LABRADOR – ISLAND TRANSMISSION LINK ENVIRONMENTAL ASSESSMENT

Furbearers and Small Mammals Component Study

June 2011

nalcor energy
LOWER CHURCHILL PROJECT

LABRADOR-ISLAND TRANSMISSION LINK: ENVIRONMENTAL COMPONENT STUDIES (CSs)		
1) Vegetation CS	**Report 1a** **Ecological Land Classification**	**Report 1b** **Wetlands Inventory & Classification**
	Report 1c **Regionally Uncommon Plants Model**	**Report 1d** **Timber Resources**
	Report 1e **Vegetation Supplementary Report**	
2) Avifauna CS		
3) Caribou & Other Large Mammals CS	**Report 3a** **Caribou & Their Predators**	**Report 3b** **Moose & Black Bear**
4) Furbearers & Small Mammals CS		
5) Marine Environment: **Fish & Fish Habitat, Water Resources CS**	**Report 5a** **Marine Fish: Information Review**	**Report 5b** **Marine Flora, Fauna & Habitat Survey**
	Report 5c **Marine Habitats (Geophysical) Survey**	**Report 5d** **Water, Sediment & Benthic Surveys**
	Report 5e **Marine Surveys: Electrode Sites**	**Report 5f** **Marine Surveys: Supplementary**
6) Freshwater Environment: **Fish & Fish Habitat, Water Resources CS**		
7) Marine Environment: **Marine Mammals, Sea Turtles & Seabirds CS**	**Report 7a** **Marine Mammals, Sea Turtles & Seabirds: Information Review**	**Report 7b** **Marine Mammal & Seabird Surveys**
	Report 7c **Ambient Noise & Marine Mammal Surveys**	
8) Species of Special Conservation Concern CS		
9) Marine Environment & Effects Modelling CS	**Report 9a** **Strait of Belle Isle: Oceanographic Environment & Sediment Modelling**	**Report 9b** **Strait of Belle Isle: Marine Sound Modelling - Cable Construction**
	Report 9c **Electrodes: Environmental Modelling**	
10) Historic & Heritage Resources CS		
11) Socioeconomic Environment: **Communities, Land & Resource Use, Tourism & Recreation CS**	**Report 11a** **Communities, Land & Resource Use, Tourism & Recreation**	**Report 11b** **Current Levels of Accessibility Along the Transmission Corridor**
12) Socioeconomic Environment: **Aboriginal Communities & Land Use CS**		
13) Socioeconomic Environment: **Marine Fisheries in the Strait of Belle Isle CS**		
14) Viewscapes CS		

Environmental Component Study Required Under the EIS Guidelines: Comprising Reports (Shaded cells above)	
Avifauna: 2, 7a, 7b	Furbearers: 4
Caribou (and Predators): 3a	Timber Resources: 1d
Water (Quality and Quantity): 5a, 5d, 5e, 5f, 6	Marine and Freshwater Fish and Fish Habitat: 5, 6, 7, 13
Species at Risk: 8	Historic Resources: 10
Viewscapes: 14	Socioeconomics: 11, 12, 13
Environmental study reports submitted as additional background information: 1a, 1b, 1c, 1e, 3b, 9	

LABRADOR – ISLAND TRANSMISSION LINK ENVIRONMENTAL ASSESSMENT
Environmental Component Studies: Introduction and Overview

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

The Project was registered under the Newfoundland and Labrador *Environmental Protection Act* (*NLEPA*) and the *Canadian Environmental Assessment Act* (*CEAA*) in January 2009 (with subsequent amendments and updates), in order to initiate the provincial and federal environmental assessment (EA) processes. Following public and governmental review of that submission, an Environmental Impact Statement (EIS) was required for the Project. The EIS is being developed by Nalcor Energy, in accordance with the requirements of both *NLEPA* and *CEAA* and the *EIS Guidelines and Scoping Document* issued by the provincial and federal governments.

In support of the Project's EIS, Nalcor Energy has undertaken a series of environmental studies to collect and/or compile information on the existing biophysical and socioeconomic environments and to identify and assess potential Project-environment interactions. This environmental study program has included field surveys, associated mapping and analysis, environmental modeling, and the compilation and analysis of existing and available information and datasets on key environmental components. This report comprises one of these supporting environmental studies.

A general guide to these Environmental Component Studies, some of which are comprised of multiple associated reports, is provided on the opposite page.

The information reported herein will be incorporated into the Project's EIS, along with any additional available information, to describe the existing (baseline) environmental conditions and/or for use in the assessment and evaluation of the Project's potential environmental effects and in the identification and development of mitigation.

This study focuses on the relevant aspects of the proposed Project – including the proposed and alternative HVdc transmission corridors, marine cable crossings, and/or other Project components and activities – as known and defined at the time that the EA process was initiated and/or when the study commenced. Project planning and design are ongoing, and as is the case for any proposed development, the Project description has and will continue to evolve as engineering and EA work continue. The EIS itself will describe and assess the specific Project components and activities for which EA approval is being sought, and will also identify and evaluate other, alternative means of carrying out the Project that are technically and economically feasible as is required by EA legislation.

The EIS and these Component Studies will be subject to review by governments, Aboriginal and stakeholder groups and the public as part of the EA process.

Nalcor Energy – Lower Churchill Project

Labrador – Island Transmission Link

Furbearers and Small Mammals Component Study

Preface

This *Furbearers and Small Mammals Component Study* has been prepared and submitted as part of the Environmental Assessment (EA) of the proposed **Labrador-Island Transmission Link**.

The objective of this study has been to gather and present environmental baseline information on furbearer and small mammal species in and near the proposed Project area, through a detailed literature review and the compilation of other existing and available information and data sets.

The study also includes habitat potential mapping for various key and representative species for the identified transmission corridors and a surrounding (approximately 15 km wide) study area, based on the Ecological Land Classification (ELC) that has been completed for the Project and its EA. This habitat potential mapping is presented generally as a series of regional summary maps, but is available at the 1:50,000 scale in a GIS system for use in the eventual EA analyses.

The *Main Report* (May 2010) presents information related to the originally defined transmission corridors from Gull Island (Labrador) to Soldiers Pond (Newfoundland). The report also includes information for the previously identified Labrador electrode line alternatives from the lower Churchill River to Lake Melville, which were being evaluated when the Project's EA and this study were initiated but are no longer under consideration by Nalcor Energy.

An attached *Supplementary Report* (April 2011) provides similar information for an additional transmission corridor option from Muskrat Falls in Labrador.

A second *Supplementary Report* (June 2011) presents the results of a detailed marten habitat potential mapping exercise that was completed for a portion of the proposed transmission corridor that is required to pass through the identified marten core area and proposed critical habitat on the southern end of the Island of Newfoundland's Northern Peninsula. This report also references the Recovery Plan for the Newfoundland marten that was released by Government in September 2010 (after the above described *Main Report* was completed).

Further information on the Newfoundland marten and other relevant species at risk will also be provided in the forthcoming *Species of Special Conservation Concern* Component Study.

The environmental information presented in this Component Study will be incorporated and used in the Project's eventual Environmental Impact Statement (EIS), which will provide a summary description of the existing environment and an environmental effects assessment for the Project.

Labrador – Island Transmission Link

Furbearer and Small Mammal Component Study

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May 7, 2010

EXECUTIVE SUMMARY

Nalcor Energy is proposing to develop the *Labrador-Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from 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 *Furbearer and Small Mammal Component Study* has been completed with the objective to gather, summarize and present information on furbearer and small mammal species in the area of, and which may therefore interact with, the proposed Project.

Approach and Methods

The Study Area comprised and encompassed the proposed and alternative HVdc transmission corridors and associated Project components.

This *Furbearer and Small Mammal Component Study* is based on research completed by the Study Team and others in support of this Project - as well as relevant furbearer and small mammal surveys and studies completed by others throughout the province and other existing and available literature. An extensive literature search was completed that provided a comprehensive listing of the primary sources of information on furbearers and small mammals relevant to the proposed Project, from which an annotated bibliography detailing relevant studies completed in Newfoundland and Labrador since 1987 was compiled.

Based on the findings of the literature review, regional overviews of the presence, abundance and distribution of furbearers and small mammals are provided for the various regions that comprise the Study Area, namely the *'Lower Churchill River and Lake Melville', 'Southeastern Labrador', 'Northern Peninsula', 'Central and Eastern Newfoundland'* and *'Avalon Peninsula'* areas.

A total of seven key and representative species were also subsequently selected upon which to focus this review, based on their status (i.e., listed species), affinities for a particular habitat type and/or representation of a particular group (e.g., terrestrial or semi-aquatic species):

- marten (*Martes americana)* - including the Newfoundland Marten (*Martes americana atrata*);
- wolverine *(Gulo gulo)*;
- red fox (*Vulpes vulpes*);
- beaver (C*astor canadensis*);
- porcupine (*Erethizon dorsatum*);
- red-backed vole (*Clethrionomys gapperi*); and
- meadow vole (*Microtus pennsylvanicus*).

A description of the available information and existing environmental conditions was prepared according to the primary sources of information available, existing conditions and status, habitat associations and distribution along the Study Area, and potential limiting factors for each of the seven identified key representative species.

An Ecological Land Classification (ELC) was previously completed along a 15 km wide regional Study Area encompassing 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.

Detailed habitat quality maps were generated for four species, indicating the abundance of primary, secondary and tertiary quality habitat distributed throughout 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 more (or marginal amounts of all) of these critical elements and tertiary habitat provides marginal foraging, protection or resting opportunities or may only be used during transit.

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 along the proposed and alternative HVdc transmission corridors. 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.

Summary of Results

Eighteen furbearer and 17 small mammal species have been confirmed in Labrador. Wolverine and least weasel (*Mustela nivalis*) may also occur in Labrador; however, their status is unconfirmed. Furbearer species recorded along the lower Churchill River valley during baseline surveys in 2006 included porcupine, red fox, grey wolf (*Canis lupus*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), river otter (*Lontra canadensis*), snowshoe hare (*Lepus americanus*), beaver, red squirrel (*Tamiasciurus hudsonicus*) and northern flying squirrel (*Glaucomys sabrinus*). In addition to these, coyote (*Canis latrans*), marten, ermine (*Mustela ermine*), lynx (*Lynx canadensis*), Arctic hare (*Lepus arcticus*), Arctic fox (*Alopex lagopus*), woodchuck (*Marmota monax*) and fisher (*Martes pennant*) have also been confirmed in Labrador. Small mammal species found in central and southeastern Labrador include deer mouse (*Peromyscus maniculatus*), woodland jumping mouse (*Napaeozapus insignis*), meadow jumping mouse (*Zapus hudsonicus*), house mouse (*Mus musculus*), southern red-backed vole, meadow vole, eastern heather vole (*Phenacomys ungava*), northern bank vole (*Clethrionomys glareolus*), rock vole (*Microtus chrotorrhinus*), pygmy shrew (*Sorex hoyi*), water shrew (*Sorex palustrus*), masked shrew (*Sorex cinerius*), star-nosed mole (*Condylura cristata*), northern bog lemming (*Synaptomys borealis*), Labrador collared lemming (*Dicrostonyx hudsonicus*), Norway rat (*Rattus norvegicus*) and little brown bat (*Myotis lucifugus*).

As a function of island biogeography, furbearer and small mammal diversity is reduced on the Island portion of the province. At present, there are 13 furbearer species that occur in Newfoundland: coyote, red fox, river otter, ermine, mink, beaver, lynx, snowshoe hare, Arctic hare, muskrat, marten, eastern chipmunk (*Tamias striatus*) and red squirrel. The 11 small mammals that have been documented on the Island include deer mouse, Norway rat, masked shrew, southern red-backed vole, northern bank vole, meadow vole, house mouse, little brown bat, northern long-eared bat (*Myotis septentrionalis*), hoary bat (*Lasiurus cinereus*) and eastern red bat (*Lasiurus borealis*). All native and introduced furbearers and small mammals are generally found throughout the province, with the known exception of red-backed vole (range does not include the Avalon Peninsula or parts of the

Northern Peninsula), the Newfoundland marten (found in isolated pockets in various parts of Newfoundland but absent from the Avalon Peninsula) and Arctic hare (generally restricted to high elevations in parts of Newfoundland).

Detailed analyses for the seven key and representative species provided the following additional information.

Marten are typically associated with conifer and open conifer forests that are widely distributed throughout the Study Area. While marten are found throughout the Study Area in Labrador, this species exists in only five isolated subpopulations in Newfoundland and is recognized as a distinct subspecies. Primary habitat for marten occupies 1,300.3 km^2 (12.2 percent) of the regional (ELC) Study Area in Newfoundland as a whole, although not all of it is known to be occupied by this subspecies. In Labrador, primary habitat for marten comprises 1,209.1 km^2 (19.5 percent) of the Study Area.

Wolverine are listed as an *Endangered* species under the *Species at Risk Act* (*SARA*) and the Newfoundland and Labrador *Endangered Species Act* (*NLESA*). Their current existence in Labrador remains unconfirmed and is based on a few incidental observations of this species over the past 45 years. Wolverine are not native nor have they been introduced on the Island. Habitat type and quality were not rated or mapped for this species.

Red fox are considered common throughout the Study Area in Newfoundland and Labrador. As a generalist species, they are found in any habitat that supports prey [e.g., snowshoe hare and microtines (rodents that belong to the subfamily Microtinae, which is comprised of voles, lemming and muskrat)]. Due to the variety of habitats of interest, habitat type and quality was likewise not rated for this species in the Study Area.

Beaver are common and occur in association with a wide range of aquatic and terrestrial habitat types. However, this species requires particular local site conditions for colony establishment (e.g., permanent source of surface water) and has habitat-specific preferences (e.g., alder beds at the mouths of tributaries or slow-flowing streams in narrow valleys with bedrock foundation). Due to the specific nature of these habitat requirements, habitat quality was not assessed for beaver in the Study Area.

Porcupine are exclusive to the Labrador portion of the Study Area, where they are considered a common species. While there are seasonal foraging preferences exhibited by this species (the inner tree bark, needles and buds of coniferous species are foraged in winter and spring; deciduous leaves, grasses, forbs and berries are foraged during summer and fall), the latter component is localized and not often distinguishable at the scale of the habitat mapping in the Study Area. Therefore, primary habitat for porcupine was assigned as conifer forest, conifer scrub, mixedwood and open conifer forests, which occupies 3,749.6 km^2 (60.5 percent) of the Study Area in Labrador.

Red-backed vole exist throughout Labrador and have expanded their range on the Island to include areas further north and east following an introduction in the Little Grand Lake area in west-central Newfoundland in 1999. Records of this species do not currently exist for the Avalon Peninsula or the most northerly extent of the Northern Peninsula. Red-backed vole prefer black spruce and lichen, conifer forest, conifer scrub, cutover and mixedwood forests. Combined, these account for 3,870.6 km^2 (36.2 percent) of the Study Area in Newfoundland and 1,446 km^2 (23.3 percent) in Labrador. The relatively low amount of primary habitat in Labrador results from the few existing cutovers in this region. As this species is a relatively recent introduction to the Island, its distribution and interaction with and/or influence on other species is being closely monitored by the Small Mammal Monitoring Network of the provincial Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation.

Meadow vole are present throughout the entire Study Area and prefer conifer forest, conifer scrub, Kalmia lichen heathland, lichen heathland, mixedwood forest and scrub/heathland/wetland habitats, which occupy 8,472 km^2 (79.2 percent) of the Study Area in Newfoundland and 5,464.5 km^2 (89.9 percent) in Labrador. Although meadow vole capture rates in some recent studies have been relatively low, this species is considered common throughout the province.

The information provided in this *Furbearer and Small Mammal Component Study* has identified key species and their habitat that occur in the Study Area and has provided detailed information on the existing conditions and status for these species, based on original field work and a review of relevant literature. Combined, this information provides for subsequent examination of specific Project interactions that will be examined in the environmental assessment of the Project.

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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 Environmental Assessment (EA) of the Project 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 *Furbearer and Small Mammal Component Study* was completed in order to identify, compile, summarize and present information on furbearers and small 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 lower 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 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 were also 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 eventually 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 average 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 Furbearer and Small Mammal Component Study

This *Furbearer and Small Mammal 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 Project and its potential interactions with the environment, it was considered appropriate and necessary to go beyond such a "traditional" approach to environmental baseline studies for the EIS.

Specifically, rather than base the furbearer and small mammal study solely on a "snap shot" understanding of the presence of these species at locations along the transmission corridor through one or more field surveys at a single point in time, a range of methods and information sources were used to provide an appropriate and meaningful understanding of their likely and potential presence, abundance and distribution in and near the Project area. The nature, and appropriateness, of this study approach was discussed with various relevant government agencies and stakeholders as part of the planning and design of the Project's environmental study program in 2008 and 2009.

The study approach was to first identify, compile and summarize the existing and available (but previously somewhat widespread) information related to furbearers and small mammals in and near the proposed 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.

This information has also been used in conjunction with the regional Ecological Land Classification (ELC) mapping work completed for the Project, to assess and map habitat suitability – and thus, the likely and potential use of

the Project area - for furbearers and small mammals along and adjacent to the proposed and alterative transmission corridors. Detailed habitat potential mapping for select species is provided in this report.

In summary, the objective of this *Furbearer and Small Mammal Component Study* is to identify gather, analyze, summarize and present information on these species in the area of, and which may 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 and relevant to the Project, as well as other relevant furbearer and small mammal surveys and the literature which provide 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 furbearers and small mammals across the geographic extent of the proposed transmission corridor, followed by detailed discussion and analyses for various key and representative species; and
- Using the above information, and based on the regional ELC completed for the Project, the development and presentation of habitat suitability mapping for furbearers and small mammals across the transmission corridor and surrounding area.

The species of furbearers and small mammals included and focused on in this study represent different ecological niches, and reflect their importance as predator and/or prey species. Species listed under the federal *Species at Risk Act* (*SARA*) or the *Newfoundland and Labrador Endangered Species Act* (*NLESA*) were also specifically considered.

2.0 APPROACH AND METHODS

The following sections provide an overview of the Study Area, methodology and study team for this Component Study.

2.1 Regional Context and Study Area

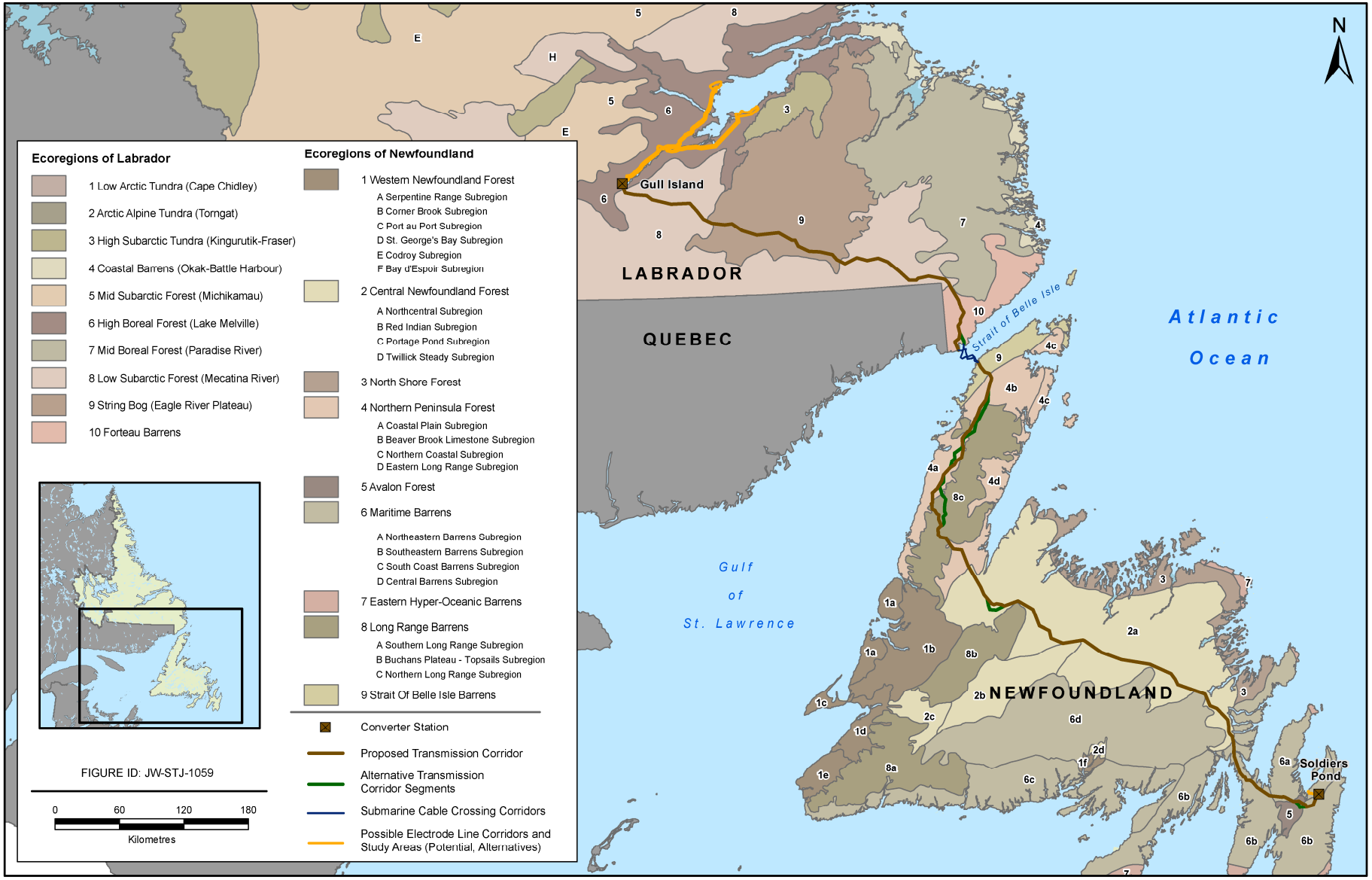
The proposed Project involves the construction and operation of an HVdc transmission system within and between Labrador and the Island of Newfoundland.

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 furbearers and small mammals 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 encompassing the proposed and alternative transmission corridors from Gull Island to Soldiers Pond. This corresponds to the Study Area used in the regional ELC carried out as part of the Project's environmental baseline study program, which has also formed the basis for the habitat suitability mapping component of this study. For other Project components, such as the potential electrode line corridors, the study focuses on the general areas involved (such as the lower Churchill River valley and Lake Melville). The analysis and discussion is, in many cases, influenced by the nature of the existing and available information sources, including the areas covered by the previous furbearer and small mammal surveys cited.

The proposed transmission line will, as described previously, be approximately 1,100 km in length, and includes 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.

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



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 delineated for Canada (Natural Resources Canada 2007), 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 lower 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.

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 mixed with numerous bogs and other wetlands, scattered hardwood stands, and rock outcrops dominated by lichens and low shrubs.

These two Ecozones are further divided into a number of Ecoregions. Ecoregions are smaller land units within Ecozones that have distinctive, recurring patterns of vegetation and soil that are determined and controlled by local climate and geology (Damman 1983; Meades 1990; Marshall and Schutt 1999; PNAD 2008). Ecoregions also differ from each other in their combinations of plant communities, landscapes, geology and other features (Marshall and Schutt 1999; PNAD 2008). There are 19 Ecoregions within the province, nine in Newfoundland (Damman 1983) and 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 ELC Area but is not intersected by the 2 km wide transmission corridor.

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

Ecoregions and Subregions
LABRADOR
High Boreal Forest-Lake Melville Ecoregion (Boreal Shield Ecozone) - encompasses the lower 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.
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 - 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.

Ecoregions and Subregions

- *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 - the most continental climate of any part of insular Newfoundland. It has the highest summer and lowest winter temperatures. Because of warm summers and high evapo-transpiration rate, soils in the northern part of this Ecoregion exhibit actual soil-moisture deficiency. The Hylocomium-Balsam Fir forest type is characteristic of this area. Forest fires have played a more important role in this Ecoregion's natural history than in other regions. Thus, much of the Balsam Fir-Feathermoss forest types have been converted to black spruce, and some of the richer site types are dominated by white birch and aspen. In areas that have been burned repeatedly, dwarf shrub (Kalmia) barrens have replaced forest stands. Raised bogs are the characteristic wetland type.

- *Northcentral Subregion* - has higher summer maximum temperatures, lower rainfall and higher fire frequency than anywhere else in Newfoundland. The subregion extends from Clarenville in the east to Deer Lake in the west and for the most part has a rolling topography below 200 m. Pure black spruce forests and aspen stands dominate this area because of the prevalence of fire. The high summer temperatures are also thought to stimulate aspen root suckering and contribute to the local success of aspen (Damman 1983). Relatively low moisture, coarse soils and the prevalence of black spruce cover types make this subregion particularly susceptible to regeneration failure. Furthermore, where tree regeneration is lacking, succession to dwarf shrub heath dominated by *Kalmia angustifolia* occurs on the nutrient-poor, coarse-textured till that is prevalent through much of this area. The rolling to undulating topography is characterized by shallow, medium-quality till, with a soil texture range from sandy loam to loam. Midslopes are dominated by the Hylocomium-Balsam Fir type, or Black Spruce-Feathermoss type on 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.

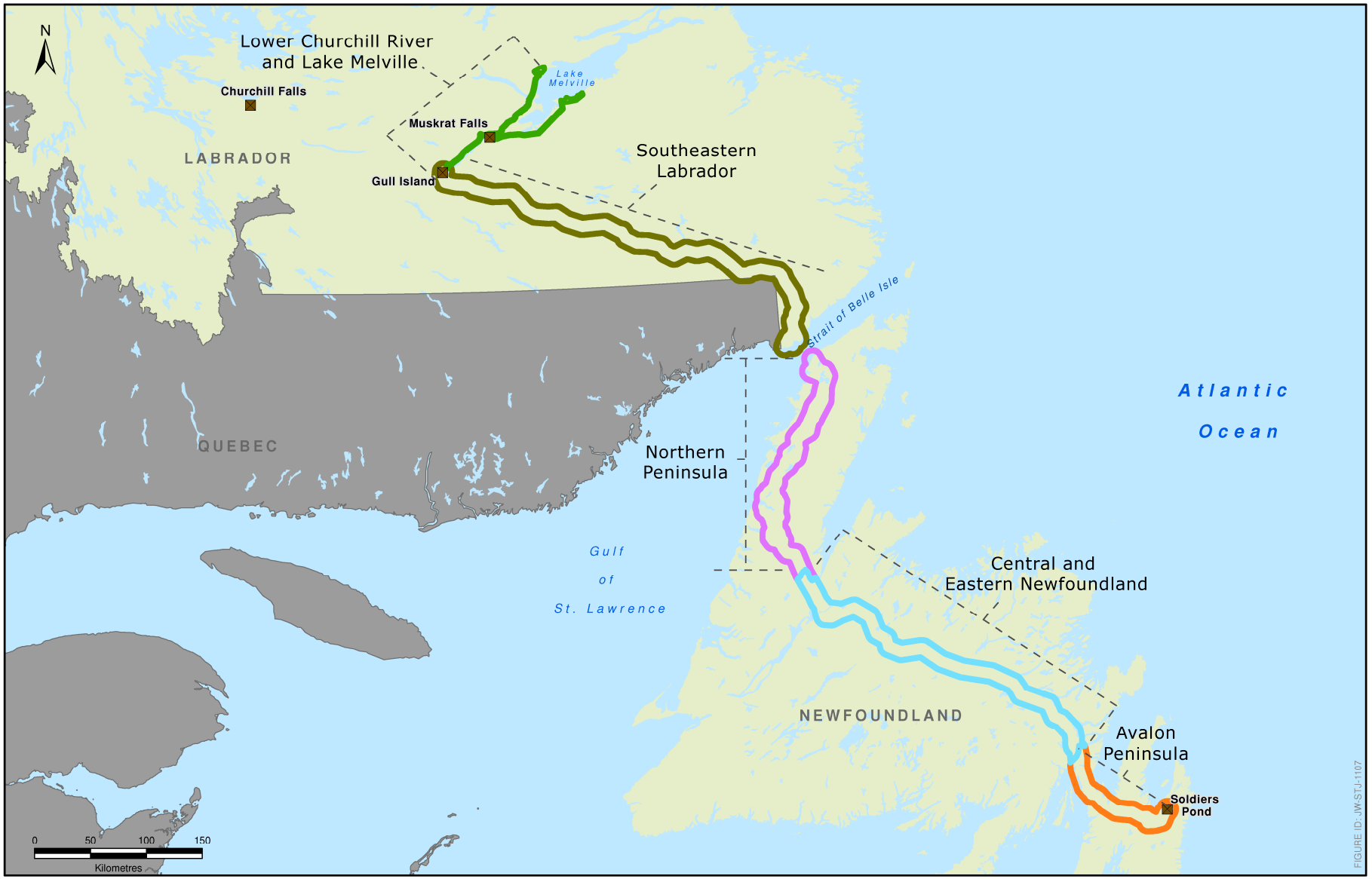
Maritime Barrens Ecoregion - extends from east to the west coast of Newfoundland along the south-central portion of the Island. This Ecoregion has the coldest summers, with frequent fog and strong winds. Winters are relatively mild, with intermittent snow cover, particularly near the coastline. The landscape 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.

Ecoregions and Subregions
▪ *Northeastern Barrens Subregion* - this subregion has lower fog frequency and somewhat warmer summers compared to other parts of the Ecoregion. Arctic-alpine species are absent from the heath vegetation and yellow birch is absent from the forest. The landscape is extensively forested with local heath vegetation, particularly along the coast. The tills are generally a shallow, rolling ground moraine with sandy loam to loam texture. The Hylocomium-Balsam Fir type occupies midslopes, and it is usually associated with gleyed podzols or gleysols. ▪ *Southeastern Barrens Subregion* - has landscape dominated by heathlands, with the forest occurring in small acreages that escaped fire. The dominant heath shrub on uplands is *Empetrum nigrum*, with *Kalmia angustifolia* forming a dense cover only in protected valleys. The topography is generally undulating with shallow, heavily compacted till and numerous large erratics. The Clintonia-Balsam Fir type is most common where the forest is still present. Good forest growth only occurs in a few large, protected valleys where the Dryopteris-Balsam Fir type dominates the slopes. Good specimens of yellow birch are also found in these stands. ▪ *Central Barrens Subregion* - occurs south of the Central Newfoundland 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 Component Study, the analysis and discussion that follows is 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.

Figure 2-2 Geographic Regions of the Study Area



- *Avalon Peninsula* – The area encompassing the HVdc transmission corridor and associated Project components from the Clarenville area 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 for furbearers and small mammals are discussed more generally within a larger geography (i.e., Labrador, Island of Newfoundland, or the province as a whole).

2.2 Methods

This *Furbearer and Small Mammal 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 original research completed throughout Newfoundland and Labrador. Where relevant, information from elsewhere (e.g., incidental sightings) has been used to supplement the understanding of existing conditions for furbearers and small mammals in the Study Area.

Initial meetings with Nalcor Energy representatives and various provincial and federal government departments and stakeholders served to focus the scope of the study by identifying key and representative species and compiling potential information sources including (but not limited to) relevant documents and data prepared for this Project and the Lower Churchill Hydroelectric Generation Project, as well as existing scientific literature.

Species included in this Component Study represent groups of furbearers and small mammals, including species listed under *SARA* and/or *NLESA*.

2.2.1 Literature Review

Existing and available information on furbearers and small mammals collected through library and internet searches and through meetings with government departments and other organizations were compiled. This resulted in the development of an annotated bibliography listing and describing relevant furbearer and small 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 one or more of the categories of furbearers and small mammals; and
- 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. Information and knowledge regarding potential Project interactions with and effects on these species with existing transmission line corridors or similar infrastructure was identified for later use in the EIS.

2.2.2 Recent and Previous Furbearer and Small Mammal Surveys for or Relevant to the Transmission Link

Several baseline studies carried out by Nalcor Energy or its predecessors in relation to the Project or other developments provide relevant information on furbearers and small mammals in the Study Area. Relevant

results from these earlier investigations have been incorporated into this Component Study.

Labrador-Island Transmission Link Ecological Land Classification

As part of the ELC for the proposed transmission corridor (described in Section 2.2.3), selected wildlife species, including furbearers and small mammals and evidence of their presence (e.g., tracks, scat, browse, dams), 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). Information from these surveys, where relevant, has been fully incorporated in this Component Study.

Wildlife Habitat Associations in the Lower Churchill River Valley (Minaskuat Inc. 2008a)

A series of general wildlife surveys were conducted along the lower Churchill River valley in 2006 (Minaskuat Inc. 2008a). These wildlife habitat association surveys were conducted during the post-breeding season of most species and before the migration or shifts to wintering area/modes of others (8 August to 14 September 2006). Rather than estimating abundance, the purpose of these wildlife surveys was to determine relative levels of use between and within habitat types. Such surveys 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 ability to collect species-specific data. Observations were non-independent, as preferred habitat in which one or more animals remained 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.

Seventy-seven transects (of >3 km in length) representing all habitat types were followed throughout the lower Churchill River valley. Each field team recorded wildlife sign, changes in habitat and time and distance covered in each habitat. Data were recorded and expressed as the number of encounters of a target parameter (e.g., observation, droppings, track/trail, browse, or other) per kilometre of each habitat type. Habitat types were graded as primary, secondary or tertiary for each mammal species based on field observations and existing knowledge/experience.

Small mammal trapping grids were also established in the lower Churchill River valley from 10 to 26 August, 2006. The study team established eight trapping grids that occurred in four pairs throughout the lower Churchill River valley. The location of each pair of trapping grids was selected prior to the surveys to include a variety of habitat types and to permit a comparison between area below and above the limits of the future reservoirs. This timing coincided with post-breeding and prior to the onset of wintering behaviour. Following established techniques used by the study team and other researchers in Labrador (e.g., Simon et al. 1998; 2002), trapping grids comprised 100 trapping stations in a 180 m by 180 m pattern set at lower and higher elevations. Each trap station consisted of two snap traps (Victor Traps) placed within 1 m of each other, with stations spaced 20 m apart. Following the initial day of set up, the traps were checked for three days; on the last day the traps were removed.

A total of 238 small mammals were collected over 4,758 trap nights involving the eight trapping grids. Red-backed vole (*Clethrionomys gapperi*) was the most frequently captured small mammal (166 or 69.7 percent),

followed by masked shrew (*Sorex cinerius*) (32 or 13.4 percent), woodland jumping mouse (*Napaeozapus insignis*) (23 or 9.7 percent) and meadow vole (*Microtris pennsylvanicus*) (17 or 7.1 percent).

Survey for Beaver Colonies in the Lower Churchill River Valley: Environmental Baseline Report (Minaskuat 2008d)

As part of the environmental baseline research for the Lower Churchill Hydroelectric Generation Project, Nalcor Energy completed surveys of beaver (*Caster canadensis*) colonies throughout the watershed. Helicopter surveys examined 63 blocks (4 km^2) during October 2006. Blocks were located at 20 km intervals along the lower Churchill River, from Happy Valley-Goose Bay to Churchill Falls, at randomly selected distances north and south of the lower Churchill River. Blocks were also examined in the vicinity of existing and proposed transmission lines. Most of the blocks were considered "medium" or "poor" habitat for beavers, with only one colony identified in the latter category. A total of 53 colonies were identified but only nine (17 percent) had evidence of a food cache and therefore considered as active. The density of active colonies was 0.04 per km^2 and considered low as compared to elsewhere in North America.

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

Northland Associates Limited (1980b) investigated wildlife use along the proposed transmission corridor from Gull Lake to the Strait of Belle Isle, based on aerial observations of animals and/or tracks, as well as local (expert) knowledge. Aerial surveys were completed during 15 to 16 February and 15 April, 1980. A Cessna 185 aircraft was flown at an altitude of 100 m above ground level (agl) and at speeds of approximately 160 km/h. One navigator/lead observer and one additional observer plus the pilot conducted the surveys, recording all observations within approximately 0.5 km on either side of the aircraft. Survey lines consisted of an outbound flight from the lower 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.

Overall, track numbers and densities were low along the surveyed lines. The furbearer (red fox (*Vulpes vulpes*), river otter (*Lontra canadensis*) and lynx (*Lynx canadensis*)) observations were located all throughout the transmission corridor, and generally associated with water bodies in the Study Area. Results indicated an area of furbearer activity (snowshoe hare (*Lepus americanus*), otter and red fox) near the St. Augustin and Little Mecatina Rivers, immediately south of the transmission corridor. The survey technique did not allow for data to be collected on small mammals.

Other Information Sources

In addition to these sources of information collected by Nalcor Energy, various other published and unpublished reports related to furbearers and small mammals in the province were accessed and incorporated into this report.

A Small Mammal Monitoring Network was initiated by the Newfoundland and Labrador Department of Environment and Conservation (DEC), Wildlife Division, in 2007. Through the cooperation of several stakeholder organizations and consulting companies, information on small mammals is collected and presented in a

consistent fashion. Sites occur throughout the province and involve a three day sampling period between 15 August and 30 September. Established protocol gives equal weight to all habitat types and emphasizes long-term monitoring. Each sampling site consists of eight lines with 15 stations per line and each station has two small mammal traps, for a total of 720 trap nights. Data collected shed insight on changes in populations and distribution including the range expansion of some small mammals. Presently, small mammal trapping occurs at 14 sites on the Island of Newfoundland and 10 throughout Labrador.

As part of the activity associated with the Small Mammal Monitoring Network, Garland (2008) compiled an annotated bibliography of relevant research conducted from 1960 to 2005 within the province. This document serves as an exhaustive list of all studies that were conducted over the 45 year period. This bibliography produced maps depicting small mammal communities (and therefore, ranges) by Ecoregion for both Newfoundland and Labrador based on the compiled studies.

Many other small mammal studies (Folinsbee et al. 1973; Riewe 1973; Simon et al. 1998; 2002) have been conducted at various localities throughout the province, although none have been found that overlap with the proposed transmission corridor. However, inferences may be made based on habitat types in which small mammal studies were conducted and habitat types through which the proposed corridor passes in each region.

2.2.3 Ecological Land Classification Habitat Mapping

As part of the Project's EA, a regional ELC has also been completed for a 15 km wide Study Area that encompasses the proposed and alternative HVdc transmission corridors from Gull Island in central Labrador to Soldiers Pond on Newfoundland's Avalon Peninsula, covering a linear distance of approximately 1,100 km. The ELC is summarized below, but has also been reported and submitted as a separate Component Study for the Project's EIS.

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 with a homogeneous cover and vegetation composition, and spaced as evenly as possible to ensure optimal distribution of ground-verified sites within the Study Area. A total of 404 plots were surveyed throughout the Study Area in Newfoundland and Labrador.

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 a scale of 1:50,000. ELC habitat classifications formed the basis for the habitat mapping exercise for selected furbearer and small mammal species included in this Component Study.

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

ELC Habitat Type	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 portion 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, regional overviews of the presence, abundance and distribution of furbearers and small mammals in the Study Area have been developed and provided for the various geographic regions described in Section 2.1. Habitat use by furbearers and small mammals during breeding was a key focus of the data analyses.

The Island of Newfoundland has only 14 indigenous mammals (Table 2-3). However, over the past 150 years, there have been both accidental and intentional introductions to the Island and there has been a natural movement resulting in range expansion of others (Table 2-3). Most of the small mammals introduced to the Island were indigenous to Labrador.

Table 2-3 Furbearer and Small Mammal Species in Newfoundland and Labrador

Species	Common Name	Newfoundland	Labrador
Furbearers			
Lynx canadensis	Canada Lynx	✓	✓
Canis latrans	Eastern Coyote	✓ Through range expansion in the mid-1980s	✓
Vulpes vulpes	Red Fox	✓	✓
Martes americana	American Marten	✓	✓
Castor canadensis subsp. caecator	American Beaver	✓	✓
Lontra canadensis	Northern River Otter	✓	✓
Ondatra zibethicus	Muskrat	✓	✓
Mustela ermine	Ermine	✓	✓
Mustela vison	Mink	✓ Introduced in 1935	✓
Lepus americanus	Snowshoe Hare	✓ Introduced 1860 to 1880	✓
Lepus arcticus	Arctic Hare	✓	✓
Canis lupus	Grey wolf	Extirpated	✓
Tamiasciurus hudsonicus	Red Squirrel	✓ Introduced in 1963	✓
Tamias striatus	Eastern Chipmunk	✓ Introduced in 1962	-
Glaucomys sabrinus	Northern Flying Squirrel	-	✓
Alopex lagopus	Arctic Fox	-	✓
Erethizon dorsatum	Porcupine	-	✓
Marmota monax	Woodchuck	-	✓
Martes pennant	Fisher	-	Vagrant
Mustela nivalis	Least Weasel	-	Undetermined
Gulo gulo	Wolverine	No conclusive data at this time to suggest that they are present; general status by DEC (2005) *at risk*; *SARA endangered*	No conclusive data at this time to suggest that they are present; general status by DEC (2005) *at risk*; *SARA endangered*
Small Mammals			
Rattus norvegicus	Norway Rat	✓	✓
Microtus pennsylvanicus	Meadow Vole	✓	✓
Mus musculus	House Mouse	✓	✓
Myotis lucifugus subsp. Atrata	Little Brown Bat	✓	✓
Peromyscus maniculatus	Deer Mouse	✓ Introduced prior to 1968	✓

Species	Common Name	Newfoundland	Labrador
Clethrionomys gapperi	Southern Red-backed Vole	✓ First recorded in 1999	✓
Clethrionomys glareolus	Northern Bank Vole	✓ Exotic/alien	✓
Sorex cinerius	Masked Shrew	✓ Introduced in 1958	✓
Microtus chrotorrhinus	Rock Vole	-	✓
Phenacomys ungava	Eastern Heather Vole	-	✓
Condylura cristata	Star-nosed Mole	-	✓
Zapus hudsonicus	Meadow Jumping Mouse	-	✓
Napaeozapus insignis	Woodland Jumping Mouse	-	✓
Dicrostonyx hudsonicus	Labrador Collared Lemming	-	✓
Synaptomys borealis	Northern Bog Lemming	-	✓
Sorex hoyi	Pygmy Shrew	-	✓
Sorex palustris	Water Shrew	-	✓
Lasiurus cinereus	Hoary Bat	✓	-
Myotis septentrionalis	Northern Long-eared Bat	✓	-
Lasiurus borealis	Eastern Red Bat	Accidental	-
Notes: DEC (undated (a)), 2005; *SARA* 2009.			

For the purpose of this report, the definition of furbearer included species managed as such by the province, as well as other medium-sized furbearing mammals such as hare and woodchuck (*Marmota monax*). Small mammal species included mice, voles, shrews, lemmings, bats and rats.

Following the general regional overviews of furbearer and small mammals across the Study Area, a number of key and representative species were subsequently identified upon which to focus the study, representing semi-aquatic and terrestrial furbearers, microtines and species of special conservation status:

- American marten (*Martes americana*) (Newfoundland marten (*Martes americana atrata*)): listed under *NLESA* and *SARA,* they are a first order carnivore and are susceptible to habitat changes;
- wolverine (*Gulo gulo*): listed under *NLESA* and *SARA*;
- red fox: a generalist predator that is found throughout a wide range of habitat types;
- beaver: represent semi-aquatic species and have a widespread distribution; a keystone species as their watershed modification is important for local ecological conditions; and present throughout the year in the Study Area and are potentially vulnerable to disturbances in any season;
- porcupine (*Erethizon dorsatum*): a non-migratory species that is widespread in Labrador and are susceptible to habitat changes;
- red-backed vole: a relatively recent introduction to Newfoundland with an expanding range; an important prey species for Newfoundland marten; and
- meadow vole: occupies a different ecological niche than red-backed vole (meadows and open grasslands versus forested), and represent a traditional prey source for Newfoundland marten.

By selecting a diversity of species that inhabit a wide range of habitat types and ecological niches, changes in distribution and abundance of species in both terrestrial and aquatic environments may be used as measurable parameters of potential environmental effects.

The distribution of these key and representative species in the Study Area is presented in Table 2-4.

Table 2-4 Key and Representative Species (Occurrence by Region)

Furbearer and Small Mammal Species	Lower Churchill River and Lake Melville	Southeastern Labrador	Northern Peninsula	Central and Eastern Newfoundland	Avalon Peninsula
Furbearers					
Marten	✓	✓	✓	✓	-
Wolverine	unlikely	unlikely	-	-	-
Red Fox	✓	✓	✓	✓	✓
Beaver	✓	✓	✓	✓	✓
Porcupine	✓	✓	-	-	-
Small Mammals					
Red-backed Vole	✓	✓	✓ (southern portion)	✓	-
Meadow Vole	✓	✓	✓	✓	✓

Notes:
1. Geographic Regions are indicated in Figure 2-2.
2. Primary sources of information are discussed for each species in Section 3.0.

A description of the available information and existing environmental conditions for key and representative species was developed 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 that may be affecting the status of a species in the region (e.g., hunting, trapping, predation and other disturbances).

Based on this compilation of information, habitat quality was assessed for each key and representative species, where appropriate. Habitat quality was classified as:

- *primary habitat*: provides foraging, protection, nesting and resting habitat;
- *secondary habitat:* provides an abundance of one or more (or marginal amounts of all) of foraging, protection, nesting and resting habitat; and
- *tertiary habitat*: provides marginal foraging, protection or resting opportunities or may only be used during transit.

A series of detailed furbearer and small mammal habitat quality maps were subsequently generated, based on the ELC habitat types identified and mapped by Minaskuat Inc. (2009a) (Table 2-2), for select species. For each species, separate maps are provided for the Southeastern Labrador, Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula regions (as applicable), based on the coverage of the ELC completed for the HVdc transmission corridor. Maps are 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 furbearer and small mammal 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 a general overview of the potential for portions of the Study Area to support particular species. 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 furbearer and small mammal habitat potential mapping should be considered along with the survey data and information from the literature that precedes it.

Also, a key focus of this study is on species that are currently designated as species of special conservation concern under federal (*SARA*) and/or provincial (*NLESA*) legislation. This includes providing information on the likely presence/absence and distribution of such species in the Study Area (based on the various surveys, existing literature, etc.), as well as, where possible and applicable, identifying and mapping potential habitat quality (primary, secondary or tertiary) to support such species across the Study Area. However, for some such species, key habitat preferences and requirements are quite specific and localized, and cannot be mapped at the scale of this Project and ELC. Where potential habitats are mapped for such species, it should be noted that these habitat ratings are not meant to denote “critical habitat” or other habitat definitions as specified in *SARA* or other applicable legislation.

2.3 Study Team

The *Furbearer and Small Mammal Component Study* was conducted on behalf of Nalcor Energy by Stantec Consulting Ltd. 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 2-5. Brief biographical statements, highlighting roles and responsibilities and relevant education and employment experience are provided in Appendix B.

Table 2-5 Study Team

Role	Study Team Member
Project Manager	Perry Trimper
Regional Leads	Perry Trimper
	Tina Newbury
	Elizabeth Way
Lead Report Authors	Tina Newbury
	Perry Trimper
	Karen Rashleigh
Information Collection Support	John Pennell
	James Loughlin
GIS/Mapping	Stephen Rowe
	Carolyn Pelley
	Jackie Bowman
	Erin Marshall
Senior Review	Earle Hickey
Senior Advisor	Colleen Leeder

The Study Team and Nalcor Energy would also like to acknowledge the generous assistance provided by Parks Canada and the Wildlife Division, Newfoundland and Labrador Department of Environment and Conservation, in providing information and mapping for select species.

3.0 RESULTS AND ANALYSIS

Species included in this study include semi-aquatic and terrestrial furbearers (including hares, woodchuck, porcupine and managed furbearer species), and small mammal species (including mice, voles, shrews, lemmings, bats and rats) and species of special conservation status that breed in the following geographic regions of the Study Area: Lower Churchill River and Lake Melville; Southeastern Labrador; Northern Peninsula; Central and Eastern Newfoundland; and the Avalon Peninsula.

The following sections are organized according to species group (i.e., furbearers or small mammals) with an introductory overview of their presence, abundance and distribution in the Study Area, as well as a more detailed presentation of the literature and results of previous investigations in the Study Area for seven key species (identified in Table 2-4).

3.1 Furbearers

Furbearers are generally defined simply as mammals having fur. While the term furbearer is most often associated with species of furbearing mammals that are and have been traditionally harvested and managed in Newfoundland and Labrador, for the purpose of this report, the term furbearer includes species managed as such by the province, as well as other medium-sized furbearing mammals such as hare and woodchuck. These species are discussed below in Section 3.1, as well as more detailed presentation of five key and representative species (i.e., marten, wolverine, fox, beaver and porcupine).

3.1.1 Regional Overviews

The following provides a general overview of the presence, abundance and distribution of furbearers in the Study Area by geographic region.

3.1.1.1 Lower Churchill River, Lake Melville and Southeastern Labrador

The Lower Churchill River, Lake Melville and the Southeastern Labrador geographic regions comprise the entire 15-km wide Study Area in Labrador. There are 18 furbearer species in Labrador, with two additional species (wolverine and least weasel (*Mustela nivalis*)) unconfirmed (Table 2-3). The lower Churchill River valley and its tributaries may be particularly important for aquatic and semi-aquatic furbearer species, as it is a dominant feature on the landscape. Available Information on furbearers in Labrador is based on dedicated studies, as well as incidental observations and is summarized below:

- Observations of furbearers and/or furbearer sign were recorded across habitat types during wildlife habitat association surveys along the lower Churchill River valley during 2006 (Minaskuat 2008c). Porcupine and their sign were most commonly recorded, with 395 observations largely comprised of browse sign. Six individuals were observed as well as droppings and tracks. Porcupine were found to use a variety of mature forested habitat, as browse was commonly observed in fir-spruce, spruce (wet site), mixed (spruce dominant), mixed (fir dominant) and mixed deciduous. A total of 27 beaver observations were made and were most often associated with wetland and riparian habitats. The majority of observations were browse, although there were two observations of individuals. Other observations included droppings and tracks. The majority of the 82 red fox observations were of tracks observed

primarily in mixed deciduous and riparian habitats. Two individuals were observed during the survey period. Observations of marten were scarce (as expected given their behaviour and the difficulty of detecting sign without snow cover), with just two observations of marten droppings found throughout the surveys. Red squirrel (*Tamiasciurus hudsonicus*) evidence was common (n=2,492), mostly in mixed (spruce dominant) and mixed (fir dominant) habitats. Other species that were recorded along the lower Churchill River valley were grey wolf (*Canis lupus*) (n=119), muskrat (*Ondatra zibethicus*) (n=26), mink (*Mustela vison*) (n=six), river otter (n=16) and snowshoe hare (n=1,254) (Minaskuat 2008a).

- Observations during the Lower Churchill Hydroelectric Generation Project ELC field surveys (Minaskuat Inc. 2008b, 2008c) yielded few observations of furbearer sign that included: grey wolf (n=16); red fox (n=four); beaver (n=four); muskrat (n=one); river otter (n=three); porcupine (n=four); and snowshoe hare (n=11). Sign of mink or marten were not documented.
- Recent surveys for beaver colonies in the lower Churchill River valley (Minaskuat Inc. 2008d) indicated relatively low (0.04/km^2) beaver abundance as compared with locations elsewhere in North America. Also, only 17 percent of the colonies observed were identified as active and the majority of them deemed to be in medium to poor habitat quality. There were no active colonies detected along the proposed transmission corridor (between Churchill Falls, Gull Island and Muskrat Falls), and seven inactive colonies. Habitat ratings of sites along or near the proposed transmission corridor were rated as 'medium' quality.
- Simon et al. (1999a) assessed the age distribution and sex ratios of marten trapped in accessible versus relatively inaccessible areas near Happy Valley-Goose Bay. It was noted that marten in easily accessible areas were harvested more intensively and were thought to be maintained by recruitment of dispersed juveniles from less accessible areas. It was shown that the proportion of adult females trapped did not increase as the season progressed and that intensively exploited marten population would be more likely enhanced by formal reserves and area closures rather than a reduction in the length of the trapping season.
- The relationship between small mammal densities and populations of marten based on fall and winter diet was examined in central Labrador by Simon et al. (1999b). The primary prey of marten in central Labrador was the red-backed vole followed by snowshoe hare. A decrease in small mammal consumption in 1996-1997 by marten was followed by a reduced marten harvest in 1997-1998, which indicated that a food shortage in 1996-1997 contributed to a reduced harvest in 1997-1998. This suggested that marten had a strong reliance on small mammals, especially red-backed vole and snowshoe hare, as a food source.
- Smith and Schaefer (2002) examined habitat selection and home range of marten in Labrador. They determined marten avoided areas of low productivity and canopy cover, but showed no selection preference for tree species composition or cover among productive forest. It was also shown that the home range area was positively related to the proportion of bog and less productive, scrub forest in the home range, but not significantly related to any of the tested factors. That is to say, that the more bog and scrub habitat in an area, the larger the home range for marten in the same area.
- Porcupine in Labrador have much larger home range sizes (up to 10 times greater) compared with elsewhere in the range of this species (Schmelzer and Fenske undated).
- S. Fudge and Associates (1989) conducted an age analyses of marten carcasses provided by trappers and examined small mammal snap trapping results at different locations in Labrador, over the course of a region wide decline. Regular fluctuations of small mammal populations are a common occurrence in Labrador and other northern ecosystems and the dependence of marten on such a prey base, combined

with an unequal sex ratio (favouring females) and a low proportion of juveniles, indicated that the population of this predator was about to decline.

3.1.1.2 Island of Newfoundland (General)

Historically, the Island of Newfoundland was home to 10 native mammals, nine of which were furbearers. Extinction, range expansion and introduction of furbearer species have altered the species composition in Newfoundland over the last 150 years.

The first record of species introduction (snowshoe hare) occurred during the period 1860 to 1880; wolf became extinct in the early 1900s; mink were introduced to the Island of Newfoundland for the purposes of fur farming in 1934 (Northcott et al. 1974) and escapees from mink farms, as well as intentional introductions by government in 1948, resulted in the widespread dispersal of the species (Northcott et al. 1974); and coyotes (*Canis latrans*) arrived on the Island through natural range expansion via pack ice on the Port au Port Peninsula in 1985 and by 2000 were widely dispersed across the Island (DEC, undated(b)).

At present, there are 13 furbearer species that are known to occur in Newfoundland (Table 2-3).

3.1.1.3 Northern Peninsula

Furbearer species that occur throughout the Northern Peninsula region include: coyote, red fox, river otter, ermine (*Mustela ermine*), mink, beaver, lynx, snowshoe hare, red squirrel and eastern chipmunk (*Tamias striatus*). Arctic hare (*Lepus arcticus*) are also found in isolated high elevation locations in the region. Marten occur at one location in the vicinity of the Main River watershed. The adjacent area is considered peripheral marten habitat (Schmelzer 2008).

Findings of relevant studies include:

- Gerrow (2002) examined Newfoundland marten status in the Greater Gros Morne Ecosystem using bait stations and live trapping sites to confirm presence. Of note, only one marten was captured in the Greater Gros Morne Ecosystem despite 597 trap nights and no marten were captured in the southern park area despite the fact it contained large amounts of habitat presumed suitable for marten. It was suggested that re-introduction may be the only management solution to re-establish marten in Gros Morne. Also, accidental mortality must be reduced or eliminated through management or method modification and forested areas must be managed in such as way to provide suitable habitat to aid in the re-establishment of marten in the Park.

- O'Donoghue (1996) conducted a preliminary examination of factors affecting the abundance of snowshoe hare on the Island of Newfoundland. Population cycles, abundance, and limiting factors that may have an effect (including predatory pressure from humans, lynx, coyotes, raptors and red squirrels) on hare were explored. Competition for winter browse with moose (*Alces alces*) was also examined along with the effects of forest harvesting practices and subsequent effects on habitat. It was concluded that hare populations have remained low since the early 1980s as a result of human factors (forestry and hunting), moose densities, and increase in predation from coyotes and red squirrels that are the traditionally cyclic nature of this species.

- Much research has been completed regarding old growth forest, timber harvesting, silviculture and their effects on marten habitat in the Western Newfoundland Model Forest (Lundrigan and Fillier 1995;

Schneider and Yodzis (no date); Sturtevant and Bissonette 1996; Sturtevant et al. 1996). Important characteristics of suitable marten habitat include coarse woody debris and small mammal abundance.

3.1.1.4 Central and Eastern Newfoundland and Avalon Peninsula

Coyote, red fox, beaver, lynx, snowshoe hare, river otter, ermine, mink, red squirrel and eastern chipmunk are found throughout Central and Eastern Newfoundland. Results of relevant studies/documents include:

- There are two areas where marten occur in the Central and Eastern Newfoundland region (in the vicinity of Red Indian Lake and Terra Nova National Park), but this species is believed to be absent from the Avalon Peninsula.
- Mink were first introduced to the Island of Newfoundland in 1934 (near St. John's) but shortly thereafter a mink farm was also established near Springdale (Northcott et al. 1974). The first record of a wild trapped mink occurred near Springdale in the 1938-1939 season (Northcott et al. 1974). The mink exhibits high ecological adaptability and is now found throughout Newfoundland in areas that are marshy, provide prey species (e.g., amphibian, bird and fish) and suitable habitat for denning (Northcott et al. 1974).
- Gosse et al. (2005) assessed home-range and habitat use by marten in eastern Newfoundland, specifically the Terra Nova National Park region. Analyses of the annual home range area for 23 resident marten in this area showed considerably larger territories than those maintained by marten across most of their geographical range. This is suggested to reflect the low diversity and abundance of small mammals available as prey in Terra Nova National Park that were commonly found elsewhere within the range for this species.
- Gosse and Hearn (2005) examined the seasonal diet of the Newfoundland marten from scat and stomach contents collected from 1983 to 2003 to determine the frequency of food types during winter and summer. It was found that meadow voles were the most prevalent food item for marten; however, there was a greater reliance on snowshoe hare as a prey species during winter. When the breadth of the diet was compared between seasons, it was found that it was greatest in the winter, possibly due to the lower availability of meadow vole.

In general, most of Newfoundland's furbearing species range Island-wide, with the notable exceptions of the Arctic hare and Newfoundland marten. Newfoundland marten exist primarily in isolated pockets on the northern peninsula, western Newfoundland and in the eastern part of the province, but are absent from the Avalon Peninsula.

3.1.2 Key and Representative Furbearer Species

The following section provides a general overview of the presence, abundance and distribution of furbearers in the Study Area. Key and representative species of furbearers identified were marten (American and Newfoundland), wolverine, red fox, beaver and porcupine.

Combined, these species represent semi-aquatic and terrestrial species, species with a wide-ranging distribution, as well as species with limited habitat preferences, and provincially and/or federally protected species.

3.1.2.1 American Marten

This house cat-sized member of the weasel family is an omnivore that preys on mammals such as snowshoe hare, voles, and shrews (CWS/CWF 1977). Also included in their diet, when available, are berries, insects and carrion. As agile climbers, arboreal resources such as birds and their eggs may also be taken opportunistically (DEC undated (c)). This tree-climbing ability is also considered important for predator (e.g., Great-horned Owl (*Bubo virginianus*), lynx and red fox) escape and use of tree cavities (i.e., may use woodpecker cavity) for natal dens (CWS/CWF 1977). Generally, marten are solitary animals with female home ranges (3 to 5 km^2) considerably smaller than those of males, which may be double this in area (CWS/CWF 1977). Females first mate at approximately three years of age and will den in cavities or crevasses (i.e., talus slopes). Mating occurs in July but young (one to five) are not born until the following March or April, as this species experiences delayed implantation (CWS/CWF 1977). Subnivean access to the small mammal prey base is considered an important habitat quality, as this species is active year round. The unique subspecies in Newfoundland has likely inhabited the Island since the latest glaciation over 10,000 years ago (CWS/CWF 1977). The pelage of this subspecies somewhat differs from its mainland counterpart in that the throat is a rufous colour as compared with the paler fur of mainland species.

American marten exist throughout Labrador in suitable habitat and once-occupied old-growth forests throughout the Island of Newfoundland (Forsey et al. 1995). Since the mid-1950s [or earlier (E. Herdman, pers. comm.)], marten populations on the Island of Newfoundland have been reduced considerably, as a result of habitat loss (industry), trapping and snaring (Forsey et al. 1995) [although trapping for marten has not been permitted on the Island since 1934 (DEC undated (c))]. This Newfoundland population of American marten was previously listed as *Endangered*, but as of 2007 was listed as *Threatened* under *SARA* and the *NLESA*. Currently, the Island population is believed to be rebounding, with numbers somewhat higher in most recent population estimates (Schmelzer 2008).

As a listed species, *SARA* requires critical habitat for marten be identified and protected, and is defined as habitat that is critical to a species' survival or recovery (*SARA* 2008). Critical habitat for marten has been identified in a draft (but as yet unreleased) recovery plan for this species.

Primary Sources of Information

Nalcor Energy completed late winter/early spring snow tracking surveys of marten and other wildlife throughout the lower Churchill River valley during 2006 (Sikumiut 2007). Studies were conducted on the effects of trapper access on marten and fall and winter diets of marten throughout Labrador in the 1980s and 1990s (S. Fudge and Associates 1989; Simon et al. 1999a, 1999b). Research on home range and habitat selection of marten was carried out in southeastern Labrador (Smith and Schaefer 2002). Research conducted in Quebec is also discussed with regards to management implications for marten in areas where forest harvesting occurs (Potvin et al. 2000).

Due to the special status of marten in Newfoundland, there has been extensive research on this subspecies, including Thompson and Curran 1995, Sturtevant et al. 1996, Gerrow 2002, Gosse and Hearn 2005, Gosse et al. 2005 and Hearn et al. 2005. Habitat use and home range of marten in and around Terra Nova National Park on the Island of Newfoundland was studied by Gosse et al. (2005). Gosse and Hearn (2005) analyzed scat and stomach contents of Newfoundland marten collected over a 20 year period.

Existing Conditions and Status

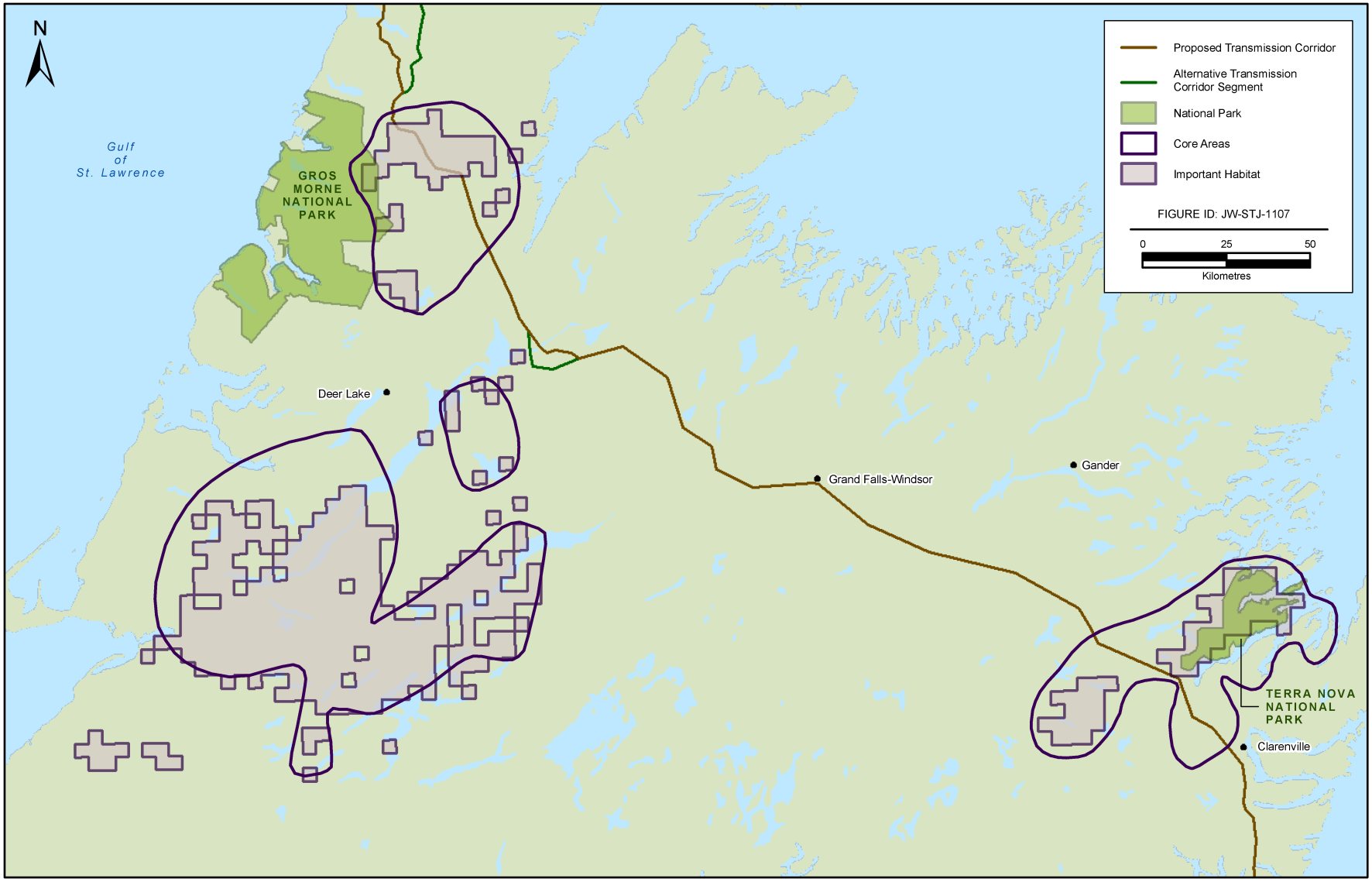
Historical trapping data indicate an apparent decline of marten in the lower Churchill River watershed in the 1950s (Northcott 1961). Causes were unknown, but likely related to the unavailability of suitable prey. Previous research in support of the Lower Churchill Project during 1979 involved ground surveys in a variety of habitat types throughout the lower Churchill River watershed. For that study, marten were not common near the river but moderately abundant on the ridges (Northland Associates Ltd. 1980a). Local residents reported that marten were not abundant in the lower Churchill River watershed at that time. These informants indicated the area west of Winokapau Lake was the only place where marten were common in the valley. On the eastern side of the valley in the Lake Melville area, Luttich and Folinsbee (1975) stated that marten had decreased in abundance and were not commonly trapped.

In areas with extensive road networks, such as the Upper Lake Melville area, age and sex ratios provided by trappers suggest that marten in this region have been over-harvested. Comparatively, areas with minimal access do not experience over harvesting (Simon et al. 1999a).

Marten were first re-introduced to this area in the early 1980s (Bateman 1984) and the first population estimate for marten on the Island of Newfoundland was made in 1985, with estimates as high as 800 animals (Snyder and Hancock 1985). In 1988, the population was estimated at approximately 300 animals (Bissonette et al. 1988) and current estimates indicate a population size of 300 to 600 animals [Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2007]. Currently, there are five subpopulations on the Island distributed among three core areas (near Main River, Terra Nova and west-central Newfoundland) that overlap or are adjacent to the Study Area (Figure 3-1).

Core areas are estimates based on visual stratification of locations of adult animals, and includes data from live trapping, accidental captures, radio-telemetry, bait stations and sightings, covering an area of 11,238 km^2 (Schmelzer 2008). Important habitat for marten as identified by the Wildlife Division is depicted in Figure 3-1 and may be considered "analogous to an area of [marten] occupation" and depicted visually based on locations of "resident marten in areas of suitable habitat" (E. Herdman, pers. comm.). Peripheral marten areas have also been identified adjacent to these three core areas, based on distribution of both adult and juvenile Newfoundland marten (i.e., habitat use), and account for an additional 12,145 km^2 (Schmelzer 2008). Using all data available (e.g., trapper records, effort and density estimates from many studies) over several decades, it has been shown that core and peripheral areas have increased in size considerably in recent years, relative to the very small areas that were identified when marten were at their lowest numbers (E. Herdman, pers. comm.; Schmelzer 2008).

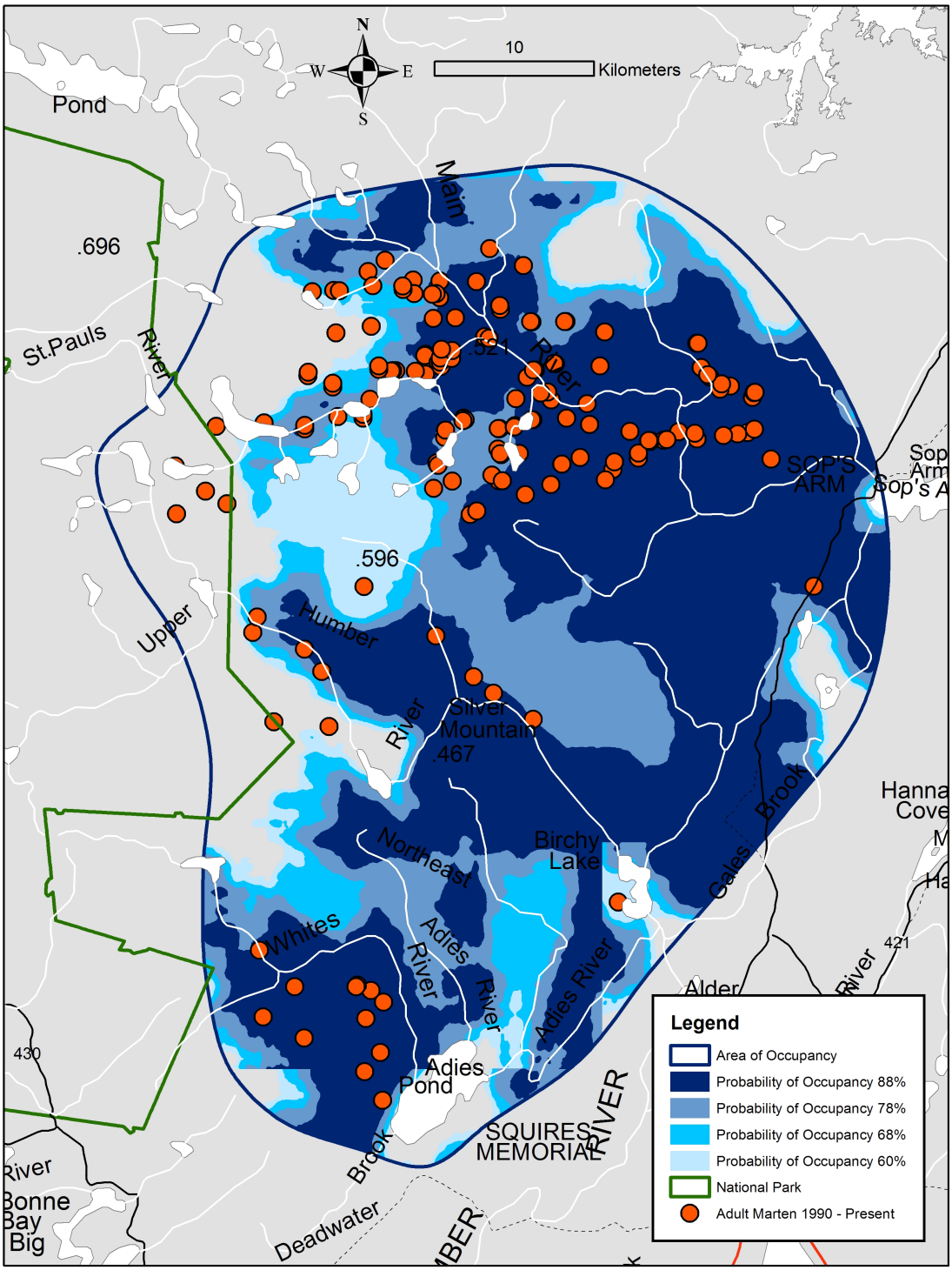
Figure 3-1 Marten Core Areas and Important Habitats in Relation to the Study Area in Newfoundland



Source: Newfoundland and Labrador Wildlife Division.

The core population of marten on the Northern Peninsula is concentrated around the Main River, adjacent to Gros Morne National Park (Figure 3-2). This area (2,177 km^2) has suitable marten habitat over 60 percent of the landscape and as a result, has the ability to support more marten than is currently documented there. This may be important for future recovery of marten on the Island (Schmelzer 2008).

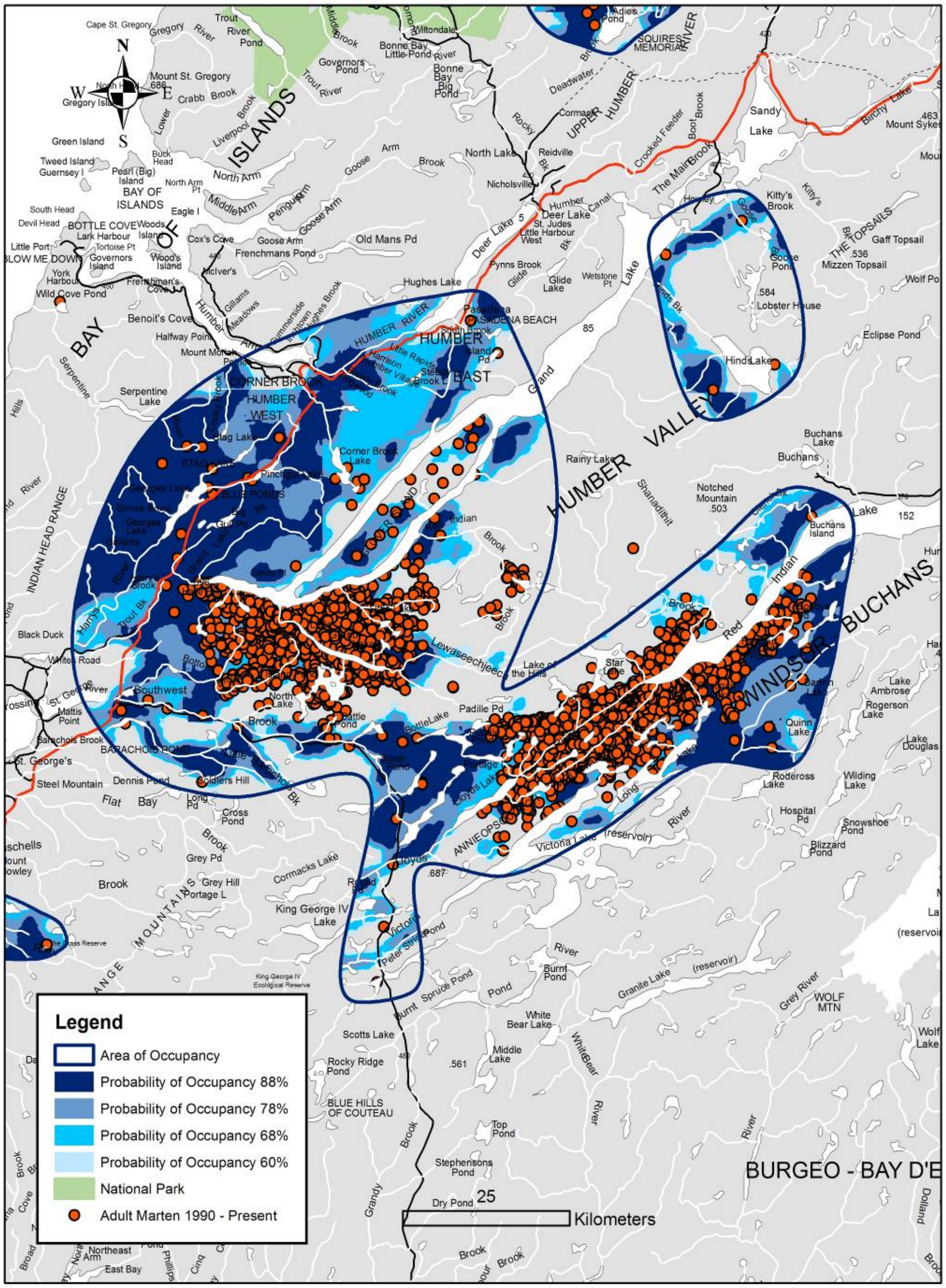
Figure 3-2 Core Area for Marten in the Main River Area, Northern Peninsula



Source: Newfoundland and Labrador Wildlife Division.

The Little Grand Lake/Red Indian Lake marten population encompasses a large area in west-central Newfoundland (6,232 km^2) (Figure 3-3). Also included is a smaller core area just south of Sandy Lake with four adult marten locations documented between 1990 and 2007. Provisional, public and wildlife reserves aid in preventing incidental trapping of marten in this area. The Little Grand Lake/Red Indian Lake core area (specifically, the smaller core area south of Sandy Lake) is located in the western part of the province, just south of the Study Area and does not overlap with the transmission corridor.

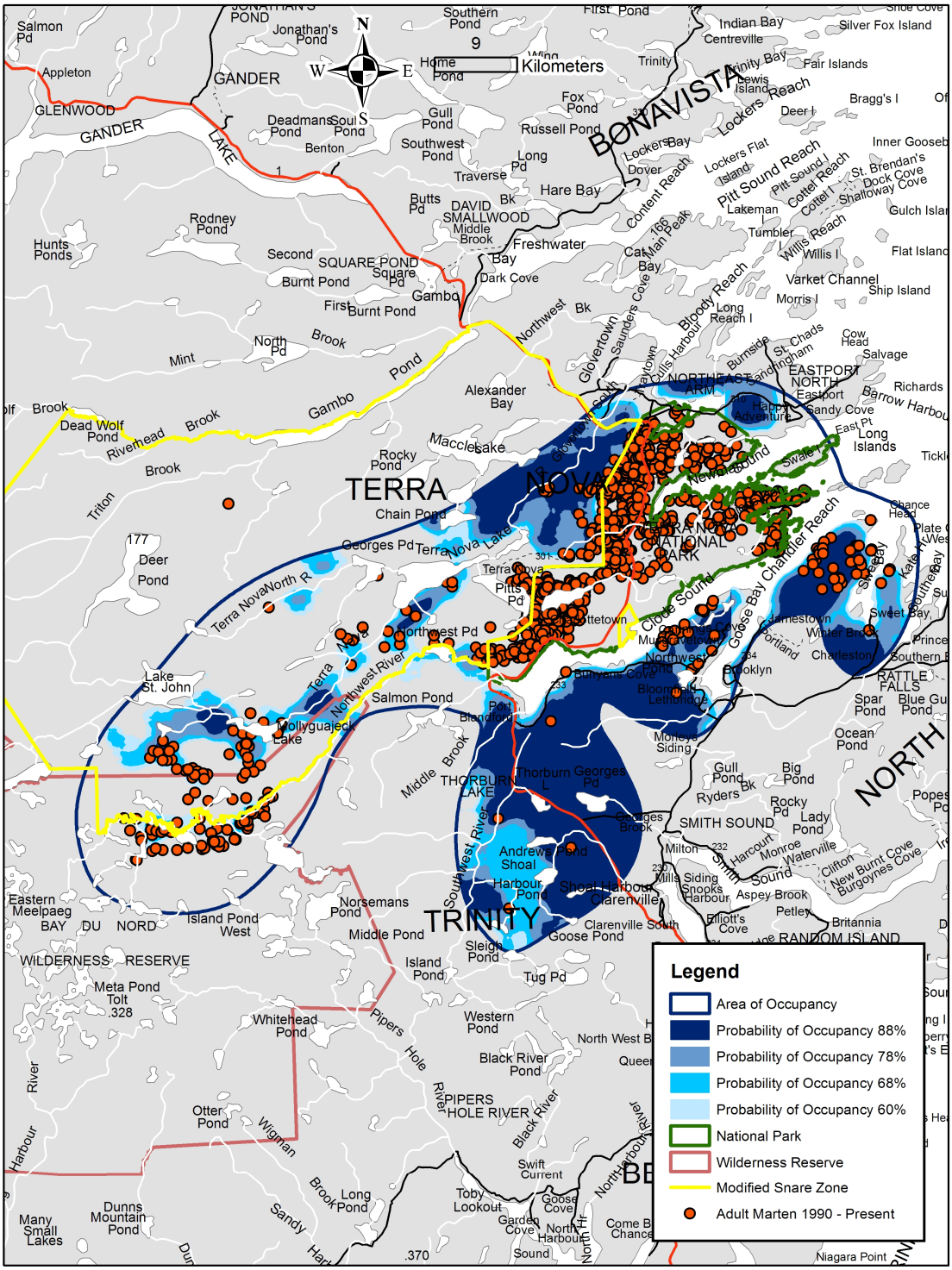
Figure 3-3 Core Area for Marten in West-Central Newfoundland



Source: Newfoundland and Labrador Wildlife Division.

The Terra Nova marten core area (2,829 km^2) encompasses Terra Nova National Park in the eastern part of the province and is approximately 10 km to the north of the Study Area (Figure 3-4). The marten population in this region consists of 25 to 30 individuals and is considered low-density (Gosse et al. 2005).

Figure 3-4 Core Area for Marten in Terra Nova National Park, Eastern Newfoundland



Source: Newfoundland and Labrador Wildlife Division.

Closures and wildlife reserves help to manage marten populations on the Island (a series of provisional, public and wildlife reserves exist in Newfoundland). Best management practices for marten were modified in 2007 by the DEC, Wildlife Division (E. Herdman, pers. comm.) and outline a new approach by identifying categorical areas 1 through 3, in which different use of traps are permitted in an effort to permit trapping while reducing negative impacts on marten. As an example, Terra Nova National Park is closed to trapping and land-based traps are not permitted in the adjacent Terra Nova Marten Study Area, following the successful relocation of marten to the 2,829 km^2 area approximately 20 years ago (Gosse et al. 2005).

Habitat Association and Distribution in the Study Area

Marten populations are closely linked with small mammal and snowshoe hare prey base. Simon et al. (1999b) noted a reduction in total marten harvest as well as female to juvenile ratios following a decrease in small mammal numbers in central Labrador. The importance of snowshoe hare as prey source for Newfoundland marten in winter has been documented (Bateman 1986), but the marten studied by Simon et al. (1999b) did not compensate in a year with low small mammals by increasing consumption of hare.

Smith and Schaefer (2002) indicated marten showed preference for productive forests over non-productive forests in Labrador, but no preference for composition within productive forest. This suggested that age and structure might have been more important for Labrador marten than forest type. Baseline studies along the lower Churchill River valley in support of the Lower Churchill Hydroelectric Generation Project found that marten were the most abundant predator, noting 77 observations of marten, with track densities of 0.8 to 1.3 per km on all transects combined and 0 to 2.28 per km on individual transects (Sikumiut 2007). The highest densities of marten tracks occurred in open and closed black spruce habitats, while no observations were made in black spruce/bog habitat (Sikumiut 2007).

Marten in Newfoundland have a generalist foraging strategy – their diet varies seasonally with availability of prey and berries. In a comprehensive study by Gosse and Hearn (2005) in which scats and stomach contents collected over a 23 year period in Newfoundland were analyzed, it was found that meadow vole were the most prevalent prey source in both summer (80 percent) and winter (47.5 percent). Though note that current distribution and availability of meadow vole may be affected by the recent occurrence of red-backed vole on the Island (Morris 1969). Marten diet was broader during winter, with snowshoe hare comprising 28 percent of their diet (Gosse and Hearn 2005), and during winter (but not summer) marten moved in response to snowshoe hare distribution (Gosse et al. 2005). Marten diets were also found to include insects, passerines, grouse, ptarmigan, eggshells, red-backed vole, fish, vegetation and carrion (Martin 1994; Gosse and Hearn 2005). Plants found in marten scat in Newfoundland include creeping snowberry (*Gaultheria hispidula*), wild sarsaparilla (*Aralia nudicaulis*), blueberry (*Vaccinium spp*.), bunchberry (*Cornus canadensis*), common raspberry (*Rubus idaeus*) and three-leaf solomon's seal (*Smilacina trifolia*) (Gosse and Hearn 2005). Berries were the second most important food type for marten in summer (Gosse and Hearn 2005).

Marten diet varies considerably in different geographic areas (Martin 1994) and the availability of food may be the most crucial factor affecting marten distribution (Mech and Rogers 1977). The spatial dynamics of marten are linked with cyclic populations of small mammal prey (Helldin 1999). During the low part of the cycle, home ranges tend to increase in size (Thompson and Colgan 1987) so they can secure enough food resources during the shortage. However, Smith and Schaefer (2002) suggested home ranges in southeast Labrador were large because habitat was generally sub-optimal, rather than due to low prey abundance.

Habitat selection by marten depends on the availability of dense canopy forest patches within a matrix of bogs and scrub (Smith and Schaefer 2002). Marten favour and are most successful in continuous late-successional coniferous forests (Buskirk 1992; Buskirk and Ruggiero 1994; Poole et al. 2004). Mature coniferous habitat is important because it provides the vertical and horizontal structure thought to be necessary for marten, regardless of tree species composition (Bowman and Robitaille 1997). This structure provides access to subnivean (under-snow) areas in winter for hunting. Buskirk and Powell (1994) postulated that this preference was greater in winter than in summer, due to higher vulnerability to predators on a snow surface.

Although often linked to coniferous trees, marten may not show selection for tree species composition or cover within productive forests (Smith and Schaefer 2002). However, marten have not been associated with deciduous forests over forests with a substantial conifer component (Buskirk and Ruggiero 1994). Chapin et al. (1997) detected no selection preferences among coniferous, deciduous, or mixed forest types during winter in Maine.

Several researchers have reported that marten require overstory canopy closure above certain thresholds for suitable habitat. Koehler and Hornocker (1977), Spencer et al. (1983), Thompson and Harestad (1994) and Fuller and Harrison (2005) considered 30 percent as the minimum amount of closure considered as habitat. The threshold for habitat is somewhat arbitrary and dependent on the definition of what constitutes habitat. It also depends on the geographic area of study, as ecotype preferences and adaptations vary for marten across its North American range. The threshold of 20 percent canopy closure in southeast Labrador (Smith and Schaefer 2002) is the most applicable for the Project due to its proximity to the lower Churchill River watershed.

Home ranges can be tens of square kilometres, with males occupying larger home ranges than females (Smith and Schaefer 2002; Gosse et al. 2005). The size of the range for females is a reflection of the food resources, while home range size of males is determined by the distribution of females (Sandell 1989). In southeastern Labrador, home-range size has been estimated at 45.0 km² for males and 27.6 km² for females – more than double the previously recorded home range sizes for marten. The home range size of the marten in the lower Churchill River watershed may be smaller than these values, given the higher quality of habitat and greater abundance of resources (Nalcor Energy 2009). Based on multi-year study (1996 to 2003) of radio-collared marten in Terra Nova National Park, home range size of animals in this area (estimated at 15.2 to 29.5 km^2) were found to be significantly larger than most across their geographic range, believed to be compensatory for a low meadow vole population in that area (Gosse et al. 2005). Habitat use by marten was consistent with other studies, indicating that structurally complex forests provide necessary predator escape, prey and denning opportunities and that open areas are avoided (Gosse et al. 2005).

Table 3-1 summarizes evidence of marten collected during ELC surveys along the transmission corridor in 2008, in relation to habitat classification. This information may provide an indication of the relative use of habitat types within the Study Area throughout multiple seasons. Evidence of marten (i.e., scat) were minimal and associated with only two habitat types in Labrador. There were no observations of live animals during surveys.

Table 3-1 Observations and/or Evidence of Marten in Relation to Habitat Type Along the Transmission Corridor, July and August 2008

Habitat Type	# Sites with Observations / Total Number of Sites	Abundance Rating	Comments
Newfoundland			
Alpine Vegetated	0/14	-	-
Burn	0/3	-	-
Conifer Forest	0/86	-	-
Conifer Scrub	0/24	-	-
Cutover	0/18	-	-
Kalmia Lichen	0/25	-	-
Mixedwood Forest	0/26	-	-
Open Conifer Forest	0/10	-	-
Rocky Barrens	0/8	-	-
Wetland	0/55	-	-
Labrador			
Burn	0/5	-	-
Conifer Forest	2/18	2	scat
Conifer Scrub	0/5	-	-
Hardwood Forest	0/2	-	-
Lichen Heathland	0/5	-	-
Open Conifer Forest	2/9	2	scat
Wetland	0/19	-	-

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 (Minaskuat Inc. 2008a).

Table 3-2 summarizes primary, secondary and tertiary habitat quality for marten. Primary habitat is identified as the conifer forest habitat type and occupies 1,200 km^2 (13.4 percent) of the Northern Peninsula and Central and Eastern Newfoundland sections of the Study Area on the Island, and 1,209 km^2 (19.5 percent) in the Labrador portion of the Study Area.

Secondary habitat is represented by the black spruce and lichen forest, open conifer forest, conifer scrub, hardwood forest and mixedwood forest habitat types. The Newfoundland portion of the Study Area comprises 3,544 km^2 (39.6 percent) secondary habitat. There is an estimated 2,778 km^2 (44.9 percent) of secondary habitat in the Labrador Study Area.

The remaining habitat types in Table 3-2 were classified as tertiary, based on the provision of limited foraging, protection or resting opportunities.

Note that the habitat area percentages discussed and mapped in the followings sections (including by Ecoregion) are for the 15 km wide ELC Area.

Table 3-2 ELC Habitat Type and Relative Quality for Marten

Habitat Type	Habitat Quality	Notes
Alpine Vegetated	Tertiary	Lack of vertical and horizontal structure
Black Spruce and Lichen Forest	Secondary	Vertical structure is marginal
Burn	Tertiary	Will use these areas for forage if adjacent to mature, coniferous forest
Conifer Forest	Primary	Cover and both vertical and horizontal structure are important (Bowman and Robitaille 1997; Smith and Schaefer 2002; Gosse et al. 2005)
Conifer Scrub	Secondary	Based on association with small mammals
Cutover	Tertiary	Lack of vertical and horizontal structure
Exposed Bedrock	Tertiary	Lack of vertical and horizontal structure
Hardwood Forest	Secondary	Labrador only (Chapin et al. 1997)
Kalmia Lichen/Heathland	Tertiary	May forage on berry species in years of small mammal crashes
Lichen Heathland	Tertiary	Lack of vertical and horizontal structure
Mixedwood Forest	Secondary	Where coniferous forest dominates mixedwood would rate as primary
Open Conifer Forest	Secondary	Cover and vertical/horizontal structure are important (Bowman and Robitaille 1997; Smith and Schaefer 2002; Gosse et al. 2005); also based on association with vole species
Rocky Barrens	Tertiary	Lack of vertical and horizontal structure
Scrub/Heathland/Wetland	Tertiary	Lack of vertical and horizontal structure
Wetland	Tertiary	Lack of vertical and horizontal structure

Notes:
1. Habitat types are described in Table 2-2.
2. Habitat quality is described in Section 2.2.4.

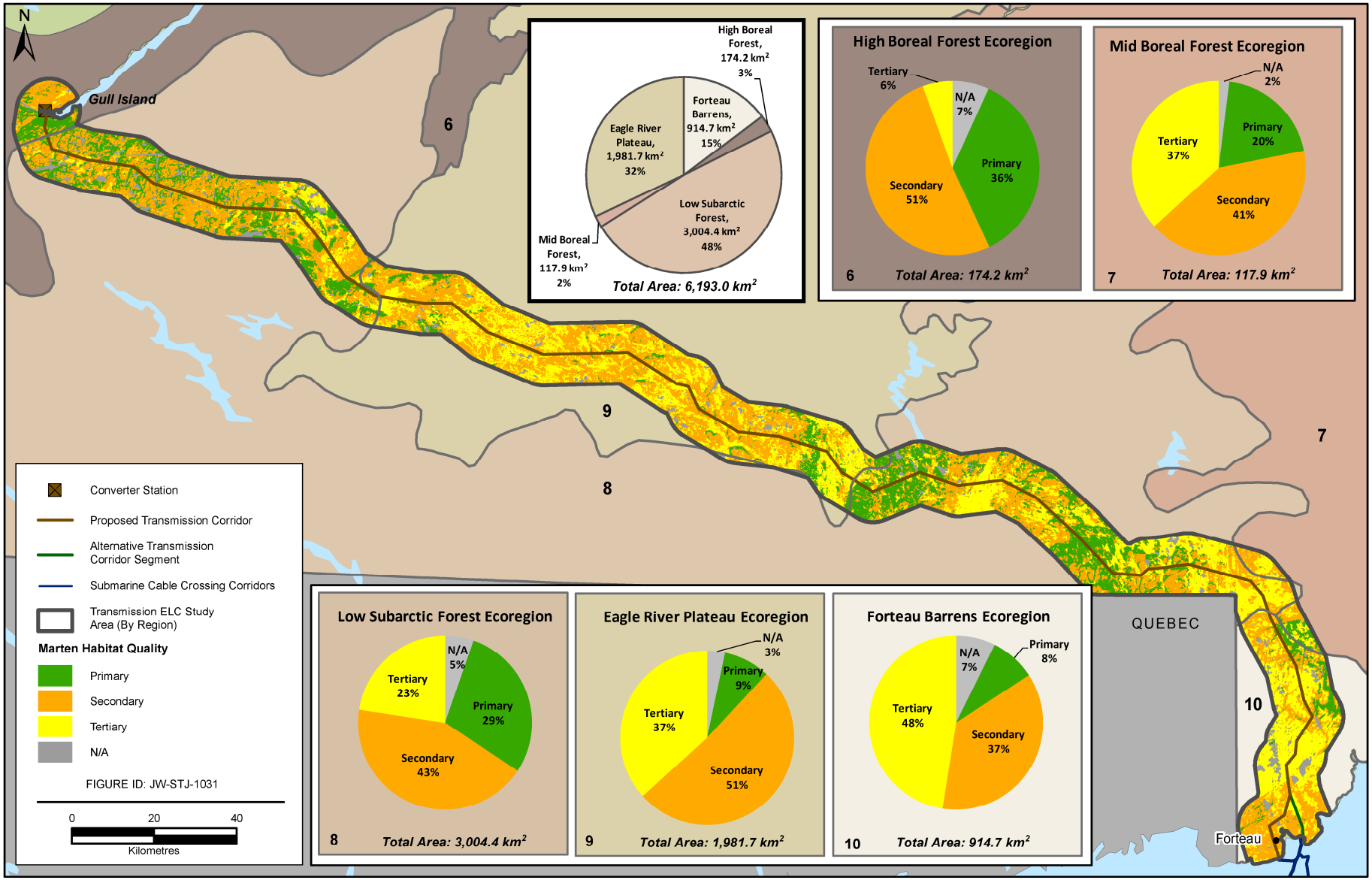
Lower Churchill River and Lake Melville

Although the lower Churchill River valley has much primary and secondary habitat for marten and therefore the potential for marten to inhabit this region, only two incidences of marten sign (i.e., scat) were detected during general wildlife surveys along the lower Churchill River valley in 2006 (Minaskuat 2008a). Based on information compiled for the Lower Churchill Hydroelectric Generation Project, 54.6 percent of habitat in this area can be classified as primary marten habitat, 24 percent as secondary habitat and six percent is considered tertiary habitat (Nalcor Energy 2009).

Southeastern Labrador

The Low Subarctic Forest Ecoregion occupies the largest portion of the Study Area in Southeastern Labrador, 29 percent of which is comprised of primary habitat for marten (Figure 3-5). Primary habitat in the Study Area in the two other major Ecoregions in the Southeastern Labrador Study Area is relatively limited (9 and 8 percent within the Eagle River Plateau and Forteau Barrens Ecoregions, respectively). Higher proportions of primary habitat (20 and 36 percent) are found in the remaining two Ecoregions in this area (Mid Boreal Forest and High Boreal Forest, respectively) but these comprise a very small proportion (5 percent) of the Study Area. Much of this region provides suitable secondary habitat for marten, with between 37 percent and 51 percent found throughout the Ecoregions.

Figure 3-5 Marten Habitat Quality: Southeastern Labrador



Northern Peninsula

The Northern Peninsula in general offers relatively low amounts of primary marten habitat, with small concentrations located in the Study Area near the northern and southern boundaries of the Northern Peninsula Forest and Long Range Barrens Ecoregions (Figure 3-6). The Northern Peninsula Forest Ecoregion comprises 50 percent of this region of the Study Area, 27 percent of which is primary marten habitat. Primary habitat also occupies 21 percent of the Long Range Barrens Ecoregion (which comprises 44 percent of the region) and the Strait of Belle Isle Ecoregion (6 percent of the Northern Peninsula Study Area) provides 14 percent of primary habitat for marten. Secondary habitat represents 38, 32 and 24 percent of the Study Area in the Strait of Belle Isle, Northern Peninsula Forest and Long Range Barrens Ecoregions, respectively. Tertiary habitat is relatively high throughout the Study Area in this region, ranging from 27 to 47 percent of Ecoregions on the Northern Peninsula.

Central and Eastern Newfoundland

The Central and Eastern Newfoundland region of the Study Area in general offers relatively little primary habitat for marten (7, 5 and 0 percent in the Maritime Barrens, Central Newfoundland Forest and Long Range Barrens Ecoregions, respectively) (Figure 3-7). Moderate proportions of secondary habitat are found throughout the region (up to 47 percent in the Central Newfoundland Forest Ecoregion, which comprises 92 percent of this region of the Study Area). Tertiary habitat is widely distributed and comprises 80, 55 and 41 percent of the Study Area in the Long Range Barrens, Maritime Barrens and Central Newfoundland Forest Ecoregions, respectively.

Avalon Peninsula

Marten are not found on the Island of Newfoundland's Avalon Peninsula (Schmelzer 2008).

Limiting Factors

Marten are first order carnivores in that they have few natural predators in Labrador aside from the fisher (*Martes pennanti*), which occurs west of the lower Churchill River watershed. Lynx, Great Horned Owl and Golden Eagle (*Aquila chrysaetos*) are other species (in the watershed) identified as occasional predators of marten (Banfield 1987).

The trapping season for marten in the Labrador East furbearer zone is typically from October 15 to March 20 and from November 1 to March 20 in the Labrador West furbearer zone. The number of licensed trappers in Labrador fluctuates based on the price of furs; current estimates provided by the Wildlife Division place the number of trappers at approximately 400 (Nalcor Energy 2009). The preferred species for trappers is marten, both in terms of number taken and market value. Trapping pressure and habitat loss have not been an important factor on the marten in Labrador to-date, due to limited access (i.e., road network) (Simon et al. 1999a).

Figure 3-6 Marten Habitat Quality: Northern Peninsula

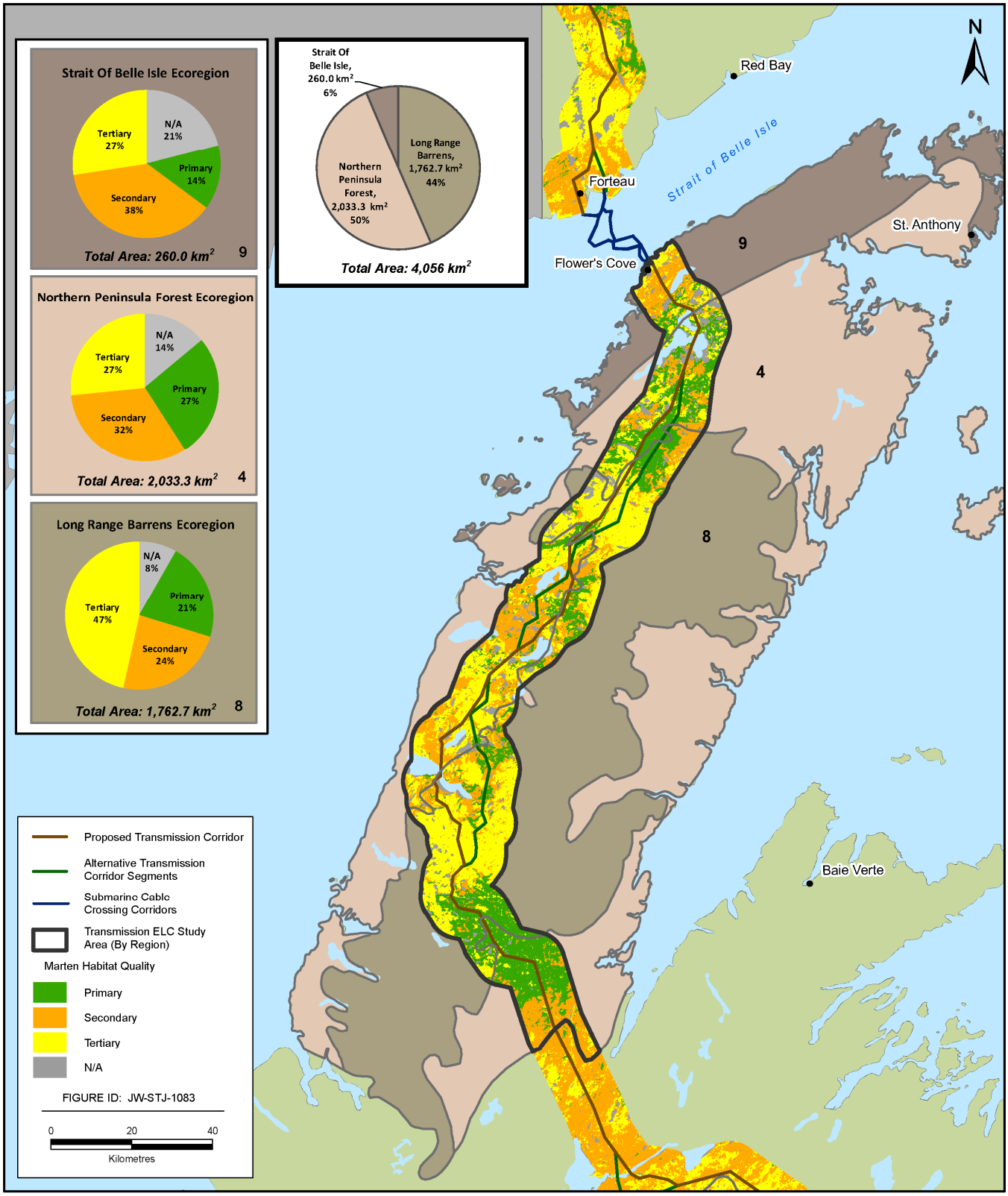
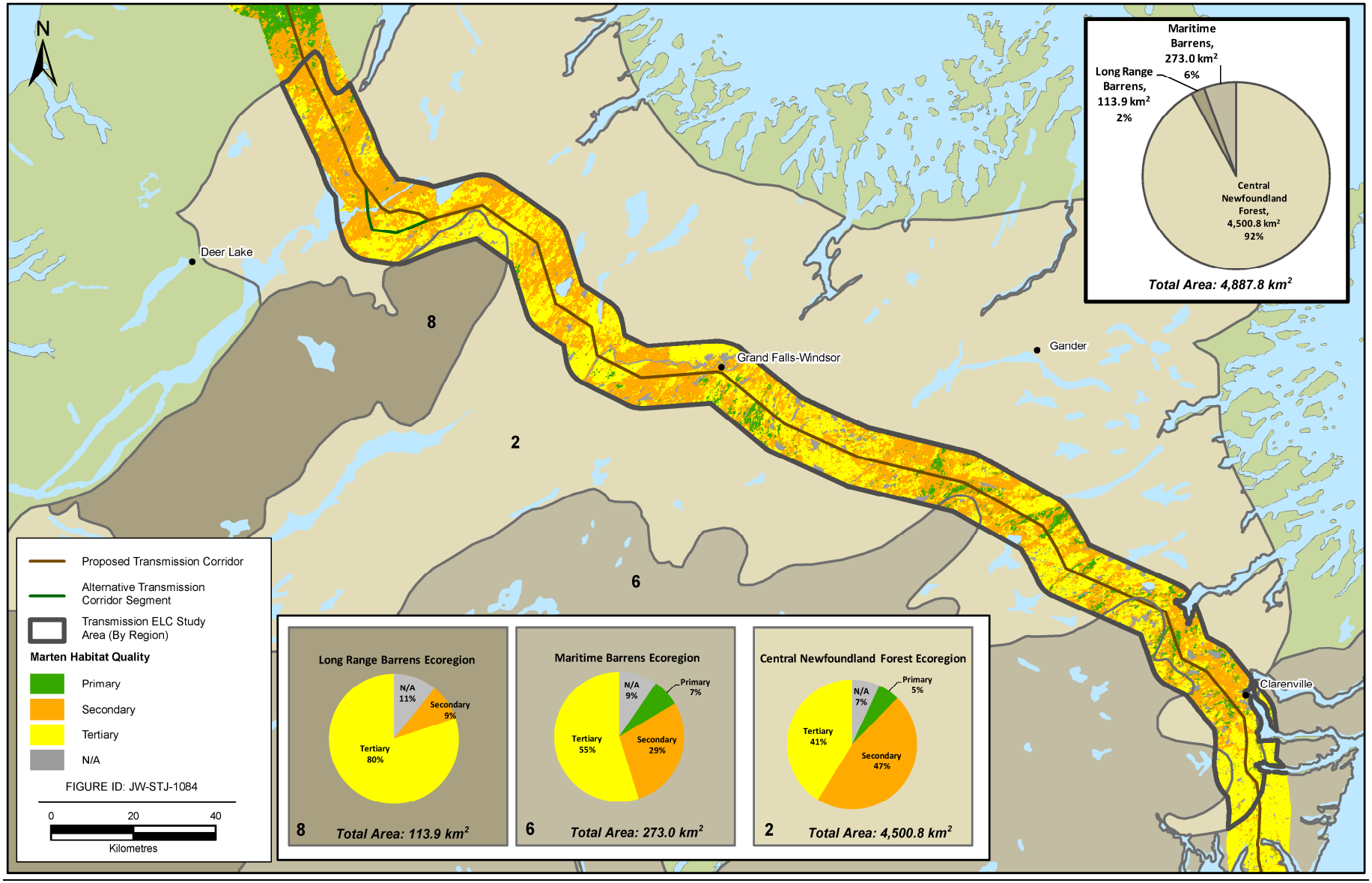


Figure 3-7 Marten Habitat Quality: Central and Eastern Newfoundland



Fryxell et al. (1999) found marten population growth rates positively correlated with small mammal densities as well as marten density but negatively correlated with hunting. Home range size related to availability of small mammals, which may be influenced by both population cycles and habitat quality (forest productivity, which may ultimately influence prey availability) (Smith and Schaefer 2000; Gosse et al. 2005). Trappers suggest that numbers reflect the availability of small mammals (Simon et al. 1999a). Studies suggest marten numbers are regulated more by the availability of snowshoe hare and feed on small mammals opportunistically (e.g., Poole and Graf 1996, in Simon et al. 1999a). Simon et al. (1999b) found that during a year of low small mammal abundance, snowshoe hare consumption did not increase. These authors documented a three year decline in marten following a decline in small mammals in Labrador.

Habitat reduction and disturbance in combination with incidental trapping has been limiting factors of marten on the Island of Newfoundland. Until recently, it was believed that old-growth forests were a habitat requirement of marten. Research conducted in Quebec concluded that forest structure (i.e., many tree stems and suitable cover provided by shrubs) rather than forest age may be the key. Suitable marten habitat provides escape routes and cover from predators.

Forsey and Baggs (2001) determined that marten tracks decreased noticeably after clear-cutting occurred and suggested that small disturbances can immediately affect sensitive species. This species is also sensitive to forest fragmentation so landscape connectivity is important. Connectivity between marten habitats may be provided by riparian linkages (Potvin et al. 2000).

3.1.2.2 Wolverine

The relatively large-size (males 12 to 18 kg; females 8 to 12 kg) and mostly dark brown-to-black pelage of the wolverine, the largest terrestrial mustelid species found in Canada, often leads some to mistaken this species as a small bear (CWS/CWF 2001a). This carnivore has strength uncharacteristic of its size, no natural predators and a fierce reputation (CWS/CWF 2001a). Found in remote locations, male home ranges can be quite large (669 km^2), overlapping that of several females (170 km^2) (Persson et al. 2010). Wolverine inhabit remote wilderness areas within the boreal forest across Canada (Banfield 1987). Although known as a scavenger of carrion (primarily ungulates), wolverine diet varies both seasonally and regionally. This species is also known to take porcupine, beaver, small mammals and snowshoe hare (Lofroth et al. 2007).

Wolverine mate in summer, generally at two years of age and two to three young are born the following March (delayed implantation). Dens may be found in tundra habitats or snow tunnels (CWS/CWF 2001a).

There are historical records for this species throughout Labrador, although current presence of this species in Labrador is unconfirmed. Reports of sightings in the last four decades suggest the species may have occurred throughout all of Labrador, in both inland and coastal areas (Fortin et al. 2005). This species does not and has never occurred on the Island of Newfoundland (Fortin et al. 2005). The wolverine has been considered culturally important in Innu folklore as 'Creator of the World' (DEC undated (c)). A recovery plan has been implemented for this eastern population of the species which includes Labrador (Fortin et al. 2005). Future activities may include human intervention such as a re-introduction of the species to the region (Fortin et al. 2005).

Primary Sources of Information

Fortin et al. (2005) compiled a National Recovery Plan for the Eastern Population of the wolverine. Wright and Ernst (2004) studied cache and resting sites of wolverine in Alberta and British Columbia. Use of snow tunneling

for den sites was presented by Magoun and Valkenburg (1983). Wolverine habitat was assessed by Wilson (1982).

Existing Conditions and Status

Wolverine in Quebec and Labrador have previously comprised the eastern population of the species. As a furbearer, this species was regularly trapped until the mid-1900s. Hunting and trapping of wolverine has been prohibited in Newfoundland and Labrador since 1950 (Fortin et al. 2005). Two captures of wolverine in Labrador in 1965 represent the last confirmed sightings of this species in Labrador, although Knox (1994) reviewed records from 1771 to 1992 that indicate tracks and wolverine were anecdotally reported up until April of 1992. This final observation was made approximately 50 km north of Forteau (southern Labrador) by a snowmobiler who followed the animal for 2 km. The capture of a wolverine in the wild in 2004 north of Montreal, Québec, confirms their persistence in the region (Fortin et al. 2005). If wolverine are present in Labrador, numbers are likely low based on very few reported sightings in recent years.

In 1989, the eastern population of wolverine was assessed and listed as *Endangered* under *SARA*, and was confirmed again in 2003. The province of Newfoundland and Labrador also recognized the species as *Endangered* under the *NLESA* in 2002. From 2004 to 2008, the National Recovery Team implemented the first phase of a recovery plan for the eastern population of the wolverine (Fortin et al. 2005). The first phase of this plan included working towards garnering the support of local groups and individuals, evaluating the population status, determining habitat needs and quality and promoting awareness of the species. In 2000, the Labrador Wolverine Working Group was formed, in 2003, hair poles were established and in 2005, the first aerial surveys for wolverine in northern Labrador were conducted. There were no hair samples collected or sightings of wolverine or tracks recorded during these surveys. The recovery potential for this species in Labrador is currently being assessed.

Habitat Association and Distribution in the Study Area

Wolverine have large home range sizes and as a result, occupy habitats with much diversity. Key to this species is an abundance of both small and large mammals and the presence of efficient predators. As a non-hunter, wolverine depend on wolves and other predators to provide carrion. Caribou carrion is the primary food source for wolverine, although small mammals may be taken when carrion is scarce. Suitable caching, resting and denning habitat is also important, although little research exists. Denning sites are often associated with rock outcrops, talus slopes and snow formations in tundra that allow for tunneling (Magoun and Valkenburg 1983). While wolverine are often thought to be associated with tundra and taiga, they are in fact known to occupy a variety of habitat types (Wilson 1982) and have large home ranges. Wright and Ernst (2004) suggest that less dense older growth forests may be important as cache sites for wolverine and that current forest harvesting techniques may be detrimental to wolverine. With an abundance of caribou and large areas of undisturbed habitat, Labrador remains seemingly suitable for, yet uncolonized by, wolverine. Fortin et al. (2005) speculate that the northern regions of Quebec and Labrador may be able to support wolverine based on the large herds of caribou that range over thousands of kilometres. As well, more southern coniferous forests with greater moose density may also be considered suitable wolverine habitat.

Due to the unconfirmed presence of this species in the Study Area and the huge range sizes that wolverine typically have, regional mapping of habitat types and quality is not possible.

Limiting Factors

Wolverine mortality has been the result of several factors, including starvation, predation (e.g., wolves, Bald Eagle (*Haliaeetus leucocephalus*)) and harvesting by humans, although the latter may not have been a huge factor for Labrador wolverine. Based on the Quebec fur market (there are no records for Labrador), the wolverine pelt harvest reached its peak in 1922/1923, with a total of 24 pelts sold. Trapping pressure may have resulted in extirpation of local populations. The decline of this species may be related to a considerable decline in caribou, as caribou were important to this scavenger that primarily survives on carrion. A decline in wolf populations may also have contributed to a decline in wolverine populations, as they often rely on predators to provide carrion (Fortin et al. 2005). Wolverine have extremely large home ranges and prefer wilderness, therefore, development may pose some threat.

3.1.2.3 Red Fox

Native to both Newfoundland and Labrador, the red fox is a generalist predator and is found throughout a wide range of habitat types. This relatively small (3.6 to 6.8 kg) member of the *Canidae* family may have a pelage of red, brown, black or silver (CWS/CWF 1993). Red fox are widespread throughout all regions of Canada. This species generally spend time in pairs but in years of poor prey, may separate for brief periods. Breeding occurs during the winter months and young (1 to 10) are born during spring (CWS/CWF 1993). Home ranges for red fox typically range 4 to 8 km^2 and are centered around the den (CWS/CWF 1993). Although their diet is made up predominantly of small mammals and snowshoe hare, red fox diet varies seasonally and may also include fish, birds and their eggs (including waterfowl and seabirds), insect, and berries (CWS/CWF 1993).

Primary Sources of Information

Information on this species in Newfoundland and Labrador is relatively limited and includes the work of Sklepkovych and Montevecchi (1996) and Khan and Evans (2006). Insight was gained from other sources, including: winter habitat use of red fox in the boreal forest of western Quebec (St. Georges et al. 1995); sensitivity of mammalian carnivores to habitat fragmentation in the southern United States (Crooks 2002); and red fox abundance in relation to boreal forest composition in Finland (Kurki et al. 1998).

Existing Conditions and Status

Limited research on red fox in Newfoundland and Labrador to date has resulted in a broad range in population estimates. Data provided by the DEC, Wildlife Division [Atlantic Canada Conservation Data Centre (ACCDC) 2008] suggest healthy red fox populations, with estimates ranging between 10,000 to 100,000 individuals in Newfoundland and the same estimate for Labrador. Jeffery et al. (2004) examined red fox from all regions of the Island of Newfoundland for the occurrence of two parasites. Sample sizes collected from trapper returns suggest healthy populations in all six regions. Studies from elsewhere have found that fox populations may be affected by vole cycles (Voigt 1987; Kurki et al. 1998).

Habitat Association and Distribution in the Study Area

The rather ubiquitous distribution of this species indicates that red fox can survive in a variety of habitats (Voigt 1987). Generally, habitat preferences include semi-open areas such as tundra, river valleys and natural forest openings. Although many carnivore species have a negative response to habitat fragmentation (Crooks 2002), in Finland, it was found that forests fragmented by agricultural land or by clear-cutting supported an increase in fox numbers. Riparian habitats were also found to be important for this species (Kurki et al. 1998).

Fox species exhibit opportunistic and flexible hoarding behaviour (both scatter and larder hoarding) that has been documented on Islands off the coast of Newfoundland in association with seabird colonies (Sklepkovych and Montevecchi 1996). The hoarding behaviour and subsequent recovery of food sources is a result of seasonal shifts in food conditions and availability.

Fox diet is seasonally varied and may include small mammals, nesting waterfowl, berries, and trout, but voles are the dominant prey source and as a result, fox numbers are affected by the cyclic microtine populations (Sklepkovych and Montevecchi 1996). Khan and Evans (2006) analyzed feces of red fox from the Northern and Avalon Peninsulas and found 84 percent of the samples tested positive for the presence of a parasite associated with caribou, indicating caribou carrion is an important food source for red fox in these areas. In winter, caribou and snowshoe hare are using black spruce-lichen forest and avoiding open habitat, resulting in red fox being strongly associated with dense spruce stands (St. Georges et al. 1995).

Table 3-3 summarizes observations and/or evidence of red fox collected during ELC surveys along the transmission corridor in 2008. This information provides an indication of the relative use of habitat types within the Study Area, throughout multiple seasons. True to the generalist nature of this species, red fox sign was found in moderate amounts (6 to 20 percent) in a variety of habitat types. The conifer forest, conifer scrub and wetland habitat types in Newfoundland yielded fewer signs of red fox (2 to 4 percent), although note these are based on small sample sizes. There was no evidence of red fox detected in the open conifer forest (Newfoundland), hardwood (Labrador), conifer scrub (Labrador) and burn (Newfoundland and Labrador) habitat types. There were no observations of live animals during these surveys.

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

Habitat Type	# Sites with Observations / Total Number of Sites	Abundance Rating	Comments
Newfoundland			
Alpine Vegetated	2/14	1 and 2	scat
Burn	0/3	-	-
Conifer Forest	2/86	2 and 3	scat
Conifer Scrub	1/24	3	scat
Cutover	1/18	2	-
Kalmia Lichen	2/25	3	scat
Mixedwood Forest	2/26	1 and 3	scat
Open Conifer Forest	0/10	-	-
Rocky Barrens	1/8	2	scat
Wetland	2/55	1 and 3	scat, tracks, run
Labrador			
Burn	0/5	-	-
Conifer Forest	1/18	3	-
Conifer Scrub	0/5	-	-
Hardwood Forest	0/2	-	-
Lichen Heathland	1/5	3	scat
Open Conifer Forest	1/9	2	-
Wetland	2/19	2	scat, foraging, scent post

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, trails and tracks would likely represent spring/summer habitat use (Minaskuat Inc. 2008a).

Habitat potential was not rated or mapped in the Study Area for red fox, due to the generalist nature of this species; this species would be expected throughout the province wherever suitable prey (e.g., snowshoe hare and microtines) are present.

Lower Churchill River and Lake Melville

Red fox would be expected to occur in suitable habitats through this region. Red fox sign was incidentally observed on four occasions during the Lower Churchill Hydroelectric Generation Project ELC field sampling in 2006 (Minaskuat Inc. 2008b). During the wildlife habitat association surveys in the lower Churchill River valley, 82 observations of red fox were recorded of individuals (n=two), droppings (n=20), tracks (n=57), browse (n=two), and other (n=one). Red fox sign was found primarily in mixed (deciduous dominant) forest and riparian areas (Minaskuat Inc. 2008a).

Southeastern Labrador

Red fox would be expected to occur in suitable habitats throughout this region. Red fox sign (e.g., scat, scent post and foraging sign) was detected at five sites [lichen heathland (n=one), coniferous forest (n=one), open conifer (n=one) and wetland (n=two)] in Southeastern Labrador during ELC surveys associated with the Project in 2008.

Island of Newfoundland

Red fox would be expected to occur in suitable habitats through the Island. Red fox sign (n=28) was found in eight habitat types (alpine vegetated, cutover, mixedwood, Kalmia lichen, rocky barrens, conifer scrub, conifer forest and wetland) across all regions of Newfoundland in the Study Area (Minaskuat Inc. 2009a). Fox sign detected included scat as well as tracks.

Limiting Factors

A variety of anthropogenic factors can lead to fox mortality in some areas. Voigt (1987) reports high mortality of red fox as a result of shooting, trapping and road kills. Red fox are sought after by trappers for pelts, hunted by farmers as pests and preyed upon by larger carnivores such as coyote, lynx and wolves (Labrador only). The health of some fox populations may be jeopardized by disease. Mortality from rabies can also remove the majority of a population during an outbreak (Voigt 1987).

3.1.2.4 Beaver

The beaver is the largest member of the rodent family in North America, with adults up to 1.3 m in length and weighing 16 to 32 kg (CWS/CWF 2005). This mammal has many adaptations for life spent largely in an aquatic environment: webbed hind feet; nostrils and ears that can close; and a transparent membrane over the eyes to name a few. The rich, brown pelage of the beaver is a dense mix of underfur and guard hairs and is treated with oil during preening to make it waterproof (CWS/CWF 2005). The beaver is well-known for its dam-building capabilities, with forepaws and incisors specially designed for this type of wood work (CWS/CWF 2005). Dam construction is central to the life of the beaver as the pond created by the damming action serves two-fold: a storage place for winter forage; and a predator-free access to the lodge, which they also build (CWS/CWF 2005). Beaver choose one mate for life and breeding occurs in January or February; with a litter of three to four kits born the following May or June (CWS/CWF 2005). These young will remain with the parents until they reach two to three years of age (Payne 1984a). The beaver is most active from dusk until dawn (CWS/CWF 2005).

As in other northern areas of Canada and Alaska, the density of beaver in Newfoundland and Labrador is lower than in the central part of North America (Novak 1987), although the species occurs throughout the Study Area.

Primary Sources of Information

Studies related to beaver, trapping and habitat in the Study Area in Labrador were primarily associated with the Lower Churchill Hydroelectric Generation Project. No recent and/or comparable studies of beaver in the Newfoundland portion of the Study Area were found. Relevant sources include:

- Lower Churchill Development Corporation - Wildlife Atlas Phase I and II contains a series of maps portraying wildlife observations and sign (Northland Associates 1978);
- Lower Churchill Development Corporation - A series of informant interviews with trappers regarding their activity in the lower Churchill River valley (Budgell 1981);
- Newfoundland and Labrador Hydro - Inventory of beaver colonies in the lower Churchill River valley (Minaskuat Inc. 2008d); and
- Chubbs and Phillips (1994) - A report on a long distance dispersal of a transplanted beaver in the Survey Area during the 1980s.

Based on the similarity in vegetation and climate, ecological conditions on the Island of Newfoundland appear comparable to those in Labrador, with respect to beaver. Applicable information reviewed included research on population dynamics (Payne and Finlay 1975; Bergerud and Miller 1977; Payne 1982; 1984a; 1984b), habitat relationships (Northcott 1971) and effects of trapping and trapline management (Payne 1975).

Existing Conditions and Status

Beaver represent an important component of the traditional diet for Innu and a mainstay of the fur industry in Labrador; this species declined in this area during the nineteenth and twentieth centuries (Budgell 1981). The species appeared to return to its former range and more abundant beginning in the 1950s; Northland Associates (1980b) reported that most of the small lakes within 32 km of the Churchill River contained beaver. Beaver in the lower Churchill River valley were considered low in abundance during the early 1970s (Northland Associates Ltd. (1978). Local residents reported a decline had occurred in this area, with the exception of the area between Gull Island Rapids and Muskrat Falls, whereas formerly numbers were higher all along the river (Nalcor Energy 2009). A subsequent survey of trapping activity on the Churchill River during 1980-1981 (Budgell 1981) indicated trapping activity had declined dramatically over the previous decades. Novak (1987) estimated the harvest density in the province as relatively low ($\geq$ 101 km^2/animal).

The most recent survey of beaver in Labrador in 2006, along the lower Churchill River, also indicated a relatively low density (0.04/km^2) compared to elsewhere in North America (Minaskuat Inc. 2008d). Additionally, only 17 percent of the colonies observed were identified as active and the majority of them deemed to be in medium to poor habitat quality. There were no active colonies and seven inactive colonies detected along the proposed transmission corridor (Minaskuat Inc. 2008d). Habitat ratings of these sites along the transmission corridor were rated as 'medium' quality.

In Newfoundland, randomly selected active beaver lodges on New World Island were completely trapped in the winters of 1967 to 1968 and 1968 to 1969 and in North Harbour in 1970-1971 (Payne 1982). Traps were set under the ice randomly at distances of 1 to 3 m and 6 to 9 m to determine the trap response of kits, yearlings

and adults, and results were used to assess colony size, sex and age structure (Payne 1982). There was no statistical difference detected in the percentage of kits, yearling and adults trapped first (Payne 1982). High densities of beaver were found in New World Island, and an overall average colony size of 3.5 individuals was calculated, which may infer a density at that time of 0.14/km^2 in the survey area (Payne 1982).

Habitat Association and Distribution in the Study Area

Habitats that provide foraging, damming, resting and feeding opportunities for beaver are preferred. In areas of lower productivity that may be found in southern Labrador (i.e., lower quality food sources), beaver are less selective regarding species of forage (Gallant et al. 2004). Willow and alder beds at the mouths of tributaries and small creeks were described as the best beaver habitat along the lower Churchill River (Northland Associates 1980a). Common aquatic plants used by beaver include pondweed (*Potamogeton sp.*), arrowhead (*Sagittaria sp.)* and lily (*Nymphaea sp.*) (Allen 1983) that are found in Labrador (Minaskuat Inc. 2008e), but were not identified during ELC field studies within the 15 km HVdc transmission corridor in 2008.

Habitat potential was not rated and mapped in the Study Area for beaver. Due to the many variables that contribute to adequate beaver habitat and life history requirements that vary seasonally, the specific habitat features comprising suitable beaver habitat are not detectable at the scale of the mapping used for this Project. For example, beaver habitat requires a permanent source of surface water; locations with extreme annual or seasonal fluctuations in the water level are not suitable (Allen 1983). Beaver can live in areas with poor food conditions, but they cannot survive where the water supply fluctuates seasonally or is fast-moving (Novak 1987). Rocky streams or lakes with rocky shorelines are also not preferred (Novak 1987). This species rarely builds lodges and food caches on large lakes with excessive wave action or flood-prone areas (Novak 1987). Slow-flowing streams in narrow valleys with a bedrock foundation are generally preferred, though beaver dams are often at a narrow point where flow may be swifter (Novak 1987). Granite bedrock is a positive feature because it retains water collected from temporary or seasonal runoffs (Novak 1987). Beaver will readily occupy artificial ponds or reservoirs if food is available (Novak 1987).

Beaver preferentially select sites with an abundance of deciduous cover (Northcott 1971). The primary food is the bark of these trees, preferentially aspen and birch in Labrador. They will also eat the bark from conifers when deciduous trees are in short supply (Van Gelder 1982). Northcott (1971) described beaver habitat and availability of food on the Island as based on the presence of trembling aspen that was preferred. However, as the occurrence of this vegetation was sporadic, alders were the most important woody food. Other deciduous species, plus balsam fir and black spruce, made up only a small portion of the diet. During summer, various aquatic and some *Ericaceous* species were used. Many of the common aquatic plants used by beaver (Allen 1983), such as pondweed, arrowhead and lily were documented during baseline surveys of the wetlands in 2006 (Minaskuat Inc. 2008e).

Table 3-4 summarizes observations and/or evidence of beaver 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. As may be expected, the only habitat type in which any beaver evidence was detected was wetlands in both Newfoundland and Labrador (4 and 11 percent), though note these are based on small sample sizes. Observations of live animals occurred also only in this habitat, providing some indication of their use during summer (July/August).

Table 3-4 Observations and/or Evidence of Beaver in Relation to Habitat Type Along the Transmission Corridor, July and August 2008

Habitat Type	# Sites with Observations / Total Number of Sites	Abundance Rating	Comments
Newfoundland			
Alpine Vegetated	0/14	-	-
Burn	0/3	-	-
Conifer Forest	0/86	-	-
Conifer Scrub	0/24	-	-
Cutover	0/18	-	-
Kalmia Lichen	0/25	-	-
Mixedwood Forest	0/26	-	-
Open Conifer Forest	0/10	-	-
Rocky Barrens	0/8	-	-
Wetland	2/55	2 and 3	Trail, cuttings
Labrador			
Burn	0/5	-	-
Conifer Forest	0/18	-	-
Conifer Scrub	0/5	-	-
Hardwood Forest	0/2	-	-
Lichen Heathland	0/5	-	-
Open Conifer Forest	0/9	-	-
Wetland	2/19	1 and 3	Animal observed, dam, cuttings

Notes:
1. Abundance rating: 0=non-existent; 1=trace; 2=common; and 3=abundant.
2. Observations may represent year-round habitat use.

Lower Churchill River, Lake Melville and Southeastern Labrador

Helicopter surveys conducted in the lower Churchill River watershed in October 2006 (Minaskuat Inc. 2008d) found active beaver colonies in 17 percent (9 of 63) of the survey blocks. Sections of the survey (in the vicinity of the existing and proposed transmission lines along the Churchill River) had higher incidence of occupancy (1.67 colonies/block) compared to riparian sections along the lower Churchill River (0.53 colonies/block). This density was relatively low compared with studies elsewhere in North America (Minaskuat Inc. 2008d). The majority of both active and inactive colonies recorded during this survey were observed in medium and poor quality habitat. Additional incidental observations of beaver or beaver sign were noted at four locations during the lower Churchill River ELC field work in 2006 (Minaskuat Inc. 2008b). Only two instances of beaver browsing were encountered in 85 km of transects surveyed during the late winter/early spring 2006 survey of furbearer habitat use in the lower Churchill River valley (Sikumiut 2007).

During the environmental assessment for Phase III of the Trans Labrador Highway (TLH) (NLDWS 2003), observations of beaver lodges and dams were recorded during aerial surveys along the proposed corridor. Although regionally common, beaver activity varied considerably but was greatest in association with smaller water bodies and streams with deciduous trees (aspen or birch) nearby.

Beaver sign was also incidentally detected at two wetland sites in Southeastern Labrador during ELC surveys in association with the Project in 2008 (Table 3-4).

Island of Newfoundland

While beaver do exist throughout the Island, comparatively little research is available on their occurrence and distribution. In Newfoundland, Payne (1982) studied beaver on New World Island and North Harbour and identified an average colony size of 3.5 individuals, which may infer a density at that time of 0.14 individual beaver per km^2 in the survey area. Evidence of beaver in the Study Area was also detected in two wetland sites during ELC surveys in Newfoundland in 2008, in association with the Project (Table 3-4).

Limiting Factors

Locations with a relatively high proportion of inactive colonies could be a result of over-trapping, animal health, predation, food availability and/or persistence of lodges (i.e., beyond their usefulness to beaver) (Payne and Finlay 1975; Bergerud and Miller 1977; Allen 1983; Payne 1984a; Novak 1987). Predators include wolf (Payne 1985; Forbes and Theberge 1996), lynx (Payne 1985) and Great Horned Owl (Payne 1985), as well as river otter (Reid et al. 1994). River otter are able to enter a beaver den via the water and kill the kits inside, although an adult or sub-adult beaver generally stays with the kits to offer protection (CWS/CWF 2005).

Trapping in Labrador may be limiting beaver abundance and increased access to currently remote areas may increase mortality and reduce abundance (Nalcor Energy 2009). Each of the three management areas (Labrador North, Labrador East and Labrador West) has a trapping season from October 15 to May 31 and recreational trapping/hunting occurs in areas adjacent to the TLH Phase I between Happy Valley-Goose Bay and Churchill Falls (Nalcor Energy 2009). The average harvest during 2002 to 2005 was 151 beaver (Minaskuat Inc. 2009b). In 1987, results from a Sheshatshiu Innu Harvest Activities study identified a harvest of 206, most of which were for consumption (Nalcor Energy 2009). One resident of North West River identified the Metchin River area (west of the Study Area) as a trapping area for beaver (Minaskuat Inc. 2009b). Trappers reported shootings of beaver in Newfoundland from American Black Duck (*Anas rubripes*) and ptarmigan hunters or as target practice (Payne 1984).

Payne (1985) suggested that winter starvation might be a more common source of natural mortality for beaver in Newfoundland than previously suspected. This may relate to the sparse supply of deciduous trees for winter food.

In Labrador at least, the results of the surveys in the lower Churchill River watershed in 2006 (Minaskuat Inc. 2008d) indicated that beaver were restricted to habitat near water and the presence of deciduous vegetation. Thus, the availability of suitable habitat throughout the province in general may limit populations in the Study Area and adjacent regions.

3.1.2.5 Porcupine

Porcupine are the province's second largest rodent, ranging from 4.5 to 5.5 kg and 68 to 100 cm in length (females and males, respectively) (CWS/CWF 2001b). This animal is covered in quills, which serve as a defense mechanism for this slow moving mammal (CWS/CWF 2001b). This species forages on a variety of plants and trees (inner bark) and may be found in forested areas across its range where suitable winter den sites may be found (Speer and Dilworth 1978; Banfield 1987; CWS/CWF 2001b). Solitary for most of the year, porcupine mate first at age one or two in early fall. Typically just one young is born early the following spring (CWS/CWF 2001b).

Porcupine reach the northern limit of their North American range in central Labrador. As a general trend, home range sizes increase at higher latitudes and this has been found to be true for porcupine in Labrador. In fact,

these porcupine have been found to occupy home ranges up to 10 times greater than recorded for other populations in North America (Schmelzer and Fenske, undated). This species does not occur on the Island of Newfoundland.

Primary Sources of Information

Schmelzer and Fenske (undated) completed a telemetry study of animals in central Labrador that provided insight into seasonal movements, home range and habitat association. Research in southern Quebec by Morin et al. (2005) and Comtois and Berteaux (2005) and in Massachusetts by Griesemer et al. (1998) were referenced with regards to forage and habitat selection. Speer and Dilworth (1978) examined winter habitat usage (winter tree use and forage) of porcupine in New Brunswick. No observations of porcupine occurred in 1979 during surveys associated with the Lower Churchill Hydroelectric Project (Northland Associates Ltd. 1980a). Surveys included extensive ground transects in a variety of habitat types throughout the lower Churchill River watershed. Incidental porcupine observations were also recorded during research along the lower Churchill River in 2008 (Sikumiut 2007; Minaskuat Inc. 2008a) and the transmission corridor in 2008.

Existing Conditions and Status

Porcupine have recovered to the point where they were included on the small game license in 2005 (DEC 2007) and were observed during baseline surveys conducted by Minaskuat Inc. (2008a) and Sikumiut (2007). Due to the limited number of studies on this species in Labrador, population estimates are broad. Numbers provided by the DEC Wildlife Division in April of 2009 places the Labrador porcupine in the range of 2,500 to 10,000 individuals (ACCDC 2008).

Habitat Association and Distribution in the Study Area

Although porcupine prefer coniferous cover, varying seasonal forage requirements, suitable resting locations and predator avoidance have resulted in porcupine occupying a variety of habitat types to varying degrees, with the exception of open water. These facts combined with their large home range sizes (Schmelzer and Fenske, undated) in Labrador justifiably label porcupine as a generalist. This species is partially tree-dwelling (i.e., in summer) and uses the full range of available resources, both vertical and horizontal (Comtois and Berteaux 2005) within the forest.

Porcupine are more restricted in their habitat use in winter (Griesemer et al. 1998). In winter, porcupine may make use of a large variety of tree species found in a forested stand. Morin et al. (2005) assessed porcupine habitat selection on a multi-scale. It was found that aspen is the major food source for porcupine at their study site on the south shore of the St. Lawrence River, Quebec. Avoidance of pure coniferous forest was observed during the Morin et al. (2005) study as this habitat type lacks summer forage, although Speers and Dilworth (1978) found that conifers comprise the vast majority of winter forage. The Speers and Dillworth (1978) finding that spruce was preferred over balsam fir concurs with results of previous similar studies (Curtis 1944; Shapiro 1949).

The Mecatina River Ecoregion, which extends across southern Labrador, is largely dominated by black spruce, although trembling aspen are found at the northern limit. The Paradise River Ecoregion covers the most southeastern part of Labrador. This Ecoregion is also dominated by coniferous species; however, aspen and birch may be found on disturbed ground. Therefore, porcupine may be found from the lower Churchill River valley extending south to the Strait of Belle Isle. There is an important seasonal attraction in spring, such as roadsides, where porcupine forage on herbaceous species (Schmelzer and Fenske undated). Porcupine prefer

coniferous cover; however, observations from the wildlife habitat surveys during the environmental baseline program for the Lower Churchill Hydroelectric Generation Project (Minaskuat Inc. 2008a), and relevant literature from Labrador (Schmelzer and Fenske undated) and Banfield (1987), indicate that they might occupy all habitat types to varying degrees, with the exception of open water (which is only used, and rarely, as a travel corridor). Habitat selection is based on feeding, predator avoidance and resting (Sweitzer and Berger 1992; Strickland et al. 1995).

Porcupine are active year-round and display seasonal changes in their foraging ranges (Sweitzer 1996). During fall and winter, they feed on the foliage, bark and cambium of black spruce, white spruce, balsam fir, arboreal foraging on bark, needles and buds. In spring and summer, they forage predominantly on grasses, forbs, fruit and other riparian vegetation (Woods 1973; Banfield 1987). Because of this seasonally different diet, Schmelzer and Fenske (undated) found that porcupine in Labrador exhibited variation in habitat selection and seasonal home range size, supporting its categorization as a generalist.

The evidence of porcupine collected during ELC surveys along the transmission corridor in 2008, in relation to habitat classification is summarized in Table 3-5. This information provides an indication of the relative use of habitat types within the Study Area, throughout multiple seasons. Relatively high proportions of open conifer (67 percent), and hardwood (50 percent) habitat types were used by this species, though note the latter habitat is based on a small sample size. The conifer forest and wetland habitat types were found to be used less frequently (17 and 5 percent, respectively). There was no evidence of porcupine use of burn, conifer scrub and lichen heathland habitat types. No observations of live animals occurred during these surveys.

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

Habitat Type	# Sites with Observations / Total Number of Sites	Abundance Rating	Comments
Labrador			
Burn	0/15	-	-
Conifer Forest	3/18	1,2 and 3	Scat, browsing
Conifer Scrub	0/5	-	-
Hardwood Forest	1/2	2	Tree barking
Lichen Heathland	0/5	-	-
Open Conifer Forest	6/9	2 and 3	Browsing, old sign
Wetland	1/19	3	Not indicated

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 3-6 summarizes primary, secondary and tertiary habitat quality for porcupine. Primary habitat includes conifer forest, conifer scrub, mixedwood forest and open conifer forest. Primary habitat occupies a total of 3,750 km^2 (60.5 percent) of the Study Area in Labrador. Secondary habitat is represented by black spruce and lichen and hardwood forest habitat types and occupies 239 km^2 (3.9 percent) in Labrador. Remaining habitats in Table 3-6 were classified as tertiary, based on limited foraging, denning, resting or feeding opportunities.

Table 3-6 ELC Habitat Type and Relative Quality for Porcupine

Habitat Type	Habitat Quality	Notes
Black Spruce and Lichen Forest	Secondary	Inner tree bark, needles and buds as winter forage
Burn	Tertiary	
Conifer Forest	Primary	Inner tree bark, needles and buds as forage
Conifer Scrub	Primary	Inner tree bark, needles and buds as forage
Hardwood Forest	Secondary	Deciduous leaves, grasses, forbs and berries as forage
Kalmia Lichen/Heathland	Tertiary	This habitat listed for the Island of Newfoundland only
Lichen Heathland	Tertiary	
Mixedwood Forest	Primary	Deciduous leaves, grasses, forbs and berries as summer forage; coniferous as winter forage
Open Conifer Forest	Primary	Inner tree bark, needles and buds as forage
Rocky Barrens	Tertiary	
Scrub/Heathland/Wetland	Tertiary	Riparian is considered secondary habitat
Wetland	Tertiary	Riparian is considered secondary habitat

Notes:
1. Habitat types are described in Table 2-2.
2. Habitat quality is described in Section 2.2.4.

Lower Churchill River, Lake Melville and Southeastern Labrador

Sikumiut (2007) repeated several ground transects from similar 1979 surveys (Northland Associates 1980b) from Gull Island through southeastern Labrador to the Strait of Belle Isle. Eighteen porcupine tracks in snow cover were identified over 80 km of transects. The highest densities were in mixedwood and predominantly coniferous habitat and no porcupine tracks were encountered in black spruce/bog and willow/alder habitats. During August and September 2006, Minaskuat Inc. (2008a) documented evidence of porcupine (observations, tracks, droppings and feeding evidence) on 128 occasions over 323 km of transect in the lower Churchill River valley. Surveys by Sikumiut (2007) indicated porcupine sign were most frequent in drier coniferous and coniferous/ mixedwood forest.

Large home range size for Labrador porcupine may be directly related to the high proportion of habitat with poor productivity. That is, these animals travel over larger areas to meet their energetic requirements (Smith 1979). Schmelzer and Fenske (undated) found that the home range of their study animals largely did not overlap. With this knowledge, it may be inferred that porcupine densities in Labrador are relatively low. There were four incidental observations of porcupine browse recorded during research for the Lower Churchill Hydroelectric Generation Project (Minaskuat Inc. 2008a).

Porcupine sign (browse, scat, tree barking) was incidentally encountered at 11 sites in the Study Area [(lichen heathland (n=one), coniferous forest (n=three), hardwood (n=one), open conifer (n=five) and wetland (n=one)] in Southeastern Labrador during the ELC surveys associated with this Project (Minaskuat Inc. 2009a).

The Low Subarctic Forest Ecoregion (3,004 km^2) occupies 48 percent of the Southeastern Labrador region of the Study Area in Labrador (i.e., exclusive of the Lower Churchill River and Lake Melville), and approximately 69 percent of this area is considered primary habitat for porcupine (Figure 3-8). The Eagle River Plateau Ecoregion (1,982 km^2) comprises 32 percent of the Study Area, of which 53 percent is primary porcupine habitat (Figure 3-8). The Forteau Barrens Ecoregion comprises 15 percent of the Study Area, with 45 percent considered primary

habitat for porcupine (Figure 3-8). The corridor passes through much smaller proportions of the High Boreal Forest and Mid Boreal forest Ecoregions (3 and 2 percent, respectively), with 82 and 61 percent considered primary porcupine habitat, respectively (Figure 3-8).

Secondary porcupine habitat is limited, comprising 7 percent or less of any Ecoregion in the Southeastern Labrador portion of the Study Area (Figure 3-8). Tertiary habitat ranges from as little as 5 percent (in the relatively minor High Boreal Forest Ecoregion, in terms of contribution to the Study Area) to 48 percent in the Forteau Barrens Ecoregion portion (Figure 3-8).

Island of Newfoundland

Porcupine are not found on the Island of Newfoundland.

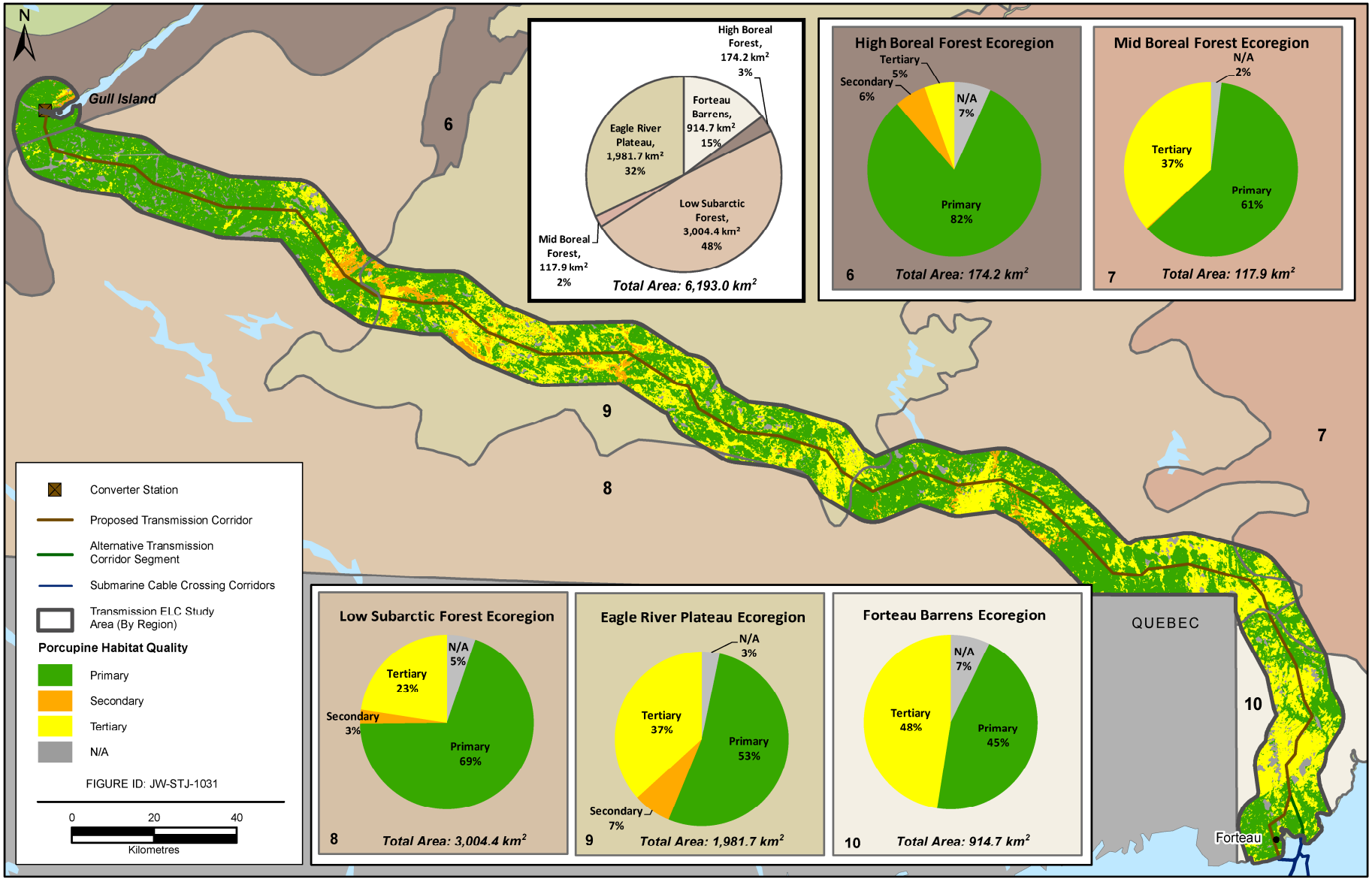
Limiting Factors

Porcupine are an important species to hunters of Labrador. Small game hunting (that occasionally includes porcupine) is a common recreational and harvesting activity in the lower Churchill River valley portion of the Study Area. It is evident from the resource and land use study (Minaskuat Inc. 2009b) that small game hunting occurs along the TLH between Happy Valley-Goose Bay and Churchill Falls. The access provided by the road makes for easier travel for snowmobiles and ATVs to favoured hunting areas on the north and south sides of the highway (Minaskuat Inc. 2009b). Residents of Mud Lake also use the highway for hunting; they seem to do so to a lesser degree and prefer to hunt small game along the shoreline of the lower Churchill River from the mouth up to Muskrat Falls using boats (Minaskuat Inc. 2009b). Results of Sheshatshiu Innu Harvest Activities from 1987 indicate a total harvest of 67 porcupine (Minaskuat Inc. 2009b). The 2007/2008 hunting season was the final year of a pilot project allowing small game hunters to hunt porcupine. Schmelzer and Fenske (undated) found that 44 percent of their study animals (n=18) were confirmed or presumed killed by hunters.

Access roads and timber harvesting have altered habitat and also created edges and openings attractive to porcupine in spring. The attraction to roadside areas for feeding makes porcupine susceptible to vehicle collisions and hunting pressure. Schmelzer and Fenske (undated) observed that Labrador roadsides often contained emergent vegetation 7 to 10 days before adjacent forested habitats. Porcupine tended to move to such areas, foraging day and night, becoming vulnerable and easily approached by hunters. Porcupine may also be considered a pest around camps for its habit of gnawing on wood.

Porcupine have few natural predators in Labrador, aside from fisher, which occurs west of the lower Churchill River watershed. Other predators include red fox, lynx, bear, wolf and Great-horned Owl. Extreme seasons, poor productivity, low growth rates and large wetlands affect habitat quality for porcupine in Labrador (Schmelzer and Fenske undated) and porcupine may succumb to winter starvation (Hale and Fuller 1995).

Figure 3-8 Porcupine Habitat Quality: Southeastern Labrador



3.2 Small Mammals

"Small mammal" is a broad and general term to group animals that may include mice, voles, shrews, lemmings, bats and rats. Small mammal populations may be linked to climatic changes, habitat alteration and natural disturbances, and they are vectors of disease and parasites (Department of Natural Resources 2004). As many of these species are prey for larger mammals as well as avifauna, understanding their distribution and population trends are useful tools.

Ecoregional distribution of studied small mammals in Newfoundland and Labrador from 1960 to 2005 indicate that small mammal communities vary across Ecoregions. Small mammal presence may be a result of fewer/lack of studies in a particular Ecoregion and/or lack of habitat requirements for a particular species in a particular Ecoregion (Garland 2008).

3.2.1 Regional Overviews

The following provides a general overview of the presence, abundance and distribution of small mammal species across the various geographic regions that comprise the Study Area. General status ratings for mammals included were obtained through the DEC (2005).

3.2.1.1 Lower Churchill River, Lake Melville and Southeastern Labrador

Seventeen small mammal species are found in Labrador occupying a wide range of ecological niches. Most of these are ground-dwelling lemmings, voles, mice and shrews; however, one bat species [little brown bat (*Myotis lucifugus*)] also occurs here.

Relevant studies and their results include:

- Small mammal trapping results in Labrador from 2007 and 2008 were summarized by Rodrigues (2009). For two sites in the Lower Churchill River and Lake Melville region, there was a total of 222 captures comprising three species (northern bog lemming (*Synaptomys borealis*), masked shrew and red-backed vole). Over the four sites in southeastern Labrador (i.e., Innu Southside [near Muskrat Falls], Anne Marie Lake, Parke Lake and TLH), there were a total of 557 specimens captured comprising six species plus one unknown (northern bog lemming, eastern heather vole (*Phenacomys ungava*), meadow vole, masked shrew, red-backed vole, and meadow jumping mouse (*Zapus hudsonicers*)). A decline in total numbers from 2007 to 2008 was recorded (Rodrigues 2009).
- During Wildlife Habitat Associations Surveys along the Lower Churchill River Valley in 2006, observations and/or evidence of several species were made across habitat types (Minaskuat Inc. 2008a). A total of 238 small mammals were collected over 4,758 trap nights involving the eight trapping grids. Red-backed vole was the most frequently captured small mammal (166 or 69.7 percent), followed by masked shrew (32 or 13.4 percent), woodland jumping mouse (23 or 9.7 percent) and meadow vole (17 or 7.1 percent). Most captures were in the spruce (wet site) habitat, the most heavily sampled habitat type. Mixed (fir dominant) habitat had the highest capture rate for red-backed vole and masked shrew. Mixed (spruce dominant) habitat had the second highest capture rate for red-backed vole. Meadow vole and woodland jumping mouse appeared to prefer some deciduous habitat, as they were both captured most often in mixed (deciduous dominant) habitat.

- Small mammal trapping was carried out at eight sites in the lower Churchill River valley/Lake Melville region in 2006 (Minaskuat Inc. 2008a). A total of four species were detected: red-backed vole, meadow vole, masked shrew and meadow jumping mouse. The results indicate that the red-backed vole is the most common small mammal in the lower Churchill River valley – accounting for 70 percent of all small mammal captures – consistent with Simon et al. (1998).
- Incidental sightings of small mammal sign were recorded along the Study Area during ELC surveys in 2008. Although specific species could not be identified by small mammal, evidence of their presence (e.g., leads/runs, scat and holes) was detected in four habitat types: lichen heathland (n=four), coniferous forest (n=eight), open conifer (n=seven) and wetlands (n=11).
- Simon et al. (1998) found that meadow vole and masked shrew were more restricted in distribution relative to other small mammal species in Labrador, perhaps due to stricter habitat requirements.

In general, the lower Churchill River valley/Lake Melville region is relatively rich in small mammal species diversity and abundance.

3.2.1.2 Newfoundland

Eleven species of small mammals are found on the Island of Newfoundland, including mice, voles, shrews, rats and bats. Relatively speaking, the Island portion of the province has fewer land-based small mammal species compared to Labrador (Table 3-7). However, there are potentially four (versus one) bat species found on the Island: little brown bat; northern long-eared bat (*Myotis septentrionalis*); and hoary bat (*Lasiuru cinereus*), with additional 'accidental' records of red bat (*Lasiurus borealis*) (B. Rodrigues, pers. comm.).

As a relatively recent introduction to the Island of Newfoundland, the southern red-backed vole distribution does not yet extend the full length of the Northern Peninsula (Table 3-7). Currently, its range extends just north of the Main River watershed. Further studies will assess this species' range expansion in the future (Rodrigues 2009).

Relevant studies and their results on the Island include:

- Folinsbee et al. (1973) documented sparse distribution of the meadow vole between 1965 and 1971 across Newfoundland (seven traplines analyzed were within the Central and Eastern Newfoundland geographic region of the Study Area). These researchers found meadow vole most commonly associated with grasslands as they are elsewhere in North America; however, the scarcity of this habitat type in Newfoundland contributes to the low numbers of this species documented.
- There were six traplines/plots assessed for meadow vole on the Avalon Peninsula between 1965 and 1971 (Folinsbee et al. 1973). Results were consistent across the Island - meadow vole were found associated with the grassland habitat type and as this habitat type is not common in Newfoundland; trapping numbers were generally low.
- The Small Mammal Monitoring Network sampled five sites on the Northern Peninsula (Rodrigues 2009). The site at Squid Cove on the northwestern portion of the Northern Peninsula falls in close proximity to the Study Area, although all five sampling sites fall within Ecoregions and habitats representative of the Study Area and similar species would likely occur. In 2007 and 2008, three species (masked shrew, meadow vole and red-backed vole) were detected, with a total of 371 small mammals captured. A decline in species was detected from 2007 to 2008.

- The Small Mammal Monitoring Network monitors six sampling sites in Central and Eastern Newfoundland (Goose Pond, Springdale, Sandy Badger, Loon Bay, North Pond and Port Blandford) (Rodrigues 2009). Four sites (Goose Pond, North Pond, Port Blandford and Sandy Badger) are in close proximity to the Study Area, although all six fall within Ecoregions and habitat types represented by the Study Area. In 2007 and 2008, there were a total of 365 captures representing three species (masked shrew, meadow vole and red-backed vole). A decline in species was detected from 2007 to 2008.
- As a recent introduction to Newfoundland, red-backed voles in the Central and Eastern Newfoundland region have expanded their range as far east as Port Blandford (Rodrigues 2009). However, this species has not yet expanded its range to include the Avalon Peninsula (Rodrigues 2009).
- Incidental observations of small mammals and their sign were recorded along the Northern Peninsula, Central and Eastern Newfoundland and Avalon Peninsula regions of the Study Area during ELC surveys in 2008. Small mammal sign was detected in several habitat types including (but not limited to) alpine vegetated, cutover, mixedwood forest, rocky barrens, conifer scrub, conifer forest, open conifer forest, wetland and Kalmia lichen.

3.2.1.3 Study Area (General)

The general presence and distribution of selected small mammals in Ecoregions in the province was compiled by Garland (2008) and is reproduced in Table 3-7. The proposed and alternate Project infrastructure passes through five Ecoregions in Labrador. Literature available and assessed by Garland (2008) indicate the presence of eight small mammal species in the High Boreal Forest Ecoregion, five in the Forteau Barrens Ecoregion, four in the Mid-Subarctic Forest Ecoregion and two in the Low Subarctic Forest Ecoregion. There were no small mammal data available for the Eagle River Plateau Ecoregion. There is literature available on the presence of small mammals in six Ecoregions of Newfoundland: four species in the Long Range Barrens and Central Newfoundland Forest Ecoregions, three in the Northern Peninsula Forest Ecoregion, and two in each of the Straits of Belle Isle, Maritime Barrens and Avalon Forest Ecoregions.

Table 3-7 Small Mammal Distribution in Ecoregions Crossed by the Transmission Corridor and the ELC Study Area in Labrador and Newfoundland

Ecoregion	Small Mammal Species							
	Masked shrew	Meadow vole	Deer mouse	Red-backed vole	Heather vole	Meadow Jumping mouse	Woodland Jumping mouse	Northern bog lemming
Labrador								
Mid-subarctic Forest	✓	✓		✓	✓			
High Boreal Forest	✓	✓	✓	✓	✓	✓	✓	✓
Low Subarctic Forest		✓		✓				
Forteau Barrens	✓	✓	✓	✓		✓		
Eagle River Plateau	No data							
Newfoundland								
Strait of Belle Isle	✓	✓						
Northern Peninsula Forest	✓	✓	✓					
Long Range Barrens	✓	✓	✓	✓				
Central Newfoundland Forest	✓	✓	✓	✓				
Maritime Barrens	✓	✓						

Ecoregion	Small Mammal Species							
Avalon Forest	✓	✓						

Notes:
1. Data taken from maps depicting Ecoregional distribution of selected small mammals in Newfoundland and Labrador, 1960-2005 (Garland 2008).
2. For a complete list of furbearer and small mammal species in the province refer to Table 2-3.

Evidence and/or observations of small mammals were also recorded during ELC surveys along the transmission corridor in 2008 (Table 3-8), providing an indication of distribution and relative habitat use in the Study Area, throughout multiple seasons. In Labrador, relatively high proportions of burn (80 percent), conifer forest (67 percent), open conifer forest (78 percent), and wetland (79 percent) habitats show evidence of small mammal use. Whereas on the Island, more moderate proportions (10 to 37 percent) of all habitat types, with the exception of two, exhibited small mammal evidence. There was no evidence of small mammal use of the burn (Newfoundland), mixedwood (Newfoundland) or hardwood (Labrador) habitat types. Observations of live animals occurred only in conifer scrub (Newfoundland) and wetland (Newfoundland and Labrador) habitat types, providing some indication of their use during summer (July/August).

Table 3-8 Observations and/or Evidence of Small Mammals in Relation to Habitat Type Along the Transmission Corridor, in 2008

Habitat Type	# Sites with Observations / Total Number of Sites	Abundance Rating	Comments
Newfoundland			
Alpine Vegetated	2/14	1 and 2	Runs
Burn	0/3	-	-
Conifer Forest	26/86	1, 2 and 3	Holes, runs, scat
Conifer Scrub	14/24	1 and 2	Animal observed, holes, runs
Cutover	2/18	1 and 2	Runs, holes
Kalmia Lichen	4/25	1 and 2	Trails
Mixedwood Forest	8/26	-	-
Open Conifer Forest	1/10	2	Not indicated
Rocky Barrens	1/8	2	Runs, holes
Wetland	10/55	2 and 3	Animal observed, holes, runs
Labrador			
Burn	4/5	1, 2 and 3	Runs, scat, holes
Conifer Forest	12/18	1 and 2	Runs, scat, holes
Conifer Scrub	2/5	1	Holes
Hardwood Forest	0/2	-	-
Lichen Heathland	3/5	2 and 3	Runs, scat, holes
Open Conifer Forest	7/19	1 and 2	Runs, scat, holes
Wetland	15/19	1, 2 and 3	Animal observed, runs, scat

Notes:
1. Observations recorded here are for all small mammal species, not just red-backed vole and meadow vole.
2. Abundance rating: 0=non-existent; 1=trace; 2=common; and 3=abundant.

3.2.2 Key and Representative Small Mammal Species

Two species of vole are included in this description: meadow vole and red-backed vole. These two small mammals were selected in part because they occupy specific niches, reflect natural disturbances and habitat changes.

The native meadow vole has historically been an important prey source for marten on the Island (Folinsbee et al. 1973) but in more recent years, the red-backed vole, in particular, has garnered more attention as its distribution across the Island is currently expanding (following its relatively recent introduction) and it now also represents an important prey species for the Newfoundland marten (Hearn et al. 2006). Both species of voles are native to Labrador and are found throughout the region in suitable habitat. Protective cover is an essential habitat requirement of both red-backed voles and meadow voles and they may co-exist in an area, though would occupy slightly different microhabitats.

Predation is an important factor in the population dynamics of prey species (Sandell 1989), such as small mammals. Many small mammal species, and also some birds, undergo predictable cyclic population fluctuations. Examples include several species of voles, mice, shrews, hares, ptarmigan and grouse (Korpimaki and Krebs 1996). Studies throughout the province indicate that voles exhibit a three-to five-year cycle, as is typical for microtine populations in boreal forests of North America (Korpimaki and Krebs 1996). For comparison, for the snowshoe hare, and their principal mammalian and avian predators, the cycle averages 9 to 10 years (Keith 1990; Krebs et al. 1995).

3.2.2.1 Red-backed Vole

Typical of voles, the red-backed vole has a short tail, rounded small ears and a pointed nose. The red-backed vole may be distinguished from the meadow vole in several ways. The Red-backed vole is slightly thinner and smaller than the meadow vole, and the ears of the red-backed vole are slightly larger (MacRae and Bruseker 2010). Although there are different phases in colouration, generally, this species can be described as having grey fur with a dorsal reddish stripe running from head to tail. The undersides of this small (12 to 15 cm in length) mammal are grey to white in colour (Nature Works 2010). Coniferous and mixedwood forests and bogs are preferred habitat (Nature Works 2010). These voles vary their diet with what is seasonally available. In spring, plant parts are consumed, with the addition of berries in summer, followed by seeds in fall (Nature Works 2010). In winter, stored foods comprise their diet, and foods such as fungi, insects and roots may be consumed opportunistically at any time (Nature Works 2010). This microtine species is most active at night. Breeding takes place from April to October, with many litters (two to eight young per litter) born during this period. This small mammal has a lifespan of approximately 10 to 20 months (Nature Works 2010).

The red-backed vole is native to Labrador but was first detected on the Island of Newfoundland in 1999 at Little Grand Lake (Hearn et al. 2006). The provincial Wildlife Division is currently tracking its spread across the Island. Interspecific competition with meadow voles may be expected (Payne 1974). This species now represents an additional prey item for marten (Simon et al. 1999b; Gosse and Hearn 2005; Hearn et al. 2006).

Primary Sources of Information

A recent comprehensive annotated bibliography on small mammal research was developed by the provincial Wildlife Division (Garland 2008). Small mammal trapping in the lower Churchill, Little Mecatina and St. Augustin River valleys by the Institute for Environmental Monitoring and Research (IEMR 2003) in 2000 and 2003 provide

relevant data for southern Labrador, as well as published studies by Simon et al. (1998, 2002). Additional literature on voles in Newfoundland and Labrador is available indirectly through studies directed primarily at marten (e.g., Simon et al. 1998; Hearn et al. 2006). The ACCDC compiles data relevant to small mammals in the province.

Existing Conditions and Status

Red-backed voles were first recorded in western Newfoundland in 1999 and the Small Mammal Monitoring Network began documenting its range expansion across the Island in 2007. It is not known whether its arrival was accidental or a deliberate introduction, but regardless, this species is now documented as the eleventh non-native terrestrial mammal on the Island (Hearn et al. 2006). A general lack of detailed studies exist for small mammal populations in the province, but red-backed vole populations for Labrador and Newfoundland are independently estimated at greater than 1 million individuals (ACCDC 2008).

Habitat Association and Distribution in the Study Area

The red-backed vole in Labrador has been associated with older, moist forests and less associated with areas having much lichen coverage (Simon et al. 1998), although Ure and Maser (1982) considered lichens an important food source for the western subspecies of red-backed vole. Small mammal trapping along the lower Churchill River valley in 2006 (Minaskuat 2008a) found red-backed voles to be in greatest abundance of the four small mammal species captured. They were captured in all six habitat types with a coniferous component. Although most captures were in wet-spruce habitat type (n=43; 3.49/100 trap nights) and the least in spruce-dry (n=15; 1.58/100 trap nights), there was a narrow range in total captures amongst the other four habitat types (n=22 to 32). Red-backed vole was also one of two most common species found in western Labrador in 1999 and were found in greater numbers on clear-cut sites compared to other forest stands (Simon et al. 2002). The presence of the eastern subspecies of red-backed vole in clearcuts within three years of harvest was also noted by Allen (1983) and is attributed to their greater dependence on herbaceous vegetation than the western subspecies. The presence of coarse woody debris is very important for travel, nesting, foraging and navigation (Simon et al. 1998).

Red-backed vole diet consists of herbaceous vegetation, insects, seeds of coniferous trees, lichens and fungi (Merritt and Merritt 1978). In the creation of a habitat suitability index for red-backed vole, Allen (1983) summarized the requirements of this species as a specific combination of: average diameter at breast height of overstory, 20 percent of the ground covered by debris (coarse woody debris with stem diameter greater than 7.6 cm); percent grass canopy; and percent canopy closure. Moist soils have also been identified as an important habitat feature in that they allow for increased plant and fungal growth (Clark 1973). Adequate food and protective cover may be found in a wide range of plant communities providing suitable red-backed vole habitat.

Table 3-9 summarizes primary, secondary and tertiary habitat quality for red-backed vole. Primary habitat includes black spruce and lichen, conifer forest, conifer scrub, mixedwood forest and cutover habitat types and comprises approximately 3,871 km^2 (36.2 percent) of the Study Area in Newfoundland and 1,446 km^2 (23.3 percent) in Labrador.

Secondary habitat is represented by Kalmia lichen heathland, open conifer forest and scrub/heathland/wetland habitat types. The remaining habitats in Table 3-9 were classified as tertiary, based on limited foraging, nesting, protection or resting opportunities.

Table 3-9 ELC Habitat Type and Relative Quality for Red-backed Vole Use Along the Transmission Corridor

Habitat Type	Habitat Quality	Notes
Alpine Vegetated	Tertiary	Negative association for this species in areas with much lichen coverage (Simon et al. 1998).
Black Spruce and Lichen Forest	Primary	Negative association for this species in areas with much lichen coverage was found in Labrador (Simon et al. 1998); although lichens are a known food source for western subspecies (Ure and Maser 1982); this habitat type would provide conifer seeds as food source; percent ground cover/debris and percent canopy closure would vary from stand to stand and therefore, some of these habitat types may provide suitable habitat. Minaskuat (2008a) also identified relatively high abundance in this habitat.
Burn	Tertiary	Coarse woody debris necessary for visual cover (Simon et al. 1998).
Conifer Forest	Primary	This species was most abundant on older successional sites in western Labrador; importance of fallen logs (Simon et al. 1998; Minaskuat 2008a).
Conifer Scrub	Primary	These sites may be important if enough moisture and coarse woody debris is available to provide cover and nest sites (Simon et al. 1998).
Cutover	Primary	In central Labrador, this species was captured most often in clear-cut sites (Simon et al. 2002).
Exposed Bedrock	Tertiary	Necessary cover forage and nesting material not found here.
Hardwood Forest	Tertiary	Necessary cover forage and nesting material not found here.
Kalmia Lichen/Heathland	Secondary	Cover provided by tree, shrub and ground cover.
Lichen Heathland	Tertiary	Negative association for this species in areas with much lichen coverage (Simon et al. 1998).
Mixedwood Forest	Primary	Positive associations for this species found in this forest type in western Labrador with trees >2 m high and containing broad-leaved shrubs (Simon et al. 1998).
Open Conifer Forest	Secondary	These sites may be important if enough moisture and coarse woody debris is available to provide cover and nest sites (Simon et al. 1998).
Rocky Barrens	Tertiary	Negative association for this species in areas with much lichen coverage (Simon et al. 1998).
Scrub/Heathland/ Wetland	Secondary	Scrub habitats preferred as they may provide enough cover and nesting (Simon et al. (1998).
Wetland	Tertiary	Fens not used by this species in western Labrador (Simon et al. 1998).

Notes:
1. Habitat types are described in Table 2-2.
2. Habitat quality is described in Section 2.2.4.

Lower Churchill River, Lake Melville and Southeastern Labrador

The red-backed vole is found throughout suitable habitat in southern Labrador (Garland 2008). The red-backed vole was trapped in the lower Churchill River valley in 2002 (IEMR 2003) and also in the Little Mecatina and St. Augustin River valleys in southern Labrador in 2001 (IEMR 2003).

Primary red-backed vole habitat is found in varying proportions across Ecoregions of the Southeastern Labrador geographic region of the Study Area (i.e., excluding the Lower Churchill River and Lake Melville region) ranging from 8 to 30 percent (Figure 3-9). Secondary habitat ranges from 18 to 52 percent for this region, while tertiary

habitat varies from 11 percent (High Boreal Forest Ecoregion) to 59 percent (Forteau Barrens Ecoregion) (Figure 3-9).

Northern Peninsula

The first red-backed vole on the Island of Newfoundland was documented in Western Newfoundland in 1999 (Hearn et al. 2006). In the past eight years, this species has spread north and east across the Island. This species occupies suitable habitats with moist microclimates. This suitable habitat may be found in the Long Range Barrens Ecoregion of the Northern Peninsula, which covers the higher country of the central portion of the peninsula. The red-backed vole range has not yet been documented north to the Strait of Belle Isle (Rodrigues 2009).

Primary red-backed vole habitat is found in greatest proportions in the Study Area in the Northern Peninsula Forest Ecoregion (34 percent of 2,033.3 km^2) (Figure 3-10). Secondary habitat for red-backed vole is dominant on the Northern Peninsula, covering the highest percentage of rated habitat in represented Ecoregions (50 percent in the Long Range Barrens Ecoregion, 46 percent for both the Northern Peninsula Forest Ecoregion and the Strait of Belle Isle Ecoregion). Tertiary habitat is found in smaller proportions and covers 15, 10 and 12 percent of the Study Area in the Strait of Belle Isle, Northern Peninsula Forest and Long Range Barrens Ecoregions, respectively.

Central and Eastern Newfoundland

The red-backed vole has been documented in the Central Newfoundland Forest Ecoregion of Central and Eastern Newfoundland (Rodrigues 2009).

Forty-three percent of the Central and Eastern Newfoundland region of the Study Area is considered primary habitat for red-backed voles, with the greatest proportion (45 percent) found in the Central Newfoundland Forest Ecoregion (Figure 3-11). Secondary habitat is found in moderate proportions ranging from 24 to 38 percent across the Ecoregions. Tertiary habitat is dominant in the Long Range Barrens Ecoregion, comprising 41 percent of the Study Area, with lesser proportions in the Maritime Barrens (30 percent) and Central Newfoundland Forest (15 percent) Ecoregions.

Avalon Peninsula

Red-backed voles have not yet been documented on the Avalon Peninsula (Garland 2008). However, given their rapid spread across most of the Island in recent years, habitat quality in this region was mapped. The Maritime Barrens Ecoregion covers 87 percent (1,519.9 km^2) of the Study Area in this region and provides 37 and 32 percent of primary and secondary habitat, respectively, for red-backed voles (Figure 3-12). Fifty-five percent of the Study Area within the Avalon Forest Ecoregion provides primary habitat, although this Ecoregion comprises only 13 percent of the Avalon Peninsula component of the Study Area. Tertiary habitat constitutes the minority of available habitat in this geographic region of the Study Area (12 percent in the Maritime Barrens Ecoregion and 2 percent in the Avalon Forest Ecoregion)

Figure 3-9 Red-backed Vole Habitat Quality: Southeastern Labrador

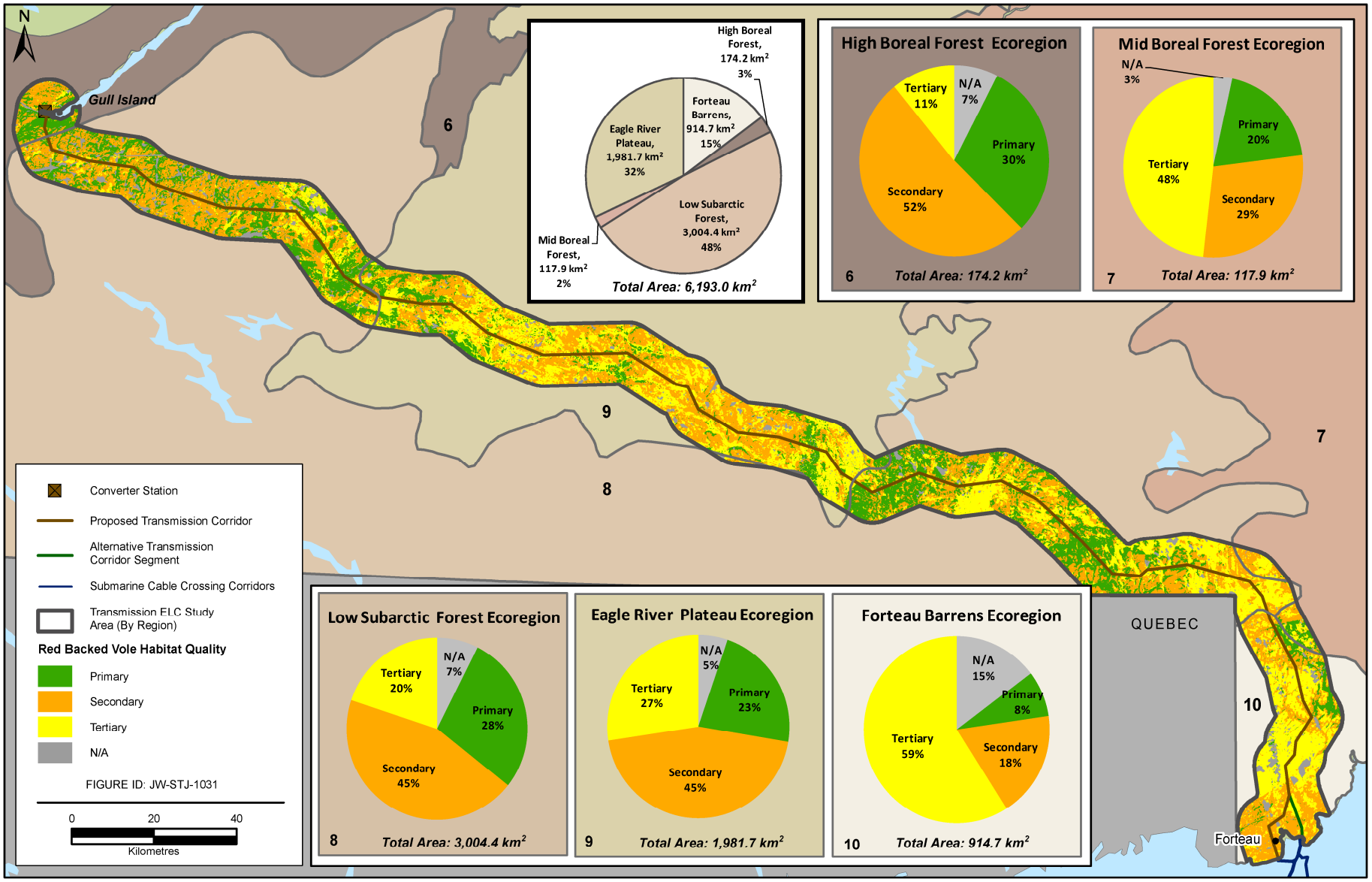


Figure 3-10 Red-backed Vole Habitat Quality: Northern Peninsula

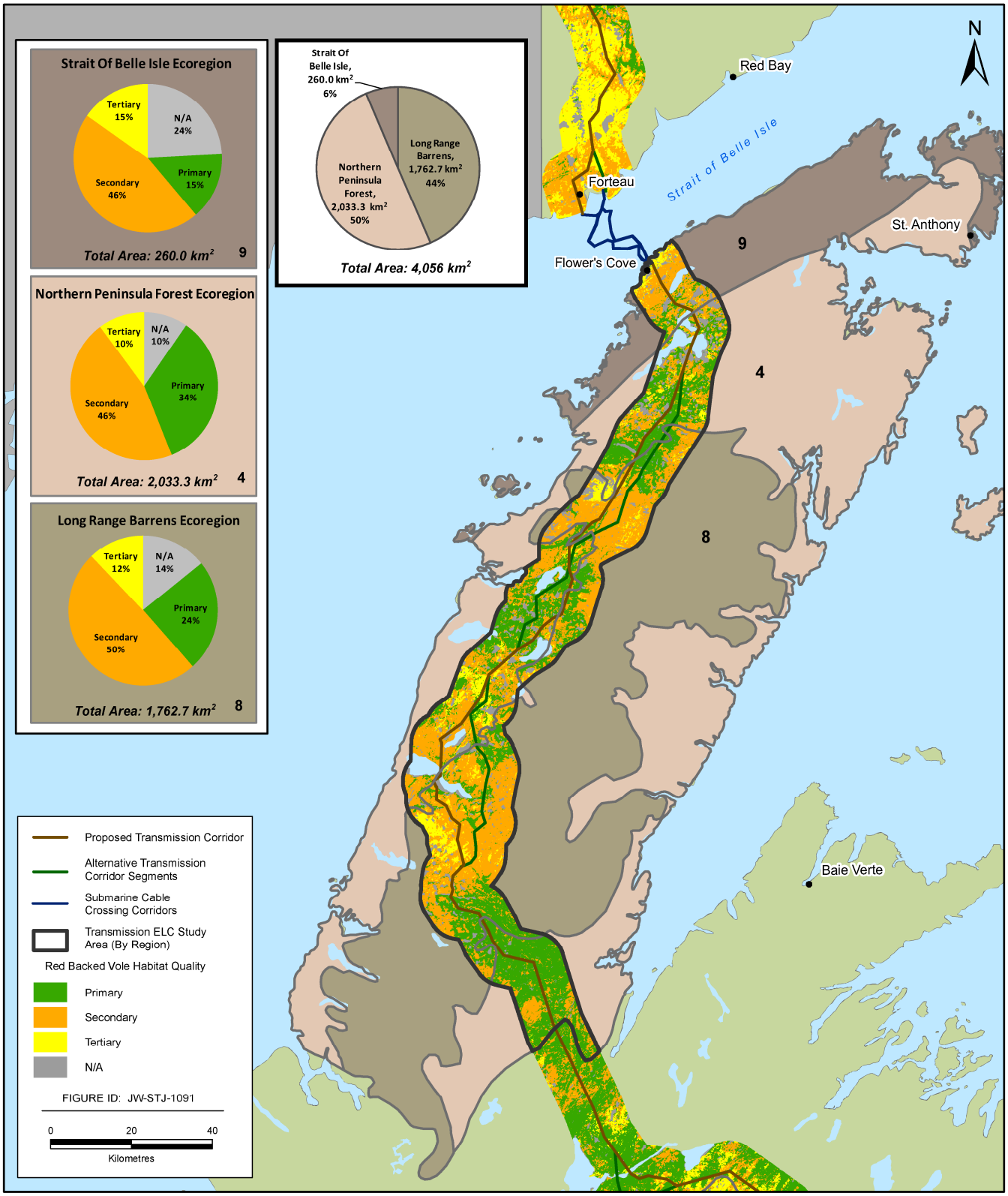


Figure 3-11 Red-backed Vole Habitat Quality: Central and Eastern Newfoundland

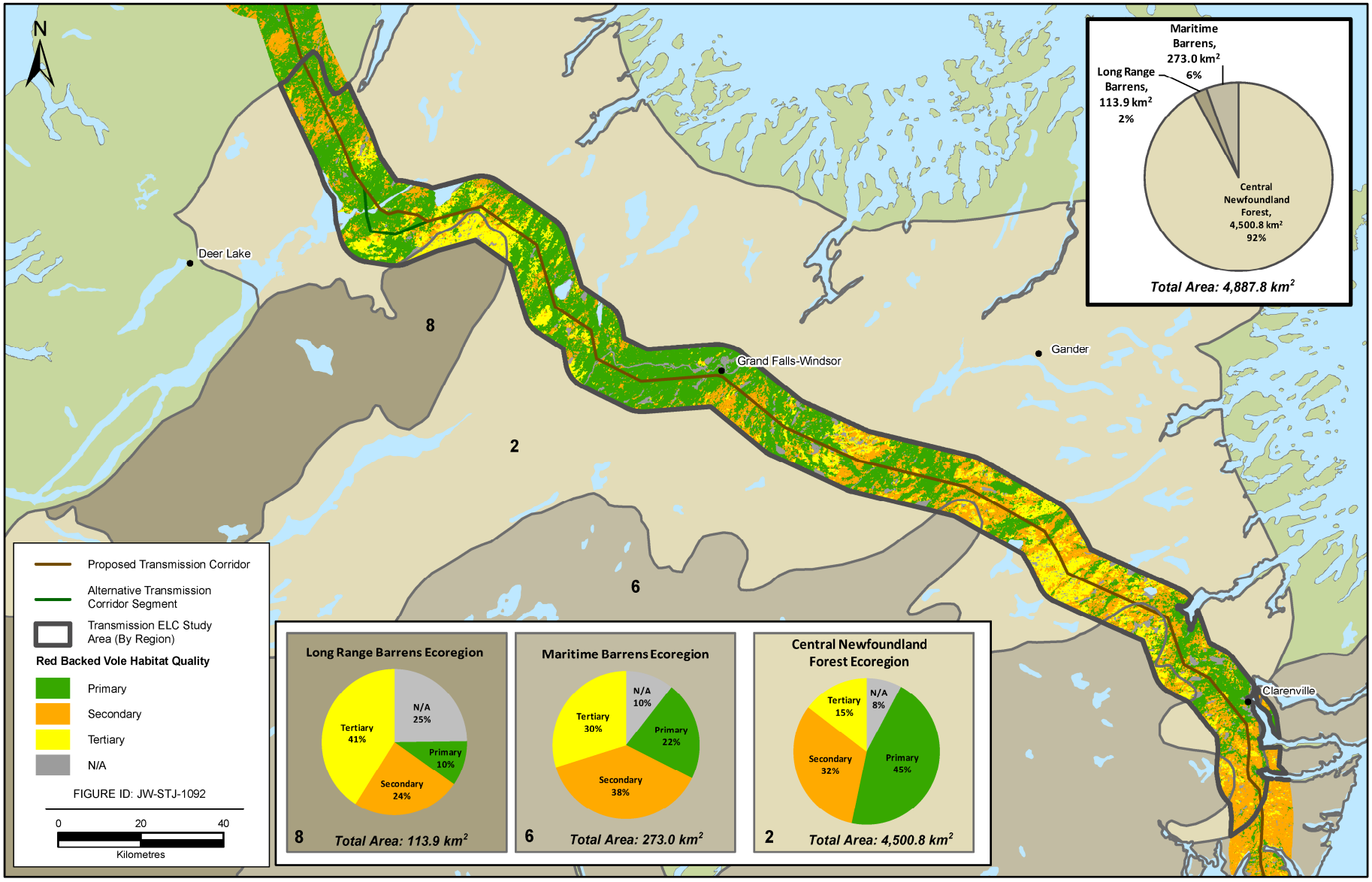
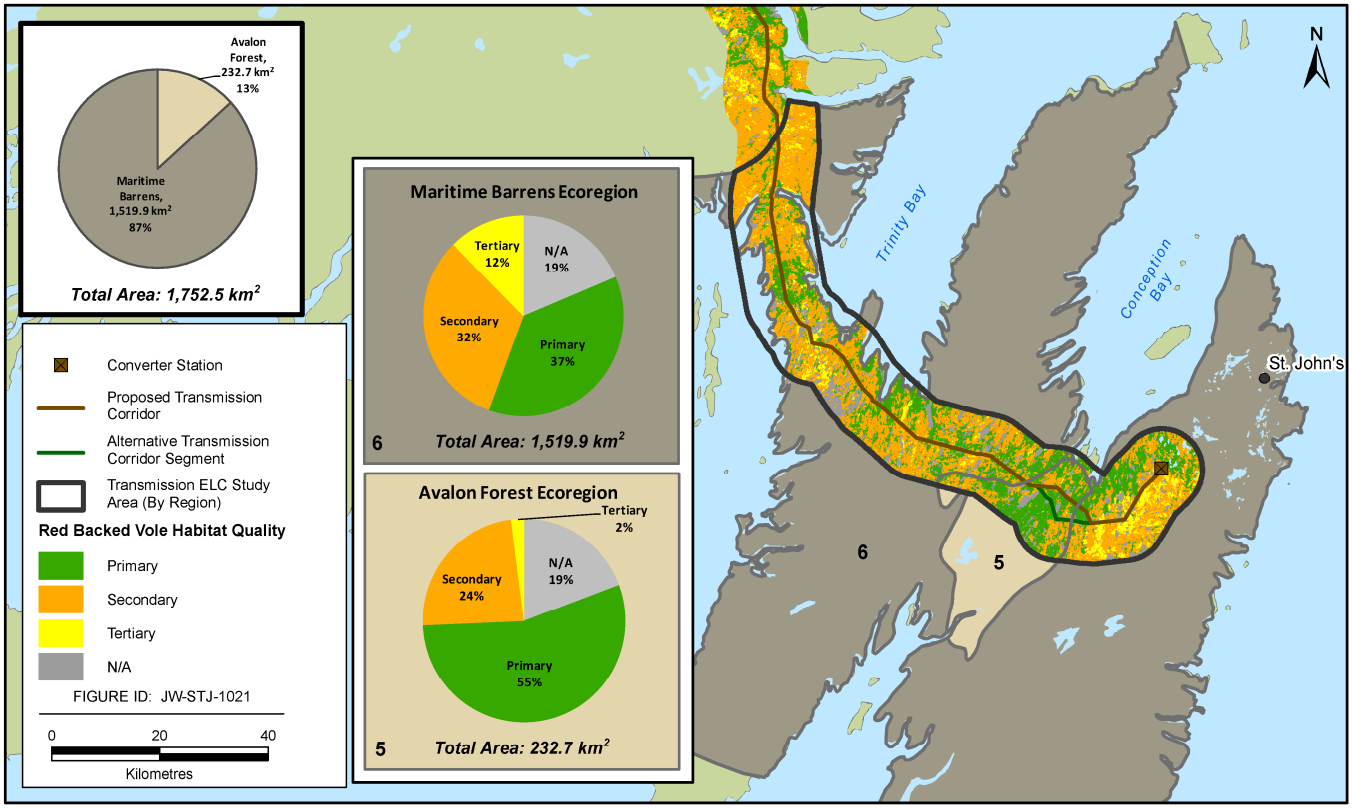


Figure 3-12 Red-backed Vole Habitat Quality: Avalon Peninsula



Limiting Factors

Small mammal populations may be affected by forest disturbance. Natural disturbances, such as forest fire, and practices such as clear cutting have similar effects on small mammal populations. Simon et al. (2002) concluded that small mammal communities in Labrador can be maintained through forest management with attention to coarse woody debris on the site, as it is an important factor in small mammal use of disturbed sites of certain ages. In general, small mammal density increases with successional age of forests (Simon et al. 1998). Red-backed vole are considered important prey source for marten and fox and populations and may therefore be affected by these predator populations.

3.2.2.2 Meadow Vole

The meadow vole is one of many native small mammals in Labrador and the only native terrestrial small mammal species in Newfoundland.

The meadow vole also has the distinguishing characteristics of vole species (i.e., rounded ears and a short tail, with grey-brown fur). Although size can vary considerably due to availability of food resources, average length and weights are 16 cm and 36.5 g, respectively (DEC undated (d)). With a short lifespan of only up to 12 months, these voles may have several litters (three to five young per litter) throughout the warmer months (April to September) (DEC undated (d)). Grass cover is an essential habitat component, but this species may be found most often in open grasslands and sometimes also in coniferous forests (DEC undated (d)). The diet of the

meadow vole is comprised of grasses, sedges, herbs, berries, seeds, insects and snails (DEC undated (d)). Predators include marten and other weasels and owls (DEC undated (d)).

Primary Sources of Information

Riewe (1973) and Folinsbee et al. (1973) provided early insight on the ecological distribution and food habits of the meadow vole. More recently, the provincial Wildlife Division developed a comprehensive annotated bibliography on small mammal research in the province (Garland 2008) and the Small Mammal Monitoring Network (Rodrigues 2009) has documented meadow vole (as well as other small mammal species) at sites across the province in the last three years. Small mammal trapping in the lower Churchill, Little Mecatina and St. Augustin River valleys by IEMR (2003) and Minaskuat Inc. (2008a) provide information on small mammals in Labrador, as well as published studies by Simon et al. (1998). Additional information on meadow vole is available through research dedicated to Newfoundland marten (e.g., Thompson and Curran 1995; Sturtevant and Bissonette 1996).

Existing Conditions and Status

This species is not listed under *SARA* or *NLESA*. The general status, as rated by DEC (2005) is *secure* (a general status category for a species that is not believed to belong in the categories *At Risk*, *May Be At Risk*, or *Sensitive*), and this species remains widespread or abundant in the province (Anonymous 2005). Population sizes are estimated at greater than 1,000,000 individuals in Labrador and a broad range estimate of 10,000 to 100,000 individuals on the Island of Newfoundland (DEC 2005).

The Small Mammal Monitoring Network documents annual captures of meadow voles across the province. Although only two years of data have yet been analyzed, it has been found that capture numbers are relatively low for this species as compared with other small mammal species. It is interesting to note that 3 of 10 study sites in Labrador saw a marked decline in number of captures of this species from 2007 to 2008. Meadow voles in Newfoundland were captured at 7 of 14 sites across the Island. An overall increase was detected in meadow vole numbers in Newfoundland from 2007 to 2008 (Rodrigues 2009).

Habitat Association and Distribution in the Study Area

Meadow vole are occasionally found in coniferous forests, barrens and bogs, although they are most often associated with wet meadows and grassland habitats (Folinsbee et al. 1973; Thompson and Curran 1995; Sturtevant and Bissonette 1996; DEC undated (d)). Grass cover is essential as forage, predator protection and as nesting material (DEC undated (d)). Abundant woody debris in areas of blowdown and some regenerating cutovers also provide suitable cover and subnivean protection (Adair and Bissonette 1997). Summer diets generally consist of herbaceous vegetation but meadow voles will also feed year-round on plants characteristic of forests, indicating their appetites have adjusted to existence in such habitats (Riewe 1973). Meadow voles may also occasionally scavenge on animal remains (Riewe 1973).

Primary, secondary and tertiary habitat quality for meadow vole are summarized in Table 3-10. Primary habitat identified for this species include conifer forest, conifer scrub, Kalmia lichen heathland, lichen heathland, mixedwood (Labrador), scrub/heathland/wetland and wetland. Primary habitat occupies 8,472 km^2 (79.2 percent) of the Study Area in Newfoundland and 5,464.5 km^2 (89.9 percent) in Labrador.

Table 3-10 ELC Habitat Type and Relative Quality for Meadow Vole Use Along the Transmission Corridor

Habitat Type	Habitat Quality	Notes
Alpine Vegetated	Tertiary	Very few grasses available for forage, cover and nesting material.
Black Spruce and Lichen Forest	Tertiary	Very few grasses available for forage, cover and nesting material.
Burn	Secondary	In Labrador, at least one of these sites was a 'recent' burn; early invasive species present; some *Microtus* found on recent burns in western Labrador (Simon et al. 1998).
Conifer Forest	Primary	Grass and sedge species available for forage, cover and nesting material.
Conifer Scrub	Primary	Conifer areas preferred as very few grasses available for forage, cover and nesting in tuckamore.
Cutover	Secondary	Very few grasses available for forage, cover and nesting.
Exposed Bedrock	Tertiary	Small amounts and few species of grasses/sedges.
Hardwood Forest	Secondary	Few grass/sedge species present.
Kalmia Lichen/Heathland	Primary	Several grass and sedge species to provide forage, cover and nesting material; moisture present.
Lichen Heathland	Primary	Lack of moisture/water and cover are limiting factors for this species (Birney et al. 1976; Reich 1981; Raphael 1987).
Mixedwood Forest	Primary	Primary for Labrador more so than the Island of Newfoundland. Several grass and sedge species to provide forage, cover and nesting material; moisture present.
Open Conifer Forest	Primary	Primary for Labrador more so than the Island of Newfoundland. Few grass and sedge species present in this forest type in the Island of Newfoundland; however, grass and sedges found in Labrador.
Rocky Barrens	Tertiary	Lack of moisture/water and cover are limiting factors for this species (Birney et al. 1976; Reich 1981; Raphael 1987).
Scrub/Heathland/ Wetland	Primary (conifer); Tertiary (tuckamore)	Very few grasses available for forage in tuckamore; in wetlands, grass and sedge species available for forage, cover and nesting material. This habitat type was mapped conservatively as primary habitat.
Wetland	Primary	Lack of grass species for forage, cover and nesting material; conifer, grass and sedge species available for forage, cover and nesting material.

Notes:
1. Habitat types are described in Table 2-2.
2. Habitat quality is described in Section 2.2.4.

Secondary habitat is represented by burn, cutover and hardwood forest, which may provide some of the necessary grass cover, depending on the individual sites. Remaining habitats in Table 3-10 were classified as tertiary, based on limited foraging, nesting, protection, resting or feeding opportunities.

Lower Churchill River and Lake Melville

Wildlife Habitat Assessment in the lower Churchill River valley (Minaskuat 2008a) found a total of 17 meadow vole captures over eight study sites, the lowest number of four small mammal species detected during these surveys. Meadow voles were most often associated with a deciduous-dominant mixed forest habitat type but were also detected in both spruce and fir-spruce coniferous forests. This species was also trapped in the Little Mecatina and St. Augustin River valleys in southern Labrador (IEMR 2003).

Southeastern Labrador

The meadow vole is found throughout southern Labrador, often in open habitats with herbs and grasses (Simon et al. 1998). The Small Mammal Monitoring Network (Rodrigues 2009) maintains four sampling sites in southeastern Labrador that occur in Ecoregions and habitats consistent with the Study Area. In 2007 and 2008, meadow vole were detected at two of these sites, with a single specimen captured at Parke Lake in 2007 and 11 and 4 individuals captured at Ship Harbour in 2007 and 2008, respectively.

The Southeastern Labrador portion of the Study Area contains a large amount of high quality habitat for meadow vole, with 87 to 97 percent of habitat rated as primary in each of the five Ecoregions (Figure 3-13). Secondary and tertiary habitats comprise less than or equal to 9 percent of any Ecoregion within the Study Area.

Northern Peninsula

The meadow vole is found throughout suitable habitats on the Northern Peninsula. Folinsbee et al. (1973) trapped voles in a variety of habitats in this region over a seven-year period. Meadow voles were generally found to be scarce across the Island and most often found in grassy areas and occasionally in barrens and bogs (Folinsbee et al. 1973).

Rodrigues (2009) detected meadow voles at three of five sampling sites on the Northern Peninsula over a two-year period from 2007 to 2008: Squid Cove in the northwestern portion of Northern Peninsula (n=one); at Crooked Pond at the base of Northern Peninsula (n=one); and at McKenzie's Brook in the southwestern portion of the Northern Peninsula (n=23).

As in Labrador (and the remainder of the Island), a high abundance of primary habitat is distributed throughout the Northern Peninsula portion of the Study Area, where primary habitat ranges between 78 and 89 percent in the various Ecoregions represented (Figure 3-14). Secondary and tertiary meadow vole habitat in this region is negligible, peaking at 5 percent in the represented Ecoregions.

Central and Eastern Newfoundland

The meadow vole is ubiquitous throughout central Newfoundland but abundance is very low (Rodrigues 2009). The Small Mammal Monitoring Network monitors small mammals annually at six sites in central Newfoundland. Single specimens of meadow vole were captured at two of these sites (Sandy Badger and Port Blandford) in 2007. There were no meadow vole captures in the central Newfoundland region in 2008 (Rodrigues 2009).

Primary meadow vole habitat is also abundant in the Central and Eastern Newfoundland portion of the Study Area. Seventy-six percent of Study Area in the Central Newfoundland Forest Ecoregion (4,501 km^2) was rated as primary habitat, and that of the relatively minor Ecoregions (i.e., Long Range Barrens and Maritime Barrens) were similarly high (87 and 85 percent, respectively) (Figure 3-15). Secondary meadow vole habitat is generally low, found in largest proportion in the Central Newfoundland Forest (17 percent). Tertiary habitat was found only in the Maritime Barrens Ecoregion (2 percent).

Figure 3-13 Meadow Vole Habitat Quality: Southeastern Labrador

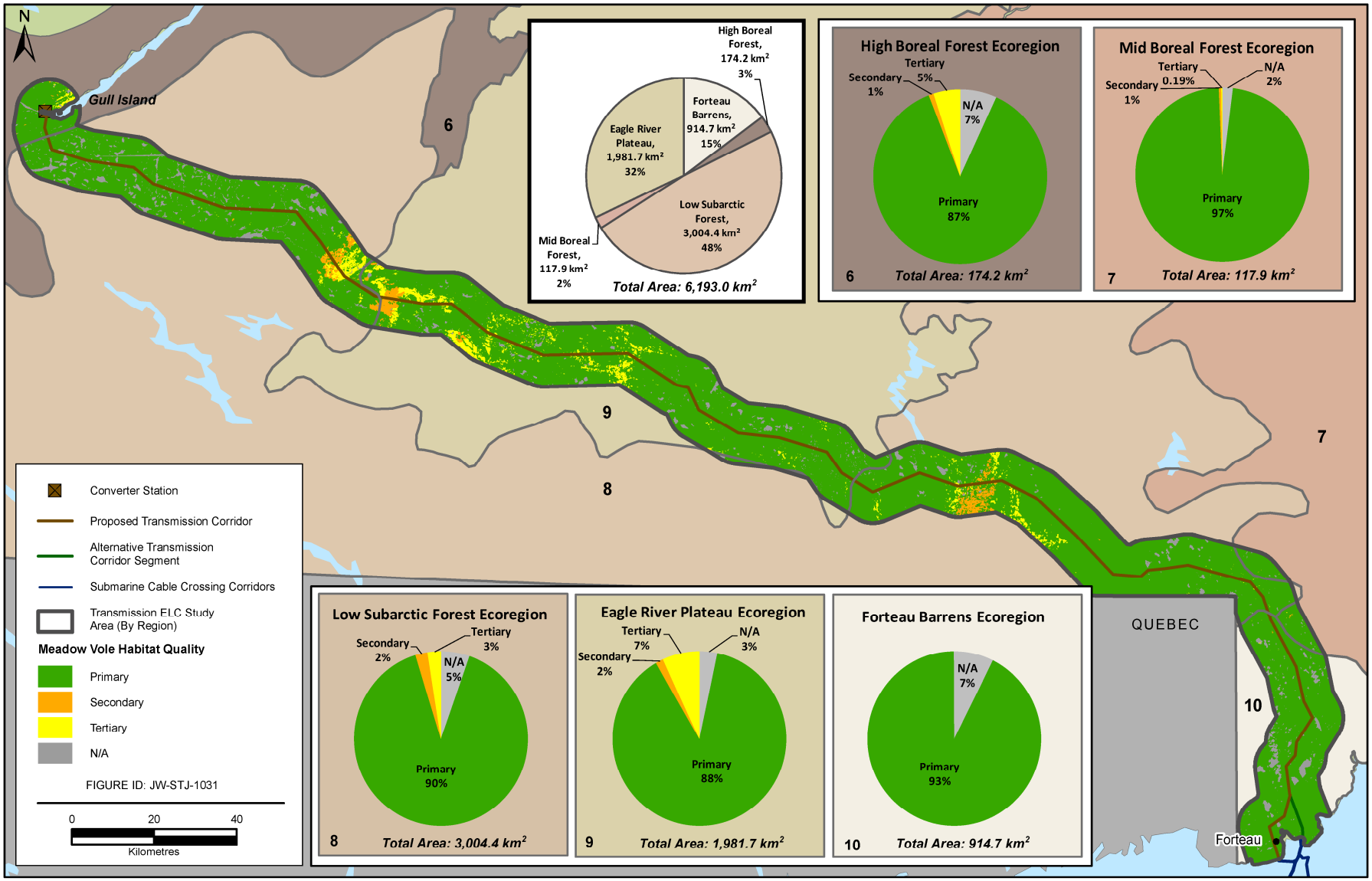


Figure 3-14 Meadow Vole Habitat Quality: Northern Peninsula

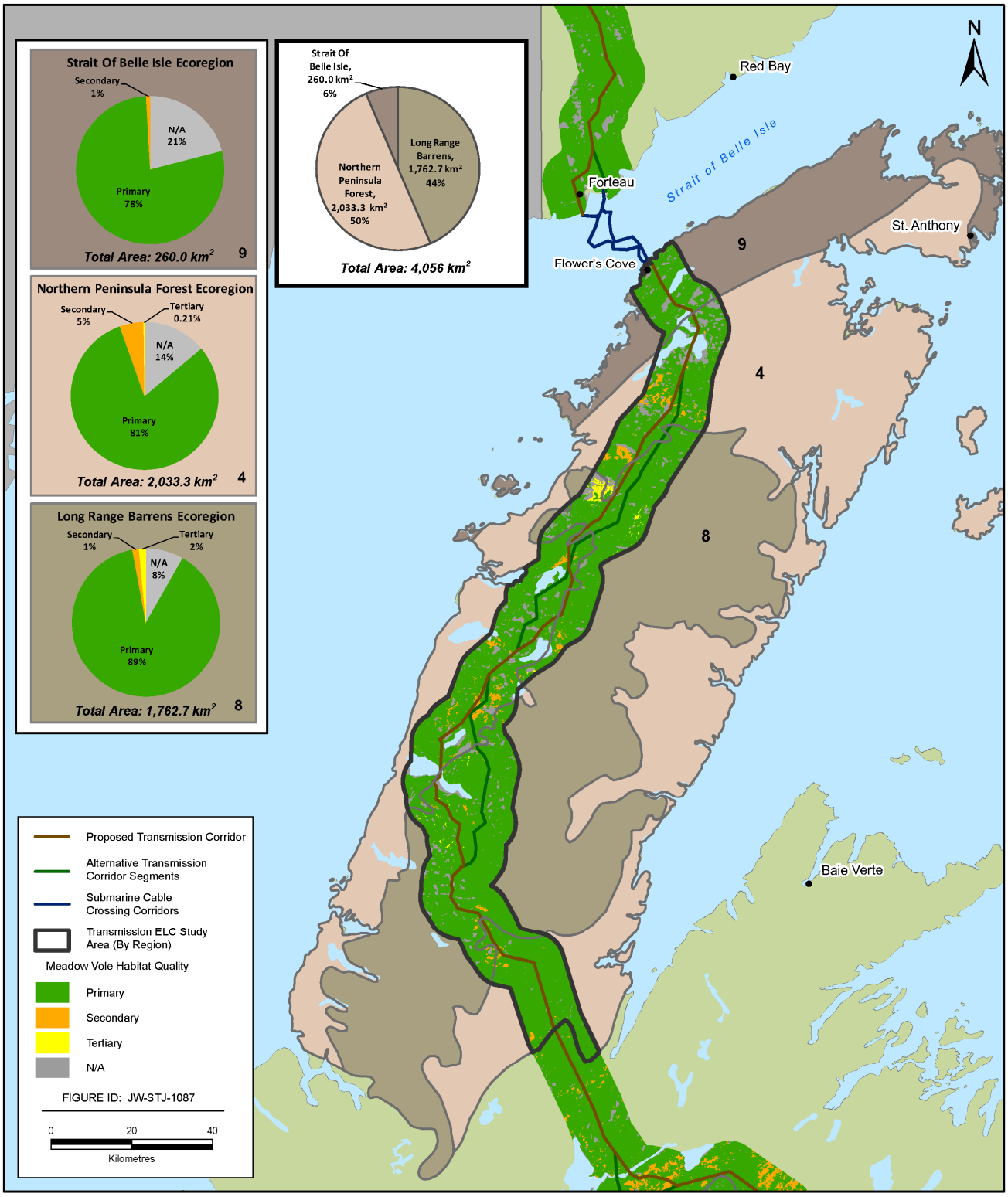
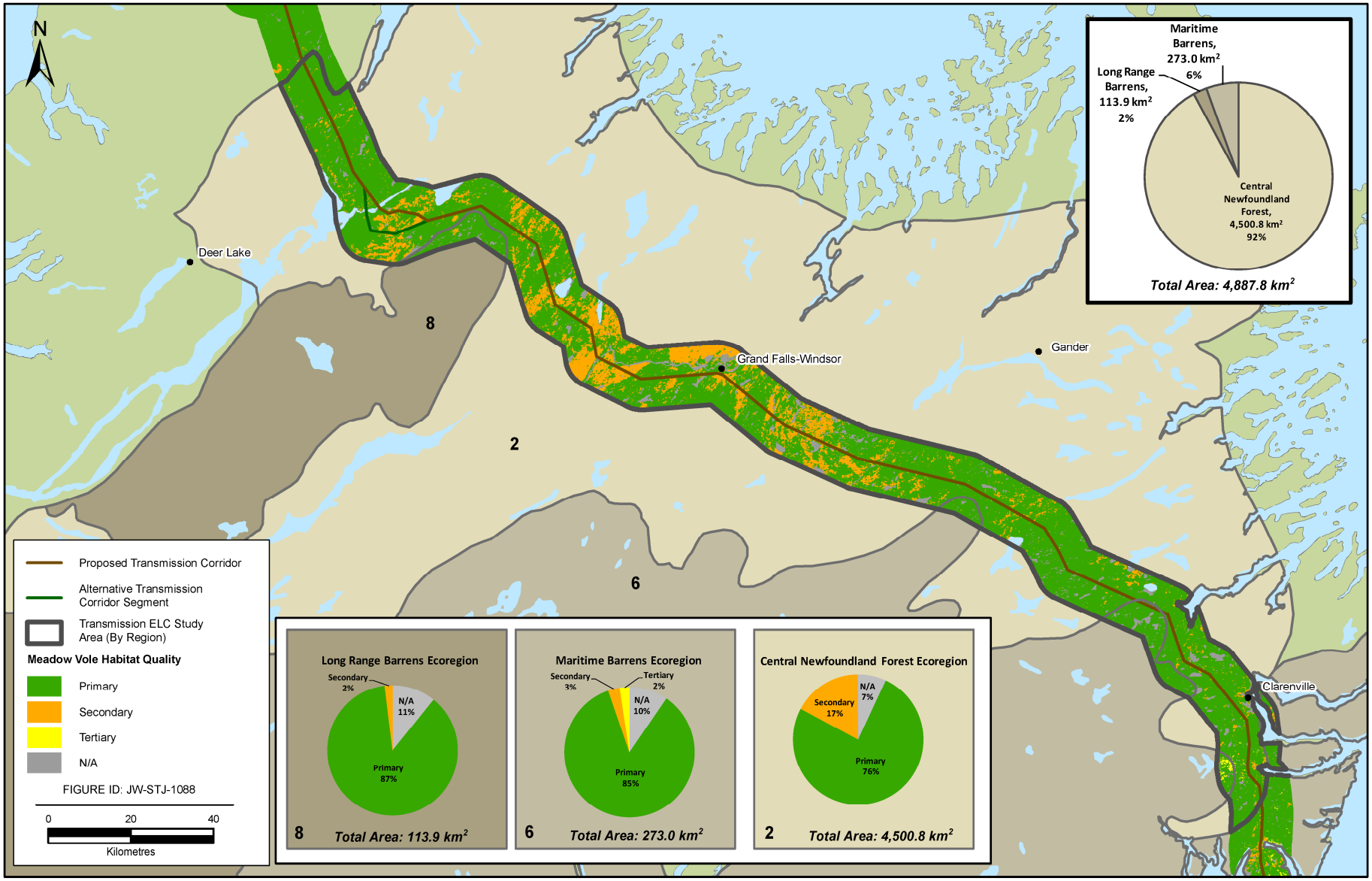


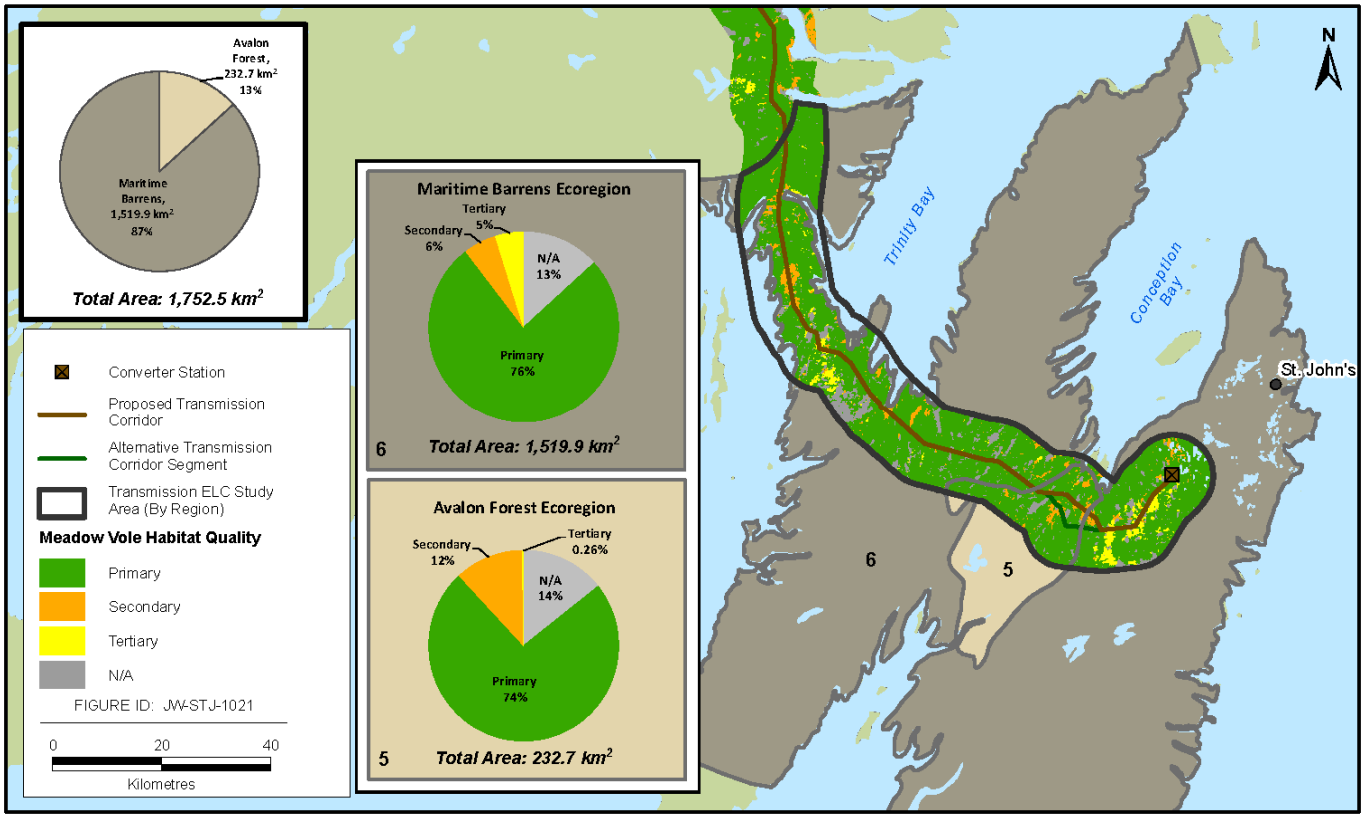
Figure 3-15 Meadow Vole Habitat Quality: Central and Eastern Newfoundland



Avalon Peninsula

The meadow vole is found throughout the Avalon Peninsula (Garland 2008). The Avalon Peninsula also provides abundant primary habitat for meadow vole (Figure 3-16). The Maritime Barrens Ecoregion comprises 87 percent of the Study Area and 76 percent of this portion of the Study Area is comprised of primary habitat for meadow vole. Seventy-four percent of the Study Area within the Avalon Forest Ecoregion (making up the remaining 13 percent of the area) provides additional primary habitat for this species (74 percent of 233 km^2). Secondary habitat quality is found in much smaller proportions in the two Ecoregions (6 to 12 percent). Tertiary habitat quality ranges from 0.26 to 5 percent of the Study Area within the two Ecoregions.

Figure 3-16 Meadow Vole Habitat Quality: Avalon Peninsula



Limiting Factors

Interspecies competition with the recently introduced red-backed vole (Hosett and Steen 2007) may prove to be a limiting factor for the meadow vole (Cameron 1964; Morris 1969; Hearn et al. 2006). Prior to the red-backed vole introduction, the meadow vole was the only small mammal prey species for some predators on the Island (Sturtevant et al. 1996). Capture numbers as indicated by the efforts of the Small Mammal Monitoring Network (Rodrigues 2009) of both vole species over the last couple of years may give early indication that the red-backed vole is out-competing the native meadow vole on the Island. Other general limiting factors include natural disturbance (forest fire) and practices such as clear cutting (Sturtevant et al. 1996).

4.0 DISCUSSION AND SUMMARY

Nalcor Energy is proposing to develop 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 *Furbearer and Small Mammal Component Study* was completed in order to identify, compile, summarize and present information on furbearer and small mammal species in the area of, and which may interact with, the proposed Project for use in the EIS.

Furbearer and small mammal species included in this Component Study represented several important groups of semi-aquatic and terrestrial furbearers and microtines. Species listed under *SARA* or *NLESA* were included in these key and representative groups.

The objective of this Component Study was to provide information on the terrestrial environment, in particular furbearers and small mammals, for the eventual EA for the proposed Project. This Component Study identifies and describes the occurrence and distribution of key and representative species in the Study Area and mapping preferred habitats of representative species based on field observations, literary sources and habitat mapping.

An overview of the key outcomes 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 Project. The annotated bibliography is an important resource that can be accessed for future and/or additional components of the Project. In addition to the resources presented in this document, literature related to potential Project effects has been retained to support the EA.
- The habitats identified throughout the Study Area represent a variety of niches important to both terrestrial and a semi-aquatic furbearer and small mammals. A variety of key and representative mammal species were selected for this Component Study that are believed to represent the diversity of habitats.
- Details on the presence of furbearers and small mammals in the Study Area and information on their distribution and relative abundance has been presented based on the available literature as well as previous baseline investigations in support of this and other projects.
- For four key and representative species, the distribution and abundance of preferred (primary, secondary and tertiary quality) habitats in the 15 km wide regional Study Area along the transmission corridor were mapped, including marten, porcupine, red-backed vole and meadow vole.

Key outcomes of this exercise are the detailed regional overviews of small mammals and furbearers in the Study Area and the habitat quality mapping products indicating areas of primary, secondary and tertiary habitat for key and representative species in the Study Area.

4.1 Regional Overviews of Furbearers and Small Mammals in the Study Area

Overviews of furbearer and small mammal species were compiled for geographic regions of the Study Area. The following sections summarize the combined results of these regional overviews.

4.1.1 Lower Churchill River, Lake Melville and Southeastern Labrador

The lower Churchill River, Lake Melville and the Southeastern Labrador geographic regions comprise the Study Area in Labrador. There are 18 confirmed furbearer species in Labrador. Furbearer species recorded along the lower Churchill River valley during baseline surveys in 2006 include porcupine, red fox, grey wolf, muskrat, mink, river otter, snowshoe hare and beaver. In addition to these species, lynx, coyote, marten, ermine, Arctic hare, red squirrel, northern flying squirrel (*Glaucomys sabrinas*), Arctic fox (*Alopex lagopus*) and woodchuck may also occur. Within this region in general, the lower Churchill River valley and its tributaries may be particularly important for aquatic and semi-aquatic furbearer species as it is a dominant feature on the landscape.

Wolverine are listed as an *Endangered* species under *SARA* and *NLESA;* however, their presence in Labrador remains unconfirmed. While the Newfoundland population of marten are listed as *Threatened* by both *NLESA* and *SARA,* the population in Labrador is not considered a species at risk.

Seventeen small mammal species are found in Labrador occupying a wide range of ecological niches. Most of these are ground-dwelling lemmings (northern bog and Labrador collared (*Dicrostonyx hudsonicus*)), voles (southern red-backed vole, meadow vole, eastern heather vole, northern bank vole (*Clethrionomys glareolus*), rock vole (*Microtus chrotorrhinis*)) mice (meadow jumping, woodland jumping, deer (*Peromyscus maniculatus*) and house (*Mus musculus*)), moles (star-nosed (*Condylura cristata*)), rats (Norway (*Rattus norvegicus*)) and shrews (pigmy (*Sorex hoyi*), water (*Sorex palustris*), masked), and one bat species (little brown bat). The meadow vole and masked shrew are believed to have more restricted distribution relative to other small mammal species in Labrador, perhaps due to stricter habitat requirements (Simon et al. 1998). Results from small mammal trapping in 2006 suggest that red-backed vole is the most common small mammal in the lower Churchill River valley (accounting for 70 percent of all small mammal captures), consistent with Simon et al. (1998).

Evidence of small mammal presence in general (e.g., leads/runs, scat and holes) was detected in only four habitats during ELC surveys along the transmission corridor in 2008 (lichen heathland, coniferous forest, open conifer and wetland habitats); however, combined, these species occupy a greater range of habitats than indicated by these data.

Small mammal species are an important prey item for several carnivorous species [e.g., marten, red fox (Hearn et al. 2006)]. Regular fluctuations of small mammal populations are a common occurrence in Labrador, as in other northern ecosystems, which may affect predators that rely heavily on them as prey.

4.1.2 Northern Peninsula, Central and Eastern Newfoundland, and Avalon Peninsula

As a function of island biogeography, furbearer and small mammal diversity is reduced on the Island portion of the province. At present, there are 13 furbearer species and 11 small mammal species that are known to occur

in Newfoundland. Furbearer species recorded on the Island are coyote, red fox, river otter, ermine, mink, beaver, lynx, snowshoe hare, Arctic hare, muskrat, marten, red squirrel and eastern chipmunk.

Small mammals that have been documented on the Island include: deer mouse, Norway rat, masked shrew, southern red-backed vole, northern bank vole, meadow vole, house mouse, little brown bat, northern long-eared bat, hoary bat and eastern red bat. Evidence of small mammal presence in general (e.g., leads/runs, scat and holes) was detected in nearly all habitat types during ELC surveys along the transmission corridor in 2008, including (but not limited to) alpine vegetated, cutover, mixedwood forest, rocky barrens, conifer scrub, conifer forest, open conifer, wetlands and Kalmia lichen.

All native and introduced furbearers and small mammals on the Island are found throughout the Central and Eastern Newfoundland geographic region of the Study Area, but some have limited distribution on the Northern Peninsula and/or the Avalon Peninsula; the red-backed vole, only recently introduced to the Island (west-central Newfoundland in 1999), has not yet expanded its range to include the Avalon Peninsula or the northernmost reaches of the Northern Peninsula, and the Newfoundland marten is found in isolated pockets throughout Newfoundland but are also absent from the Avalon Peninsula. Arctic hare are generally restricted to high elevation locations in parts of the province.

4.2 Key and Representative Species and ELC Habitat Quality Mapping

Seven key and representative species were identified and discussed in this report, in the context of the primary sources of information available, baseline conditions, habitat associations and distribution along the Study Area, as well as any limiting factors.

For four of these species (marten, porcupine, red-backed vole and meadow vole), the distribution of primary, secondary and tertiary habitats were mapped along the Study Area (i.e., 15 km wide area along the transmission corridor) from Gull Island in Labrador to Soldiers Pond on the Island's Avalon Peninsula. Habitat type and quality could not be accurately mapped for wolverine, red fox and beaver.

4.2.1 Marten

Marten are considered common throughout Labrador, where approximately 1,209 km^2 primary habitat (19.5 percent) and 2,778 km^2 (44. percent) secondary habitat are found in the Study Area. On the Island, where marten are listed as *Threatened* (Newfoundland sub-species) by both *NLESA* and *SARA,* there have been three important areas identified for marten: Main River on the Northern Peninsula; and Little Grand Lake/Red Indian Lake and Terra Nova National Park in Central and Eastern Newfoundland. Primary habitat in these geographic regions was identified in proportions of approximately 23 and 5 percent, respectively. Marten are not found on the Avalon Peninsula.

4.2.2 Wolverine

The presence of wolverine in Labrador is currently unconfirmed. As an *Endangered* species under *SARA* and *NLESA*, the recovery plan for the eastern population of wolverine identifies the need for further research on this

species in Labrador. The reintroduction of this species may be considered as a part of this plan in the future. Wolverine does not occur on the Island of Newfoundland.

4.2.3 Red Fox

Red fox are common in Newfoundland and Labrador. As a generalist species that can find prey in almost any habitat type, they would be widely distributed throughout the Study Area.

4.2.4 Beaver

Beaver are found throughout the province, although their abundance may have declined in the past 60 years. This species requires particular local site conditions for colony establishment (e.g., permanent source of surface water) and has habitat specific preferences (e.g., alder beds at the mouths of tributaries or slow-flowing streams in narrow valleys with bedrock foundation). Due to the specific nature of these habitat requirements, habitat quality was not assessed for beaver in the Study Area.

4.2.5 Porcupine

Porcupine are only found in the Labrador portion of the Study Area. This species is highly adaptable and can be found in a variety of habitat types. Primary habitat is abundant, and occupies 60.5 percent (3,750 km^2) of the Southeastern Labrador portion of the Study Area. Secondary habitat was determined to occupy 3.9 percent (239 km^2) of the Study Area primarily due to the fact that secondary riparian habitat cannot be mapped at the scale of the ELC.

4.2.6 Red-backed Vole

Red-backed voles are considered common in Labrador and are found throughout the Study Area in this region, with 1,446 km^2 (23.3 percent) of the Study Area in Labrador rated as primary habitat. An additional 2,533 km^2 (41 percent) of the Labrador Study Area is considered secondary habitat. On the Island, red-back voles have recently been introduced and they are now considered common throughout most of the Island (excluding the most northern part of the Northern Peninsula and the Avalon Peninsula). Primary habitat comprises 3,940.7 km^2 (36.8 percent) and secondary habitat 4,811.5 km^2 (50 percent) for the Study Area of the Island.

4.2.7 Meadow Vole

The meadow vole is common in suitable habitat throughout the Study Area. Nearly 90 percent (5,564 km^2) of the Southeastern Labrador Study Area is considered primary meadow vole habitat. Throughout the Island Study Area, primary habitat is also high and was identified for 3,419 km^2 (84.3 percent) of the Northern Peninsula Study Area, 3,752 km^2 (83.4 percent) of the Central and Eastern Newfoundland Study Area, and 1,302 km^2 (74.3 percent) of the Avalon Peninsula Study Area.

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APPENDIX A

Select Annotated Bibliography

APPENDIX A

Existing and available information on furbearers and small mammals 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 studies completed in Newfoundland and Labrador during the past approximately 20 years. Documents related to marten, wolverine, fox, beaver, porcupine and furbearers and small mammals in general are presented separately, below.

For a complete list of references and literature cited in this Component Study please refer to Section 5.0.

AMERICAN MARTEN

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The distribution of Newfoundland marten was likely spatially structured, even at a regional scale, likely due to the expansive barren, cliffs and lakes in western Newfoundland, which are essentially permanent barriers. Marten habitat selection processes were also explored using data for home ranges.

Bowman, J.C. and J.-F. Robitaille. 1997. Winter habitat use of American martens *Martes americana* within second-growth forest in Ontario, Canada. Wildlife Biology 3: 97-105.

Marten winter habitat use within second-growth boreal forests of northeastern Ontario was modelled using discriminant function analysis and multiple regressions. Typically, marten have been associated with old-growth forests; however, this study demonstrated that marten do use second-growth forests, and respond to similar structural characteristics as in mature/overmature forests. In particular, this study found marten to be associated with high values for percent of spruce or fir trees; tree height; number of downed logs; and canopy closure (i.e., closed spruce-fir forests with abundant downed logs). This habitat type provides protection from snow and predators, as well as provides marten with access to the subnivean layer (to forage) in areas where snow breaks have resulted from downed logs.

Burskirk, S.W. and L.L. McDonald. 1989. Analysis of variability in home-range size of the American marten. Journal of Wildlife Management 53: 997-1007.

Telemetry studies were used to estimate home range size of American marten. Home range size of males, but not females, varied significantly among study sites, and those of males were larger than females. Home range size was not correlated with latitude or mean annual temperature. Sample duration was a source of variation in home range size. The authors concluded that at that time, a need remained to identify ecological factors that may explain variability in sizes of marten home ranges.

Chapin, T.G., D.J. Harrison and D.M. Phillips. 1997. Seasonal habitat selection by marten in an untrapped forest preserve. Journal of Wildlife Management 61: 707-717.

Landscape- and stand-scale habitat of 38 radio-collared resident adult marten was investigated in northcentral Maine in the absence of trapping or logging during the 35 years prior. Habitat preferences were not determined at the landscape-scale, but at the stand-scale, marten selected habitats in greater proportion to their availability

during summer but not winter. During summer, marten were most abundant in stands with substantial spruce budworm-caused mortality, but no selection preferences were found for mature, well-stocked coniferous, deciduous, or mixed forest types. Results suggest that marten do not require a dense or coniferous forest overstory and that vertical and horizontal forest structure may be more important habitat components than age or species composition of the forest overstory.

Drew. G.S. 1995. Winter Habitat Selection by American Marten (*Martes americana*) in Newfoundland: Why Old Growth? A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Wildlife Ecology, Utah State University, Logan, UT.

The winter habitat preference of American marten in western Newfoundland was explored. It was found that marten do not use habitat types proportional to their availability. This predator preferred defoliated and late-seral conifer stands over other habitats. The author suggested that while age structure in winter habitats is important, marten perceive stem structure as decreasing predation risk, making defoliated stands attractive habitat in the winter season.

Environment Canada. 2009. Species at Risk – Newfoundland Marten. Available online: http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=134 Last updated May 13, 2009.

This reference includes a description of marten habitat, population, distribution, threats and recovery initiatives.

Fillier, D., C. Lundrigan and K. Knox. 1995. Pine Marten Habitat Utilization Study 1993-1995. Western Newfoundland Model Forest. Report Number 2-201-005.

Information regarding habitat use by a marten population in western Newfoundland was collected and used in an integrated planning process for forest resources. Marten were found to prefer and use old-growth, softwood-dominated forests to other available habitats in western Newfoundland.

Forsey, S.E. and E.M. Baggs. 2001. Winter activity of mammals in riparian zones and adjacent forests prior to and following clear-cutting at Copper Lake, Newfoundland, Canada. Forest Ecology and Management 145: 163-171.

Winter tracks were assessed for Newfoundland marten, short-tailed weasel (*Mustela erminea*), red fox, red squirrel, and snowshoe hare to determine track abundance among habitat types. Track abundance was higher in forest interior versus riparian habitats and this difference was significant (p<0.05) for marten. Tracks were also more abundant within riparian buffers than clear-cut/open areas. Track abundance for marten was higher pre-road access to sampling locations. Results indicated that for some environmentally sensitive species (e.g., marten), small disturbances or alterations in habitat caused immediate and significant effects.

Fredrickson, R.J. 1990. The Effects of Disease, Prey Fluctuations, and Clear-Cutting on American Marten in Newfoundland, Canada. M.Sc. Thesis, Utah State University, Logan, UT.

In Newfoundland, changes in marten social spacing appeared to be in response to food resources. No effects of mating access and intruder pressure from transients on the spatial dynamics of resident marten were detected. Home range abandonment, dispersal duration and reduction in home range colonization by females contributed

to an increase in the proportion of female transients, which in turn contributed to increased female mortality rates.

Fryxell, J.M., J.B. Falls, E.A. Falls, R.J. Brooks, L. Dix and M.A. Strickland. 1999. Density dependence, prey dependence, and population dynamics of martens in Ontario. Ecology 80: 1311-1321.

Population densities of marten were estimated based on 20 years of age-specific harvest statistics and using cohort analysis, and discussed in relation to small mammal fluctuations. Decreased harvesting at the start of the study contributed to an overall increase in marten over the 20 year period. Changes in rates of population growth were positively correlated with population densities of deer mice, red squirrels and flying squirrels. Marten also showed evidence of density-dependant population growth, but the abundance and variability of marten populations was apparently not correlated with harvesting (37.9 percent mortality due to trapping over the 20 year study period).

Gerrow, J.S. 2002. Distribution and Abundance of the American Marten (*Martes americana*) in the Greater Gros Morne Ecosystem: Final Report (2001-2002). Report prepared for Gros Morne National Park of Canada.

American marten population and status in the Greater Gros Morne Ecosystem was examined using bait stations and live trapping sites to confirm presence. Of note, only one marten was captured in Gros Morne despite 597 trap nights and no marten were captured in the southern park area, despite the fact it contained large amounts of habitat presumed suitable for marten. It was suggested that re-introduction may be the only management solution to re-establish marten in Gros Morne. Also, accidental mortality must be reduced or eliminated through management or method modification and forested areas must be managed in such as way to provide suitable habitat to aid in the re-establishment of the marten in the Park.

Godbout, G. and J.-P. Ouellet. 2008. Habitat selection of American marten in a logged landscape at the southern fringe of the boreal forest. Ecoscience 15(3): 332-342.

This study tests the specificity that American marten are sensitive to intensive logging and are often associated with old-growth coniferous forests. To this end, 15 marten were radio-tagged and habitat selection was studied in mixed forests of the southern boreal forest, over a two-year period and at two scales (landscape and home range). Mature coniferous forests (>60 years old) were selected at both scales and mature mixed forests were not selected or avoided. Thinned forests (0 to 15 years old) and young forests (0 to 60 years old) were strongly avoided, while partially logged forests had no effect on selection. The authors concluded that partial logging should be favoured for conservation of this species, rather than clear-cuts and precommercial thinning.

Gosse, J.W., R. Cox and S.W. Avery. 2005. Home-range characteristics and habitat use by American martens in eastern Newfoundland. Journal of Mammalogy 86: 1156-1163.

Home-range and habitat use by marten in eastern Newfoundland, specifically the Terra Nova National Park region, was examined. Analyses of the annual home-range area for 23 resident marten in the Terra Nova National Park area showed that areas of use were comprised of significantly larger territories than those maintained by marten across most of their geographical range. This is suggested to reflect the low diversity and abundance of small mammals used as prey in Terra Nova National Park, which were commonly found elsewhere within the geographical range for this species.

Gosse, J.W. and B.J. Hearn. 2005. Seasonal diets of Newfoundland marten, *Martes americana atrata*. Canadian Field-Naturalist 119: 43-47.

The seasonal diet of the Newfoundland marten was examined from scat and stomach contents collected between 1983 to 2003 to determine the frequency of food types of marten during winter and summer. It was found that meadow voles were the most prevalent food item for marten; however, there was a greater reliance on snowshoe hare as a prey species during winter. When the breadth of the diet was compared between seasons, it was found that it was greatest in the winter, possibly due to the lower availability of meadow vole.

Hargis, C.D., J.A. Bissonette and D.L. Turner. 1999. The influence of forest fragmentation and landscape pattern on American martens. Journal of Applied Ecology 36: 157-172.

The authors examined the difference in marten capture rates from sites with relatively low levels of fragmentation (i.e., forest connectivity maintained and non-forest cover ranged from 2 to 42 percent) in the Uinta Mountains of northern Utah. A significant decrease in marten capture rates was found in increasingly fragmented landscapes and marten were 'nearly absent' from landscapes with >25 percent non-forest cover. Marten capture rates were lower in areas <100 m to open (non-forested) patches. Small mammal densities were significantly higher in clear-cuts versus forests, and marten densities were not correlated with their abundance or association with clear-cuts. The authors conclude that in addition to the structural aspects of mature forests, landscape pattern in which the forest occurs should be considered.

Hearn, B.J., D.J. Harrison, C. Lundrigan, W.J. Curran and A.K. Fuller. 2005. Scale-dependent Habitat Selection by Newfoundland Marten. Western Newfoundland Model Forest. Report Number 2-216-002.

The basic demographic attributes of marten populations in Newfoundland were examined by evaluating multi-scale habitat selection by marten, and comparing the age structure and average daily survival of resident marten with different amounts of mature and over-mature forests in the marten home range. It was found that marten used a broad range of habitat types in their home range, including recent cuts, thinned stands and medium height softwood stands, as well as the typical mature and over-mature forest. This study was contradictory to past studies of specialized habitat selection by Newfoundland marten.

Hearn, B.J., C.G. Lundrigan and W.J. Curran. 2000. Pine Marten Demographics Research Project. Western Newfoundland Model Forest. Report number 2-201-007.

The distribution, population dynamics and ecology of marten were explored in relation to old-growth forest in Newfoundland, particularly near Little Grand Lake. Of importance was a review of the population and distribution of marten in the Little Grand Lake area from 1995 to 1999.

Howes, L. 1993. Pine Marten Distribution Study. Western Newfoundland Model Forest. Report Number 2-201-001.

The distribution of pine marten in western Newfoundland was examined. It was noted that marten distribution was related to the distribution of over-mature conifer-dominated stands, and therefore suggested this was their preferred habitat.

Hynes, N. 1999. The Newfoundland Marten Prey Base and the Introduction of the Red-backed Vole. Western Newfoundland Model Forest. Report Number 2-201-008.

An extensive literature review regarding the effects of the introduction of the red-backed vole on both marten populations and the distribution of the meadow vole in Newfoundland was conducted. The prey base afforded to Newfoundland marten and the limitations of an inadequate prey base on the Island (with only three species available in western Newfoundland) were described. The effect of the introduction of the red-backed vole on other small mammals, most notably the meadow vole, was also examined.

Lundrigan, C. and D. Fillier. 1995. Pine Marten Baseline Component-1995 Annual Report Draft. Western Newfoundland Model Forest. Report Number 2-201-007.

The pine marten population and habitat affiliations were studied with respect to timber management. Marten population status and its habitat requirements in western Newfoundland were updated and it was found that marten preferred older growth, softwood-dominated forest.

McGowan, C. and W.S. Davidson. 1994. A Genetic Analysis of Pine Marten (*Martes americana*) in the Western Newfoundland Model Forest. Western Newfoundland Model Forest. Report Number 2-201-002.

Baseline genetic data were examined to: 1) determine the level of genetic variability between geographically isolated groups of pine marten; and 2) develop genetic markers that may be useful in captive breeding programs. There was a low level of genetic variation between the three sample locations, which suggested that populations on the Island may be managed as a single population.

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

This regulation provides the provincial listing of all species of special conservation status, according to Schedule (A - *Endangered*, B-*Threatened* or C-*Vulnerable*).

Newfoundland Marten Education Committee. 2005. The Newfoundland Marten Website. Online at: http://www.newfoundlandmarten.com

This state provides links to a series of websites related to marten and other endangered species.

Poole, K.G., A.D. Porter, A. de Vires, C. Maundrell, S.G. Grindale and C.C. St. Clair. 2004. Suitability of young deciduous-dominated forest for American marten and the effects of forest removal. Canadian Journal of Zoology 82: 423-435.

Fifty-two radio-collared marten were monitored over a four-year period in deciduous-dominated habitat (i.e., generally considered lower quality) in northeastern British Columbia. Snow-tracking was used to obtain an index relative of abundance for marten (and other species) and small mammal tracking was also conducted during one year. The study area was an overgrown agricultural field consisting of mainly 30 to 40 year old stands of regenerating trembling aspen (5,880 ha). Home range size of males was 3.3 km^2 and that of females was 2.0 km^2; small home range sizes were interpreted to correlate to good quality habitat and prey availability.

Density estimates ranged from 0.24 to 0.37 marten/km^2. Marten avoided non-forested habitat and showed a preference for mature coniferous stands (>25 percent conifer; 7 percent of the study area), but used all habitat types available, including extensive use of deciduous-dominated stands and deciduous stands <40 years old. The authors conclude that young deciduous forests have sufficient cover, structure and prey to maintain moderate densities of resident marten.

Potvin, F., L. Belanger and K. Lowell. 2000. Marten habitat selection in a clearcut boreal landscape. Conservation Biology 14: 844-857.

Marten habitat selection was studied in a 123 km^2 black spruce-dominated study area in western Quebec, based on the findings of 20 radio-collared marten over a two-year interval. Habitats and forest structure in the cut block are the result of a harvesting technique called the protection of regeneration cutting technique that involves equally spaced harvesting trails. Winter home ranges within the study area were delineated. Marten avoided open regenerating stands comprised mostly of recent clearcuts with sparse regeneration during winter, and did not select coniferous stands (even mature or over-mature stands), but preferred deciduous and mixed stands generally with a dense coniferous shrub layer. Winter home ranges usually contained <35 percent open or closed regenerating stands and >40 percent uncut forest.

S. Fudge and Associates Limited. 1989. The Implications of Small Mammal Decline on Marten in Labrador and Northeastern Quebec. Prepared for Fenco Newfoundland Limited, St. John's, NL.

Results of small mammal snap trapping at different locations in Labrador were compared to age analyses of marten carcasses provided by trappers that documented a region-wide decline. Regular fluctuations of small mammal populations are a common occurrence in northern ecosystems. The dependence of marten on this prey base, and unequal sex ratio favouring females with a low proportion of juveniles, indicated that the population of this predator was about to decline.

Schneider, R.R. and P. Yodzis. No Date. Running Head: Extinction Dynamics in the American Marten (*Martes americana*). Western Newfoundland Model Forest. Report Number 2-209-001.

Using the relationship between marten mortality rate, habitat quality and size, the capability of marten as an indicator species for the health of old-growth forest was examined. The dynamics of small mammal populations and their impact on local extinction of marten are also discussed.

Simon, N.P.P., F.E. Schwab, M.I. LeCoure and F.R. Phillips. 1999. Fall and winter diet of Martens, *Martes americana*, in central Labrador related to small mammal densities. Canadian Field-Naturalist 113: 678-680.

The relationship between small mammal densities and populations of marten based on fall and winter diet in central Labrador was explored. The primary prey of marten in central Labrador was the boreal red-backed vole followed by snowshoe hare. A decrease in small mammal consumption in 1996-1997 by marten was followed by a reduced marten harvest in 1997-1998, which indicated that a food shortage in 1996-1997 contributed to a reduced harvest in 1997-1998. This suggested that marten had a strong reliance on small mammals, especially red-backed voles and snowshoe hare, as a food source.

Simon, N.P.P., F.E. Schwab, M.I. LeCoure, F.R. Phillips and P.G. Trimper. 1999. Effects of trapper access on marten population in central Labrador. Northeast Wildlife 54: 73-76.

The age distribution and sex ratios of marten trapped in accessible versus relatively inaccessible areas near Happy Valley-Goose Bay were studied. It was noted that marten in easily accessible areas were harvested more intensively and were thought to be maintained by recruitment of dispersed juveniles from less accessible areas. It was shown that the proportion of adult females trapped did not increase as the season progressed and that an intensively exploited marten population would be more likely enhanced by formal reserves and area closures rather than a reduction in the length of the trapping season.

Smith, A.C. and J.A. Schaefer. 2002. Home-range size and habitat selection by American marten (*Martes americana*) in Labrador. Canadian Journal of Zoology 80: 1602-1609

When examining habitat selection and home-range of marten in Labrador, it was found that marten avoided areas of low productivity and canopy cover, but showed no selection preference for tree species composition or cover among productive forest. It was also shown that the home range area was positively related to the proportion of bog and less productive scrub forest in the home range, but not significantly related to any of the tested factors.

Sturtevant, B.R. and J.A. Bissonette. 1993. Second Growth Forest as Marten Habitat in Western Newfoundland: The Coarse Woody Debris Connection. Western Newfoundland Model Forest. Second Interim Progress Report Number 2-208-001.

This interim report presents the progress of the first year of a study on second-growth forest as marten habitat. No data were analyzed in this report; a summary of the study objectives and the intended role of the first field season in pursuit of the objectives are presented. Results of the field program are presented in Sturtevant and Bissonette (1996).

Sturtevant, B.R. and J.A. Bissonette. 1996. An Examination of Second Growth Forest as Potential Marten Habitat in Western Newfoundland. Western Newfoundland Model Forest. Report Number 2-202-008.

Second-growth forest was examined for suitability as potential marten habitat in western Newfoundland. It was noted that coarse woody debris and small mammal abundance and prey relationships for marten strongly influenced habitat selection. It was found that meadow vole, the primary food source for marten, is most abundant in over-mature stands with a high level of coarse woody debris and could be considered the most important factor to explain why marten select older mature forest as primary habitat.

Sturtevant, B.R., J.A. Bissonette, and J.N. Long, 1996. Temporal and spatial dynamics of boreal forest structure in western Newfoundland: Silvicultural implications for marten habitat management. Forest Ecology and Management 87(1-3): 13-25.

Results of this modelling activity indicated that critical elements of marten foraging habitat are found within a senescent (ageing) forest stand structure. The paper provides a good summary of known and previously studied characteristics of marten habitat, namely, the requirement for protection from predators, access to prey (particularly during winter), thermoregulation and den sites. Marten are also particularly dependant on the structure associated with old growth forests. Younger stands in western Newfoundland are the result of logging

activities in that area. The authors suggest that intensive silviculture is necessary to promote marten habitat within managed forests in Newfoundland; silviculture would replicate the structure of older forests within younger stands.

Thompson, I.D. 1994. Marten populations in uncut and logged boreal forests in Ontario. Journal of Wildlife Management 58: 272-280.

The hypothesis that logged boreal forests (3 to 40 years old) were low quality habitat and resulted in higher marten mortality and lower productivity than in uncut forests was tested. Characteristics of uncut forests were: coniferous-dominated; several vertical layers of vegetation; moss ground cover; and dense overhead canopy in winter. Characteristics of logged forests were: deciduous-dominated (trees and shrubs); few vertical layers of vegetation; litter ground cover; and open canopy in winter. Densities of marten were higher in uncut forests (0.8 to 1.1 marten/km^2 compared to 0.08 to 0.2 marten/km^2) and those resident in uncut forests rarely used adjacent logged forests. The age of marten was significantly higher in uncut forests (3.15 versus 2.00 mean years); marten were more productive and had lower rates of mortality. The author suggests that old growth boreal forests may be preferred because they offer a lower risk of predation compared to open habitats resulting from logging activities.

Thompson, I.D. and W.J Curran. 1995. Habitat suitability for marten of second-growth balsam fir forest in Newfoundland. Canadian Journal of Zoology 73: 2059-2064.

The relationship between marten, its prey Meadow Vole, and the age of the forest habitat (i.e., old-growth versus second-growth) was studied. Use of a multivariate discriminate model indicated that older forest contained more ground-level structure when compared to second-growth forest, while factors including canopy cover and subnivaean access did not differ significantly. As a result, meadow voles likely responded to the ground-level structure of habitat and this structure is unavailable in the second-growth forest. It was suggested that marten would not use second-growth habitat due to the lack of meadow vole, which formed a necessary part of their diet.

Tucker, B.J. 1988. The Effects of Forest Harvesting on Small Mammals in Western Newfoundland and its Significance to Marten. Utah State University, Logan, UT.

There is a limited prey base on the Island for marten. The two prey species found in abundance on the Island were meadow vole and masked shrew in old-growth forests of the study area. Meadow vole was found to be most important as a prey species for marten; this species was also found to undergo population fluctuations typical of most microtines. Meadow vole numbers declined from 25.0 animals per hectare in spring 1986 to zero in spring 1987, possibly due to a viral outbreak of encephalitis in the marten population in fall 1986. Marten prefer mature coniferous and mixed forests and use regenerating cutovers minimally, although results of this study and of the literature suggest both masked shrew and meadow vole would be more abundant in regenerating cutovers. Although this suggests that prey abundance above certain threshold densities is not critical to marten habitat selection, prey availability should also be considered (i.e., prey species may be more abundant in logged areas but prey availability may be reduced).

Fortin, C., V. Banci, J. Brazil, M. Crête, J. Huot, M. Huot, R. Lafond, P. Paré, J. Schaefer and D. Vandal. 2005. National Recovery Plan for the Wolverine (*Gulo gulo*) [Eastern Population]. National Recovery Plan No. 26. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, ON. 33 pp.

This recovery plan presents information on wolverine in Quebec and Labrador and provides insight on the historic and current distribution of wolverine in Canada, population size and trends, factors contributing to the their status (e.g., health and malnutrition, mortality, home range, density, reproductive age), various habitat-related factors (e.g., habitat requirements, human impacts on habitats), the species role in the ecosystem and interactions with humans (including ecological niche and interspecific competition and sociopolitical factors) and their recovery potential (in terms of habitat availability and quality, food sources and biological factors influencing recovery). The following points are relevant to this Component Study:

- the historical distribution appears to have coincided with the distribution of caribou within the taiga Ecoregion of the Canadian Shield. Currently, population size and demographic trends are not known;
- natural mortality includes starvation (most common) and predation (by wolves, cougars, black bears (*Ursus americanus*) and eagles); hunting and trapping in this area was likely never very high;
- wolverines have a low natural density and they are capable of surviving at low densities; reproductive rate is also low;
- home range size is very large, with those of males larger than females; and
- wolverine occupy a variety of habitat types, from boreal forests to Arctic tundra. Some habitat characteristics that have been identified by various authors include climax stage coniferous forests; undisturbed and far from human presence; presence of adequate parturition habitats (e.g., protected areas); food availability; combination of varied habitat and abundant food; and habitats that support caribou (the carcasses of which wolverine feed on). Coniferous forests with high moose populations may also be able to support wolverine.

Knox, K. 1994. Research into the Historical Distribution of the Wolverine (*Gulo gulo*) in Labrador. Newfoundland and Labrador Department of Tourism and Culture, Wildlife Division, St. John's, NL.

This report provides extensive documentation of research regarding the historic distribution and their key habitats in Labrador. The study examined information from 1771 to 1992, and reviewed documents trapping data, sightings, number of pelts traded and anecdotal information about the presence of these animals in the area. Also included were maps with locations of wolverine sightings or tracks.

Wright, J.D., and J. Ernst. 2004a. Wolverine, *Gulo gulo*, resting sites and caching behaviour in the boreal forest. Canadian Field-Naturalist 118: 61-64.

Resting and caching beaviour of wolverine in northwestern Alberta and northeastern British Columbia were examined in the field, based on snow-tracking studies during 1997 to 2000. Tracks were located on 10 occasions, resulting in 13 tracking events. Tracks were only located on upland landscapes. When compacted corridors were encountered, wolverine diverged from their original line of travel 100 percent of the time. Five caches were

observed; all consisted of bones and/or sections of moose hides believed to have been scavenged from wolf kills. Trail systems around the cache were well used and of varying ages, indicating that the sites were used frequently and until the nutritive value of the cache was exhausted. Cache sites were in climax or over-mature stands of black spruce or mixedwood stands of high complexity (i.e., dominated by conifers and with a trembling aspen and balsam poplar component consisting of mostly dead or dying individuals), but less dense than those associated with travel. A detailed description of each individual cache is also provided in the text.

Wright, J.D and J. Ernst. 2004b. Effects of mid-winter snow depth on stand selection by wolverines, *Gulo gulo luscus*, in the boreal forest. Canadian Field-Naturalist 118: 56-60.

Wolverine in northwestern Alberta and northeastern British Columbia were studied to determine whether climax boreal conifer stands were selected during winter because the dense canopy provided a buffering effect on ground snow-depths. Snow-tracking was used to monitor animals during three consecutive winters (1997 to 2000). Tracks were located on 10 occasions over the study period (mean density of 1 track/3,400 km searched), and found only in upland (versus lowland) landscapes. When linear corridors were encountered during travels, wolverine diverged from their original line of travel under the forest canopy 100 percent of the time, to follow along linear corridors encountered with compacted snow (n=17). Snow depths along routes selected for travel were significantly less than other sampled depths. Random snow depths in closed canopy areas were significantly less than random open areas, in upland landscapes, but there was no significant difference found in random samples in lowland areas. The authors conclude that habitat preferences are found at the stand and landscape scales that are unrelated to food availability, but rather, select stands that offer the greatest buffering effect from snow depth, particularly climax conifer forests.

RED FOX

Jeffery, R.A., M.W. Lankester, M.J. McGrath and H.G. Whitney. 2004. *Angiostrongylus vasorum* and *Crenosoma vulpis* in red foxes (*Vulpes vulpes*) in Newfoundland, Canada. Canadian Journal of Zoology 82: 66-74.

Red fox carcasses (366 specimens) from six locations in Newfoundland were examined 2000 to 2002 for the presence of parasites. Eighty-seven percent of fox were infected with *Crenosoma vulpis*, with higher proportions of young-of-the-year versus yearlings or adults affected. *Angiostrongylus vasorum* occurred only in southeast Newfoundland (i.e., was absent from areas with mean winter temperatures below -4°C), where 56 percent of fox were affected. Forty percent of foxes had dual infections. Potential effects of infection are breathing difficulties, chronic cough, dyspnoea, exercise intolerance, stunted growth, tachycardia, anaemia, pale mucous membranes, prolonged clotting times and disseminated intravascular coagulation.

Kurki, S., A. Nikula, P. Helle and H. Linden. 1998. Abundances of the red fox and pine marten in relation to the composition of boreal forest landscapes. Journal of Animal Ecology 67: 874-886.

This field program was carried out in two study areas in northern and southern Finland. Decreasing proportions of old-growth forests and increasing proportions of young forests and agricultural lands was positively correlated with track density of red fox. Landscape composition explained 26 and 11 percent of red fox habitat use and 10 and 6 percent of marten habitat use, in northern and southern Finland, respectively. Results indicated that: competition or intra-guild predation by red fox does not affect marten abundance on a landscape

scale; and red fox (a generalist species) may elevate predation pressure in boreal landscapes fragmented by human activities.

Sklepkovych, B.O. and W.A. Montevecchi. 1996. Food availability and food hoarding behaviour by red and Arctic foxes. Arctic 49(3): 228-234.

In Newfoundland, food for red fox is superabundant in summer and scarce during winter. On Baccalieu Island, primary food consists of seabirds, some landbirds, berries and occasional discards of the lighthouse keepers. This study found that foxes on Baccalieu Island made large larder hoards (hiding many prey at or near den sites) over an eight-year period, compared to scatter hoards (hiding single or small numbers of prey at dispersed sites). Hoarded prey was heavily used during winter. The authors conclude that larder hoarding is associated with a superabundance of prey and appears to represent a flexible response to environmental conditions (not species-specific or tightly linked with territorial behaviour).

St. Georges, M., S. Nadeau, D. Lambert and R. Decaire. 1995. Winter habitat use by ptarmigian, snowshoe hares, red foxes, and river otters in the boreal forest-tundra transition zone of western Quebec. Canadian Journal of Zoology 73: 755-764.

Winter track surveys of 46 randomized plots were conducted and the presence of species tracks and habitat characteristics recorded for each 1-km section of riparian edge (as well as some non-riparian) habitat. Habitat use and availability were assessed for red fox (and other species); fox either avoided or did not significantly prefer non-riparian habitat, but were significantly associated with dense spruce stands. Fox abundance was negatively associated with latitude, reflective of the negative correlation of coniferous cover and prey species (hares, ptarmigan) with latitude.

BEAVER

Fryxell, J.M. 2001. Habitat suitability and source-sink dynamics of beavers. Journal of Animal Ecology 70: 310-316.

Theories of population dynamics were studied using beaver populations in Algonquin Park, Ontario, monitored over an 11-year period. Total population was found to be less variable than population size of individual beaver colonies, suggesting that local parameters have a greater effect on abundance among years than widespread parameters such as weather. Mean colony size and probability of annual recurrence were associated with local food availability. Overall numbers declined over the course of the study; the five source colonies where young production exceeded adult numbers could not compensate for the nine colonies that had negative net production. The authors hypothesize that habitat suitability for beavers declines as woody plant succession is increased by selective foraging by beavers.

Fryxell, J.M. and C.M. Doucet. 1993. Diet choice and the functional response of beavers. Ecology 74: 1297-1306.

Beavers in an enclosure were studied to assess foraging selection and cutting rates in response to changing sapling availability. The mean size of saplings cut increased with increasing distance from the lodge and was positively correlated with sapling density. Trembling aspen (*Populus tremuloides*) was preferred to speckled alder (*Alnus rugosa*) and red maple (*Acer rubrum*) was least selected. Results indicate that beaver facultatively

adjusted feeding preferences in relation to long-term energy gain. Greater detail on the foraging responses by beavers to sapling size and species combinations are provided.

Gallant, D., C.H. Berube, E. Tremblay and L. Vasseur. 2004. An extensive study of foraging ecology of beavers (*Castor canadensis*) in relation to habitat quality. Canadian Journal of Zoology 82: 922-933.

Foraging choices by beavers were investigated for 25 beaver colonies in New Brunswick. Results indicate that at greater distances from their lodge, beavers selected larger but fewer trees and were more species-selective, in high quality (but not low quality) habitats. Preferred woody plant species were beaked hazelnut (*Corylus cornuta*), pin cherry (*Prunus pensylvanica*), willows and aspen species. Red maple is sometimes selected when preferred species were scarce, but has a lower digestibility. Beavers were less selective of stem size and distance from lodge in lower quality habitats. In general, beavers did not travel far on land in intermediate or lowest quality habitats, and it is possible that beavers were accessing aquatic plants (an important seasonal food item) in lower quality habitats. Speckled alder was often selected for construction of dams and lodges.

McTaggart, S.T. and T.A. Nelson. 2003. Composition and Demographics of Beaver (*Castor canadensis*) Colonies in Central Illinois. American Midland Naturalist 150: 139-150.

A total of 239 beavers were harvested and aged. Average colony size was 5.6 beavers and family groups consisting of a breeding pair and at least one offspring comprised 86 percent of colonies. Fourteen percent of colonies consisted of a breeding pair only. Fetal rates were 3.0, 3.4, and 4.2/female for yearlings, two-year olds and older adults, respectively. Mortality rates were estimated at 13 percent in utero and >50 percent from zero to six months.

Minaskuat Inc. 2008. Inventory of Beaver Colonies in the Lower Churchill River Valley. Prepared for the Lower Churchill Hydroelectric Generation Project, St. John's, NL.

The distribution of beaver colonies adjacent to the Churchill River, within the valley further from the main stem and between Churchill Falls and Happy Valley-Goose Bay, was assessed. An aerial survey explored the waterway, slope, adjacent cover type and underlying geology, with lodges, dams and fresh cuttings or food caches denoting active colonies noted. It was found that the density of active beaver colonies was relatively low (0.04/km^2) compared to elsewhere in North America.

Rosell, F., O. Bozser, P. Collen and H. Parker. 2005. Ecological impact of beavers *Castor canadensis* and their ability to modify ecosystems. Mammal Review 35: 248-276.

This paper includes a description of historical and current distribution of beaver. In North America, beaver were hunted intensively and large proportions of some populations depleted prior to 1900 (after nearly four centuries of exploitation). Since this time, protective measures were introduced, as well as, by 1920, the initiation of reintroduction programs. Currently, beavers in North American are abundant and the population in the USA is estimated as high as 12 million individuals.

Sun, L., D. Muller-Schwarz and B.A. Schlute. 2000. Dispersal pattern and effective population size of the beaver. Canadian Journal of Zoology 78: 393-398.

A combination of live-trapping, tagging and observation were used to determine dispersal patterns in New York between 1984 and 1996. Seventy-four percent of beavers initiated dispersal downstream following spring break-up. Females dispersed considerably further from natal colonies than males (10.15 ± 2.42 (standard error) km versus 3.49 ± 0.86 km). Males in particular seem to disperse to nearest available sites. Natal dispersals were comprised largely of two (64 percent) and three (21 percent) year olds, and some one-year olds (12 percent). Some beavers dispersed a second time as adults. Population size in the study area was estimated between 161 to 378 beavers (depending on survey method).

PORCUPINE

Griesemer, S.J., T.K. Fuller and R.M. DeGraaf. 1996. Denning patterns of porcupines, (*Erethizon dorsatum)*. Canadian Field-Naturalist 110: 634-637.

Winter denning of porcupines from two locations in Massachusetts was studied over two consecutive winters (starting in 1992) to determine whether den sharing was related to den density, den distribution, weather, or mating season. Where den availability was lower, porcupines that shared dens did so relatively often, but overall, the number of porcupines that denned with another porcupine at least once was lower. Severe weather reduced den sharing. Male-female pairing was not limited to the mating season. Mating activity did not explain late-winter den sharing.

Griesemer, S.J., T.K. Fuller and R.M. DeGraaf. 1998. Habitat use by porcupines (*Erethizon dorsatum*) in central Massachusetts: Effects of topography and forest composition. American Midland Naturalist 140: 271-279.

Radio-collared porcupines were monitored during 1990 to 1993, in central Massachusetts to examine habitat use. Resting porcupines were generally found on tree limbs in summer and in dens (e.g., rock caves, tree cavities) in winter, during daylight hours. Rock dens were more prevalent in habitats with abundant talus, and tree cavities where talus was absent. Use of oaks (*Quercus sp*.) in summer and hemlocks (*Tsuga canadensis*) in winter for feeding and resting (when not in dens) was more than expected. Generally, tree species selected varied according to study area and to species availability.

Hale, M.B. and T.K. Fuller. 1995. Porcupine *(Erethizon dorsatum)* demography in central Massachusetts. Canadian Journal of Zoology 74: 480–484.

Fifty radio-collared porcupines were monitored to obtain estimates of survival and reproduction. Estimates were applied to a model of porcupine population dynamics. Annual survival of adults (>1 year old) was 0.67 ± 0.07 (mean ± standard error) and was slightly higher for females versus males (0.74 ± 0.08 versus 0.56 ± 0.12). Natural mortality included starvation (annual mortality rate 0.08), injuries (0.05), interactions with humans (0.04) and disease (0.05). Annual survival of juveniles ranged from 0.37 to 0.39. Minimum birth rates (females >2 years old) ranged from 0.62 to 0.64. Results indicate a decreasing population.

Keith, L.B. and J.R. Cary. 1991. Mustelid, squirrel, and porcupine population trends during a snowshoe hare cycle. Journal of Mammalogy 72: 373-378.

Cyclic populations of snowshoe hare were studied from 1961 to 1977 in Alberta. Annual capture rates for porcupine were variable and unrelated to cycles of snowshoe hares or to fluctuations of other species. Porcupine populations were low by 1975. Declines in population following the onset of cycle declines of hares may have resulted from increased predation on young as hares became scarce. Possible predators identified were Great Horned Owl and coyote.

Morin, P., D. Berteaux and I. Klvana. 2005. Hierarchical habitat selection by North American porcupines in southern boreal forest. Canadian Journal of Zoology 83: 1333-1342.

Summer habitat selection by porcupines on the St. Lawrence River Estuary, Quebec, was determined at the landscape, home range and single tree scales, using radio-telemetry. Over 300 dens were identified during this long-term study (>5 years); most animals changed dens often and used high-quality dens most of the time. Den use in summer was higher than expected. Porcupines were generalists at the landscape level but selected habitat features at the home range, and tree scales. At the home range level, forests dominated by trembling aspen and mixed forests were most selected, whereas human-used land and conifer forests were least selected. At the tree scale, fruit-producing trees (e.g., *Sorbus* sp.), were most selected, and trembling aspen selected more compared to other deciduous trees. Seventy-three percent of observations of feeding animals were in aspen.

Schmelzer, I. and J. Fenske. No Date. Life at the Limit: An Intraspecific Analysis of Home Range Variation for a Wide-ranging Rodent, the North American Porcupine (*Erethizon dorsatum*) in Central Labrador, Canada.

Eighteen animals were tracked from 1999 to 2001 using radio-telemetry and seasonal and annual variation in home range size were compared at the individual and population level. Home range size was approximately 10 times larger than previously recorded. Movements during summer were particularly extensive. Summer home ranges were significantly larger (569 ± 228 ha) than other southern populations (67 ± 19 ha), whereas winter ranges were similar. Hunting is a main limiting factor for Labrador porcupine and associated with high-risk foraging by porcupine during spring. The authors conclude that spatiotemporal variation in resources may be an important range determinant for porcupine (a generalist species) in northern systems, and likely other species similarly expanding their range northward.

Speer, R.J. and T.G. Dilworth. 1978. Porcupine winter foods and utilization in central New Brunswick. Canadian-Field Naturalist 92: 271-274.

The winter foods and wintering areas of porcupine in New Brunswick were studied in an 800 ha area over two winters from 1973 to 1975. Dens (n=69) and roost trees (n=18) were located by researchers walking transects. At 22 den or roost trees parameters such as soil moisture, shrub density, crown closure, slope, distance to water and distance to potential den site were recorded. Further information (i.e., species, diameter, distance to nearest neighbour, area of wood exposed by bark feeding and amount of twig feeding) was collected for roost trees with diameter at breast height greater than 6 cm. Conifers were found to be important as roost trees and for providing shelter. Selection of a den site was not found to be an important factor in selection of winter areas. A variety of tree species were used as forage but a preference for spruce, white pine and eastern larch was

demonstrated. The vast majority of bark-feeding was on conifers (91 percent). Implications for forest managers were identified.

Strickland, D., J.T. Flinders and R.G. Cates. 1995. Factors affecting selection of winter food and roosting resources by porcupines in Utah. Great Basin Naturalist 55: 29-36.

Porcupine in this study were associated primarily with gambel oak (*Quercus gambelii*) and used it as a food source and for roosting. The most common species in the study area (big-toothed maple, *Acer grandidentatum*) was rarely used. Coniferous species were not used in proportion to their availability, although their dense canopies would provide thermal advantages. A diet rich in oak results in a diet rich in proteins (compared to high-fat conifer diets). The authors theorize that the porcupines have a layer of adipose tissue that they use as an energy reserve.

Sweitzer, R.A. 1996. Predation or starvation: Consequences of foraging decisions by porcupines (*Erethizon dorsatum*). Journal of Mammalogy 77: 1068-1077.

This five-year study examined hypotheses about foraging. Predictions were: 1) predation would be greater in open habitats; 2) small porcupines would be more vulnerable to predation; and 3) nutritionally-stressed porcupines would trade off increased risk of predation for decreased risk of starvation. Results confirmed hypothesis #1 (>90 percent of kills were in open grasslands or juniper shrublands) and #3 (high rates of predation in open areas in late winter supported this hypothesis). Mountain lions (*Puma concolor*) were one of the most common predators (coyotes were also identified as a main predator), but predation by mountain lions was independent of body size of porcupines. The authors conclude that poor nutritional status may lead animals to feed in environments where predation is high. Other limiting factors discussed included weather conditions. Nearly all instances of starvation occurred during winters with a relatively high number of days with snow cover (55 to 59 days compared to 2 to 34 days during other years).

Sweitzer, R.A. and J. Berger. 1992. Size-related effects of predation on habitat use and behaviour of porcupines. Ecology 73(3): 867-875.

Over two winters, porcupine in the Great Desert Basin (Nevada) were studied to test whether: 1) habitat use varied with activity level (foraging versus sleeping) and age class of animals; and 2) when nutritionally stressed, animals may accept increasing predation risks to avoid starvation. Results were based on field observations of ear-tagged/tail-marked individuals and on experimental manipulation of the environment. This involved increasing perceived risk of predation by using predator urine, and simulated predator encounters with dogs. Capture-recapture techniques were used to monitor body condition over the duration of the study. Sleeping porcupines avoided open/high-risk habitats. Animals foraging in high-risk environments had less mass loss than those in low-risk environments. In general, juveniles remained in low-risk habitats, two-year olds shifted to high-risk areas when body condition deteriorated, and habitat used by adults was not strongly influenced by body condition. This report also presents some information on porcupine diets in general and the shift from poor quality winter diets consisting of tree and shrub bark, to nutrient-rich spring and summer diets consisting of forbs, grasses and riparian vegetation.

Canadian Wildlife Service and Canadian Wildlife Federation. 2009. Mammal Fact Sheets. Hinterland Who's Who. Available at: http://www.hww.ca/hww.asp?id=8&pid=1

This site provides a link to various mammal fact sheets, including marten, wolverine, red fox, beaver and porcupine.

COSEWIC (Council on the Status of Endangered Wildlife in Canada). 2009. Canadian Species at Risk. http://www.cosewic.gc.ca.

This site provides information on Canadian wildlife species, wildlife species assessments and status reports. Information on both marten and wolverine are provided. Marten in Newfoundland have declined and the population size was estimated at 300 to 600 individuals in five subpopulations. Marten were first designated *Not at Risk* in 1979, then later listed as *Threatened* (1986), *Endangered* in 1996 and 2000, and as *Threatened* again in 2007. Wolverine were originally listed in 1982, prior to the recognition of separate populations (western and eastern). The eastern population was originally listed as *Endangered* in 1989. Evidence suggests that this species (eastern population) may be *extirpated*.

DEC (Newfoundland and Labrador Department of Environment and Conservation). No date. Endangered Species and Biodiversity. Available at URL: http://www.env.gov.nl.ca/env/wildlife/endangered.htm

This website provides links to factsheets on provincially-listed species of special conservation status. Marten and wolverine are relevant to this Component Study. Marten were listed *as Threatened* in 2007, and there is only an estimated 300 to 500 mature marten remaining in five subpopulations. The population is believed to be stable, after being reduced from an estimated 800 animals in 1986 to 300 in 1996. Most of the marten population occurs near Little Grand Lake, with small populations at Red Indian Lake, Glover Island, Main River and Terra Nova National Park. Limiting factors identified include accidental trapping and snaring and habitat loss due to forestry, fire and insect damage. Wolverine were listed as *Endangered* in 2002. Population estimates are unknown. Historically, this species was trapped, but numbers declined as early as the early twentieth century. It is likely that this species is extirpated. Limiting factors include extremely low densities and large home ranges, vulnerability to accidental trapping and persecution, and the requirement of sufficient amounts of caribou as it survives primarily as a scavenger.

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

The impacts of snow vehicles on small mammals in the Gros Morne National Park were studied. The negative effects on small mammals included compaction of burrows due to excess weight of snow vehicles and a less acceptable micro-environment due to compaction-induced temperature differentials. Trail use by furbearing mammals was also examined, with some species such as snowshoe hare avoiding areas with trails, while some species such as red fox made use of them as travel corridors.

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

Habitat suitability for beaver, muskrat, mink and marten in the Star Lake area was examined in association with a proposed hydroelectric development in central Newfoundland. It was found that Star Lake did not have suitable habitat for muskrat, beaver or mink. However, there was suitable marten habitat on both the eastern and southern sections of the lake, with evidence of marten recorded during field programs. Marten were confined to these forest stands. It was thought that this population of marten may have dispersed from another elsewhere.

Jacques Whitford. 1997. Environmental Baseline Technical Data Report: Furbearers. Prepared for the Voisey's Bay Mine/Mill Project EIS.

Snow-tracking (including direct observation, tracks, scat, feeding places and housing structures) was used to determine the presence and diversity of furbearers in the vicinity of a mine in Voisey's Bay. Permanent transects were established and surveyed in March and April 1996. Potentially sensitive summer habitat was also identified. The only live animal encountered during winter surveys relevant to this Component Study was red fox. Signs of the following relevant species were recorded: marten; porcupine; and red fox. Evidence of summer use was associated with red fox, beaver, marten and porcupine. All animals encountered were typical of Labrador. Red fox and porcupine were evenly distributed throughout all areas sampled in winter. Marten were associated with the control and proposed mine sites. In general, furbearers were more abundant along riparian areas during summer.

Jacques Whitford. 2001. Environmental Effects Monitoring Program Long Harbour Phosphorous Plant Decommissioning Snowshoe Hare Sampling 2000.

The levels of fluoride and metals in snowshoe hare in the vicinity of the former phosphorus plant at Long Harbour area were examined and compared to a control area near Millertown, Newfoundland. Results showed that snowshoe hare analyses from 2000 were in the normal value range and showed a decrease of approximate 67 percent since 1992. It was also noted that the fluoride levels in Long Harbour were within the range of background levels for the rest of the Island.

Jacques Whitford. 2001. Duck Pond Copper-Zinc Project Environmental Impact Statement. Prepared for Thundermin Resources Inc., Toronto, ON.

Information on the abundance and distribution of semi-aquatic furbearers, including otter, mink, muskrat and beaver were collected via extensive literature search, discussion with the provincial Department of Forest Resources and Agrifoods personal, local trappers and incidental observations during various field programs. During a dedicated furbearer survey, all locations of tracks of semi-aquatic and other furbearers were recorded and mapped. A residual environmental effects summary was included, indicating there would be a low magnitude of effect of the mining project on semi-aquatic furbearers in the project area. It was stated that Duck Pond mine will not result in significant adverse environmental effects to semi-aquatic furbearers.

Jacques Whitford. 2007. Environmental Assessment of Snowmobile Use in Gros Morne National Park. Prepared for Parks Canada, Halifax, NS.

The impact of snowmobile use on snowshoe hare in Gros Morne National Park was studied. Habitat used by hare in the Park was described. Population levels of Arctic hare in the Park were considered low, but were within the natural variability of the population cycle. There were also indications that the population was increasing.

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

The known and potential small mammals found in the Mealy Mountains area in Labrador are described. A synopsis of mammals and their key habitats in the Mealy Mountain area is provided.

Ledrew, Fudge and Associates Limited. 1992. Terrestrial Component Study Long Harbour Decommissioning EIS. St. John's, NL.

In support of the environmental assessment of the decommissioning options associated with this former phosphorus plant, snowshoe hare were collected in the vicinity to examine levels of terrestrial environmental contamination. During the 1970s, researchers found high levels of fluoride in snowshoe hare. These animals were larger than normal, mandibles exhibited severe osteofluorosis, and their teeth were showing abnormal and irregular wear. With the assistance of local residents, snowshoe hare were snared and analyzed for mercury, copper, fluoride, cadmium, lead, zinc and polychlorinated biphenyl in kidney, liver and other tissue in the early 1990s. Results indicated that most samples were consistent with control animals. Those with higher levels were lower than reported previously. It was suggested that these individuals may have been older and contracted the fluoride during the operation of the plant two to three years earlier.

Minaskuat Inc. 2008a. Wildlife Habitat Associations in the Lower Churchill River. Prepared for the Lower Churchill Hydroelectric Generation Project, St. John's, NL.

Wildlife and associated habitats along the lower Churchill River in Labrador were examined in association with a proposed hydroelectric project. Small mammal trap sites were established in various habitats throughout this river valley to determine small mammal habitat associations. Habitats were also surveyed for several species of wildlife and of relevance, furbearers including wolf, porcupine, red fox, American marten, snowshoe hare, red squirrel, beaver, muskrat, river otter and mink.

Minaskuat Inc. 2008b. Wetland Assessment and Evaluation. Report prepared for the Lower Churchill Hydroelectric Generation Project, St. John's, NL.

Muskrat was the most widely distributed and most likely semi-aquatic furbearer found in wetland habitats in the survey area along the lower Churchill River. Of the different wetland habitats used by muskrat, marshes were the most preferred habitat, followed by fens; bogs and shallow-water wetlands were the least preferred.

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

Information on the abundance and distribution of furbearers including marten, mink, river otter, least weasel, ermine, red fox, lynx, wolf, red squirrel, northern flying squirrel, beaver, muskrat, black bear, porcupine and wolverine were collected via extensive literature search, harvest information from trapping statistics and incidental observations during various field programs.

Northland Associates Limited and Jacques Whitford. 1998. Report No. 1: Pre-Construction Period (May 1996 to April 1997) and Initial Construction Period (May 1997 to November 1997). Prepared for CHI Canada Inc., Montreal, QC.

Distribution, size and use of home range by marten in the Star Lake area were examined using radio-telemetry as part of a baseline study for a proposed hydroelectric development. It was noted that more marten needed to be collared to gain enough experimental baseline data to interpret the possible effects of the Star Lake project on marten.

Northland and Associates Limited and Jacques Whitford. 1999. Report No. 2: Construction Period: December 1997 to November 1998. Prepared for CHI Canada Inc., Montreal, QC.

Data on the distribution, size and use of home range by marten in the Star Lake area were presented. It was noted there was no conclusive indication of an effect of Star Lake on marten distribution.

Sikumiut Environmental Management Ltd. 2007. Furbearer Winter Habitat Use Study. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

A literature review of winter habitat use by furbearers in Labrador was conducted that identified several data gaps that would be filled with a field survey program. Various winter habitats ranging from softwood-dominated stands to wetlands were examined for signs of mammals during the field survey, with habitat preferences for each species recorded. Species studied included porcupine, snowshoe hare, ermine, mink, marten, river otter, coloured fox, wolf and lynx.

SMALL MAMMALS

Barnum, S.A., C.J. Manville, J.R. Tester and W.J. Carmen. 1992. Path selection by *Peromyscus leucopus* in the presence and absence of vegetative cover. Journal of Mammalogy 73(4): 797-801.

Path selection and avoidance of mice were tracked in Minnesota and Maryland. Logs >5 cm in diameter were selected and those <5 cm avoided. Preferences in other site characteristics differed between sampling locations; mice selected forb cover and avoided grass cover in Minnesota and selected bare ground and avoided leaf cover in Maryland. In addition, pathways were repeatedly used in Maryland but not in Minnesota. This species appears to restrict movements to paths that offer protection from predators that search by sight/sound.

Begeron, J-M. and L. Jodoin. 1993. Intense grazing by voles (*Microtus pennsylvanicus*) and its effects on habitat quality. Canadian Journal of Zoology 71: 1823-1830.

The effects of crowding on vegetation was studied by placing meadow voles in fenced plots. Densities equivalent to 1,000 to 1,300 voles/ha were reached at the end of the first summer, after which (i.e., in fall) they were removed from plots. Plot biomass (yields of green biomass) was reduced in fall (15 percent) and in the following spring (52 percent in the grazed plots. Dead matter was also reduced by grazing (>7 percent). Biomass quality generally did not vary between fall and spring collections, but one chemical investigated varied significantly between grazed and ungrazed plots during both sampling periods. Intense grazing was concluded to result in quantitative changes on meadows that are noticeable the following spring, although the nutritive constituents of vegetation are relatively unaffected. The authors conclude that their results support the idea that voles do not induce defensive mechanisms in heavily grazed plants.

Boutin, S., C.J. Krebs, R. Boonstra, M.R.T. Dale, S.J. Hannon, K. Martin, A.R.E. Sinclair, J.N.M. Smith, R. Turkington, M. Blower, A. Byrom, F.I. Doyle, D. Hik, L. Hofer, A. Hubbs, T. Karels, D.L. Murray, V. Nams, M. O'Donoghue, C. Rhoner and S. Schweiger. 1995. Populations changes of the vertebrate community during a snowshoe hare cycle in Canada's boreal forest. OIKOS 74: 69-80.

Changes in snowshoe hare populations were not correlated with changes in populations of red-backed vole (which showed peaks during the low, increase and early decline phases of the hare cycle). Wolverine showed no correlation with hare or vole numbers. Other species not relevant to this Component Study were also presented and discussed. The authors conclude that species in the boreal forests of Canada do not exhibit the strong synchrony found between voles and other members of the vertebrate community in northern Fennoscandia (Scandinavian Peninsula, the Kola Peninsula, Karelia and Finland).

Bowman, J., G. Forbes and T. Dilworth. 2001. Landscape context and small-mammal abundance in a managed forest. Forest Ecology and Management 140(2-3): 249-255.

Small-mammal abundance was assessed in relation to landscape context, when context was considered independently of within-stand vegetation and at different spatial extents. The study area was on a private industrial forest in northern New Brunswick. Landscapes were classified as tolerant hardwood, partially-cut tolerant hardwood (<15 years since intervention), softwood, mixedwood, clear-cut (<15 years) and plantation (<15 years). Small mammal trapping was carried out in spring and fall of 1995 (5,120 trapnights, sample size of 1,500 representing more than eight species). The four most abundant small mammal species in this sampled habitat were red-backed voles, deer mice, short-tailed shrews (*Blarina brevicauda*), and woodland jumping mice; all four species were significantly related to within-stand vegetation characteristics. Generally, red-backed voles and woodland jumping mice were most abundant in softwood sites, while deer mice and short-tailed shrews were most abundant in hardwood stands and in clear cuts. No species was abundant in plantations. Landscape context was related to the distribution of red-backed voles (that were negatively associated with softwood plantations) and jumping mice (that were positively associated with the amount of softwood forest).

Bowman, J.C., D. Sleep, G.J. Forbes and M. Edwards. 2000. The association of small mammals with coarse woody debris at log and stand scales. Forest Ecology and Management 129: 119-124.

No significant relationships between small mammals and individual logs of different decay classes were found (i.e., at the log scale, in the reference area only). Similarly, no significant relationships were identified at the stand level (comparing a reference area to more intensively managed forests, the latter with >50 percent clear-cuts and softwood plantations) between small mammal abundance (any species) and either average decay class of logs or the overall abundance of logs. However, the authors note that red-backed voles were the most abundant microtine in their study area, and that they were found to be significantly related (at least in intensively managed forests) to the abundance of the most decayed logs (that were rare in the intensively managed landscape).

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

The distribution and abundance of small mammals in Gros Morne National Park was examined to determine the impact of competition to native species from non-native species. Of relevance was a comparison of percentage of non-native versus native small mammals occurring in the Park, which indicated 91 percent of small mammal captures that occurred in 2001 were non-native species. The red-backed vole was also noted as being on the Island and expanding its range towards Gros Morne at approximately 12 km per year placing stress on the native meadow vole.

Garland, S. 2008. Small Mammal Data Compilation Project Final Project Report. Prepared for the Government of Newfoundland and Labrador-Wildlife Division, Atlantic Canada Conservation Data Centre and Institute for Environmental Monitoring and Research.

This report contains maps for Newfoundland and Labrador depicting Ecoregions and associated small mammals; it also contains a reference list of small mammal and other studies in the province from 1960 to 2005.

Harper, S.J., E.K. Bollinger and G.W. Barrett. 1993. Effects of habitat patch shape on population dynamics of meadow voles (*Microtus pennsylvanicus*). Journal of Mammalogy 74: 1045-1055.

This two-year field experiment in Ohio looked at the edge-to-area ratios of four square (40 m by 40 m) and four rectangular (16 m by 100 m) experimental patches of equal size (1,600 m^2) to assess effects of habitat patch shape on meadow vole population dynamics. Hypotheses were that dispersal rates would be higher, home ranges larger and population densities lower in rectangular versus square patches. Results indicate that the total number of dispersers (but not rates) was higher in rectangular patches when densities of voles were low. Home ranges were similar between patches, but of different shape in different shaped patches. Patch shape did not appear to affect population density, recruitment, body mass of dispersers, body mass of residents, survival, or age structure. The authors conclude that the plasticity of behaviour (in terms of changes in shape of home range) may have prevented differences in population dynamics between the patch shapes. Meadow vole appear to be an edge-tolerant species.

Jacques Whitford. 1997. Environmental Baseline Technical Data Report: Small Mammals. Prepared for the Voisey's Bay Mine/Mill Project EIS.

Small mammals were collected in the vicinity of a proposed nickel and copper mine in northern Labrador to determine concentrations of environmental contaminants within local herbivores. Deer mouse, red-backed vole, Arctic shrew (*Sorex arcticus*) and meadow vole were captured using snap traps during 1996 and analyzed for 24 trace metals. The concentrations of metals in small mammals were found to be consistent with values reported elsewhere from uncontaminated sites.

Mihok, S. and R. Boonstra. 1992. Breeding performance in captivity of meadow voles (*Microtus pennsylvanicus*) form decline- and increase-phase populations. Canadian Journal of Zoology 70: 1561-1566.

Meadow voles in a decline-phase population (1985) were compared to those of an increase-phase population (1986) to investigate why the former often fails to increase, using a combination of field and laboratory settings. The 1985 population were found to have lower breeding rates (35 versus 100 percent), and for the laboratory animals, there was a longer period between when females paired with a male and when they gave birth.

Parker, G.R. 1989. Effects of reforestation upon small mammal communities in New Brunswick. Canadian Field-Naturalist 103: 509-519.

Populations of 11 species of small mammals in conifer plantations in New Brunswick were studied in 1981 and 1982, and compared to populations in mature conifer and naturally regenerating sites. The study found that immediately following forest harvesting, density, richness and diversity increased. Masked shrew and red-backed vole were the most abundant and ubiquitous species. Overall densities were lowest in 15 to 17 year spruce plantations and diversity was greatest in the youngest spruce plantations and in naturally regenerating clear-cuts. Grazers (Microtinae) were positively associated with increases in ground cover values for grasses, sedges and deciduous and conifer foliage. Numbers of insectivores (Soricidae) declined with age following site disturbance.

Peles, J.D. and G.W. Barrett. 1996. Effects of vegetative cover on the population dynamics of meadow voles. Journal of Mammalogy 77: 857-869

Patch quality was assessed in relation to population dynamics and dispersal of meadow voles. Twelve experimental grassland patches, with varying degrees of vegetative cover (reduced cover, enhanced cover and control), were sampled. Findings indicated that reducing the cover had negative effects on meadow voles (although enhancing cover did not increase population density or survivorship). Mean population densities and recruitment were significantly greater in control and enhanced-cover treatments compared to reduced-cover treatments during one year of the investigation. Mean body mass of females was significantly greater in the enhanced control treatments during both years. Survivorship of female voles from the founder populations was higher in the control and enhanced-cover treatments. Significantly greater densities and lower per capita dispersal in 1993 compared to 1992 were related to an increase in both components of cover (i.e., biomass of standing crop and litter).

Simard, J.R. and J.M. Fryxell. 2003. Effects of selective logging on terrestrial small mammals and arthropods. Canadian Journal of Zoology 81: 1318-1326.

Small mammal trapping was used to examine the effect of selective logging on small mammal habitat preference. It was noted that a decrease in mature trees led to a decrease in seed productivity, which affected the number of small mammals found at a site. Lower seed productivity translated to less food resources in selective cut sites compared to pristine stands for small mammals, making it less preferred. It was stated there were significantly more deer mice caught in mature stands when compared to stands that had been selectively logged.

Simon, P. 1996. The Effect of Forest Fire on Vegetation Structure and its Effect on Small Mammal Biodiversity in Western Labrador. Department of Biology, Memorial University of Newfoundland. St. John's, NL.

Different successional stages following a forest fire were shown to directly affect the distribution and presence of small mammals in central Labrador. It was found that trends in the vegetation structure, as well as soil types, water availability and competition, determined the small mammal fauna present in an area. It was suggested that small mammal communities in central Labrador may be maintained by emulating natural disturbance in the habitat.

Simon, N.P.P., F.E. Schwab, E.M. Baggs and G.I. Mct. Cowan. 1998. Distribution of small mammals among successional and mature forest types in western Labrador. Canadian Field-Naturalist 112: 441-445.

Secondary succession following a forest fire affected vegetation structure and small mammal populations in western Labrador (near Labrador City). The abundance of small mammals captured on a plot increased with the successional age of the vegetation. In particular, it was found that a mammal species could be positively associated with vegetation found within a plot and the presence of that vegetation may be used as a predictor of a particular species.

Simon, N.P.P., C.B. Stratton, G.J. Forbes and F.E. Schwab. 2002. Similarity of small mammal abundance in post-fire and clearcut forests. Forest Ecology and Management 165: 163-172.

Small mammal abundance in a post-fire forest and a clearcut forest near Happy Valley-Goose Bay were found to be similar. There was little to no difference between a clearcut with high levels of coarse woody debris and a post-fire forest with respect to small mammal abundance. It was suggested that by emulation of natural disturbances, one can maintain small mammal communities in central Labrador.

Tucker, B.J. 1988. The Effects of Forest Harvesting on Small Mammals in Western Newfoundland and its Significance to Marten. Utah State University, Logan, UT.

There is a limited prey base on the Island for marten. The two prey species found in abundance on the Island were meadow vole and masked shrew, in old-growth forests of the study area. Meadow vole was found to be most important as a prey species for marten; this species was also found to undergo population fluctuations typical of most microtines. Meadow vole numbers declined from 25.0 animals per hectare in spring 1986 to zero in spring 1987, possibly due to a viral outbreak of encephalitis in the marten population in fall 1986. Marten prefer mature coniferous and mixed forests and use regenerating cutovers minimally, although results of this study and of the literature suggest both masked shrew and meadow vole would be more abundant in regenerating cutovers. Although this suggests that prey abundance above certain threshold densities is not critical to marten habitat selection, prey availability should also be considered (i.e., prey species may be more abundant in logged areas but prey availability may be reduced).

APPENDIX B

Profiles of Study Team Members

APPENDIX B

Study Team

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 furbearers and small mammals. Regional leads for the Island portion of this study (based in 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 this 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 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.

Elizabeth Way, M.Sc., is a 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 EA.

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 EAs in the energy, water and waste, transportation and industrial sectors. She is skilled at interacting with diverse study teams, subconsultants, clients, agencies and the public. She has experience in provincial (Ontario and Newfoundland and Labrador) and federal EA project development and management, consultant team coordination, public involvement and report preparation and coordination. Ms. Peddle also has extensive public consultation and communications experience related to risk assessment, mining, oil and gas, transportation and waste management. She has gained experience in all aspects of EA management and preparation and has developed and participated in numerous public consultation programs. Her skills include project management and consultant team coordination, public and stakeholder consultation program development, design and implementation, EA consultation and EA preparation.

John Pennell B.Sc., worked with the Biological and Ecological Sciences Group in St. John's, specializing in environmental sciences. Since 2007, Mr. Pennell assisted in field programs, report writing, literature review and data management for several projects related to terrestrial studies, including the Lower Churchill Hydroelectric Generation Project. He has also gained experience related to Socioeconomic Assessment for the Lower Churchill Hydroelectric Generation Project. He has also assisted in report writing, literature review, data management and field programs for both ELC and rare plant studies for transportation, mining and power development projects.

James Loughlin, B.Sc., was a Level II scientist with Stantec Consulting Ltd.'s St. John's office. Since 2008, Mr. Loughlin has 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 Group with Stantec Consulting Ltd. in St. John's, Newfoundland and Labrador. 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., MGIS (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, utilities 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 modelling and mapping, biophysical assessments and high-level cartographic presentations. Ms. Bowman has also been involved in the design, implementation and management of spatial data for large EIS projects.

Erin Marshall, B.Sc., is a GIS Analyst in the Information Management 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 and satellite and LiDAR imagery.