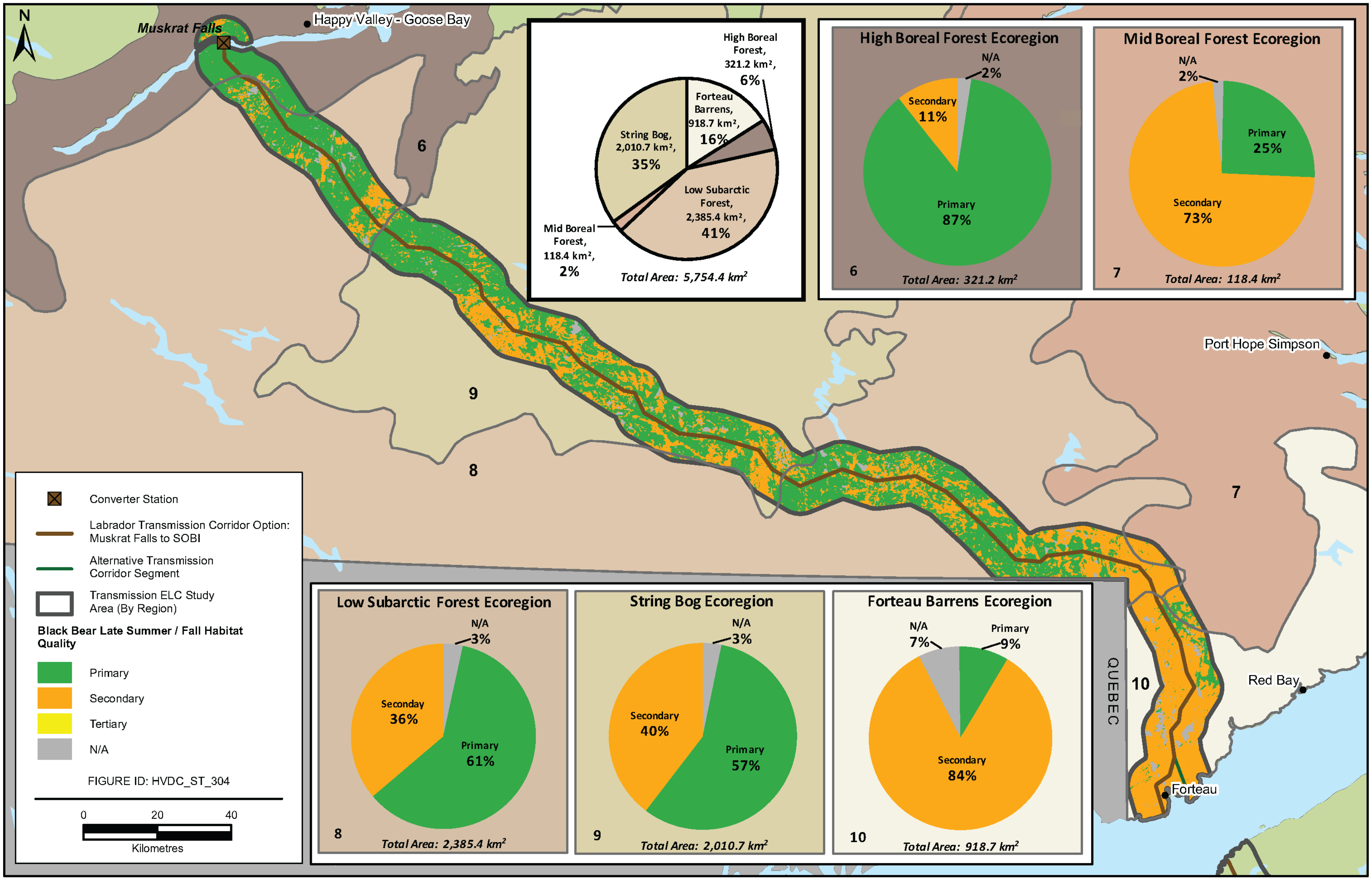


Figure 3.6 Black Bear Late Summer / Fall Habitat Quality in the Study Area



4.0 SUMMARY

Nalcor Energy is proposing to develop the *Labrador - Island Transmission Link*, a HVdc transmission system extending from Central Labrador to the Island of Newfoundland's Avalon Peninsula. In support of the EA for the Project, this study provides information on moose and black bear and their habitats within a 15 km wide Study Area surrounding a recently identified transmission corridor option from Muskrat Falls to the Strait of Belle Isle. This supplementary report expands and updates the scope of the initial *Moose and Black Bear Study* (Stantec 2010a) prepared for the EA, for eventual use in Project planning and in the EIS.

Information on moose and black bear within the Study Area was obtained through both a review of existing reports and an update of an ELC-based habitat model. Information reviewed includes that presented in the initial *Moose and Black Bear Study*, the TLH-3 (Cartwright Junction to Happy Valley-Goose Bay) EIS and associated reports, and other sources.

Moose are known to be found in the Study Area, but in relatively low densities, with the transmission corridor overlapping three MMAs along its northwestern and southeastern potions. Black bear are likewise known to be distributed throughout the Study Area, and use a varied range of habitats.

Based on the updated ELC model, habitat quality mapping was completed for the Study Area. Maps were colour-coded to reflect habitat quality and indicate the percentage of identified primary, secondary and tertiary habitat available within the ecoregions that comprise the Study Area. The results of the habitat models indicate that:

- The Study Area is comprised of 21 percent (1,204.7 km^2) primary moose habitat during the spring / summer and 25 percent (1,461.7 km^2) during the fall / winter; and
- Primary black bear habitat accounts for 50 percent (2,905.2 km^2) during the spring / early summer and 52 percent (2,992.8 km^2) in the late summer / fall.

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