VOLUME ONE

Labrador Nature Atlas

LINDSAY NOTZL, RANDAL GREENE AND JOHN L. RILEY

NATURE CONSERVANCY CANADA

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Title page: Mistasin Lake. *Nestor Lewyckyj*

The Nature Conservancy of Canada (NCC) is a non-profit, non-advocacy organization that takes a business-like and supportive approach to land conservation and the preservation of Canada's biological diversity. Its activities involve creative partnerships and solutions with individuals, corporations, community and First Nation groups, conservation organizations and government agencies that shares its goals. Since 1962, NCC and its supporters have helped protect 2.6 million acres (1 million hectares) of ecologically significant lands and waters across Canada, and have assisted and advised the owners and managers of many more in their approaches to nature conservation.

For further information contact
Nature Conservancy of Canada at 1 877 343-3532,
or by email at nature@natureconservancy.ca.

NCC's Atlantic Region offices:
NCC Atlantic Region
180 - 924 Prospect Street
Fredericton, NB E3B 2T9
506 450-6010 Toll-free 1 877 231-4400
Atlantic@natureconservancy.ca

NCC Newfoundland and Labrador
49-55 Elizabeth Street, Suite 208
PO Box 11, St. John's, NL A1A 1W8
709 753-5540

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Alpine tundra. Isabelle Schmelzer

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CORE TEAM PARTNERS included included professional staff and managers of participating organizations and agencies: Canadian Boreal Initiative; Environment Canada (Canadian Wildlife Service); Innu Nation; Institute for Environmental Monitoring and Research; Memorial University of Newfoundland (Biology Dept.); Nature Conservancy of Canada; Newfoundland and Labrador Depts. of Environment and Conservation (Parks and Natural Areas Division and Wildlife Division) and Natural Resources (Forest Services Branch, Centre for Forest Science and Innovation); Nunatsiavut Government; NunatuKavut Community Council; Stantec Consulting Ltd.; and Torngat Wildlife, Plants and Fisheries Secretariat.

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Kalmia angustifolia. Valerie Courtois

INTRODUCTION

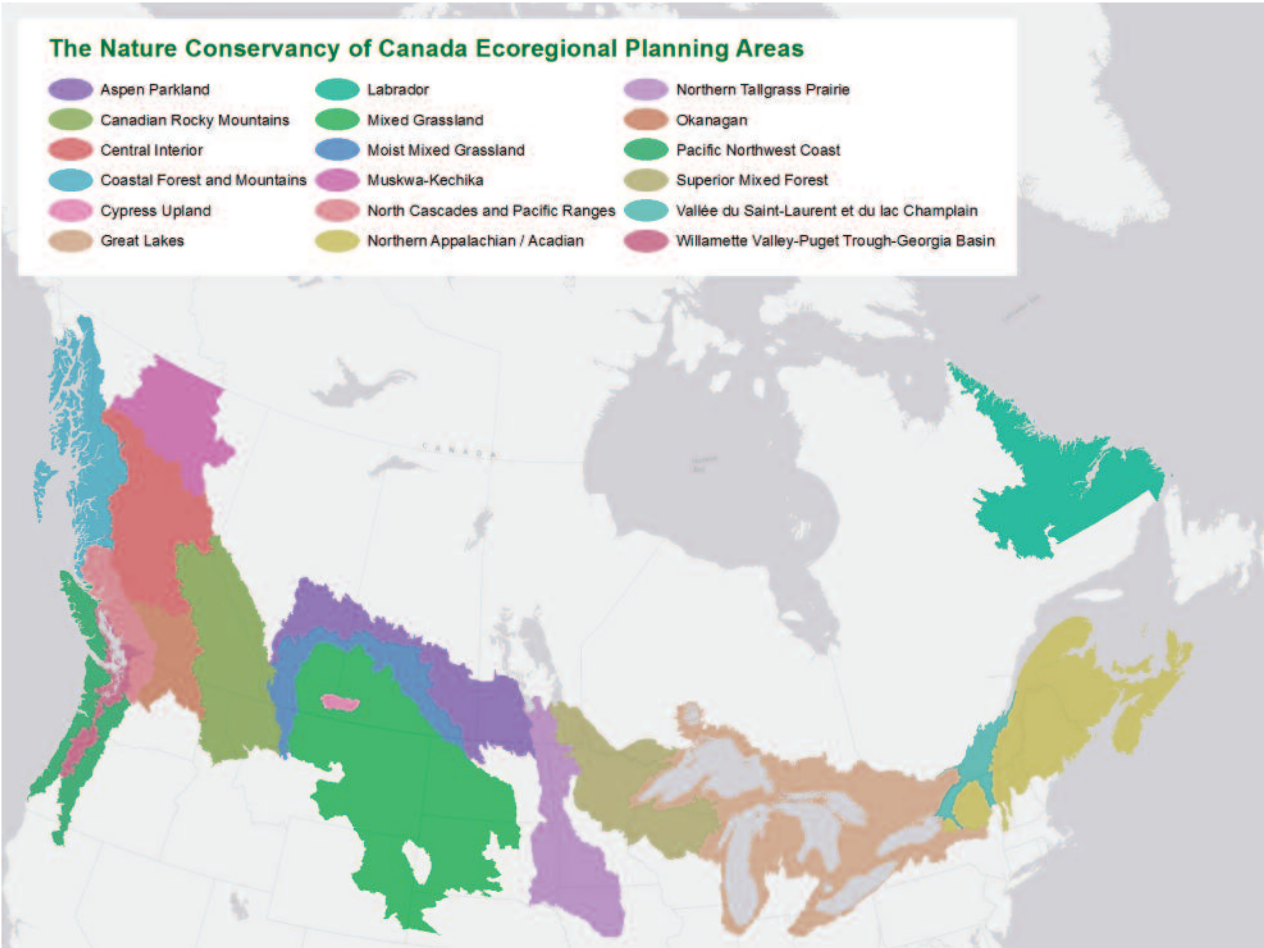
THE LABRADOR NATURE ATLAS is a product of the *Labrador Conservation Blueprint*, a partnership led by the Nature Conservancy of Canada (NCC) from 2009 to 2013. The goal was to assemble, map and share the best-available digital information about the geography and biological features of Labrador; describe Labrador's ecological diversity; support conservation and informed resource stewardship; and share results openly with interested audiences. Relative to southern Canada, there is little high-quality information available about Labrador's natural environment. Thus, NCC's first priority was to improve access to ecological information, and develop new ways to assess data so they can be more fully considered in land-use decisions and development approvals.

Since 2000, NCC has completed *Conservation Blueprints* of eighteen ecological regions across Canada, providing science-based information on which to base conservation and land-use decisions, based on the assembly, creation and analysis of information using Geographic Information Systems (GIS). These have identified regional conservation priorities, places where conservation has already occurred and priorities for the conservation of native species and ecological systems. (Reports and mapping are available online at http://science.natureconservancy. ca/resources/docs/.)

Conservation Blueprints have focused NCC and its partners in their work. Federal and provincial agencies are committed to conserving significant natural areas through various mechanisms including protected areas, land-use planning and regulation, wildlife conservation, and private-land conservation. The motivation is a shared knowledge that native species and habitats in Canada have been reduced in extent and in condition by modern industrial activities. Most recently, during 2012's conference of the parties to the Convention on Biological Diversity held in Nagoya, Japan, Canada committed itself to enhancing conservation of Canada's biological diversity.

Nagoya Target 11 states: *By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.*

In 2003, NCC released a report, *Looking North*, that recommended NCC extend its conservation planning to parts of boreal and northern Canada, including Labrador. Canada's North faces an entirely different conservation reality than southern Canada. In the South, land is fragmented by sprawling urban development and agricultural conversion, much of it permanent. In the North, vast stretches of unbroken wilderness remain, supporting ecosystems that function at landscape scales and species that migrate over large distances. Healthy populations of species that are extirpated or are in decline southward, continue to sustain themselves. The region is sparsely populated, mostly in small but historical Aboriginal and outpost communities that continue to live in close connection to the land.



Approximately 26,000 people reside in Labrador. Traditional and resource communities are now growing, in tandem with forestry, mining, hydro development, and other industrial activities. Much of the land falls under Aboriginal title and is the subject of ongoing comprehensive land claims. The settlement of Aboriginal land claims has played a key role in recent developments; for example the signing of the Labrador Inuit Land Claims Agreement and the development of the Voisey's Bay nickel mine.

A Nature Atlas for Labrador

Labrador — or "The Big Land" as it is sometimes called —stretches from the Strait of Belle Isle north to the arctic tip of Cape Chidley, and from the Labrador Sea to the McPhayden Plateau in the west. It has vast expanses of tundra, taiga, and boreal forest ecosystems — from the severe beauty of lichen-strewn barrens to rich spruce-fir forests. Giant wetlands, as much as 100 km^2 in size, sequester vast stores of carbon in their soils. Labrador is part of one of the ten largest intact forest landscapes remaining in the world, and its Torngat Mountains are North America's highest peaks east of the Rockies.

Labrador's globally-significant landscapes are strongholds for wide-ranging mammals like Gray Wolf, Lynx, and Marten. Its pristine and mostly free-flowing rivers are world renowned for Atlantic Salmon, Arctic Char, and sea-run Brook Trout. The George River Caribou herd — once the world's largest herd of migratory caribou — travel extraordinary distances to reach their calving grounds, while threatened sedentary Caribou herds depend on its boreal forests. Polar Bear, iconic symbols of the North, hunt seals up and down the Labrador coast.

Labrador's boreal ecosystems support significant populations of landbirds, shorebirds and waterfowl, including a large proportion of the eastern breeding population of Black Duck. Its offshore islands sustain massive colonies of breeding seabirds like Atlantic Puffin, Razorbill, Common and Thick-billed Murre, and Guillemot.The Gannet Islands Ecological Reserve hosts the largest colony of Razorbill in North America, while breeding Common Eider make use of offshore islands. Rare and at-risk species like Harlequin Duck, Peregrine Falcon, and Golden Eagle are widespread.

Labrador's long coastline is dotted with rich coastal habitats, including the longest undeveloped beach on the Atlantic seaboard, the most pristine salt marshes in Atlantic Canada, and key stopover sites for migrating shorebirds. Rare calcium-rich bedrocks found along the Strait of Belle Isle harbour endemic plants such as Fernald's Milk-vetch.

Land ownership and management responsibility in Labrador are changing. The Labrador Inuit Land Claims Agreement (LILCA), signed in 2005, settled fee-simple ownership of 15,800 km² (about 5 percent of Labrador) and co-management authority of 72,520 km² (about one-quarter of Labrador) to the Nunatsiavut Government. Similarly, the signing of the "Tshash Petapen" (New Dawn Agreement) will confer fee-simple ownership of 13,000 km² (about 4 percent of Labrador) and co-management of 36,260 km² (12 percent) to the Innu Nation, representing the Innu communities of Sheshatshiu and Natuashish. The Agreement-in-Principle was signed in 2010 by the Innu Nation, the Government of Canada, and the Government of Newfoundland and Labrador. NunatuKavut Community Council, representing the southern Inuit of Labrador, has also filed a claim with the Government of Canada. The signing of the LILCA mandated the development of a regional land use plan to guide future development in the region, and a similar requirement is included in the Innu Agreement-in-Principle. Aboriginal leadership in land and resource planning and management will be strengthened and capacity increased through the settlement of such land claims.

Labrador and the island of Newfoundland

The pace of development in Labrador is increasing. Labrador will remain relatively intact over the coming few decades, but development will have an increasingly large and visible impact on the landscape. Proposals

Atlantic Salmon. Jon Feldgajer

include road-building, hydro-electricity generation and transmission, and mineral development, particularly of iron ore, uranium, and rare earth elements. Labrador's Aboriginal people have a stake in where, when and how such developments occur. These decisions will define the Labrador of future generations, and they deserve our best collective efforts to balance their impacts while preserving Labrador's unique global legacy. Unlike many other parts of Canada, Labrador has the opportunity to conserve "the best of the best," not just "the best of what's left." At the same time, a balanced approach to conservation and sustainable development must be struck. We hope the *Labrador Nature Atlas* contributes to such informed decision-making.

THE PROJECT

The Labrador Conservation Blueprint began with an initial agreement between NCC and the Newfoundland and Labrador Department of Environment and Conservation, Parks and Natural Areas Division, to develop a conservation assessment and revise ecoregion/ecodistrict mapping for Labrador. This support was augmented with additional support and encouragement from other agencies, foundations and corporations, which allowed the project to meet the broader goals set by the full project partnership, and develop its final reports and website. In September 2009, NCC opened its project office in Happy Valley-Goose Bay, Labrador. Introductions and relationship building with organizations active in wildlife, resource and environmental management were guided by Mr. Winston White, a true son of Labrador and NCC Atlantic Regional Board Member, and the project grew into a broad-based collaboration.

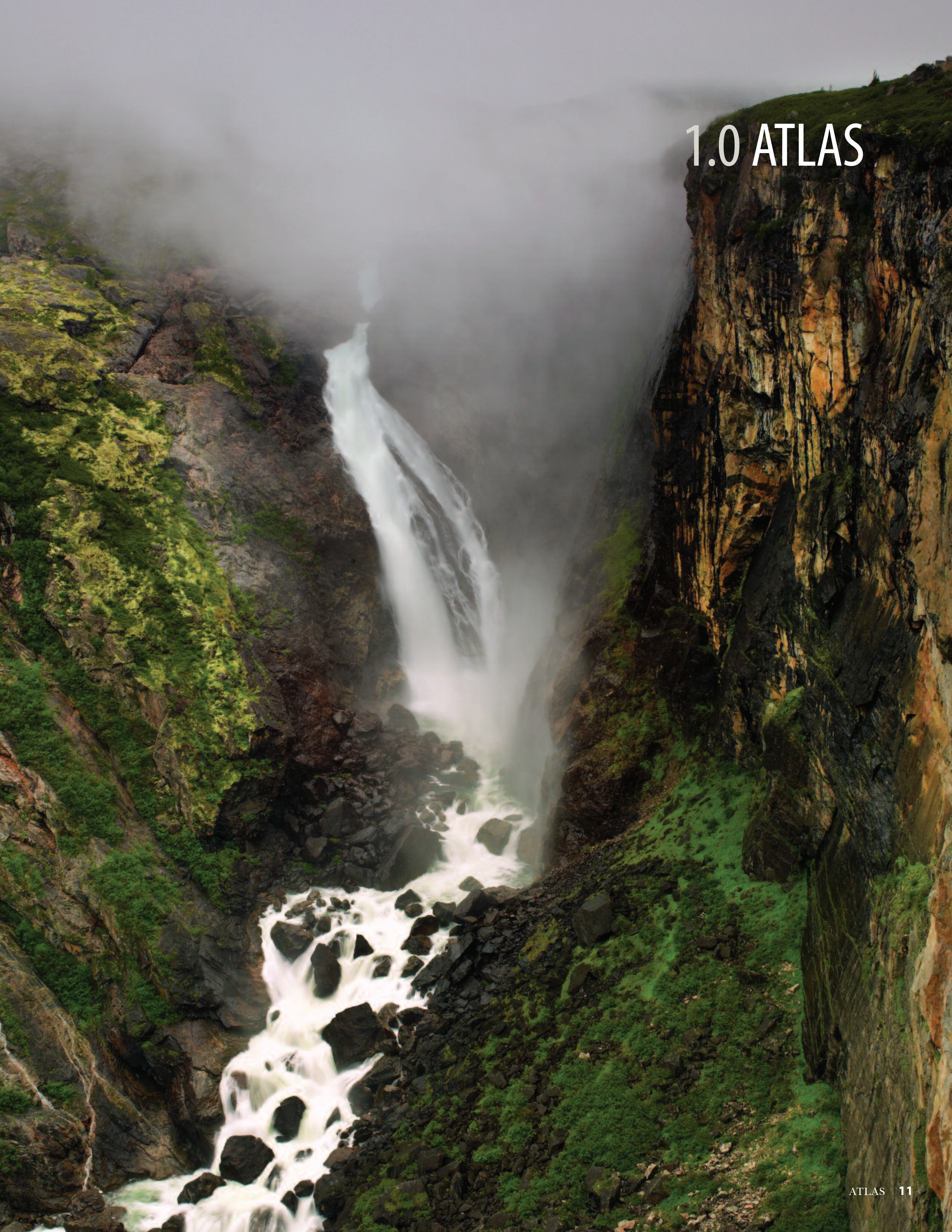
The project Core Team was established in March 2010, a gathering of NCC, NL agency staff, EC agency staff, Aboriginal groups, and local groups with a common interest in biodiversity conservation and land-use planning. The Core Team developed a terms of reference that insisted on building peer-review into the Blueprint process, a sharing of information and expertise, and working together toward mutually-beneficial goals. Core Team members — representatives of the partner agencies noted in the Acknowledgements — were responsible for reviewing all aspects of the project including data inputs, analysis methods, and final products. Seven one- and two-day meetings were held in Happy Valley-Goose Bay to review project progress and revise outcomes based on collective input. Decisions were made by consensus. Subject professionals from inside and outside Labrador were invited to lead workshops, providing opportunities to learn from experiences in other jurisdictions and connecting team members with professionals elsewhere in Canada.

Substantial effort was put into gathering, consolidating and harmonizing existing information, to avoid duplication of effort, and to fill data gaps wherever possible. This included: Ecological Land Units (ELUs) to provide a means of characterizing Labrador's life-supporting landscapes; a Human Footprint to illustrate the impacts of industrial development; revised Ecoregions and Ecodistricts; and new land-cover data for Labrador. Regional experts provided input into the establishment of conservation priorities among species, ecosystems and landscapes.

The team benefitted from the work of the Canadian BEACONs (Boreal Ecosystems Analysis for Conservation Networks) Project, out of the University of Alberta, whose work is focussed on new conservation planning frameworks and decision-support tools for Canada's boreal. These map-based modelling tools were then customized to support the project's "made in Labrador" approach. Scenario modelling was used to assess landscape values from different points of view, at different scales. Results of scenario runs identifying areas for possible conservation of key species and ecological systems have been provided to the Newfoundland and Labrador Department of Environment and Conservation, Parks and Natural Areas Division.

A 3-year partnership between NCC and Grenfell Campus, Memorial University of Newfoundland, has made it possible to freely share information online that was developed during the project, through a web-based mapping tool called the *Newfoundland and Labrador Nature Atlas* (www.nlnatureatlas.ca). It is designed to be a one-stop hub for biodiversity information, and a "living document" that can be updated over time as new information becomes available. One of its goals is to encourage continued collaboration between interested groups in Labrador. As resources and interest permit, the Core Team will review use of the Atlas, and continue to discuss conservation opportunities that may arise from the application or analysis of Atlas data in Labrador.

Opposite: Fraser River waterfalls, Kogaluk River Valley. Geoff Goodyear



1.0 ATLAS

1.1 LABRADOR FROM SPACE

Labrador is larger than the rest of Atlantic Canada combined, at 294,330 km².

From space, Labrador's natural diversity is clear. Less than one percent of it has been converted for development. Fifty-five percent is forest or woodland; 20 percent is rockland, tundra, barren, or steep slopes; 15 percent is lakes or rivers; and 10 percent is wetland (Roberts *et al.* 2006, Riley *et al.* 2013).

1.2 TOPOGRAPHY

The physical shape of Labrador — its topography — helps frame its habitats and accessibility.

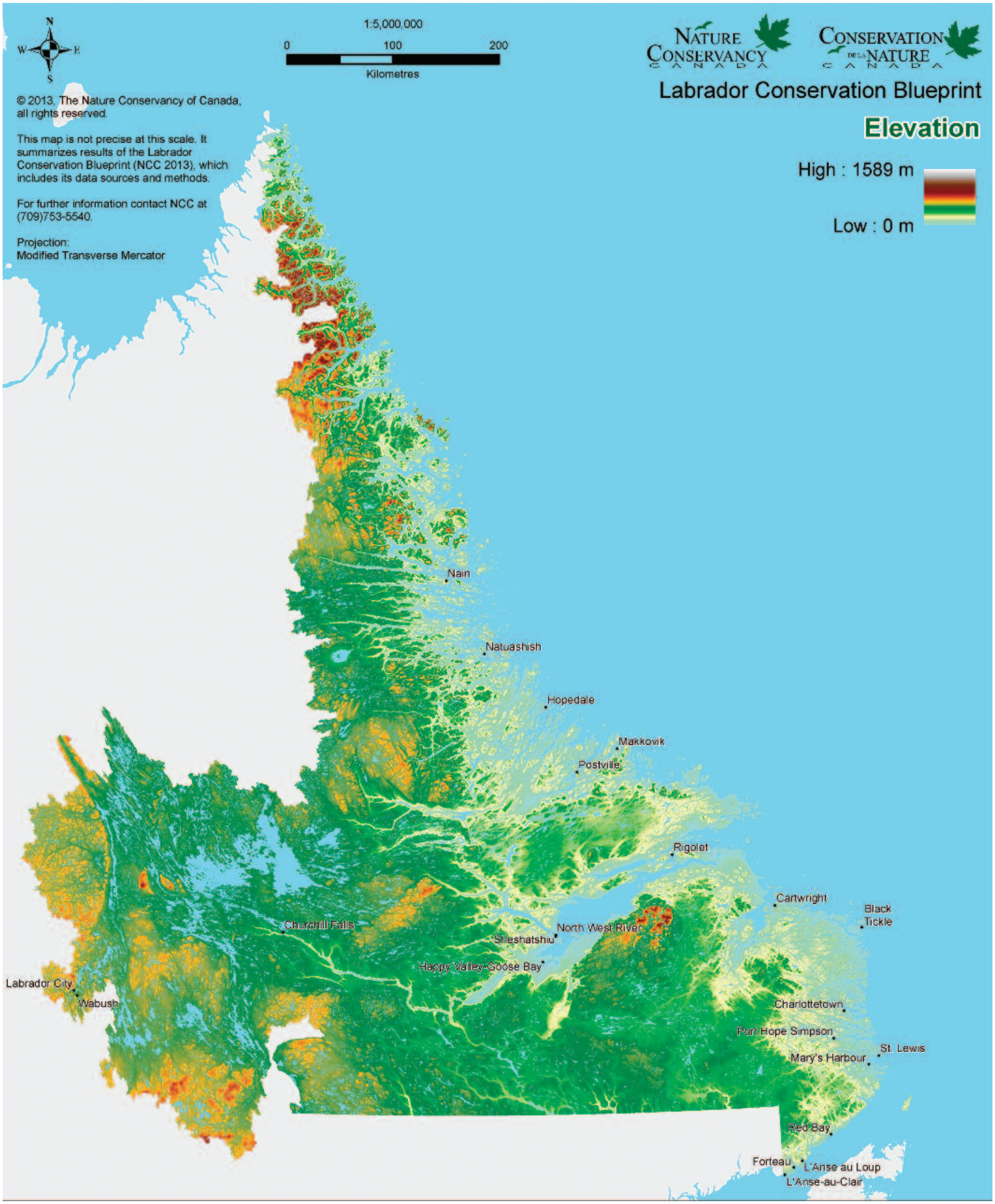
It includes highlands, south- and north-facing slopes and cliffs, and wide lowlands that flank the sea and reach up its valleys and fjords. Labrador's coastline is 7,885 km long (GNL 2001). Labrador rises to 1,589 m ASL in the Torngat Mountains in the north, 967 m ASL in the Romaine Hills in the southwest, and 1,188 m ASL in the Mealy Mountains south of Lake Melville. Other prominent uplands include the Red Wine Mountains at 884 m ASL, McPhayden Plateau at 867 m ASL, Harp Lake at 843 m ASL, and Benedict Mountains at 804 m ASL (NRC 2000).

Labrador Trough. John Riley

Cliff face, Mealy Mountains. Valerie Courtois


Torngat Mountains. Chris P. Sampson


Calving Plateau. Isabelle Schmelzer



Data source: NRCan 2000 (See 1.5.1 Elevation for more detail.)

1.3 WILDLIFE

1.3.1 Mammals

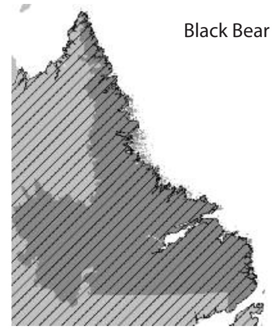
Labrador supports 38 native land mammal species.

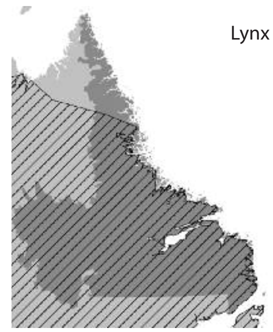
Common species include Snowshoe Hare (*Lepus americanus*), Porcupine (*Erethizon dorsatum*), Red Squirrel (*Tamiasciurus hudsonicus*), Black Bear (*Ursus americanus*), Red Fox (*Vulpes vulpes*), Beaver (*Castor canadensis*), and Ermine (*Mustela erminea*). Some species, such as Caribou (*Rangifer tarandus*), have been relatively well studied, while little is known about others like the Northern Flying Squirrel (*Glaucomys sabrinus*), Star-nosed Mole (*Condylura cristata*), Northern Myotis (*Myotis septentrionalis*), and Little Brown Bat (*Myotis lucifugus*). Wolverine (*Gulo gulo*), Polar Bear (*Ursus maritimus*), and Labrador's three Woodland Caribou herds (Mealy Mountains, Red Wine Mountains, and Lac Joseph) are considered at risk. Other rare species include small mammals like Rock Vole (*Microtus chrotorrhinus*), Woodland Jumping Mouse (*Napaeozapus insignis*), Pygmy Shrew (*Sorex hoyi*), and Water Shrew (*Sorex palustris*) (ACCDC 2011a, Meades 1990, NL DEC 2010a).

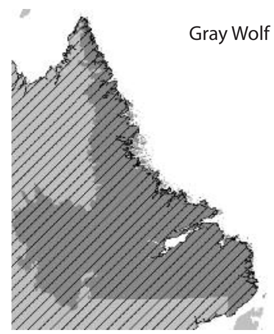
Species like Gray Wolf (*Canis lupus*), Black Bear, Red Fox, Ermine, Least Weasel (*Mustela nivalis*), Groundhog (*Marmota monax*), Deer Mouse (*Peromyscus maniculatus*), and Masked Shrew (*Sorex cinereus*) make use of a wide range of habitats. Other species that are particularly dependent on tundra or barren habitats include Arctic Fox (*Vulpes lagopus*), Arctic Hare (*Lepus arcticus*), and Ungava Collared Lemming (*Dicrostonyx hudsonius*) (Meades 1990).

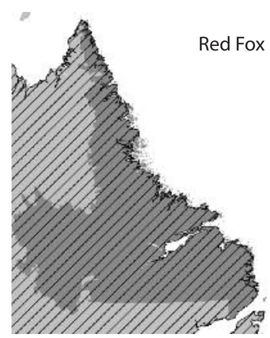
Many of Labrador's mammals prefer wooded, forested, or shrub-rich habitats. Examples include Lynx (*Lynx canadensis*), Marten (*Martes americana*), Moose (*Alces alces*), Porcupine, Snowshoe Hare, Red Squirrel, Northern Flying Squirrel, Little Brown Bat, Northern Myotis, Southern Red-backed Vole (*Myodes gapperi*), and Eastern Heather Vole (*Phenacomys ungava*). Denizens of wetlands include Meadow Vole (*Microtus pennsylvanicus*), Meadow Jumping Mouse (*Zapus hudsonius*), and Northern Bog Lemming (*Synaptomys borealis*), while Star-nosed Mole and Mink (*Mustela vison*) prefer water edges and aquatic-terrestrial ecotones. Beaver, Muskrat (*Ondatra zibethicus*) and River Otter (*Lontra canadensis*) rely on aquatic habitats. (Meades 1990).

Black Bear, Saglek. Geoff Goodyear

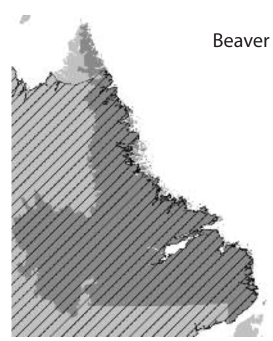


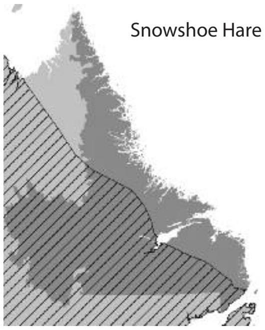


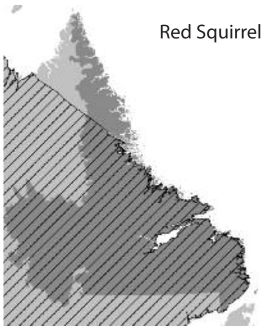


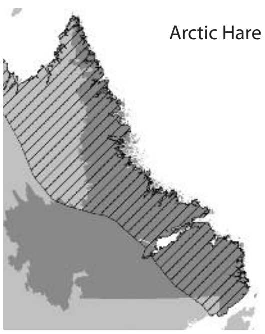


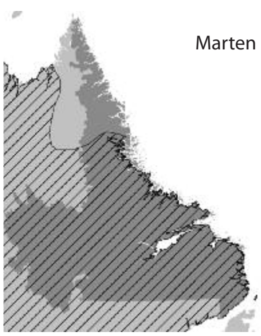
Lynx. Steve Michelin
Gray Wolf. Geoff Goodyear
Red Fox. Sara McCarthy
Beaver. Creative Commons

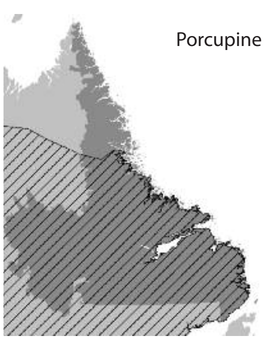












Snowshoe Hare, transitional colouring. D. Sikes, Creative Commons

Red Squirrel. D.Gordon, E. Robertson

Arctic Hare. Ansgar Walk, Creative Commons

Marten. Tim Gage, Creative Commons

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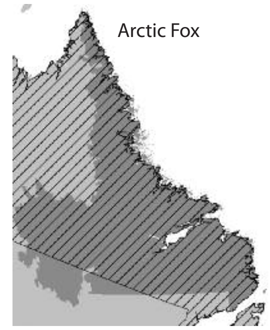
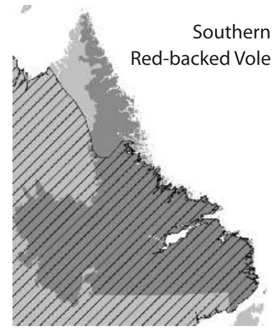
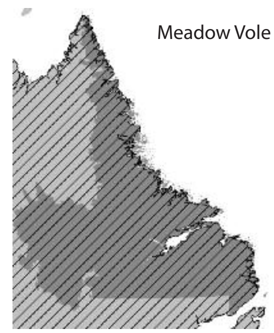
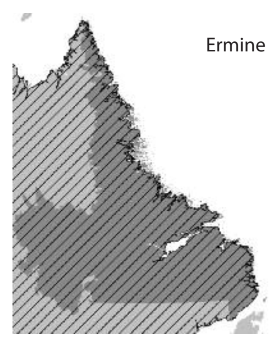
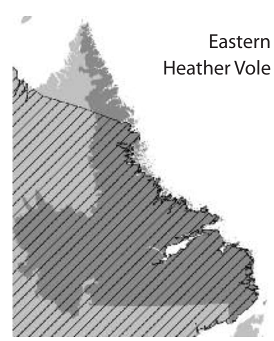










Arctic Fox. Algkalu, Creative Commons

Southern Red-backed Vole. D.Gordon, E. Robertson

Meadow Vole. Creative Commons

Ermine. Creative Commons

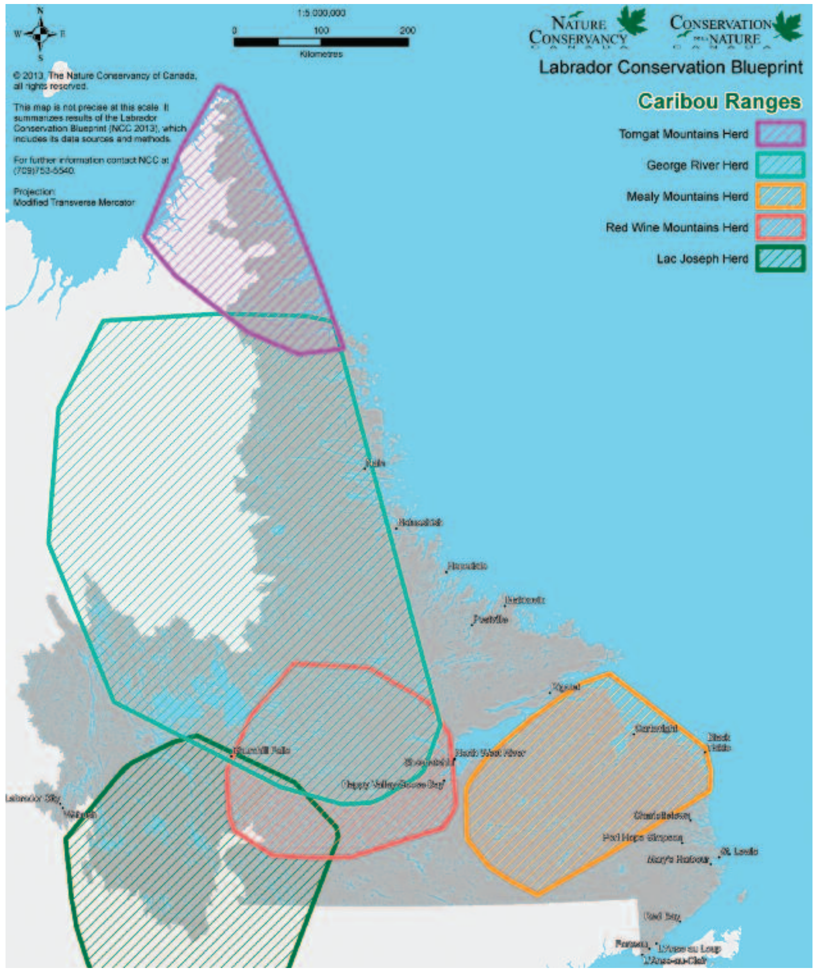
Eastern Heather Vole. Red Butte Canyon Research Natural Area

Data sources: NatureServe, and IUCN 2007a.

Rare and Special Mammals

Caribou *(Rangifer tarandus)*

Caribou is the most widespread member of the deer family, occurring in all Canadian Provinces and Territories except New Brunswick, Nova Scotia and Prince Edward Island. They are an essential northern herbivore and the only vertebrate grazer on lichen in boreal, taiga and tundra habitats. Caribou are, in turn, a primary food for many predators and an important food source for northern residents (Bergerud *et al.* 2008, Hummel and Ray 2008, COSEWIC 2011). Caribou populations face variable threats such as habitat loss and predation, the latter in part a function of human activities. Populations have decreased and ranges have contracted across most of Canada (Bergerud 1974, EC 2011a, Schmelzer *et al.* 2004).



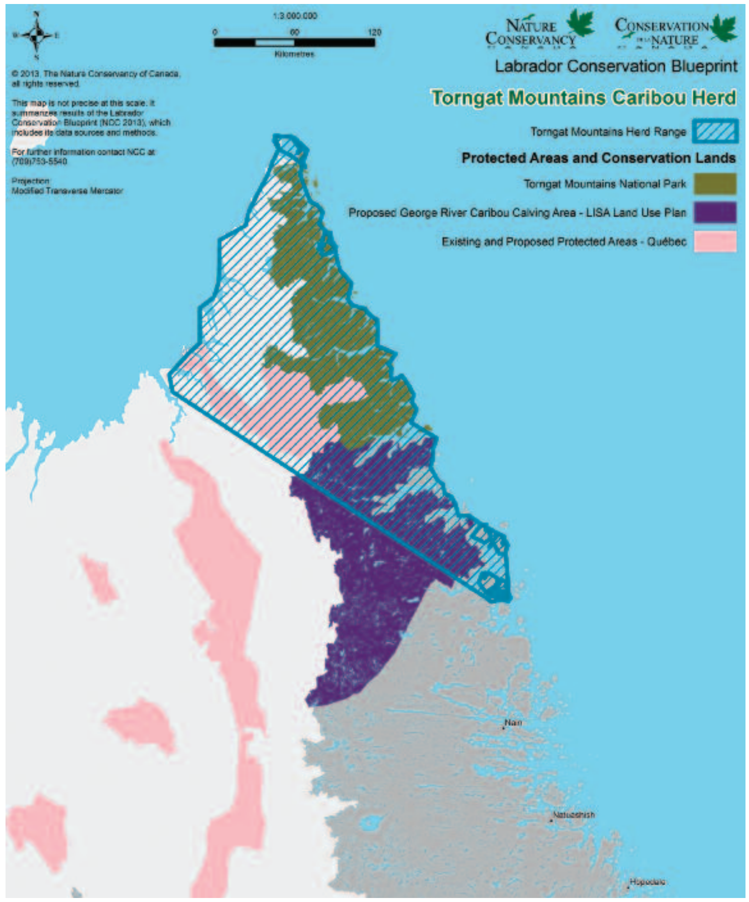
Data sources: TWPFS 2013, NL DEC 2012b,c

Caribou in Canada have been categorized into "ecotypes" based on adaptation to environmental conditions. In Labrador, 'sedentary' boreal caribou include the provincially and nationally threatened Lac Joseph, Mealy Mountains, and Red Wine Mountains herds (COSEWIC 2011; Designatable Unit 6). 'Migratory' caribou are represented by the George River herd (COSEWIC 2011; Designatible Unit 4). Sedentary caribou are solitary other than cow-calf pairs and small winter groupings (Schmelzer 2012), while migratory caribou travel in groups year-round (Bergerud *et al.* 2008). Sedentary caribou move shorter distances (≤ 100 km) between summer and winter ranges, and spend the entire year below the tree line (Schmelzer 2012). Migratory caribou travel thousands of kilometres annually, from their calving and summering grounds above the tree line, to wintering areas in the taiga or boreal forests to the south (Couturier *et al.* 1990, Bergerud *et al.* 2008, Taillon *et al.* 2012). Female sedentary caribou "space out"— distancing themselves from one another during calving to avoid predators (Bergerud 1994, Bergerud *et al.* 2008, Hummel and Ray 2008). Females calve alone, on islands or in large peatlands, and spend several months alone with their calves during the time when calves are most vulnerable to predation. Individuals congregate during the fall rut and in winter, but in much smaller groups than migratory herds (Schmelzer 2012). Migratory caribou "space away" by undertaking long-distance migrations to spring calving grounds where they give birth in large groups (Bergerud 1994, Bergerud *et al.* 2008, Hummel and Ray 2008). They breed during the fall migration, disperse into smaller groups during the winter, and reassemble into large groups, sometimes tens of thousands of individuals, on their way back to their calving grounds (Bergerud *et al.* 2008). Both movement strategies help caribou avoid predators, particularly wolves (Bergerud *et al.* 2008, Hummel and Ray 2008). Although rutting areas of migratory and sedentary caribou in Labrador are fully separated, winter ranges can overlap, especially below the treeline, during which time caribou

Oppposite: Caribou in Eclipse Channel, Torngat. Geoff Goodyear

intermingle and are difficult to distinguish from one another (Schmelzer *et al.* 2004; Couturier *et al.* 2009).

Mountain caribou may be either 'migratory' or 'sedentary' (Hummel and Ray 2008). The Torngat Mountains herd in Labrador (COSEWIC 2011; Designatible Unit 10) is considered sedentary because females calve alone at higher altitudes and undertake short, vertical migrations between seasonal ranges (Schaefer and Luttich 1998).



Data sources: CEC 2010, COSEWIC 2013, LISA Regional Planning Authority 2012, Parks Canada 2009.

MOUNTAIN AND MIGRATORY ECOTYPES

Torngat Mountains Caribou Mountain Ecotype

The Torngat Mountains herd occurs in the northern Quebec-Labrador peninsula between latitudes 57°N and 60°N. An historic survey suggests this herd numbered as many as 5,000 animals in 1980 (Bélanger and Le Hénaff 1985) though uncertainty around this estimate is considerable. Current numbers are unknown. In recent years, residents and hunters in Nain and Kangiqsualujjuaq and biologists in Labrador and Quebec have expressed concern that this population is declining (COSEWIC 2011, TWPFS 2009). Research has found that individuals now face higher mortality rates, higher levels of predation, and lower overall survivorship (TWPFS 2009).

Torngat Mountains Caribou move only about one-sixth of the distances traveled by George River Caribou between seasonal habitats (COSEWIC 2011). There is seasonal overlap of the ranges of the Torngat Mountains herd and the George River herd and, genetically, these two ecotypes are similar (Boulet *et al.* 2007). Range overlap occurs during post-calving and spring migration, although Torngat Caribou maintain exclusive ranges during calving, rutting, and throughout early and mid-winter (Schaefer and Luttich 1998, COSEWIC 2011, TWPFS 2009).

Females calve alone in alpine and sub-alpine habitats at higher elevations. They use a variety of winter habitats, including windswept alpine ridges, subalpine forests and lowland forests (Schaefer and Luttich 1998, Hummel and Ray 2008). In winter, they move west to Ungava Bay, although some may overwinter along the coast near Hebron Fjord and Okak Bay (COSEWIC 2011, TWPFS 2009).

Caribou West of Okak. Geoff Goodyear

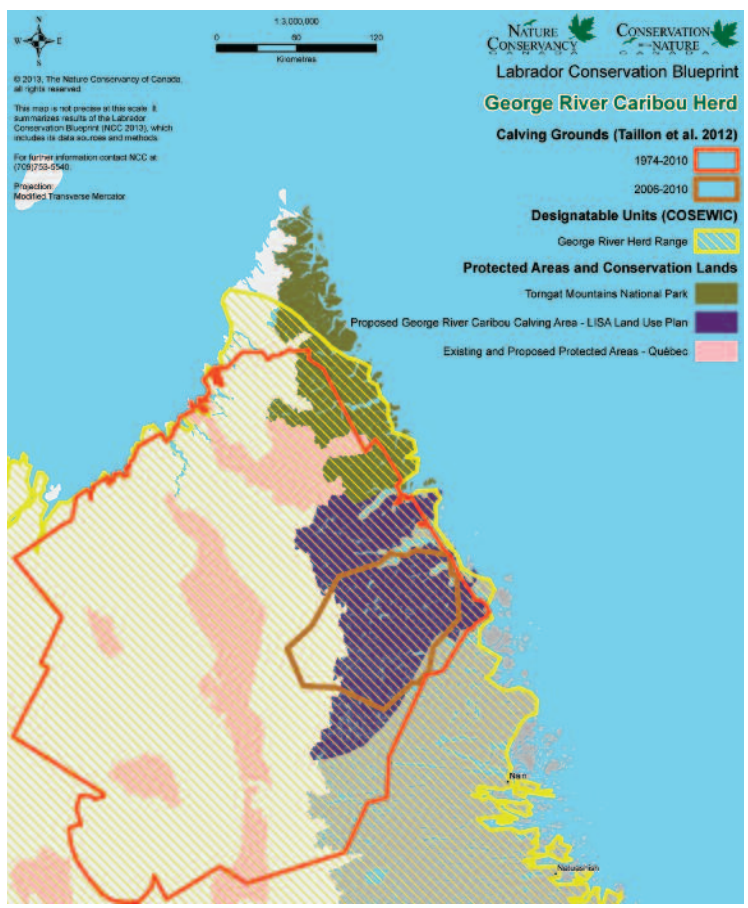
The herd's total range is approximately 36,373 km² (TWPFS 2013), of which 46 percent (16,746 km²) occurs in Labrador. Of the Labrador range, 94 percent falls within the boundaries of the Torngat Mountains National Park (9,488 km²; 57 percent) and the proposed George River Calving Area under the Labrador Inuit Settlement Area Land Use Plan (6,244 km²; 37 percent) (TWPFS 2013, Parks Canada 2009, LISA Regional Planning Authority 2011).

George River Caribou — Migratory Ecotype

George River Caribou occur in tundra and taiga habitats of northern Labrador. Their population has cycled from lows of 5,000 animals in the 1950s to highs of 775,000 between 1985 and 1993 (Couturier *et al.* 1996, Bergerud *et al.* 2008, Couturier 2012). Data suggests there are presently less than 20,000 animals, representing a 95 percent decline over a 20 year period (NL DEC 2013). Very low adult survival rates, and low calf survival, are significant concerns for population recovery (S. McCarthy, pers. comm., 2013). Studies have shown a link between the amount of landscape disturbance and the survival of newborn calves, with lower recruitment associated with higher disturbance rates (EC 2011a, McCarthy *et al.* 2007). This is significant as new developments are proposed in the herd's calving range, when pregnant caribou and newborn calves are most vulnerable to human disturbance (Bergerud *et al.* 2008, Hummel and Ray 2008, EC 2011a, Taillon *et al.* 2012). The herd's range contracts and expands according to its population size. At its peak, the herd ranged over 681,800 km² (Couturier 2012). Presently it is less than 125,000 km² (Couturier 2012).

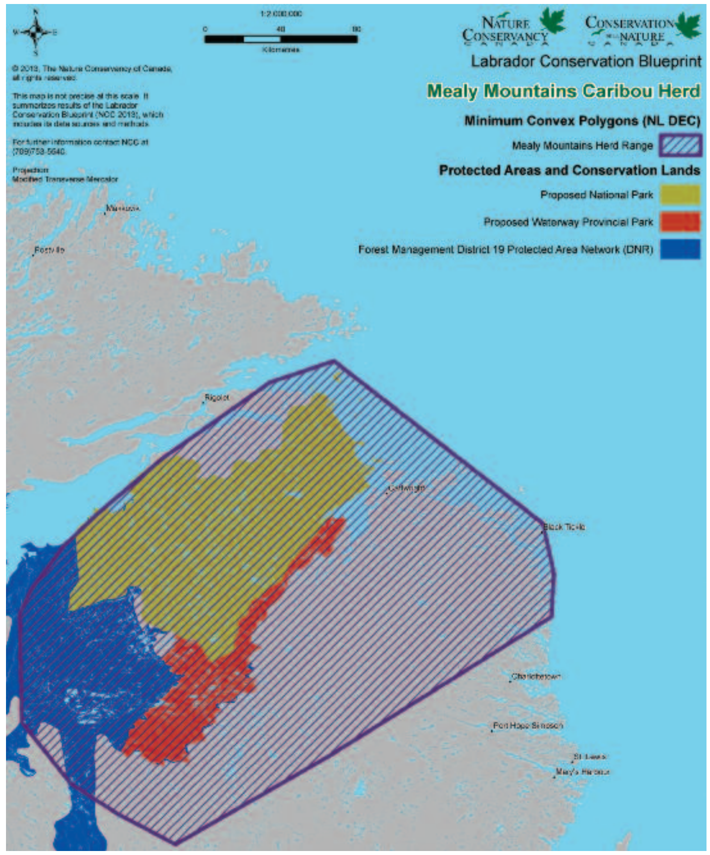
This population displays aggregated calving behaviour. Calving grounds are usually occupied between late May and early July. Over 93 percent of females return annually to calving grounds, defined as the area used from calf birth to when calves start to consume vegetation (Taillon *et al.* 2012). Calving grounds are discrete (Boulet *et al.* 2007, Couturier *et al.* 2009), although range overlap with the Red Wine Mountains herd, the Lac Joseph herd and, on rare occasions, the Mealy Mountains herd may occur in winter (Couturier *et al.* 1999, Schmelzer *et al.* 2004). The degree of range overlap changes over time in relation to population size (Bergerud *et al.* 2008, COSEWIC 2011).

Although calving grounds are not geographically fixed over time at a local scale, they have been located in the same general areas for centuries (Couturier 2012, Taillon *et al.* 2012). The cumulative calving grounds used annually from 1974 to 2010 occupies an area of 89,000km² (Taillon *et al.* 2012); of which 24 percent (22,222 km²) occurs in Labrador. Of the Labrador portion, 78 percent falls within the Torngat Mountains National Park (3,456 km²; 16 percent) and in the proposed LISA George River Calving Area (13,830 km², 62 percent) (Parks Canada 2009, LISA Regional Planning Authority 2011). To accommodate for population recovery, conservation strategies should consider calving areas used in the past and predicted to be used in the future. However, spatial and temporal variability in calving grounds must also be considered. Some researchers recommend that areas with shifting boundaries be considered and defined based on 3–5 year annual calving grounds. Calving grounds from 2006–2010 occupied an area of 9,860 km², nearly 80 percent of which occurred in Labrador (Taillon *et al.* 2012). Of this, 76 percent was located within the proposed LISA George River Calving Area (LISA Regional Planning Authority 2011).



Data sources: CEC 2010, COSEWIC 2013, LISA Regional Planning Authority 2012, Parks Canada 2009, Taillon *et al.* 2012.

SEDENTARY WOODLAND ECOTYPE



In Labrador there are three herds of sedentary boreal caribou — Lac Joseph, Red Wine Mountains, and Mealy Mountains. Each is listed as 'Threatened' under the *Endangered Species Act of Newfoundland and Labrador* (ESA NL) and the federal *Species at Risk Act* (SARA) (Schmelzer *et al.* 2004). Female caribou use large home ranges (~5000km^2), adding areas throughout their lifetime, which allows them to respond to fire events, changes in habitat quality, or number of predators in their range (Rasiulis *et al.* 2012). Caribou show fidelity to their population range as well as to areas used seasonally, especially calving and post-calving areas (Schaefer *et al.* 2000, Rasiulis *et al.* 2012, Schmelzer 2012).

Seasonal range shifts occur between summer and winter ranges, and these areas are connected by spring and fall migrations. The relative intactness of the Labrador landscape currently permits exchange of caribou between adjacent ranges, and populations collectively form a metapopulation across central and southern Labrador (Schmelzer 2012). Genetic information indicates that animals in different populations are related to one another but that gene flow is limited by distances > 200 km (Boulet *et al.* 2007, Courtois *et al.* 2003). Maintaining landscape connectivity is key to facilitating movement of caribou throughout seasonal parts of their range, and preserving interchange between populations (Schmelzer *et al.* 2004, Schmelzer 2012).

Sedentary caribou in Labrador occur at densities of 3–5 caribou per 100 km^2 for most of the year (Bergerud *et al.* 2008, Schmelzer *et al.* 2004, Schmelzer 2011). Prior to calving in June, females disperse widely from areas of winter aggregation. During calving, females are generally solitary. They do not form postcalving aggregations and travel alone, with their calves, or in groups of 2–3 adult-calf pairs (Brown *et al.* 1986, Schmelzer 2012). Prior to the rut caribou form small groups of < 10 animals. They are most gregarious in late winter, when they form groups of 10–5 animals in lichen-rich areas (Brown *et al.* 1986, Schmelzer 2011, Schmelzer 2012).

A typical lichen woodland in winter. Isabelle Schmelzer

Habitats preferred for calving include large peatlands, islands, peninsulas of large lakes, or combinations of these features. Dense conifer stands with *Sphagnum* or shrub understoreys are also used, especially if they occur in proximity to wetlands or lakes. Alpine areas, burns, lichen woodlands and anthropogenic features are avoided (Schmelzer 2012). Female caribou show fidelity to particular calving areas, even to specific sites (Brown *et al.* 1986, Schaefer *et al.* 2000, Schmelzer *et al.* 2004). From late December to mid April, when caribou are on their winter ranges, lichen woodlands and lichen-shrub woodland are strongly selected. Caribou also use ice-covered waterbodies for rest and refuge (Schmelzer 2012).

Mealy Mountains Caribou

The Mealy Mountains herd occupies about 24,000 km^2 from east of the Kenamu River to the coast; Groswater Bay south to Hawke's Bay, and inland to the headwaters of the Alexis and St. Augustin rivers (Schmelzer *et al.* 2004, Schmelzer 2012). It has experienced large population fluctuations over time, declining from 2,600 caribou in 1958 to 284 animals in 1975, and recovering to near historic levels following a hunting closure in the late 1990s (Schmelzer *et al.* 2004, Bergerud *et al.* 2008). In 2005 the herd appeared to be stable at 2,100 caribou. Recent survey data indicates a decline to 1,604 individuals (Schmelzer and Wright 2012).

The Mealy Mountains range is unique in that it contains treeless coastal barrens and offshore islands. Due to the moderate coastal climate, subarctic forests are largely absent, while close-canopied Black Spruce and Balsam Fir forests are prevalent. Roughly 40 percent of the range is composed of peatlands with open pools of water and hummocks dominated by shrub Black Spruce and Labrador Tea. Eskers occasionally support ribbons of lichen woodland. Notable geographic features include the Mealy Mountains, which reach heights of more than 1,000m ASL, the 40 km 'Wunderstrand' beach, and the Eagle plateau. Large rivers, including the Eagle, White Bear and Paradise, flow from their headwaters in the interior to the coast (Meades 1990, Lopoukhine *et al.* 1978, Schmelzer 2012, Riley *et al.* 2013).

Caribou calve throughout the range in extensive treed peatlands, lakes with islands, peninsulas of large lakes or combinations of these features. In particular, the headwaters of the English, North, White Bear and Eagle Rivers (Schmelzer and Wright 2012e), as well as inland from the coast south of Cartwright to Charlottetown, are used. The Mealy Mountains are infrequently used for calving; burns and coastal areas are avoided, with the exception of large off-shore islands (*e.g.* George's Island) (Folinsbee 1979, Hearn and Luttich 1987, Schmelzer 2012, Schmelzer and Wright 2012e). Females regularly return to former calving sites, frequently < 15 km from sites used the year before (Schmelzer *et al.* 2004, Popp *et al.* 2011).

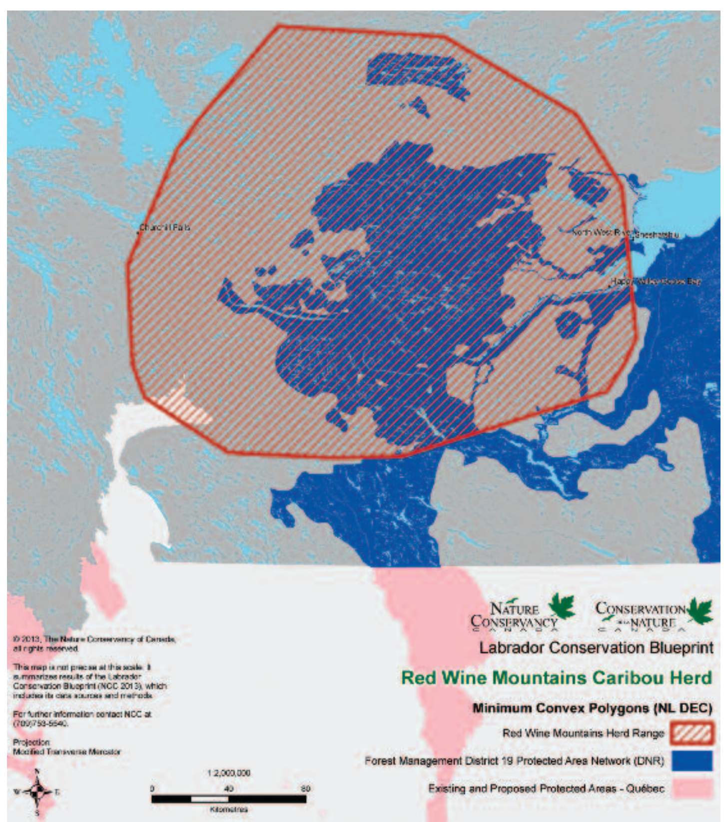
Wintering areas include offshore islands, and caribou make extensive use of coastal barrens during this time of year (particularly north of Cape Porcupine and south of Table Bay). Open conifer-lichen forests are also used, though these are less common than in other caribou ranges. The Crook's Lake and Parke Lake areas are frequented during winter, as are areas along the Eagle River, and the headwaters of the St. Paul River. Small groups of caribou also aggregate on the Mealy Mountains or open peatlands along the south shore of Lake Melville between Carter Basin and Etagaulet Bay (Schmelzer and Wright 2012f, Schmelzer 2012).

Overall, 53 percent of the preferred calving and post-calving areas, and 42 percent of preferred wintering areas occur within the Mealy Mountains National Park Reserve and the adjacent proposed Eagle River Waterway Provincial Park (Parks Canada 2009, NL DEC 2009b, Schmelzer and Wright 2012e,f)

Red Wine Mountains Caribou

The Red Wine Mountains caribou range spans 26,000 km², east of the Smallwood Reservoir and west to Grand Lake and Hamilton Inlet, south to Dominion Lake and north to the Seal Lakes. The range is bisected by the Trans Labrador Highway and the lower Churchill River. While caribou are distributed throughout the range, the

Typical wetland calving habitat. Isabelle Schmelzer



Shoreline and island habitats used by boreal caribou during calving.
Isabelle Schmelzer

majority of home ranges occur in a region east of the Metchin River to Lower Brook and south of the Beaver River in the north, following a contraction in northern and western portions of the range during the 1990s (Schaefer *et al.* 2001, Schmelzer *et al.* 2004). The herd has made consistent use, since 1993, of a core area at the heart of the range (Schmelzer 2008 *in* Hummel and Ray 2008). It currently numbers 97 individuals, down from 741 animals in 1989 (Schmelzer *et al.* 2004, Bergerud *et al.* 2008, Schmelzer 2012).

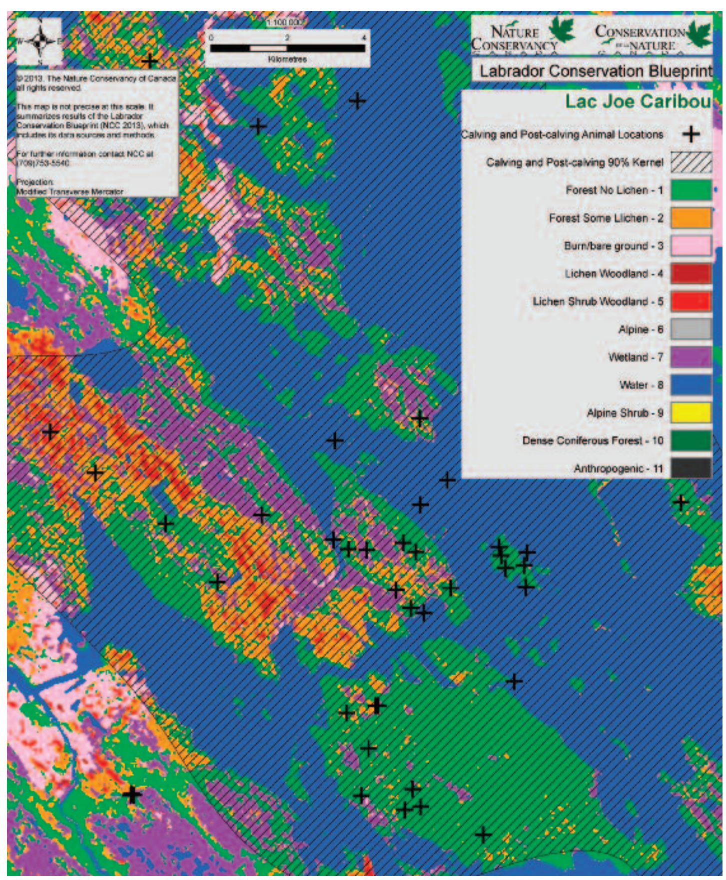
The Red Wine Mountain range is a diverse mixture of boreal, taiga, and alpine habitats. Major river valleys (*e.g.* Naskaupi, Red Wine, Goose and Churchill) contain productive, close-canopied forests, dominated by Black Spruce, although Balsam Fir, White Birch, and Trembling Aspen also occur. The Red Wine Mountains reach heights of 600- 900 m ASL and are dominated by alpine habitats at higher elevations, with some Tamarack and Black Spruce on lower valley slopes. An extensive upland plateau in the Goose River headwaters consists of string bogs and open conifer forest (Meades 1990, Lopoukhine *et al.* 1978, Schmelzer 2012, Riley *et al.* 2013).

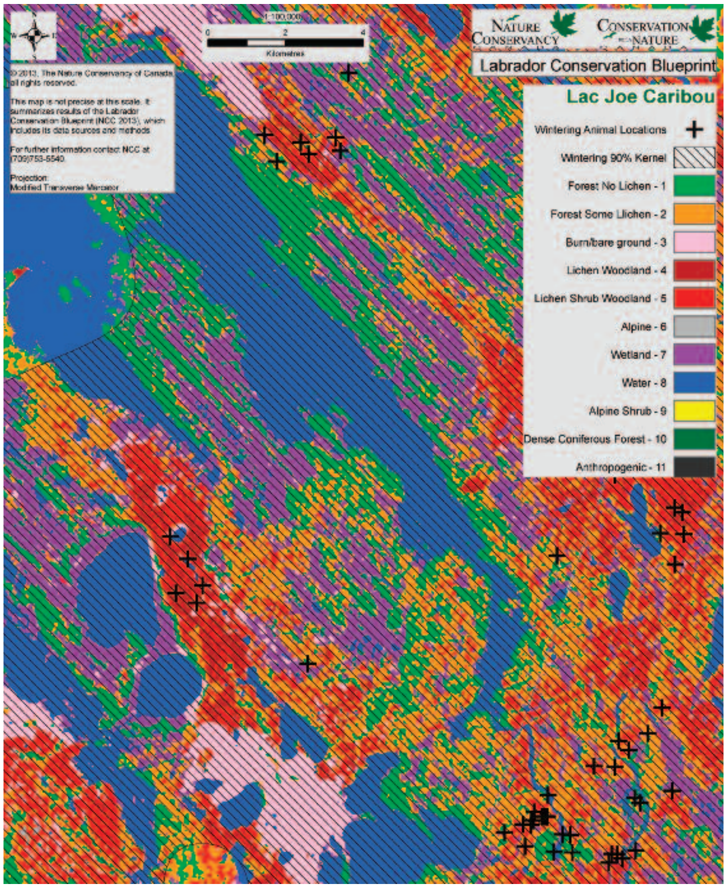
Calving areas include peatlands, islands, and peninsulas of large lakes, particularly east of Wilson Lake to series of unnamed lakes south of Goose River and west of Upper Brook. A mosaic of wetlands, forests and lakes with islands, from Beaver Brook to the Traverspine River are used in the southern part of the range (Schmelzer and Wright 2012c, Schmelzer 2012). Wintering areas occur in open-lichen woodlands, well-drained river uplands, and tundra and alpine habitats of grasses, sedges and Dwarf Birch. Caribou winter primarily north of the Churchill River, throughout the Goose and Cache River headwaters, and north to the Red Wine River. In the south, an area northwest of Dominion Lake is used year-round (Schmelzer and Wright 2012d, Schmelzer 2012).

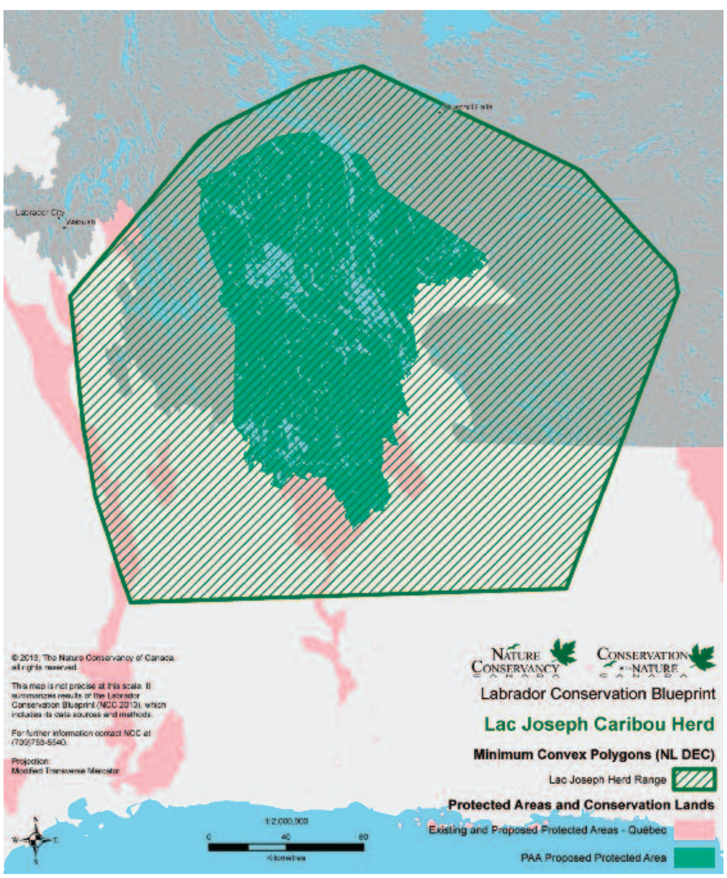
A large portion of preferred calving and post-calving areas, as well as wintering areas, occur within the part of Forest Management District 19 identified as a Protected Areas Network (NL DNR and Innu Nation 2012, Schmelzer and Wright 2012c,d). This designation prohibits commercial forest harvesting, silviculture, and construction of forest access roads. It does not preclude other types of development (*e.g.* mining), and boundaries may change during 5-year renewal cycles (NL DNR and Innu Nation 2012).

Lac Joseph Caribou

The Lac Joseph caribou range, at about 66,000 km² (Schmelzer 2012), spans from south of the Trans-Labrador Highway between Winokapau Lake in the east and Wabush to the west, and south to the Quebec/Labrador border Schmelzer *et al.* 2004, Schmelzer 2012). It is bisected in the West by the Québec North Shore and







Boreal caribou select lichen woodlands and lichen-shrub woodlands in winter and wetlands, shorelines and peninsulas during calving.

Labrador Railroad and to the south by the Quebec border. The herd range historically included lands now inundated as part of the Smallwood Reservoir (Bergerud 1974, Pilgrim 1978, Saint-Martin 1987, Schmelzer *et al.* 2004). This population first declined during the 1860s (Folinsbee 1979), and continued to do so until at least the late 1890s (Banfield and Tener 1958). It recovered to 4,500–6,000 animals between 1954 and 1972 (Pilgrim 1981 *in* Bergerud *et al.* 2008) though it is possible migratory caribou were inadvertently included in that count. It declined sharply throughout the 1980s; numbering only 445 animals by 1986 (Saint-Martin and Théberge 1986), and recovering to just over 2,000 animals in 2000. A decline to 1,282 caribou was observed in 2009 (Schmelzer 2011).

Mid and low subarctic forest, eskers and upland plateaus dominate the Lac Joseph caribou range. Black Spruce is the dominant species, though Jack Pine and Trembling Aspen occur sporadically. Peatlands bordered by Black Spruce-*Sphagnum* stands occupy poorly-drained sites while lichen woodlands occur on well-drained areas and river uplands (Schmelzer 2012, Meades 1990, Lopoukhine *et al.* 1978, Riley *et al.* 2013).

Calving is concentrated around Atikonak Lake and a series of lakes and string bogs west of the Atikonak River to Panchia Lake in the central part of the range; Lac Joseph and Dumbbell Lake area in the west; and between Atikonak and Domogaya Lakes, and Lac aux Sauterelles and Lac Thevet in the south (Schmelzer and Wright 2012a, Schmelzer 2012). Caribou winter in open lichen woodlands and lichen-shrub woodlands near Lac Joseph, around Atikonak Lake, Ashuanipi Lake in the west; and Lac Brûlé, Domogaya Lake and Lac aux Sauterelles in the south (Schmelzer and Wright 2012b, Schmelzer 2012).

A provincial Wilderness Reserve, approximately 17,268 km^2, was proposed in the Lac Joseph-Atikonak Lake area in 1973 (PAA 2012). It would conserve 76 percent of preferred calving and post-calving areas, and 42 percent of preferred wintering habitats (PAA 2012, Schmelzer and Wright 2012a,b).

Rare and Special Mammals

A number of Labrador mammals are of conservation interest

Species that are considered to be of conservation interest may be rare in Labrador, rare nore globally, the particular jurisdictional responsibility of Newfoundland and Labrador, or may have perceived risks to their populations as reflected by their regulation under legislation.

These species exhibit one or more of the following distribution and abundance patterns (which are also applied in the identification of rare and special birds, fish, other wildlife, and flowering plants, in sections 1.3.2-1.4.2, below):

- Globally rare, with fewer than 100 known populations (ranked G1-G3 by NatureServe)
- Rare in Labrador (sub-nationally rare), with fewer than 100 known populations (ranked S1-S3 by NatureServe)
- Endemic, or with a global distribution limited to the region
- Population declining
- Designated as Threatened or Endangered nationally or provincially (regulated under the federal *Species at Risk Act*, or provincial *Endangered Species Act*)
- Extremely wide-ranging individuals, requiring conservation of habitat at very large scales (Groves *et al.* 2000)

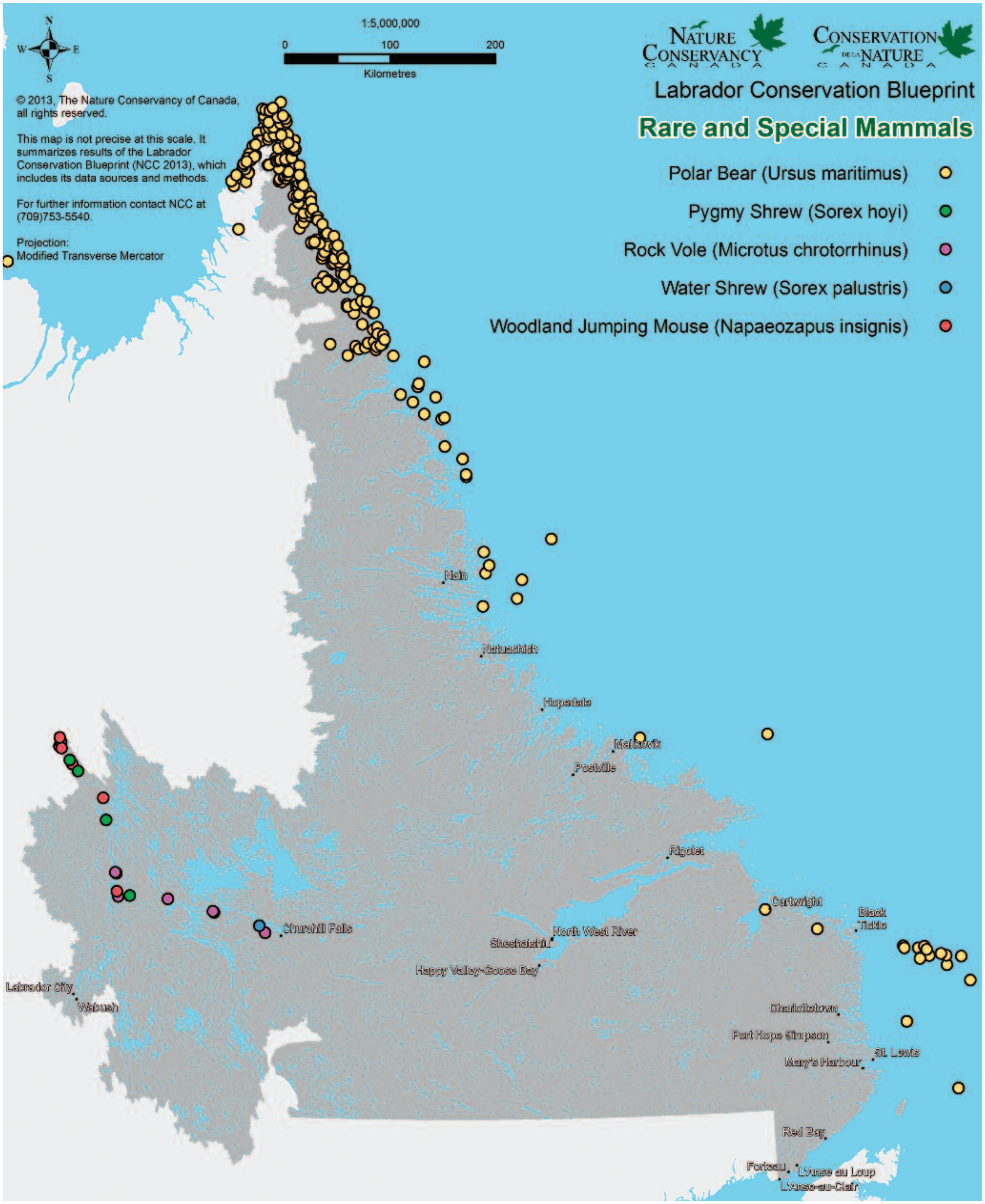
Full NatureServe definitions: <http://www.natureserve.org/explorer/ranking.htm# globalstatus>

Full COSEWIC definitions: <http://www.cosewic.gc.ca/eng/sct2/sct2_6_e.cfm>

Full SARA definitions: <http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm#tbl5>

Full NL ESA definitions: <http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/index.html>

Common Name	Scientific Name	NatureServe Global Rank	NatureServe Labrador Rank	Population Status	SARA Status	COSEWIC Status	NL ESA Status
Wolverine	*Gulo gulo* (Eastern pop)	G4	S1	Extreme wideranging	EN	EN	EN
Torngat Mountains Montane Caribou	*Rangifer tarandus*	G5	S5	Declining?			
George River Migratory Caribou	*Rangifer tarandus*	G5TNR	S5	Declining			
Red Wine Mountains Woodland Caribou	*Rangifer tarandus*	G5TNR	S2/3	Declining	TH	TH	TH
Lac Joseph Woodland Caribou	*Rangifer tarandus*	G5TNR	S2/3	Declining?	TH	TH	TH
Mealy Mountains Woodland Caribou	*Rangifer tarandus*	G5TNR	S2/3	Declining?	TH	TH	TH
Polar Bear	*Ursus maritimus* (Davis Strait pop)	G3	S2/3	Unknown	SC	SC	VU
Rock Vole	*Microtus chrotorrhinus* ssp *ravus*	G4	S1	Unknown			
Woodland Jumping Mouse	*Napaeozapus insignus*	G5	S1?	Unknown			
Pygmy Shrew	*Sorex hoyi*	G5	S1?	Unknown			
Water Shrew	*Sorez palustris*	G5	S1?	Unknown			



Data source: ACCDC 2011a

Polar Bear (*Ursus maritimus*)

Davis Strait population

Polar Bear, with their white fur and black noses, are known to everyone. Their thick fat reserves are well-adapted to life on the sea ice. Males can weight over 800 kg but average just less than 500 kg, while females generally do not exceed 400 kg. Polar Bear have powerful claws and canine teeth, and hunt almost exclusively for seals — Ringed, Bearded, Harp, and Harbour seals (Brazil and Goudie 2006).

There are about 15,000 Polar Bear in Canada, about two-thirds of the global population. They live throughout Canada's North, as far south as James Bay and the Labrador coast. They are monitored as 14 sub-populations, and the Polar Bear in Labrador belong to the Davis Strait sub-population, which ranges between Labrador, Newfoundland, Quebec, Nunavut, and Greenland (COSEWIC 2002). Overall, this population is thought to number between 1400 and 1650 animals overall but the number in Labrador is not known (*ibid.*, Brazil and Goudie 2006). During years of favorable ice conditions, hundreds may be present, and 81 of 623 bears captured in 2005 as part of a study of the Davis Strait population were from the Labrador coast (*ibid.*). In the late 1970s, Stirling and Kiliaan (1980) estimated there were 60 to 90 bears living in northern Labrador. The majority of sightings are in the Cape Chidley, Seven Islands, Saglek, and Nain Coast ecodistricts, where their densities may be lower than in other parts of their range (0.47 bears/100 km; *ibid.*).

Polar Bear are mobile and move long distances. They reside, for the most part, on the northern Labrador coast, and then move southward seasonally (Brazil and Goudie 2006). In the spring, they follow the pack ice and its seals southward. They return north as the ice breaks up (Harrington 1994). In the summer, most bears reside on the windward shores of the Labrador coast (Taylor *et al.* 2001). In rare cases, they can remain until summer on the south coast of Labrador and on the island of Newfoundland (Brazil and Goudie 2006).

Polar Bear and cub, Torngat Mountains National Park. Chris P. Sampson

Polar Bears, Torngat Mountains National Park. Chris P. Sampson

Polar Bear have low reproductive rates, and mortality rates among adult females are critical. However, the effects of hunting, contaminant bioaccumulation and climate change have not been documented in relation to Labrador bears (Brazil and Goudie 2006, COSEWIC 2002). Important habitats in Labrador include on-shore denning sites. Females display high fidelity to denning sites, often excavated in snow drifts inland from the coast. Such sites have not yet been mapped in Labrador (Brazil and Goudie 2006). They are reported, however, by Labrador Inuit on the Nanuktut Islands, North Aulatsivik Island, Soapstone Island, Iron Strand, at the mouth of Napartok Bay, between Saglek and Nachvak Fjords, north of Kangalaksiorvik Fjord, and the Pyramid Islands (Brice-Bennett 1977). A possible den was also observed in Seven Islands Bay in 1973 (Smith *et al.* 1975). Future work to record and track denning locations in Labrador is important for the identification of key terrestrial areas for Polar Bear conservation. (ACCDC 2011a: 956 reported observations; 1 population assessed (Davis Strait population. 127 observations within protected area and other conservation lands; 829 outside protected area and other conservation lands).

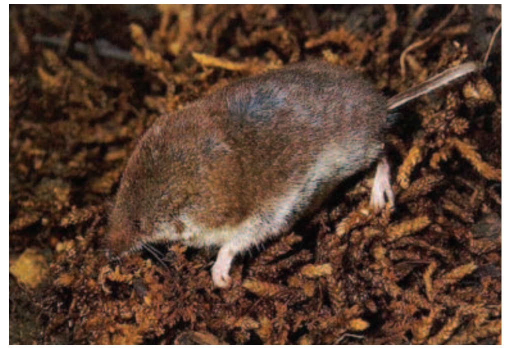
Wolverine (*Gulo gulo*)
Eastern population

Wolverine are medium-sized carnivores that resemble small bears. They occur across the northern boreal, taiga and arctic regions of Canada, and once ranged widely throughout all of Labrador and Quebec (COSEWIC 2003a). A survey in 2006 found no evidence of Wolverine or their tracks, suggesting the species is likely extirpated from Labrador, or persisting at very low population levels. This is consistent with local knowledge stating Wolverine have been rare since the 1940s. Recent reports of animals or tracks likely represent individuals on the move from adjacent areas in Quebec or cases of mistaken identity (Schmelzer 2006a).

Wolverine scavenge and hunt ungulates and rely on Caribou during late winter. Beginning in the late 1800s, Labrador's Wolverine population collapsed after the decline of the George and Leaf River Caribou herds and the abandonment of traditional migration routes (Schmelzer 2006). Elsewhere, Wolverine have compensated for low Caribou numbers by preying on Moose (Dalerum 2005), Porcupine (Lofroth *et al.* 2005), Beaver (Magoun *et al.* 2004), Ptarmigan (Dalerum 2005), Muskrat (Landa *et al.* 2005), and Snowshoe Hare (Schmelzer 2006a).

Research suggests some areas in Labrador may have higher capacity to support wolverine recovery based on the presence of Caribou, Moose, and other prey (Schmelzer 2006). In northern Labrador, recovery potential is considered highest between Hebron and Saglek Fjords, and secondarily to the north and south of Nachvak Fjord. Southern areas with 'high' recovery potential include: southeast of the Mealy Mountains in the Eagle River watershed, south of Harp Lake near Seal and Snegamook Lakes, and south of the Smallwood Reservoir. Other areas with 'good' potential were identified west of Voisey's Bay and in the vicinity of Border Beacon (NL DEC 2005). (ACCDC 2011a: 0 reported observations; 0 populations assessed.)

Wolverine. Creative Commons / National Parks Service



Woodland Jumping Mouse. D. Gordon E Robertson, Creative Commons

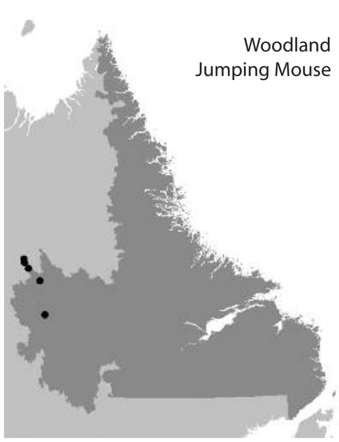
Pygmy Shrew. Discover Life

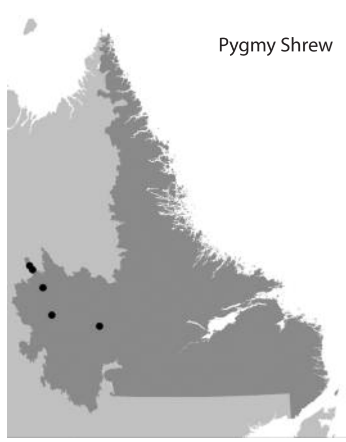
Woodland Jumping Mouse (*Napaeozapus insignis*)

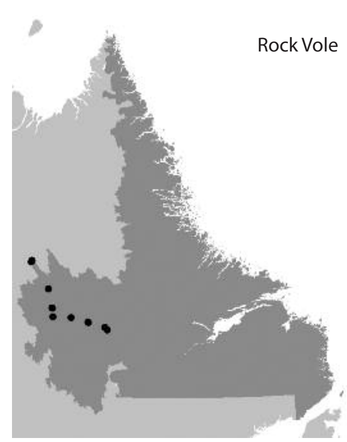
The Woodland Jumping Mouse is greyish-brown, with yellowish flanks, white underparts, and large ears. It has a white tip on its long tail. It feeds on fungi, herb, roots, seeds and fruit, is sociable, and appears to be colonial. It occurs in shrubby conifer forests and excavates shallow burrows under debris on the forest floor (Banfield 1974). The range of the Woodland Jumping Mouse in Labrador was thought to be restricted to sites south of Hamilton Inlet and the Churchill River (Banfield 1974). Two specimens were reported from Lower Brook, a tributary of the Churchill River, in 2010 (Rodrigues 2011) and 2012 (D. Jennings, pers. comm., 2013). Records in the ACCDC database are from sites along the Labrador Trough, extending its documented range. (ACCDC 2011a: 5 records; 0 populations assessed. None within protected areas and conservation lands.)

Pygmy Shrew (*Sorex hoyi*)

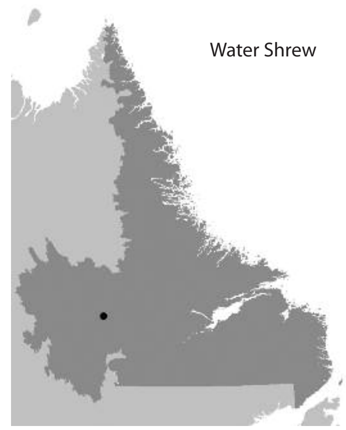
The Pygmy Shrew is only 3.5 inches long, one of the smallest mammals in the world. They are brown above and grey below in summer, and olive-brown above and pale underneath in winter. This insectivorous shrew lives near wetlands in the boreal forest, in grassy meadows, *Sphagnum* bogs, and shrub edges (Banfield 1974). Pygmy Shrew occur from the Atlantic to Alaska. Two subspecies may occur in Labrador: *alnorum* in the north, and *hoyi* in the south (*ibid.*). None were reported by the Small Mammal Monitoring Network between 2007 and 2012 (Rodrigues 2012) as they elude most mammal traps (Banfield 1974, B. Rodrigues, pers. comm., 2010). Two reports were made from Black Spruce forests 55 km west of Happy Valley-Goose Bay (Simon *et al.* 2002a), and they may be present on the Adlavik Islands (Lansing 2005). The ACCDC database includes 6 records from around the Smallwood Reservoir (ACCDC 2011a: 6 records; 0 populations assessed. None within protected areas and conservation lands.)







Water Shrew. Smithsonian, *North American Mammals*, Roger W. Barbour



Water Shrew (*Sorex palustris*)

The Water Shrew has a black coat, long snout, and webbed feet. It is a carnivore that feeds on insects, primarily larvae of stoneflies, caddisflies and mayflies, as well as fish eggs and small fish. It is seldom found far from water, and preferred habitats are the forested banks of swift-flowing streams. Water Shrew range from Alaska to Ungava and, in Labrador, they probably belong to the subspecies *labradorensis* (Banfield 1974). There is a single record in the ACCDC database, from an area south of the Smallwood Reservoir (2011). None were reported between 2007 and 2012 by the Small Mammal Monitoring Network (Rodrigues 2012), which may be attributable to the types of traps used (B. Rodrigues, pers. comm., 2010). (ACCDC 2011: 1 record; 0 populations assessed. None within protected areas and conservation lands.)

Rock Vole (*Microtus chrotorrhinus* ssp. *ravus*)

The Rock Vole is small and brown, with a short-tail, large ears, and yellow-orange snout (Banfield 1974). There are two subspecies: *chrotorrhinus*, widely distributed across eastern Canada and U.S. Midwest; and *ravus*, restricted to the Ungava Peninsula and Labrador (Banfield 1974, Lansing 2005). Rock Vole live in isolated colonies often in rocklands or talus slopes, or in cool, mossy woods near streams and ponds (Banfield 1974). They forage on a range of northern shrubs and fruits (Lansing 2005). Banfield (1974) considered the Rock Vole rare and restricted to habitats near the Strait of Belle Isle, and Lansing (2005) documented it northward, based on specimens from the Adlavik Islands. However, none were found by the Small Mammal Monitoring Network between 2007 and 2012 (Rodrigues 2012). The Rock Vole has now been observed south of the Smallwood Reservoir and in the Labrador Trough, and may be more common than records suggest. (ACCDC 2011a: 12 records observations; 0 populations assessed. None within protected areas and conservation lands.)

Rock Vole. Smithsonian, *North American Mammals*, Roger W. Barbour

Spruce Grouse. Darroch Whitaker

1.3.2 Birds

Labrador's birdlife is described geographically in relation to its "bird conservation regions" (BCRs), of which there are three in Labrador:

- **Arctic Plains & Mountains (BCR 3, the Arctic Cordillera Ecozone);**
- **Taiga Shield (BCR 7, the Taiga Shield Ecozone); and**
- **Boreal Shield (BCR 8, the Boreal Shield Ecozone) (BSC n.d., ESWG 1995).**

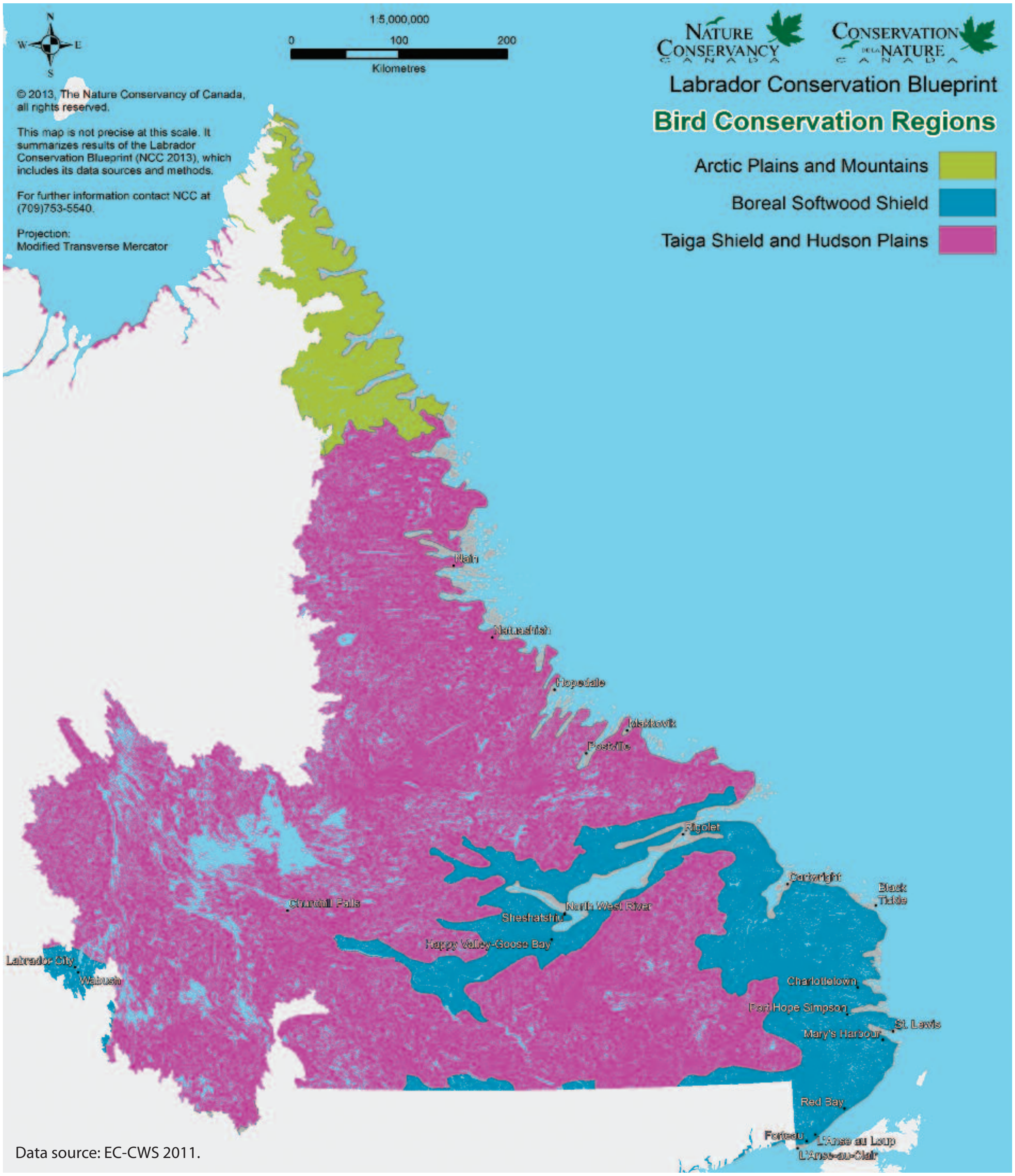
LANDBIRDS

Arctic Plains & Mountains

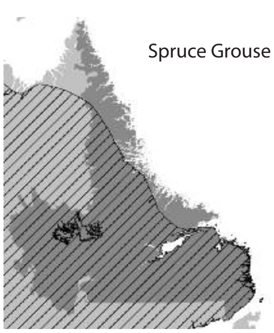
Labrador's arctic habitats of tundra, permafrost, ponds, lakes and wetlands, rocklands, deep fjords, and striking cliffs provide breeding grounds for species like Rough-legged Hawk, Golden Eagle, Gyrfalcon, Peregrine Falcon, Rock Ptarmigan, Snowy Owl, Horned Lark, Northern Wheatear, American Pipit, Lapland Longspur and Snow Bunting (NABCI Canada 2012, Harrington 1994). The region's expansiveness, challenging terrain and weather isolate it, and the status and trends of these species are poorly known (NABCI Canada 2012). New monitoring in Torngat Mountains National Park should address the paucity of information, as well as possible effects of climate change. Possible effects may include changes in habitat and food sources, increases in predator populations, and more frequent storm events (NABCI Canada 2012).

Taiga Shield & Boreal Shield

Canada's boreal and taiga ecosystems are of global importance for breeding birds (Blancher 2003), with more than 300 species relying on its vast, intact habitats (Blancher and Wells 2005, NABCI Canada 2012). This is particularly true for landbirds, notably warblers, sparrows and thrushes. Sixty-three percent of all finch species, 93 percent of thrushes, and 53 percent of warblers in the U.S. and Canada breed in the boreal (Blancher 2003, Blancher and Wells 2005).



Data source: EC-CWS 2011.



More than 50 percent of the global populations of approximately 40 landbird species rely on Canada's boreal for breeding, including: Ruffed Grouse, Yellow-bellied Flycatcher, Northern Hawk Owl, Boreal Owl, Merlin, American Three-toed Woodpecker, Boreal Chickadee, Bohemian Waxwing, Dark-eyed Junco, Pine Grosbeak, White-winged Crossbill, White-throated Sparrow, White-crowned Sparrow, Lincoln's Sparrow, Swamp Sparrow, Fox Sparrow, Ruby-crowned Kinglet, Blackpoll Warbler, Magnolia Warbler, Wilson's Warbler, Yellow-rumped Warbler, Black-throated Green Warbler, Hermit Thrush, Swainson's Thrush, and Northern Waterthrush (Blancher 2003, Blancher and Wells 2005).

Gray Jay. Darroch Whitaker

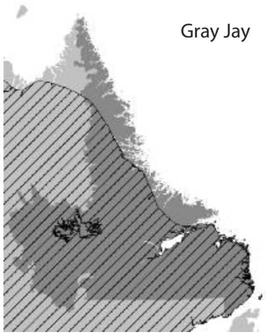
Black-backed Woodpecker.
Lisa de Leon

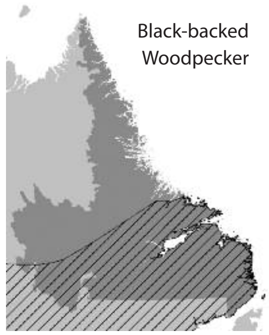
Many birds are almost entirely dependent on Canada's boreal, which provides habitat for 80-90 percent of the world's breeding populations of Gray Jay and Rusty Blackbird, and over 90 percent of Tennessee Warbler, Palm Warbler, Black-backed Woodpecker, Spruce Grouse, and Northern Shrike (Blancher 2003, Blancher and Wells 2005).

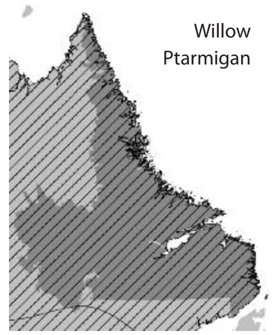
More than 90 percent of boreal landbirds migrate south each fall and nearly all leave Canada for the winter. Over-wintering species tend to have smaller breeding numbers than migrant species. Common species that remain through the winter include: Ruffed Grouse, Spruce Grouse, Willow Ptarmigan, Rock Ptarmigan, Great Horned Owl, Northern Hawk Owl, Boreal Owl, American Three-toed Woodpecker, Black-backed Woodpecker, Gray Jay, Common Raven, Boreal Chickadee, Bohemian Waxwing, Snow Bunting, Pine Grosbeak, White-winged Crossbill, Common Redpoll, and Pine Siskin (Blancher 2003, Blancher and Wells 2005).

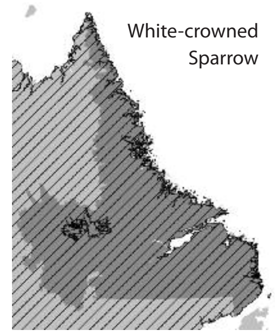
In Labrador, different habitats attract different landbirds. Mature conifer forests attract Ruby-crowned Kinglet, Yellow-rumped Warbler, and Boreal Chickadee. Broadleaf forests, which are relatively rare in Labrador, attract Yellow-bellied Flycatcher (Schwab *et al.* 2001, Simon *et al.* 2000, 2002b). Woodlands regenerating after fire and less than 40 years old attract Fox Sparrow, White-throated Sparrow, White-crowned Sparrow, Tennessee Warbler, and Wilson's Warbler (Schwab *et al.* 2001, 2006, Simon *et al.* 2000, 2002b, 2003). More recent burns, less than 10 years old and rich in snags, attract the highest densities of Black-backed Woodpecker (Schwab *et al.* 2001, 2006, Simon *et al.* 2002b).

Across Canada, boreal shrub and forest-edge birds are declining, while interior forest birds appear to be stable (NABCI Canada 2012). Declining bird species include: Least Flycatcher, Swainson's Thrush, Olive-sided Flycatcher, Gray-cheeked Thrush, Wilson's Warbler, Common Nighthawk, Bank Swallow, White-throated Sparrow, Rusty Blackbird, Dark-eyed Junco, Purple Finch, Pine Siskin, Horned Lark, Boreal Chickadee, Gray Jay, and Great Horned Owl (Blancher 2003). Migrating birds may be declining because of changes to their winter habitats in the south. Other threats may be the impacts of industrial development and infrastructure but these are very local in Labrador (NABCI Canada 2012).










Willow Ptarmigan
David Elliot


White-crowned Sparrow
Darroch Whitaker

Boreal Chickadee. Darroch Whitaker

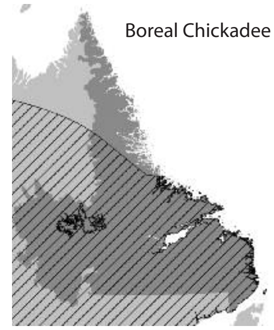
Pine Siskin. Darroch Whitaker

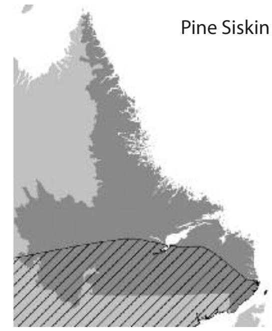
Yellow-rumped Warbler. Colin Jones

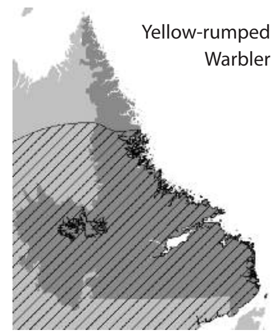
Female White-winged Crossbill. Darroch Whitaker

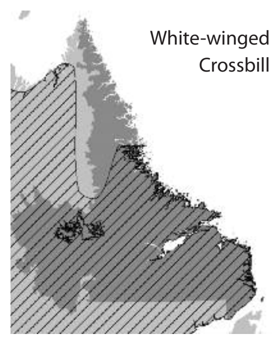
Male Pine Grosbeak. Lorraine Cooper

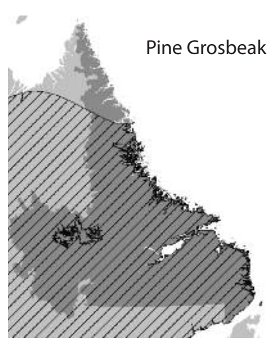
Slate-coloured Junco. Darroch Whitaker

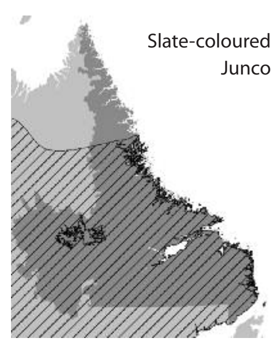


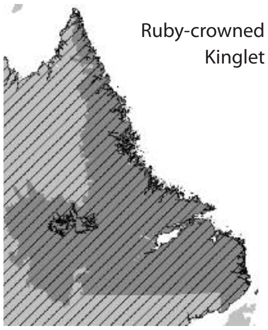


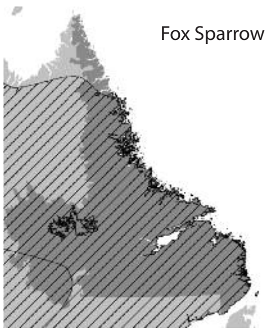


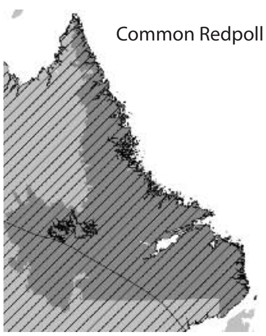


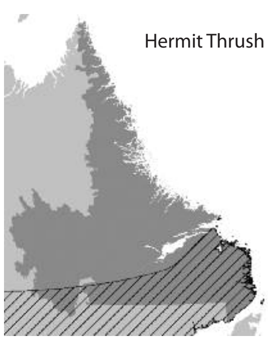




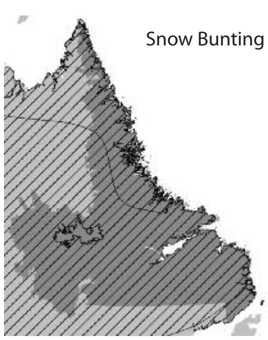


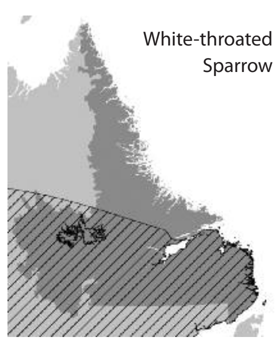


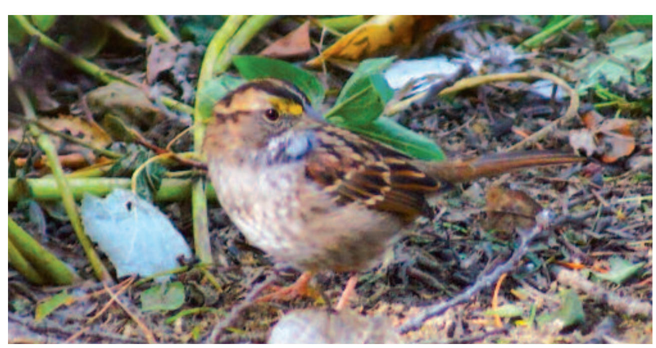


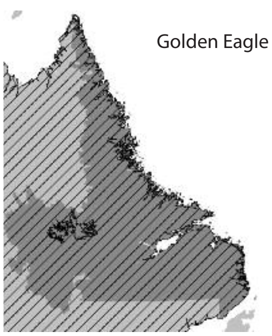


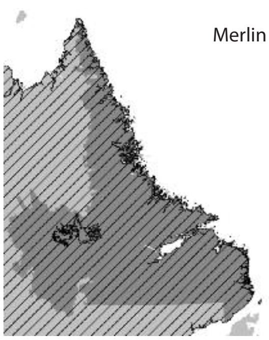
Ruby-crowned Kinglet. Dave Brown
Fox Sparrow. Lorraine Cooper
Common Redpoll. Darroch Whitaker
Hermit Thrush. Ann Brokelman
Snow Bunting. Ann Brokelman
White-throated Sparrow. Lorraine Cooper

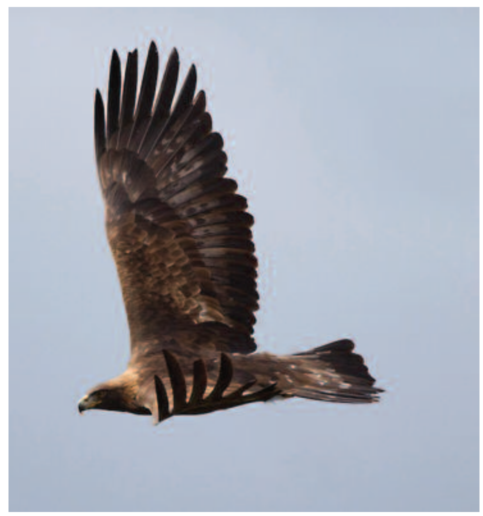












Bald Eagle. Saul Bocian
Boreal Owl. Ann Brokelman
Osprey. Ann Brokelman
Golden Eagle. Ann Brokelman
Merlin. Jenny Gear

Source of range maps:
Ridgely *et al.* 2007

Black Duck. Darroch Whitaker

WATERFOWL

Arctic Plain and Mountains

Labrador's Arctic supports strong populations of Canada Goose, Greater Scaup, Common Eider, Long-tailed Duck, Red-breasted Merganser, and Harlequin Duck (Harrington 1994). An abundant breeder is the northern race of Common Eider (ssp. *borealis*), which nests colonially on small offshore islands (Lock 1986), including both Galvano Island and Seven Islands IBAs[1], which are part of Torngat Mountains National Park (IBA Canada 2012, Parks Canada 2009). Northern Pintails also breed in northern Labrador, although they are uncommon (Harrington 1994).

Waterfowl use the northern bays and fjords during their summer moulting period. Rafts of 50 to 100 or more Black Duck can be seen in coastal areas at this time, particularly from Saglek south. White-winged, Black, and Surf Scoter as well as Common Goldeneye also make use of northern coastal habitats during moulting. A small population of King Eider has consistently over-wintered in the open waters around Killiniq Island (Harrington 1994).

Taiga Shield and Boreal Shield

Fifty percent or more of the continental populations of Black Duck, Green-winged Teal, Ring-necked Duck, Greater Scaup, Lesser Scaup, Surf Scoter, Black Scoter, Common Goldeneye, and Common Merganser breed in Canada's boreal and taiga regions (Blancher and Wells 2005). These regions are as rich in wetlands as in forest, and many species of ducks and geese rely on them for breeding. Despite modest breeding densities, the scale and intactness of the landscape makes it important continentally for waterfowl breeding (Lemelin *et al.* 2008).

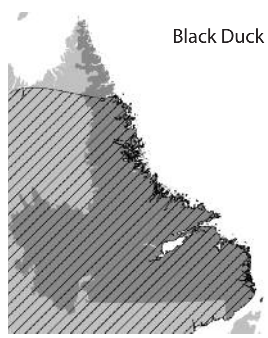
Labrador's coastal and interior wetlands support 19 species of waterfowl. These are dabbling ducks (such as Black Duck, Green-winged Teal, Northern Pintail, and Mallard), diving ducks (such as Greater and Lesser Scaup, and Ring-necked Duck) and sea ducks (such as Red-breasted and Common Merganser, Common and Barrow's Goldeneye, Long-tailed Duck, Harlequin Duck, King and Common Eider (*dresseri* and *borealis*), and Surf, Black and White-winged Scoter). Canada Goose are also present (EHJV 2007, NAWMP 2004). Populations appear stable or on the rise but survey data are largely lacking (Gilliland *et al.* 2008). Breeding densities are low (0.3 IBP/km^2) (EHJV 2007).

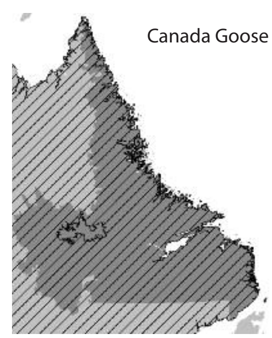
[1] IBA – Important Bird Area: documented sites key for one or more bird species at some stage of their life cycle, see map 1.11.3.

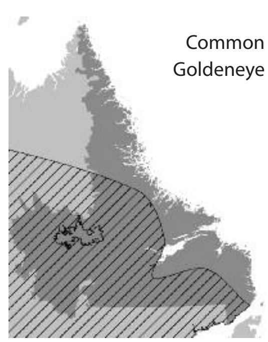
Black Duck and Canada Goose are the most common inland nesting waterfowl, and Green-winged Teal is the most widely distributed dabbling duck in Labrador (EHJV 2007). Greater Scaup may be widespread but occur in lower densities than Lesser Scaup. Common Goldeneye is more numerous in east-central Labrador. Red-breasted Merganser tends to be more common than Common Merganser. Surf Scoter is the most widely distributed of the three scoter species, and occurs at the highest densities (Gilliland *et al.* 2008, 2009).

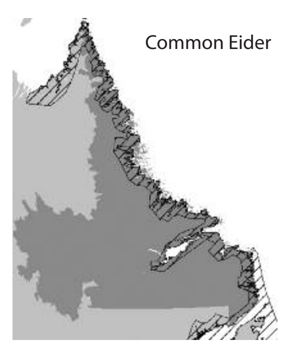
Common Eider is a common coastal nesting species (EHJV 2007), and the Nain Coastline, Table Bay and South Groswater Bay IBAs support at least one percent of the continental breeding population. Eider at the first of these sites is the northern subspecies (*borealis*), while the majority present at the latter two sites are of the Atlantic subspecies (*dresseri)* (IBA Canada 2012). Key moulting sites for Common Eider (*dresseri*) are St. Peter's Bay and Tumbledown Dick and Stag Islands IBAs. St. Peter's Bay is also likely an important breeding site, while the Point Amour IBA is a migratory stopover (Russell and Fifield 2001b,c, IBA Canada 2012). More than 60,000 migrating Common Eider (ssp. *borealis*) have been recorded at Point Amour IBA in the Strait of Belle Isle (IBA Canada 2012).

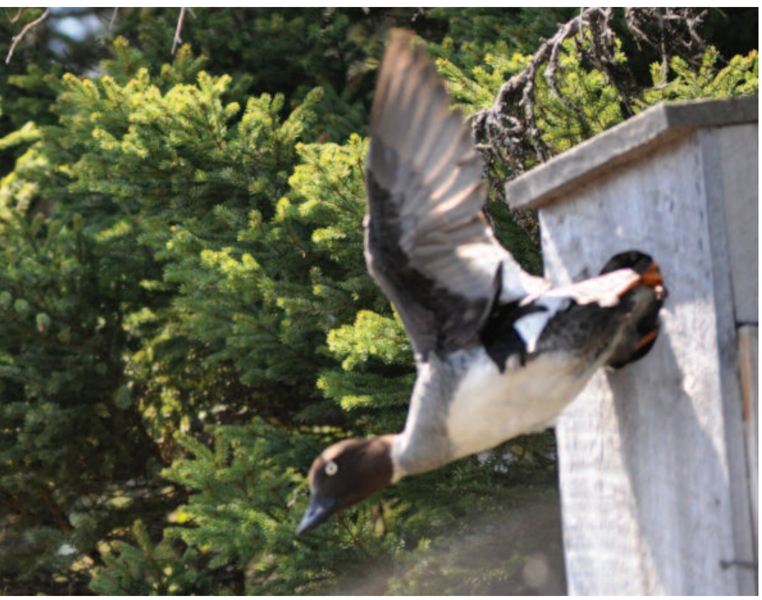
Uncommon nesters are Ring-necked Duck, White-winged Scoter and Black Scoter, Northern Pintail,









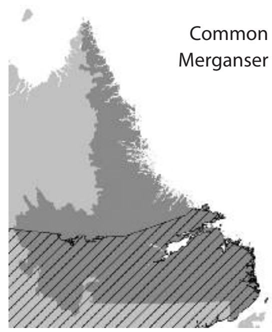


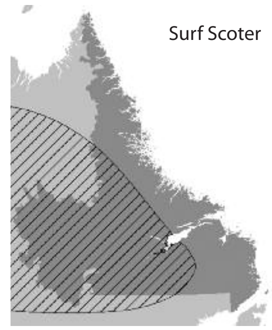
Canada Goose. Darroch Whitaker
Common Goldeneye nest box. Albert Elson
Common Eider. Alain Lusignan

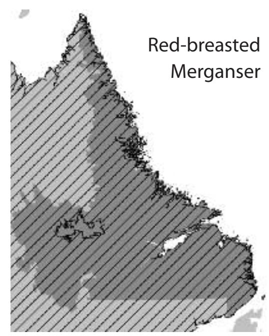
Bufflehead and Hooded Merganser are rarely observed. (Northern Pintail may be more common in west-central Labrador (Gilliland *et al.* 2008, 2009).) Flocks of moulting Harlequin Duck occur around the Gannet Islands Ecological Reserve and IBA and the Tumbledown Dick and Stag Islands IBA, and pre-moult flocks can be found at the Seven Islands Bay, Nain Coastline and St. Peter's Bay IBAs (Russell and Fifield 2001 a,b, IBA Canada 2012).

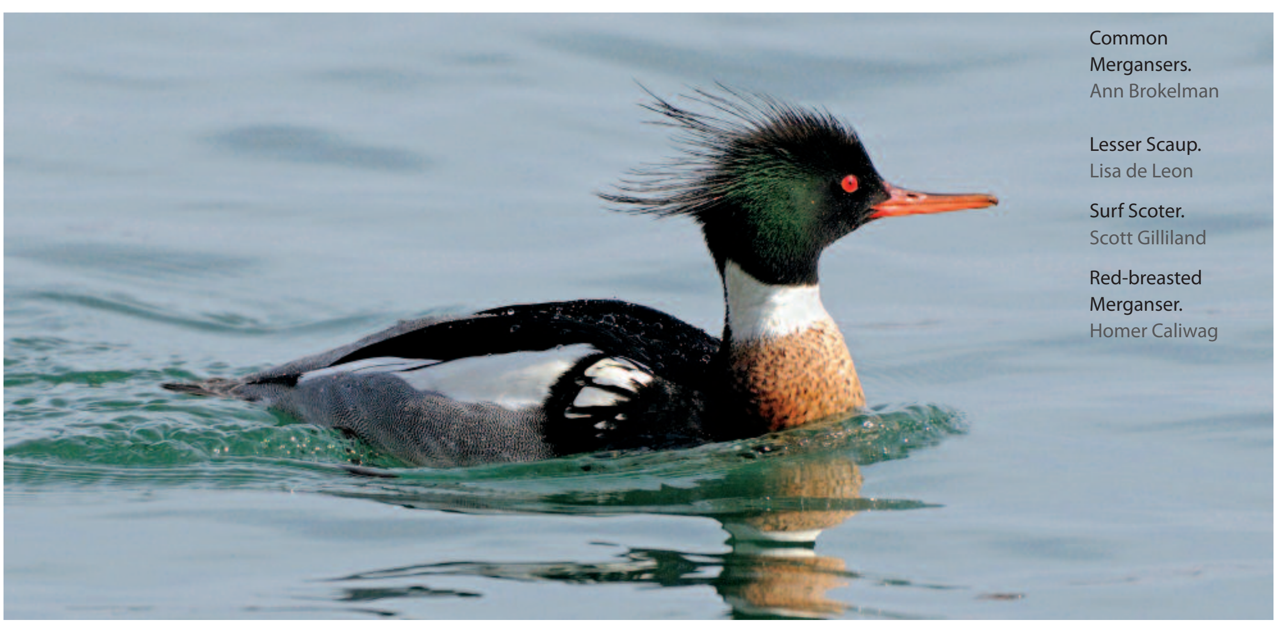
Large, pre-moulting aggregations of Surf Scoter have been observed at The Backway IBA, while Black Scoter use the South Groswater Bay Coastline during this time. Cape Porcupine is a globally significant site for staging and moulting Surf, Black and White-Winged Scoter, primarily Surf Scoter. Other important moulting sites, again chiefly for Surf Scoter, are Nain Coastline and Table Bay (Russell and Fifield 2001a,b, IBA Canada 2012).

The Goose Brook IBA is significant for staging Canada Geese, with more than five percent of the North Atlantic population recorded here (IBA Canada 2012). The waterfowl that over-winter in Labrador's off-shore waters include Black Duck, Common Eider, Long-tailed Duck, and Harlequin Duck (EHJV 2007).







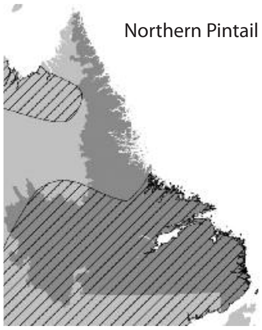


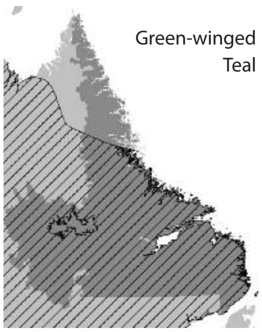
Common Mergansers. Ann Brokelman

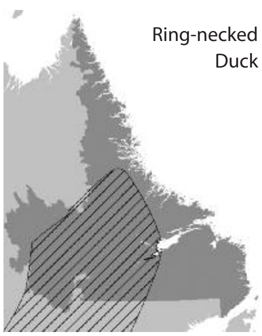
Lesser Scaup. Lisa de Leon

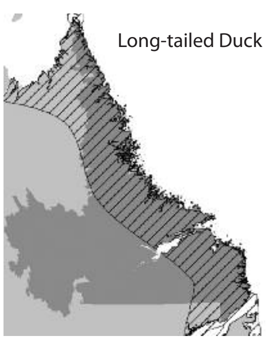
Surf Scoter. Scott Gilliland

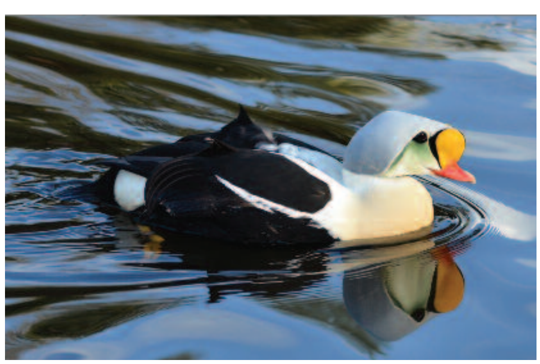
Red-breasted Merganser. Homer Caliwag











Northern Pintail. Darroch Whitaker
Green-winged Teal. Lisa de Leon
Ring-necked Duck. Lisa de Leon
Long-tailed Duck. Ann Brokelman
King Eider. Creative Commons

Data source: Ridgely *et al.* 2007

Red-necked Phalarope. Lisa de Leon

SHOREBIRDS

Arctic Plain and Mountains

Canada's Arctic provides nesting grounds for millions of North American shorebirds, many of which are experiencing continental population declines, possibly due to the loss or degradation of migratory stopovers and habitats in regions where they winter (NABCI Canada 2012).

Shorebirds breeding in northern Labrador include Semipalmated Sandpiper, Least Sandpiper, and Semipalmated Plover (Harrington 1994, Todd 1963, Veitch 1993). Least Sandpiper reaches its northern breeding limit between Koroc River and Ramah Bay, south of which it is a common shorebird on the Labrador coast (Todd 1963). The Red-necked Phalarope has a more extensive and southerly distribution than the Red Phalarope and is a common breeder in northern Labrador (Godfrey 1986). Non-breeding or post-breeding Red Phalaropes are summer visitors (Harrington 1994).

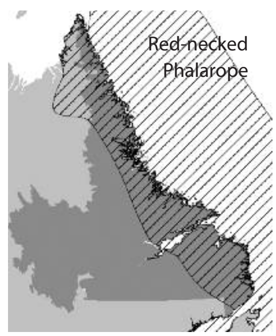
Species that stopover in numbers in northern Labrador during migration include American Golden-Plover, Black-bellied Plover, White-rumped Sandpiper, Purple Sandpiper, and Pectoral Sandpiper (Godfrey 1986, Harrington 1994, Todd 1963, Veitch 1993). Wilson's Snipe and Spotted Sandpiper can also be observed at the limit of their breeding range near the tree-line, as well as Greater Yellowlegs, although its breeding range is farther south (Godfrey 1986).

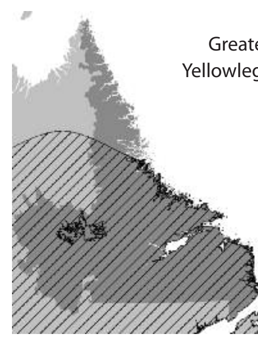
Taiga Shield and Boreal Shield

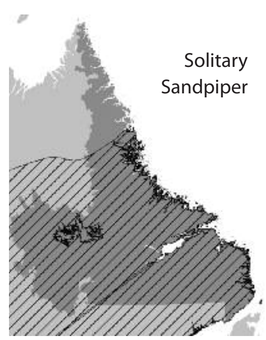
Canada's boreal and taiga support 50 percent or more of North America's breeding populations of Semipalmated Sandpiper, Greater Yellowlegs, Solitary Sandpiper, Spotted Sandpiper, Least Sandpiper, Wilson's Snipe, and Red-necked Phalarope, and nearly 100 percent of the global population of Short-billed Dowitcher (Blancher and Wells 2005). All of these breed in Labrador (ACCDC 2011a). Some of these are declining in population continentally (Donaldson *et al.* 2000), but Labrador trends are not known.

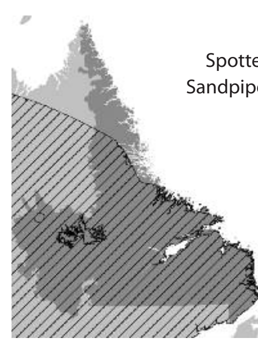
Migrating shorebirds also rely on Labrador wetlands for stop-overs in the fall and spring. Examples include Black-bellied Plover, American Golden-Plover, Sanderling, White-rumped Sandpiper, Pectoral Sandpiper, Purple Sandpiper, Ruddy Turnstone and Dunlin (Blancher and Wells 2005, ACCDC 2011a). Long-distance migrants use coastal staging areas as part of a long chain of habitats for refueling for long journeys south. Such staging areas can be vulnerable to human disturbance (Donaldson *et al.* 2000).

The most significant of the 7 Labrador sites surveyed regularly for shorebirds by the Canadian Wildlife Service is the 40 km-long Porcupine Strand, a stop-over for Semipalmated Plover, Black-bellied Plover, White-rumped Sandpiper, Least Sandpiper, Semipalmated Sandpiper, Dunlin, and Sanderling (EC-CWS 2009). Also notable are coastal sites in southern Labrador with sandy beaches, tidal pools, and intertidal mudflats. Examples include Forteau beach, which attracts foraging Semipalmated Plover, Ruddy Turnstone, Spotted Sandpiper, Greater and Lesser Yellowlegs, White-rumped Sandpiper, Short-billed Dowitcher, and Semipalmated Sandpiper. Greater Yellowlegs and Semipalmated Plover are often found in Cartwright Harbour, while Table Bay is important for Greater Yellowlegs and Spotted Sandpiper (EC-CWS 2009).









Lesser and Greater Yellowlegs. Darroch Whitaker
Solitary Sandpiper. Lisa de Leon
Spotted Sandpiper. Darroch Whitaker

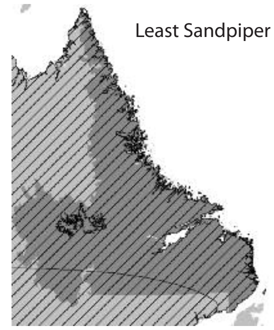
Least Sandpiper. Darroch Whitaker

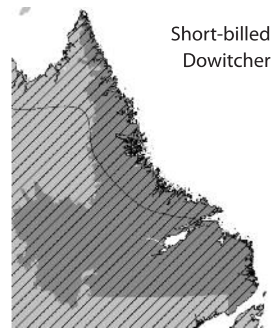
Short-billed Dowitcher. Darroch Whitaker

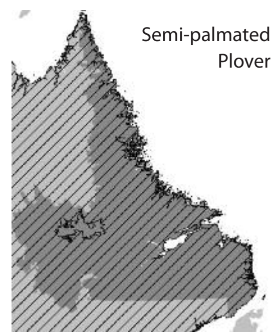
Semi-palmated Plover. Darroch Whitaker

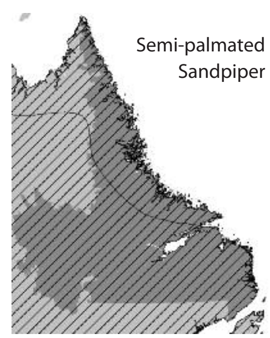
Semi-palmated Sandpiper. Darroch Whitaker

Wilson's Snipe. Saul Bocian









Great Black-backed Gull. Darroch Whitaker
left: Common Tern. Saul Bocian

WATERBIRDS

"Waterbirds" include colonial seabirds (such as auks, murres and puffins), inland colonial nesters (such as gulls, terns and cormorants), and non-colonial nesters (such as loons and bitterns). Some waterbirds congregate in huge colonies, where they can be vulnerable to disturbance and predation. Individual birds can be long-lived and reproduce slowly, so their populations, once reduced, take time to recover. Waterbirds are also vulnerable to oil spills, off-shore oil and gas development, and entanglement in fishing gear. Their food sources can be affected by changes in ocean foodchains due to shifts in commercial fish populations and, perhaps, climate change (Milko *et al.* 2003, NABCI Canada 2012).

Canada supports about 15 million breeding seabirds, as well as millions of migrants, such as shearwaters, which breed in the southern hemisphere and summer in Canada. Fifty percent or more of the continental breeding population of Herring Gull, and Common and Arctic Tern occur in Canada's boreal (Blancher and Wells 2005).

The majority of Labrador's sixteen Important Bird Areas (IBAs) contain continentally or globally significant sites for congregatory species (IBA Canada 2012). Such IBAs regularly support ≥ 1 percent of the North American or global population, or ≥ 20,000 individuals (≥ 10,000 pairs) of one or more waterbirds (BirdLife International n.d.). Six of these, including Bird Islands, Gannet Islands, Northeast Groswater Bay, Quaker Hat Island, Nain Coastline and the Offshore Islands Southeast of Nain, meet these criteria for breeding seabirds (IBA Canada 2012, EC-CWS 2012b).

Colonial seabirds nesting on Labrador's offshore islands include Atlantic Puffin, Razorbill, Common Murre, Thick-billed Murre, and Black Guillemot (IBA Canada 2012, Nettleship and Glenn 1992, EC-CWS 2012b). Other

Common Loon. Saul Bocian
American Bittern. Ann Brokelman
Glaucous Gull. Ann Brokelman
Ring-billed Gull.. Ann Brokelman
Arctic Tern. Darroch Whitaker

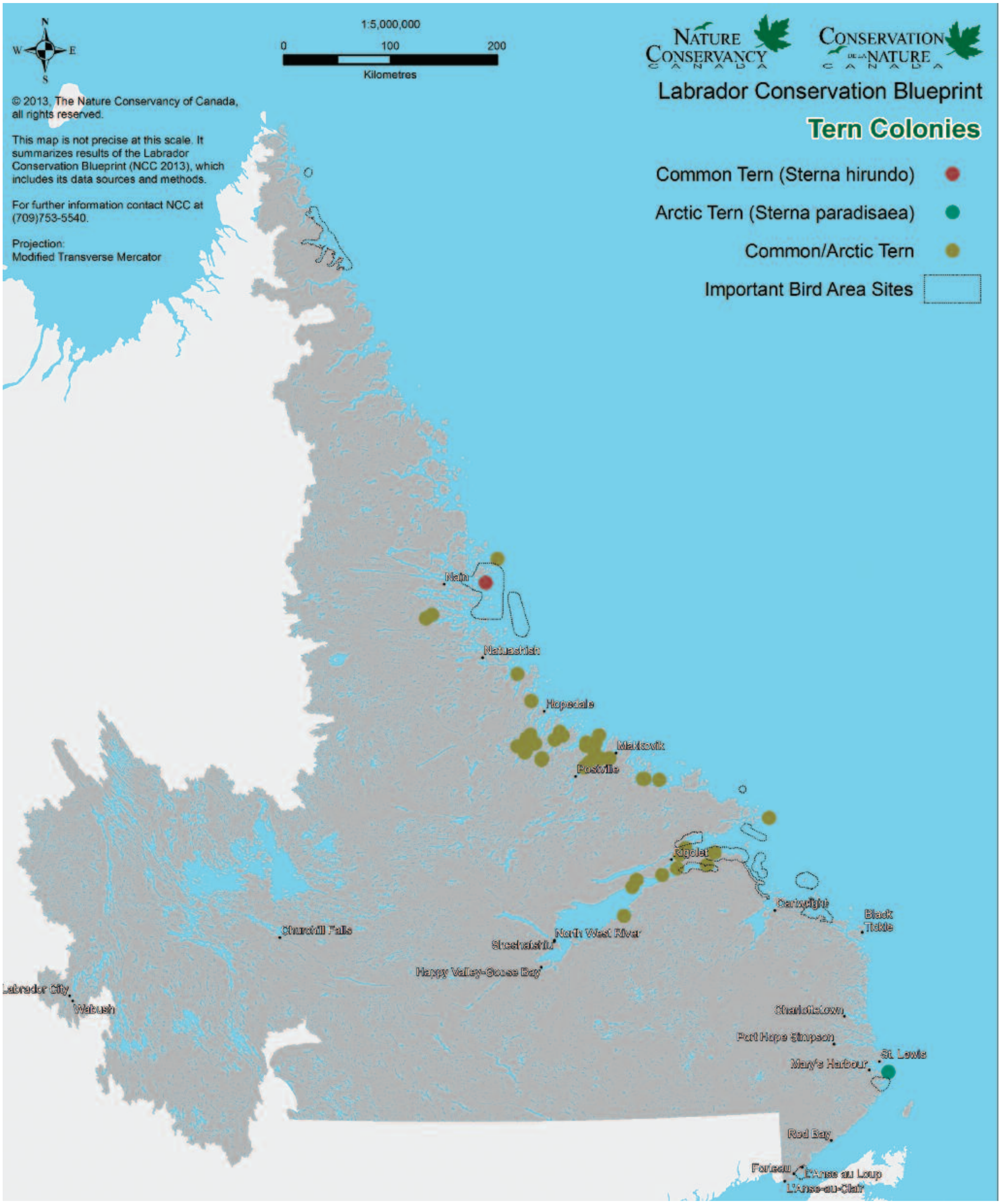
Northern Fulmar. Roy John
Leach's Storm-Petrel. Lisa de Leon
Black-legged Kittiwake. Darroch Whitaker

colonial breeders are Black-legged Kittiwake, Great Black-backed Gull, Glaucous Gull, Herring Gull, Ring-billed Gull, Leach's Storm-Petrel, Northern Fulmar, Double-crested Cormorant, and Arctic and Common Tern (Nettleship and Glenn 1992, EC-CWS 2012b). Breeding colonies for Black-legged Kittiwake include two within the Gannet Islands Ecological Reserve, one within the Quaker Hat Island IBA and one on Red Island. Only three colonies of Leach's Storm Petrel are known in Labrador; one within the Bird Island IBA, one on Gannet Islands, and one on Saint Peter Islands. Documented colonies of Northern Fulmar are within the boundaries of the Gannet Islands Ecological Reserve (EC-CWS 2012b). The Bird Island IBA, Gannet Islands IBA, Northeast Groswater Bay IBA, and the Offshore Islands Southeast of Nain IBA also support breeding Greater Black-backed Gull. Ukallik Island, within the Nain Coastline IBA, supports more than one percent of the continental population of breeding Glaucous Gulls. The Nain Coastline and Offshore Islands Southeast of Nain IBAs are also important for nesting Black-backed and Herring gulls.

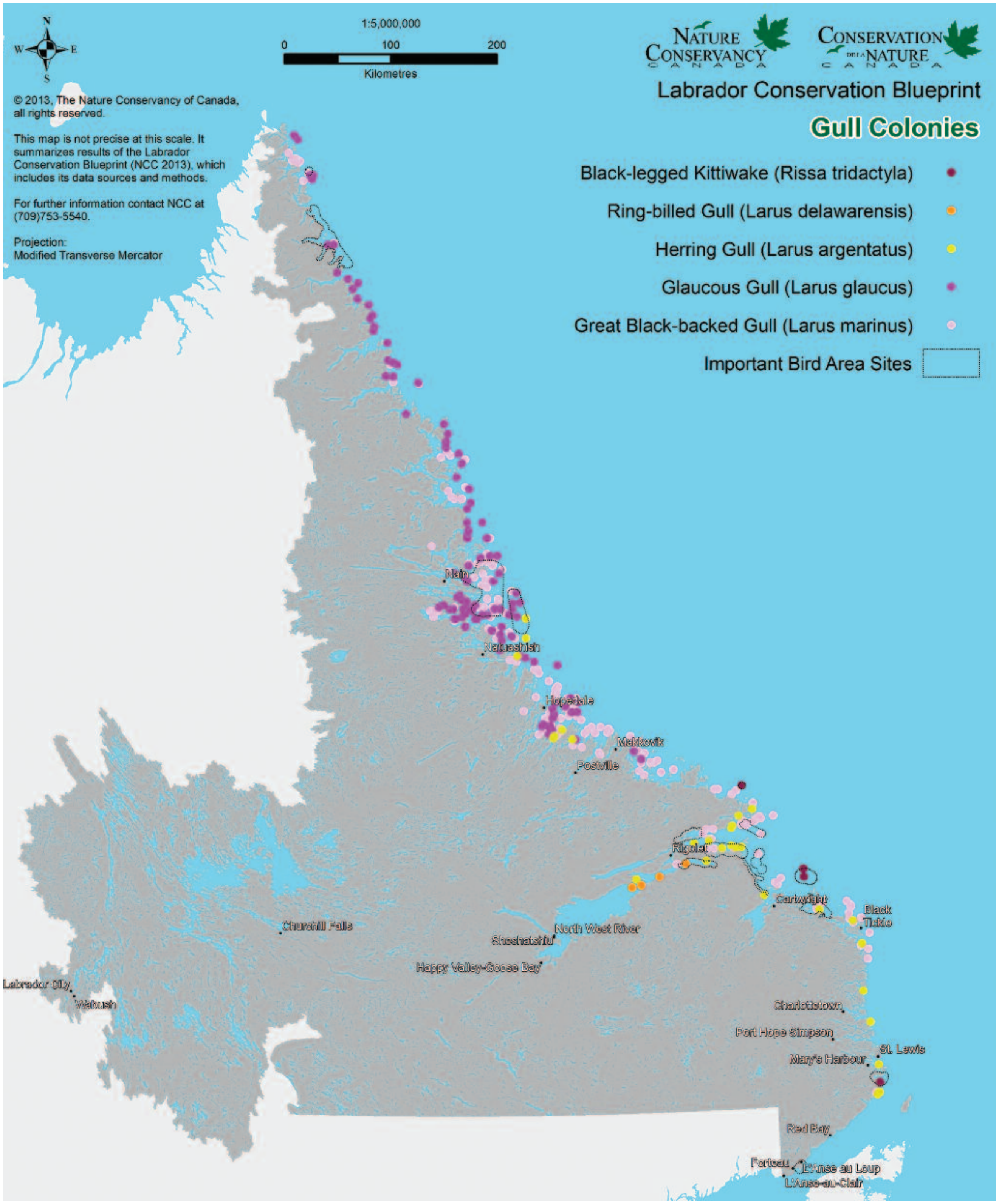
Non-breeding seabirds that frequent Labrador's marine or coastal waters include: Lesser Black-backed Gull, Iceland Gull, Ivory Gull, Long-tailed Jaeger, Pomarine Jaeger, Great Skua, Greater Shearwater, Sooty Shearwater, Manx Shearwater, Wilson's Storm-Petrel, Northern Gannet, and Dovekie (EC-CWS 2011, ACCDC 2011a).

Some waterbirds congregate during moulting, feeding, migration, or wintering (Milko *et al.* 2003). Point Amour IBA in the Strait of Belle Isle has been known to harbour groups of Black-legged Kittiwake in summer and Common Loons during spring migration (IBA Canada 2012).

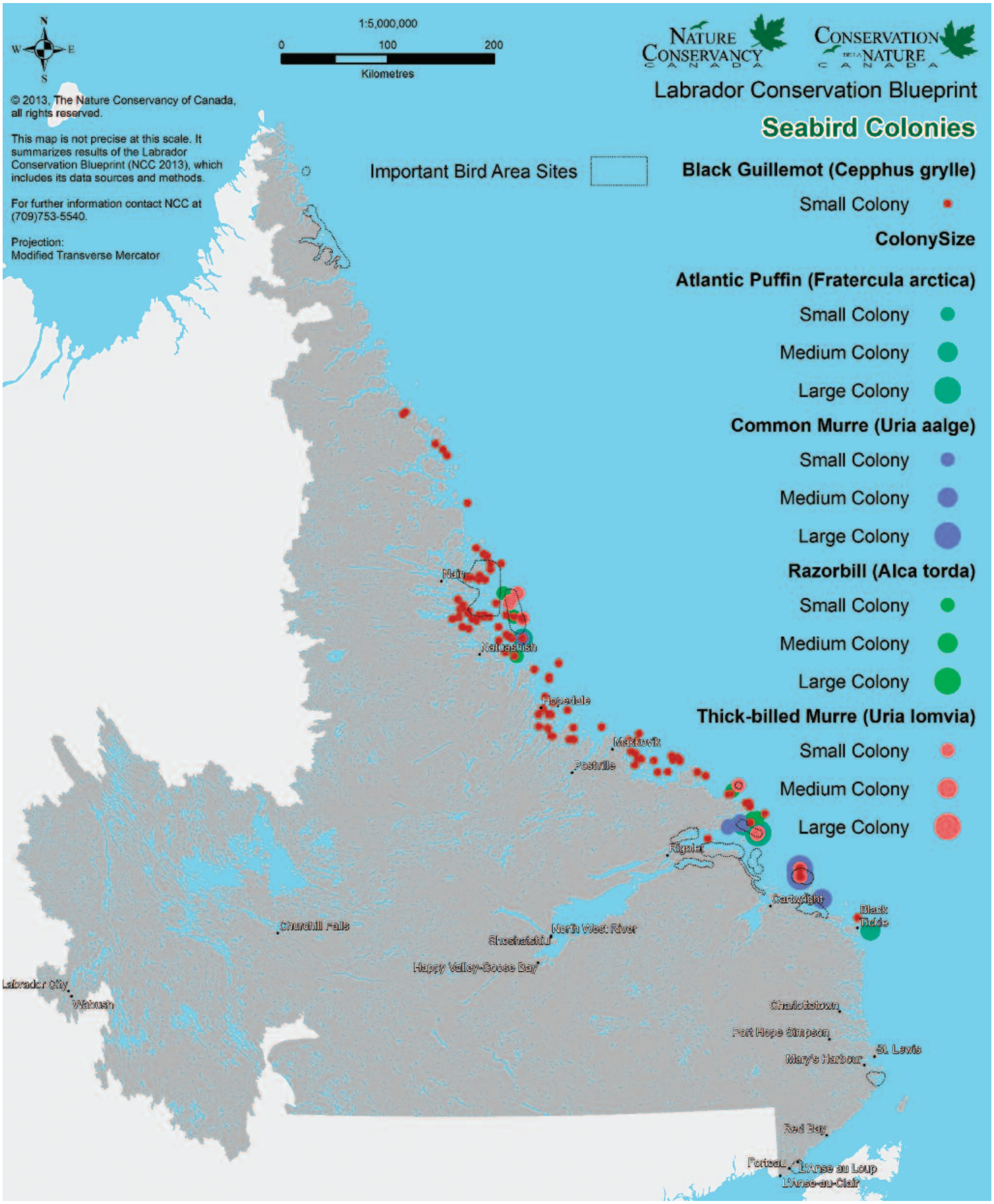
American Bittern, Common Loon and Red-throated Loon are non-colonial aquatic or wetland-dependent breeders present in Labrador (EC-CWS 2011, ACCDC 2011a). One-half or more of North America's breeding Common Loon occurs in the boreal region (Blancher and Wells 2005). North American populations of American Bittern are declining overall (NABCI Canada 2012). They are understudied rangewide (Milko *et al.* 2003), and Labrador is no exception, with a single recorded observation (ACCDC 2011a).



Data sources: EC-CWS 2012b, IBA Canada 2012.



Data sources: EC-CWS 2012b, IBA Canada 2012.



Canada's Atlantic seabird populations have been on the increase since low numbers in the 1970s. During breeding, colonies can be vulnerable to disturbance (Milko *et al.* 2003). They are habitats of conservation interest.
Data sources: EC-CWS 2012b, IBA 2008

Important Bird Areas (IBAs) in Labrador

Bolded IBAs support congregations of breeding seabirds; see map 1.11.3 for IBA locations (IBA 2008).

Bird Islands
Cape Porcupine
Galvano Island
Gannet Islands
Goose Brook
Nain Coastline
Northeast Groswater Bay
Offshore Islands Southeast of Nain
Point Amour, Strait of Belle Isle
Quaker Hat Island
Seven Islands Bay
South Groswater Bay Coastline
St. Peter's Bay
Table Bay
The Backway
Tumbledown Dick and Stag Islands

Atlantic Puffin colony, Groswater Bay.
Canadian Wildlife Service

Atlantic Puffins. Sabina Wilhelm, Canadian Wildlife Service

Atlantic Puffin (*Fratercula arctica*)

Atlantic Puffin are called the "clowns of the sea" for their black-and-white bodies, reddish legs and coloured bills. They excavate burrows on grassy cliffs or nest on islands among rocks and scree. They feed by diving for fish, and overwinter in the Atlantic Ocean (Lowther *et al.* 2002). IBAs important for Atlantic Puffin include:

- Gannet Islands: more than 75,000 birds or 10 percent of the North American population;
- Northeast Groswater Bay: more than 35,000 birds or almost 5 percent of the North American population; and
- Bird Islands: more than 15,000 birds or two percent of the North American population (IBA Canada 2012, EC-CWS 2012b,c).

Another important site is Nunaksuk Island, which has 6,500 breeding birds or about one percent of the North American population (EC-CWS 2012b,c). (18 sites assessed; 6 priority sites identified.)

Razorbill, Thick-billed Murre and Common Murre.
Sabina Wilhelm, Canadian Wildlife Service

Common Murre (*Uria aalge*)

Common Murre are medium-sized auks with black backs and heads, a white underside, and a long pointed bill. They breed in dense colonies on islands, rocky cliffs, and sea stacks. A single egg is incubated on a bare rock ledge on a cliff face. Common Murre winter and feed at sea (Ainley *et al.* 2002). IBAs for Common Murre include:

- Gannet Islands: over 60,000 breeding birds, nearly one percent of the North American population (IBA Canada 2012, EC-CWS 2012b,c).

Other important colonies include the Herring Islands and The Doughboy in northeast Groswater Bay, Quaker Hat Island, Little Bird Island, and Nunaksuk Island (EC-CWS 2012b,c, Russell and Fifield 2001a,b). (16 sites assessed; 2 priority sites identified.)

Razorbill. Neekoh, Creative Commons

Black Guillemot. Darroch Whitaker

Razorbill (*Alca torda*)

A black seabird with a white underside and a thin white line from the eye to the bill, the Razorbill nests on rocky cliffs, on ledges or crevices. They winter on the open sea (Hipfner and Chapdelaine 2002). IBAs for them:

- Gannet Islands: nearly 30,000 birds or 2.5 percent of global population and 39 percent of North American;
- Northeast Groswater Bay: more than 7,500 or greater than 10 percent of North American population;
- Bird Islands: over 3,000 birds or 4 percent of North American population;
- Quaker Hat Island: 900 birds or more than one percent of North American population; and
- Offshore Islands Southeast of Nain: 650 birds or one percent (IBA Canada 2012, EC-CWS 2012b,c, Russell and Fifield 2001a,b).

Smaller colonies that each support nearly one percent of North America's birds include Little Bird Island and western Twin Island (EC-CWS 2012b,c). (24 sites assessed; 9 priority sites identified.)

Thick-billed Murre colony. Canadian Wildlife Service

Black Guillemot (*Cepphus grylle*)

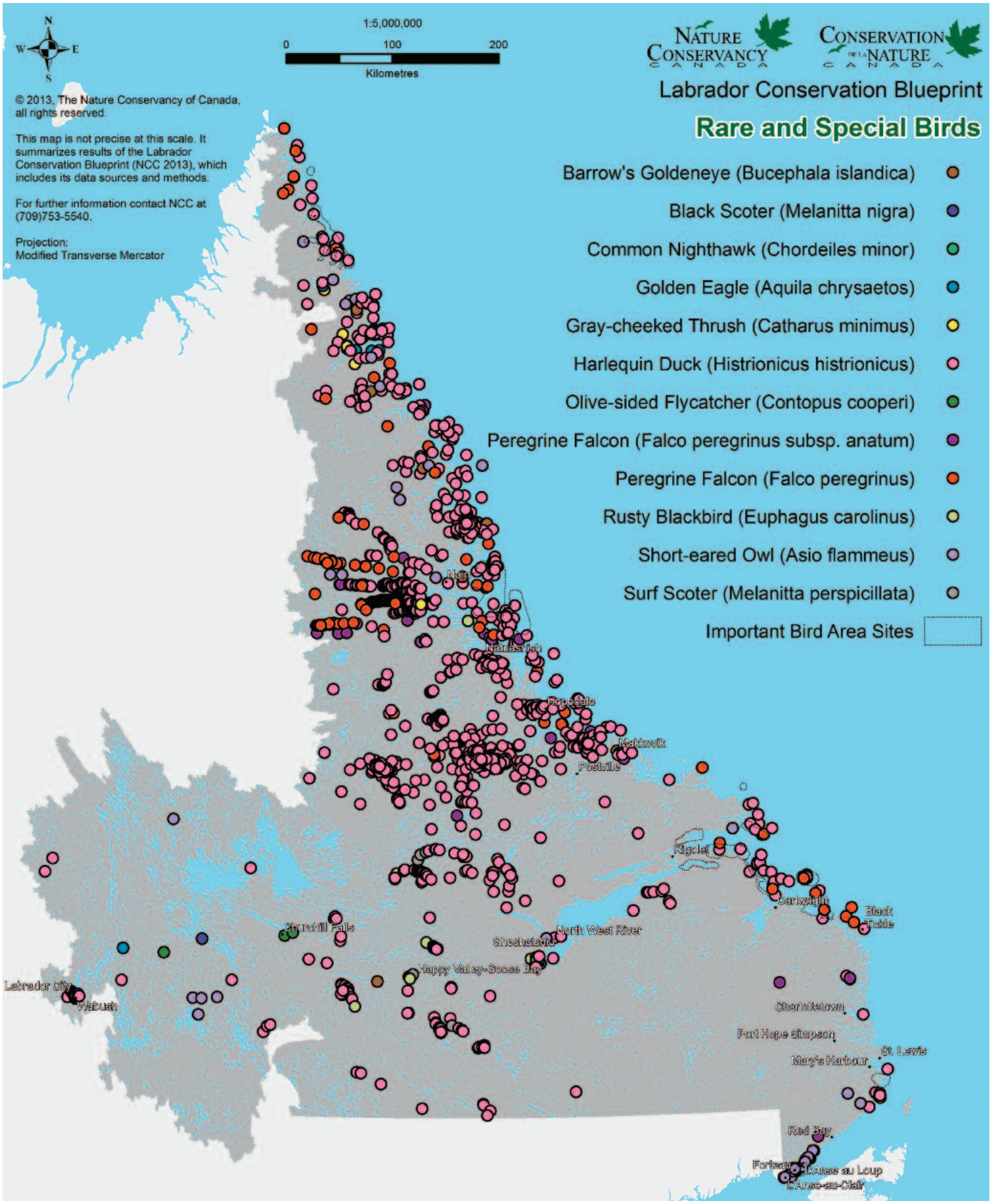
Black Guillemot is medium-sized, with a black body, white wing patches, red legs, and a dark bill. They breed along the north Atlantic on rocky shores, cliffs and islands, in cavities or under overhanging rocks. They breed at lower densities than other seabirds and often overwinter near breeding sites, moving to open waters but not migrating south. Preferred forage areas are near-shore waters (Butler and Buckley 2002).

Important sites include: the Nain coastline (335 birds, 0.2 percent of North American population), and some of the offshore islands southeast of Nain (453 birds, 0.2 percent of North American population). Of particular note are Ukallik, Nuasumak, Imilikiluk, Little Black, Conical, and Ragged Islands (IBA Canada 2012, EC-CWS 2012b,c, Russell and Fifield 2001a). None meet the criteria for IBA designation. (54 sites assessed; 0 priority sites identified.)

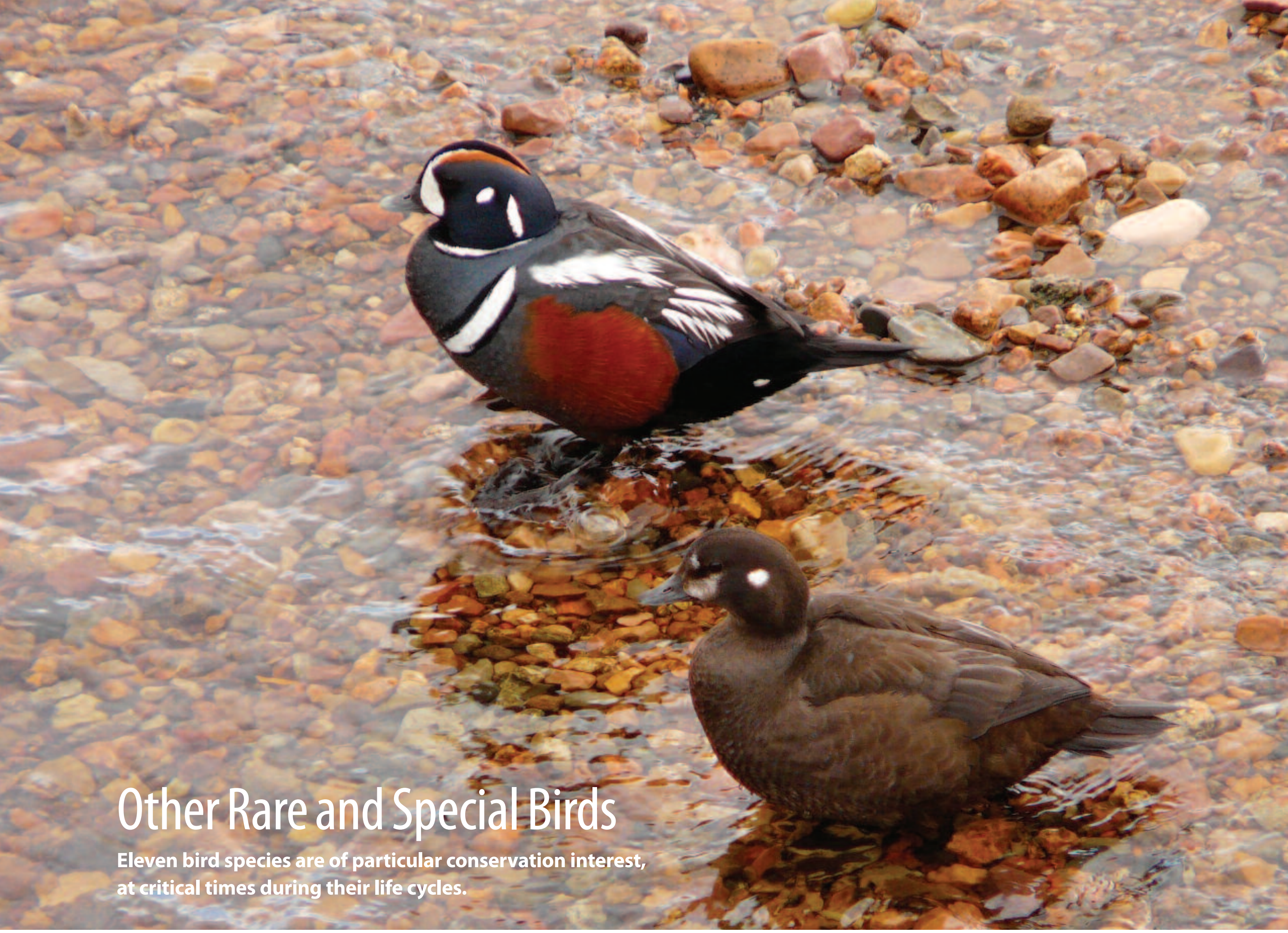
Thick-billed Murre (*Uria lomvia*)

Thick-billed Murre are black, with white underparts and a long bill. They are larger than the Common Murre, with thicker and shorter bills and a white gape stripe. They nest in dense colonies with small territories, less than one square foot per individual. Eggs are laid directly on bare rock, on narrow ledges and steep cliffs facing the water. They move to ice-free waters in the north Atlantic to winter (Gaston and Hipfner 2000).

Areas harbouring near or more than 3,000 breeding Murre (about 0.1 percent of North America's population) include: Gannet Islands; Offshore Islands Southeast of Nain (especially Kidlit – 3,072 birds, and Castle – 3,770 birds); and the Pyramid Islands east of Nain (IBA Canada 2012, EC-CWS 2012b,c, Russell and Fifield 2001a,b). None meet the criteria for IBA designation. (9 sites assessed; 0 priority sites identified.)



Data source: ACCDC 2011a



Other Rare and Special Birds

Eleven bird species are of particular conservation interest, at critical times during their life cycles.

Male and female Harlequin Duck. Darroch Whitaker

Common Name	Scientific Name	NatureServe Global Rank*	NatureServe Labrador Rank*	Population Status	SARA Status*	COSEWIC Status*	NL ESA Status*
Common Nighthawk	*Chordeiles minor*	G5	S2B	Unknown	TH	TH	TH
Olive-sided Flycatcher	*Contopus cooperi*	G4	S2/3B	Unknown	TH	TH	TH
Short-eared Owl	*Asio flammeus*	G5	S3/4B	Unknown	SC	SC	VU
Barrow's Goldeneye (Moulting & Staging)	*Bucephala islandica*	G5	S2/3B	Unknown	SC	SC	VU
Rusty Blackbird	*Euphagus carolinus*	G4	S3/4B	Unknown	SC	SC	VU
Peregrine Falcon	*Falco peregrinus* ssp. *anatum* and *tundrius*	G4T4	S3B	Unknown	SC	SC	VUL
Harlequin Duck	*Histrionicus histrionicus*	G4T4	S4B	Unknown	SC	SC	VU
Gray-cheeked Thrush	*Catharus minimum*	G5	S4B	Unknown	SC	SC	VU
Surf Scoter	*Melanitta perspicillata*	G5	S5b	Declining			
Black Scoter	*Melanitta nigra*	G5	S2/3B, S3M	Declining			
White-winged Scoter	*Melanitta fusca*	G5	TBD	Declining			

* For definitions and sources, see page 28.

Common Nighthawk (*Chordeiles minor*)

The Common Nighthawk is a medium-sized bird with brown plumage mottled with black, white and buff. It is an insectivore that feeds primarily at dusk and dawn (COSEWIC 2007a). Predominantly a southern bird, declines are also evident in northern populations, possibly related to declines in insect numbers (COSEWIC 2007a, Todd 1963). Common Nighthawk use varied breeding habitats, including conifer and mixedwood forests, woodlands, forest clearings and old burns, rock barrens, beaches, shores, and sand dunes. They are highly territorial, and females exhibit fidelity to nest sites. Average home range size is roughly 28.3 hectares (COSEWIC 2007a). (ACCDC 2011a: 4 records; 0 populations assessed.)

Common Nighthawk. Gavin Schaefer, Creative Commons

Harlequin Duck (*Histrionicus histrionicus*)

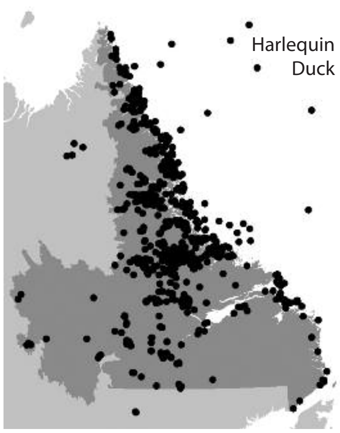
The Innu refer to the Harlequin Duck as Nutshipaushtukueshish, meaning 'duck that lives with rapids,' based on their preference for fast-flowing waters. Potential breeding habitat consists of rapids interspersed with pools, narrow rivers, and inlets of lakes and bays (Todd 1963, Trimper *et al.* 2008). A significant part of the breeding range of eastern Canada's population of Harlequin Duck occurs in Labrador (*ibid.*), with its primary breeding distribution extending from Hamilton Inlet to Nachvak fjord (Goudie *et al.* 1994). When waters open up, pairs move upstream from coastal staging areas or arrive from wintering areas (Trimper *et al.* 2008).

An estimated 395 breeding pairs have been confirmed along Labrador rivers (southern Labrador - 5, Hamilton Inlet - 130, Makkovik/Davis Inlet - 135, Nain/Okak - 100, Saglek/Cape Chidley - 25) (Chubbs *et al.* 2001, Trimper *et al.* 2008). Population numbers appear to be stable or increasing (Trimper *et al.* 2008).

In Southern Labrador, observations have been made along the St. Paul's River, in the headwaters of the Eagle River, and at Muskrat and Parke Lakes. In Hamilton Inlet, breeding is known on the Fig River (Trimper *et al.* 2008). Sightings have also been reported from Cape Caribou River, English River and Double Brook (Dawson and Finney 1985), and nests are known from Shipiskan Lake (JWEL 2003), Adlatok/Udjoktok River (JWEL 1997a; VBNC 1997), and Big River (Trimper *et al.* 2008). In the north, nesting occurs on Reid Brook (Chubbs *et al.* 2000), Ikadlivik, Kangeklualuk, Koglukokoluk, Makhavinekh, Zoar (JWEL 1997a; VBNC 1997; Heath 2001; Thomas 2006), Hebron Fjord and tributaries, Saglek Fjord, Ikarut River, Qamanialuk, Harlequin Brook, and North Freytag Brook (Dawson and Finney 1985, Goudie *et al.* 1994, Rodway *et al.* 1998, Veitch 1992). Harlequin show high degrees of site fidelity, with pairs returning to the same area, often within 100 m, over successive years (Trimper *et al.* 2008).

Labrador's coastline has several important moulting and staging sites for Harlequin Duck (Trimper *et al.* 2008). Moult locations are known from southern Labrador (Gilliland *et al.* 2002), while northern concentrations may indicate critical staging areas (Brodeur *et al.* 2002, Chubbs *et al.* 2008, Robert *et al.* 2008). Aggregations of these ducks have been sighted along the coast in the Nain-Okak Region (IBAs), where birds are thought to be staging prior to departing for moulting areas in Greenland (Chubbs *et al.* 2008, Gilliland *et al.* 2002, Trimper *et al.* 2008).

The most significant moulting site is in the vicinity of the Gannet Islands Ecological Reserve and IBA, with up to 248 moulting males recorded (Adams *et al.* 2000, Gilliland *et al.* 2002). Tumbledown Dick and Stag Islands support approximately 60 and 50 moulting birds respectively (Gilliland *et al.* 2002, IBA Canada 2012). Moulting

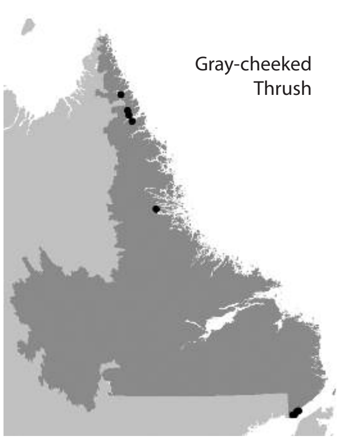


ducks have also been observed at the Herring Islands, Tinker Island, Little East Puffin Island and Sardine Island (Brodeur *et al.* 2002, Robertson *et al.* 2002), which form part of the Northeast Groswater Bay IBA (IBA Canada 2012). The St. Peter's Bay IBA is another traditional moulting area for Harlequin Ducks with groups between 30 and 72 individuals having been observed (Gilliland *et al.* 2002, IBA Canada 2012). (ACCDC 2011a: 2634 records; 0 populations assessed.)

Gray-cheeked Thrush. Marcel Gahbauer, McGill Bird Observatory

Gray-cheeked Thrush (*Catharus minimus*)

The Gray-cheeked Thrush breeds in boreal forests from Alaska to Labrador. It occurs widely in Labrador, south of Hebron Fjord (Todd 1963, Godfrey 1986, Lowther *et al.* 2001, Dalley *et al.* 2005), and in mature conifer stands and wooded valleys north of Hamilton Inlet (Dalley *et al.* 2005, Lowther *et al.* 2001, Todd 1963). It is a secretive bird, nesting close to the ground in well spaced territories, and little is known about it in Labrador (Dalley *et al.* 2005). It may be declining across Canada (Downes and Collins 2003). (ACCDC 2011a: 11 records; 0 populations assessed.)



Short-eared Owl. Ann Brokelman

Short-eared Owl (*Asio flammeus*)

The Short-eared Owl has a large round head, yellow eyes, and inconspicuous "ear" tufts. They fly low, hunting over open habitats, and hunt intensively at dawn and dusk (COSEWIC 2008, Schmelzer 2005). Eleven individuals were recorded in NL during deliberate surveys in 2003, and the species has probably always been uncommon to rare in Labrador (Schmelzer 2005). They prefer open habitats such as those abundant along the south coast, and above the treeline, where there are high densities of small mammals (COSEWIC 2008, Schmelzer 2005). Nests are built on the ground, and consist of flattened grasses or other vegetation (Schmelzer 2005:2). Important areas in Labrador include the coastal barrens between L'Anse au Clair and Red Bay, Hebron, Little Ramah Bay, Nachvak and Kangerdluksoak Fjords (Harrington 1994, Schmelzer 2005). Nests have also been reported at Okak, in the Nain area including Port Manvers Run, Davis Inlet, and Hopedale (Schmelzer 2005). (ACCDC 2011a: 56 records; 0 populations assessed.)

Rusty Blackbird (*Euphagus carolinus*)

The Rusty Blackbird is dark, with pale yellow eyes and a black curved bill. Adult males are black with a green sheen, and purple gloss on head and neck, and females are brownish-grey without gloss. Rusty Blackbirds occur in all Canadian provinces and territories and, in Labrador, Davis Inlet is the northern limit of its breeding range (COSEWIC 2006a). Data indicate Rusty Blackbird populations have declined in general over the last 40 years, but Labrador trends are as yet undocumented (*ibid.*). (ACC DC 2011a: 25 records; 0 populations assessed.)

Rusty Blackbird. Ann Brokelman, Barrow's Goldeneye. Creative Commons

Barrow's Goldeneye (*Bucephala islandica*) (moulting & staging)

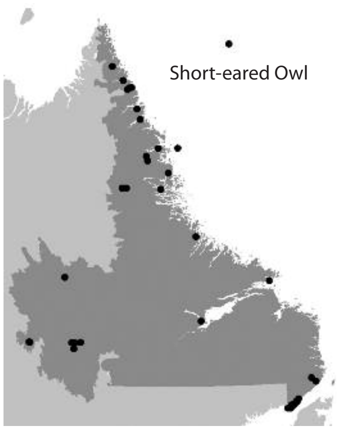
Barrow's Goldeneye is a diving duck with a short neck, large round head, yellow eyes, and a small grey bill. Breeding males are boldly coloured (above), and females have a dark brown head and greyish-brown back. The eastern population of Barrow's Goldeneye is centred in Québec where they breed near small lakes at high elevations, nesting in tree cavities (COSEWIC 2000, Godfrey 1986, Robert *et al.* 2000, 2002). Their breeding status in Labrador remains unclear. Pairs have been observed at Gosling Lake, Winokapau Lake, and in the Goose and Churchill River and their tributaries during breeding season, and in northern Labrador at Okak Bay (Schmelzer 2006b).

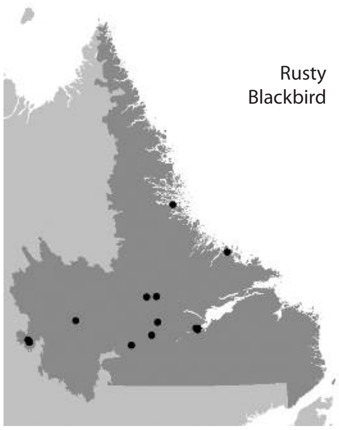
Adult male birds travel north to moult after breeding, in Labrador in inlets and bays between 58˚N and 60˚N from Nain Bay to north of Nachvak Fjord, including Rowsell Harbour, Ramah Bay, Little Ramah Bay, and Hebron Fjord (Harrington 1994, Todd 1963, Robert *et al.* 2000, 2002). (ACCDC 2011a: 9 records; 0 populations assessed.)

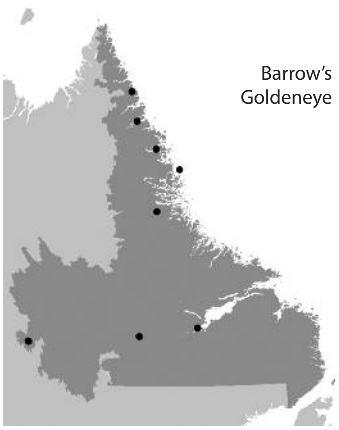
Peregrine Falcon (*Falco peregrinus* ssp. *anatum/tundrius*)

The Peregrine Falcon is a crow-sized bird of prey with long, pointed wings. Two subspecies — *anatum* and *tundrius* — are recognized. The *tundrius* birds tend to be smaller and paler in colour, and *anatum* birds have an or ange or brownish tinge to underparts. Both subspecies are treated as a single unit by COSEWIC (2007b).

Peregrine Falcons inhabit a range of habitats from Arctic tundra to coastal shores (COSEWIC 2007b). In Labrador, preferred nesting sites are ledges on cliffs between 50 and 200 m in height and up to several kilometers long (Holroyd and Banasch 2012). At the landscape scale, suitable nest sites are patchily distributed but may be locally common. Breeding sites are selected based on access to sufficient food resources. Peregrine Falcons are aerial hunters that dive on other birds primarily, including shorebirds, waterfowl, woodpeckers, jays, thrushes, Ptarmigan, and Longspur and Snow Bunting, and also consume bats, small mammals, and rarely, insects, and







Peregrine Falcon, Table Bay, Peregrine chicks, Peregrine in flight. Geoff Goodyear

fish. In Labrador, nesting female falcons favour colonial seabirds, particularly Black Guillemots, where they nest in close proximity to falcon nests. Peregrines have been observed carrying birds, lemmings and deer mice to nest sites (*ibid.*)

Peregrines show a high degree of nest site fidelity and will often re-use nest sites for several successive seasons. Alternate sites may also be selected on the same cliff or other cliffs within a pair's territory, and birds may re-occupy sites that have been vacant for many years. In Labrador, at least one nest site has been occupied for up to 145 years, although not necessarily continuously (COSEWIC 2007b). Peregrine Falcons occupied at least 28 sites in Labrador in 2005, 18 of which were occupied by territorial pairs. Twenty-two of these sites occur on the coast, while only 6 occur inland along rivers and lakes. Coastal areas may be preferentially selected due to the moderating effect of the maritime climate, or access to food (COSEWIC 2007b, Holroyd and Banasch 2012).

Ten percent of known nest sites occur within the Torngat Mountains National Park and 31 percent on Labrador Inuit Lands (LIL) (COSEWIC 2007b). Peregrine Falcons of the *tundrius* subspecies nest on islands within the Nain Coastline IBA, while birds of the *anatum* subspecies use Devil's Lookout Island, in the southern portion of Table Bay, and Bird Islands (Russell and Fifield 2001b, IBA Canada 2012).

The minimum population of Peregrine Falcon in Canada in 2005 was 1168 mature individuals (969 *anatum* and 199 *tundrius*) (COSEWIC 2007b). Low average productivity per attempt-to-nest may be a concern in Labrador (Holroyd and Banasch 2012). (ACCDC 2011a: 212 records; 0 populations assessed.)

Olive-sided Flycatcher (*Contopus cooperi*)

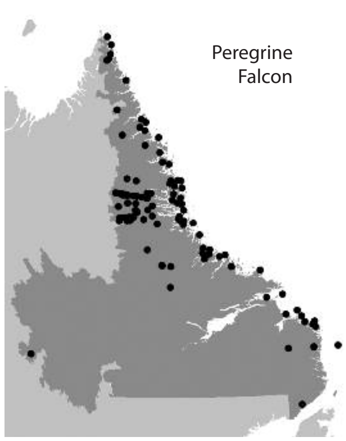
Olive-sided Flycatcher is a brownish olive-grey colour with a white breast and belly. More than half of the breeding range is in Canada, generally at low densities, but in large numbers (est. 450,000 breeding adults; COSEWIC 2007c). They prefer open habitat with tall trees or snags, from which they feed on insects. They also use areas that have been burned. Black Spruce and Tamarack near wetlands or water are preferred for nesting. Females can have strong nest site fidelity (COSEWIC 2007c). The Canadian population is declining, for reasons that may relate to declines in other insectivores as well in recent years (COSEWIC 2007c). (ACCDC 2011a: 4 records; 0 populations assessed.)

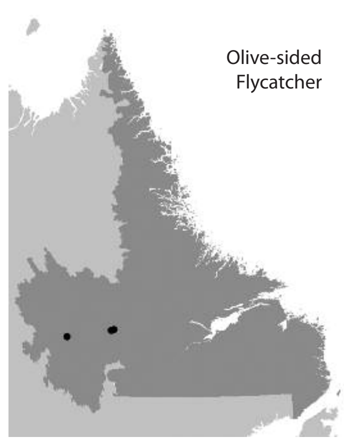
Olive-sided Flycatcher. Jean Iron
Surf Scoter. Alan D. Wilson, Creative Commons

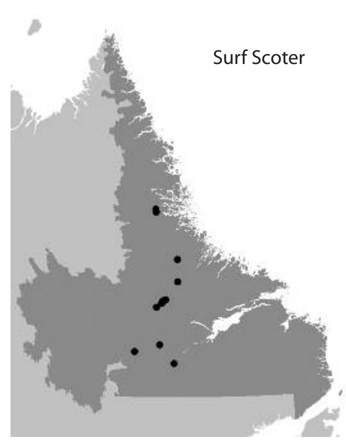
Surf Scoter (*Melanitta perspicillata*)

Surf Scoters breed in Canada's boreal forest and winter along its ocean coasts. Western scoters are declining in numbers (DUC and DUI 2006) but population trends are not known for eastern scoters (Bordage and Savard 1995, Gilliland *et al.* 2008, Savard *et al.* 1998). In 2008-2009, surveys undertaken in the Low-level Flight Training Area (LLTA) in central Labrador showed Surf Scoter pairs generally well-spaced on breeding grounds, and recent density estimates averaged 17.8 to 23.2 pairs/ 100km^2 (Gilliland *et al.* 2009). They appeared to breed in higher densities in open wetlands in areas such as the Kanairiktok River watershed, and south of the Naskaupi and north of the Red Wine rivers (Gilliland *et al.* 2008, Gilliland *et al.* 2009).

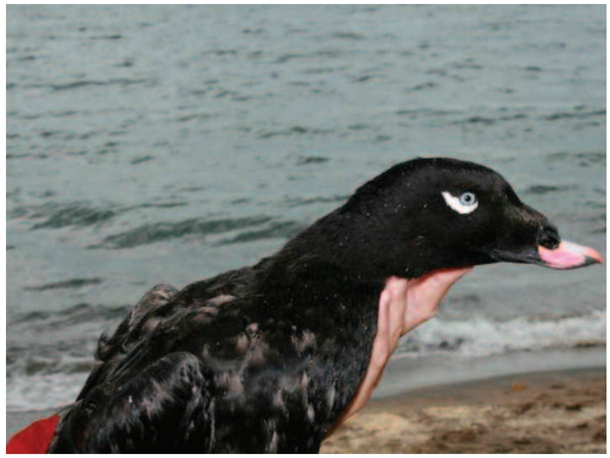
Adult males form large moulting flocks on the coast (*ibid.*, DUC and DUI 2006, IBA Canada 2012). IBAs known for their staging and moulting scoters include the Nain Coastline, The Backway, Cape Porcupine, and Table Bay. Up to 12,500 scoters have been observed in the first of these, representing one percent of the global population. The largest moulting flock recorded in eastern Canada –between 26,070 and 34,740 individuals – was in the vicinity of The Backway IBA, 3 percent of the global population. More than 10,000 individuals have been recorded near Cape Porcupine and nearly 5,000 moulting scoters on the southern Porcupine Strand to Trunmore Bay. Table Bay has been used by up to 1,500 moulting scoters (IBA Canada 2012). (ACCDC 2011a: 10 records; 0 populations assessed.)







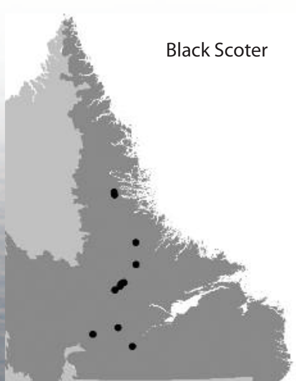
Black Scoter. Scott Gilliland



White-winged Scoter. Scott Gilliland

Black Scoter (*Melanitta nigra*)

Black Scoter has a remote, limited distribution. Its eastern population breeds mostly in the boreal forests of Quebec and Labrador, and winters along the Atlantic coast (DUC and DUI 2006). Little is known about the breeding behaviour or habitat requirements of this species. They tend to select relatively small lakes with rocky substrates and little vegetation, surrounded by dense shrub cover (DUC and DUI 2006). Breeding Black Scoters were identified during surveys of the LLTA in 2008 and 2009, although Black and White-winged Scoters are scarcer than Surf Scoter (Gilliland *et al.* 2008, 2009). Moulting Black Scoters have been reported from the Nain Coastline, The Backway, Cape Porcupine, and Table Bay IBAs, sites also known for their importance to moulting Surf Scoters. In 1980, over 1,500 moulting Black Scoters were observed in the South Groswater Bay Coastline IBA, roughly 1 percent of the eastern North American population (IBA Canada 2012). (ACCDC 2011a: 2 records; 0 populations assessed.)



White-winged Scoter (*Melanitta fusca*)

White-winged Scoter is the largest North American scoter. They breed, moult and winter in isolated areas and little is known of their ecology. Some data suggest long-term population declines across their boreal breeding range (DUC and DUI 2006). Their preferred breeding habitat is large freshwater or brackish lakes with abundant submerged vegetation and sandy substrates, and females are known to return to the same area year after year to nest (*ibid.*). In Labrador, breeding White-winged Scoter were only observed on 8 out of 62 plots in the LLTA surveys in 2008 and 2009. (Their distribution was weakly correlated with that of Lesser and Greater Scaup (Gilliland *et al.* 2008).)

Moulting White-winged Scoter are reported from the Nain Coastline, The Backway, Cape Porcupine, and Table Bay IBAs, sites also important for moulting Surf Scoter (IBA Canada 2012). They winter in shallow, inshore waters of bays, estuaries and sheltered coastlines (DUC and DUI 2006). (ACCDC 2011a, 0 records, 0 populations assessed.)

Surf Scoters and Harlequin Duck. Juliana Coffey

Arctic Char. Darroch Whitaker

1.3.3 Freshwater Fish

Globally, freshwater species and habitats are increasingly imperiled (McAllister *et al*. 1997, Ricciardi and Rasmussen 1999). More than a third of freshwater fish populations are at risk of extinction (IUCN 2009). The undisturbed, free-flowing rivers of Canada's boreal serve as last refuges for sea-run migratory fish like the Atlantic Salmon, Arctic Char, and sea-run Brook Trout, and represent unique opportunities for conservation (Abell 2002, PEG 2011).

A total of 25 freshwater spawning fish, and one freshwater species that spawns in marine waters (catadromous), occur in Labrador. These include Atlantic Salmon, Arctic Char, Brook Trout, Lake Trout, Northern Pike, Burbot, Lake Whitefish, Round Whitefish, Rainbow Smelt, Lake Chub, Longnose Dace, Longnose Sucker, White Sucker, American Eel, Threespine Stickleback, Ninespine Stickleback, Mottled Sculpin and Slimy Sculpin (Black *et al.* 1986).

Unbroken by dams and unaltered by pollutants or invasive species, Labrador rivers provide hundreds of thousands of kilometres of spawning habitat for freshwater fish (Scott and Crossman 1973, PEG 2011). Local communities depend on small-scale fisheries, while commercial sport fishing attracts tourists from around the world. Labrador fish are famed for their abundance and size but northern fish grow slowly due to the cold temperatures and lower productivity of lakes and rivers. Thus, very large fish occurring in these waters also tend to be old fish (Browne 2007). The low ecological productivity of freshwater habitats and skewed age distributions make fish populations vulnerable to intensive fishing pressure and other human disturbances (PEG 2011).

The conservation of freshwater biodiversity also relates to the management of adjacent landscapes. For example, what amount of land in a catchment should remain intact and how much of it? Abell (2002) suggests that conservation focus on the watersheds of un-impounded rivers, which is the condition of the vast majority of Labrador's watersheds. A further conservation focus should be on those aquatic systems supporting the full range of fish

top: Land-locked Arctic Char, bottom: Brook Trout. Lorraine Cooper

and fish habitats in Labrador and, to this end, Abell (2002) suggests an emphasis on relative biodiversity value, with catchments supporting higher numbers of species being priorities over those with lower overall diversity. Few of Labrador's waterways have been developed, and there is only a cursory inventory of the occurrence and distribution of freshwater fish species, or their populations. Much of the available data were collected as part of environmental impact assessments, and there are still large areas where little survey effort has been expended (Perry and Joyce 2003).

In the freshwater realm, focal species for conservation planning are often wide-ranging migratory fish that may be adversely affected if migratory connections are severed. River species that undertake such migrations require access to particular seasonal habitats, such as spawning grounds (Abell 2002). In Labrador, attention has focussed on Atlantic Salmon, Arctic Char, and sea-run Brook Trout. However, there has been little Labrador research into the movements of these species, and little is known about seasonal habitat requirements, or preferred spawning locations. Several northern rivers have been identified as important for spawning Char (LISA Regional Planning Authority 2012). No information is available on important areas for Brook Trout.

Atlantic Salmon (*Salmo salar*)

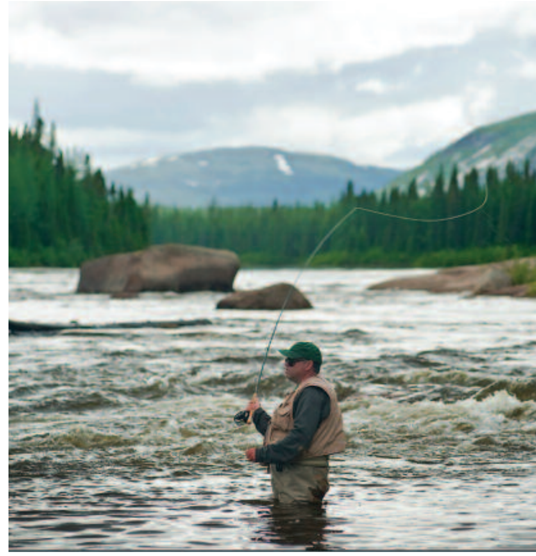
More than half of the remaining rivers supporting healthy populations of Atlantic Salmon are found in Quebec and Newfoundland and Labrador. In contrast, this species has been lost from or is endangered in more than 150 rivers in New England and the Maritime Provinces (PEG 2011, COSEWIC 2010). Salmon require cool, clear, well-oxygenated rivers or streams for spawning. Gradients are generally low to moderate, with gravel, cobble and boulder substrates for reproduction and several years of rearing. Salmon undertake ocean-scale migrations as older juveniles and adults, returning to their natal rivers to spawn with a high degree of fidelity. Eggs are laid in gravel nests, in riffles of streams or groundwater seepages on shoals in lakes. Freshwater habitats along the Labrador coast remain largely pristine. Although abundance data are not available for most rivers in which Salmon spawn, available data suggest population increases (COSEWIC 2010).

Anderson (1985) estimated the total production of adult Salmon for 120 of Labrador's rivers. He also identified complete and partial impediments to fish migration caused by natural barriers such as steep waterfalls. Using this information, we have identified highly productive rivers supporting adult Salmon. This list was cross-referenced with the 28 scheduled Salmon rivers, as well as sites identified as having significant hydroelectric potential, as a kind of "threat" analysis. A gap analysis was also performed to see how many of these occur within existing or proposed protected areas and/or conservation lands (*e.g.*, LISA Land Use Plan). Results are shown in the table opposite.

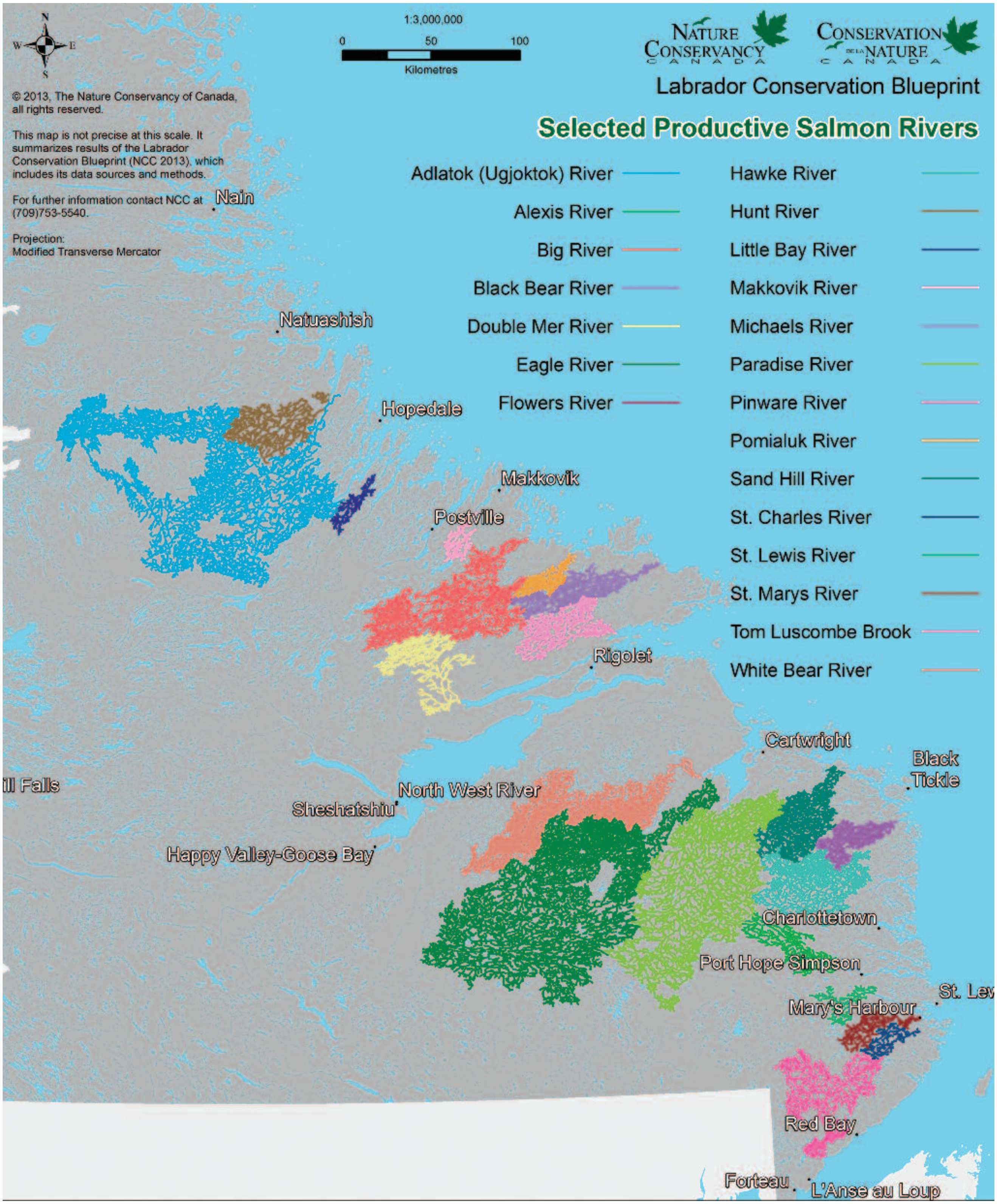
Selected Productive Atlantic Salmon Rivers in Labrador

River name	Estimated production of adult Salmon (Anderson 1985)	Scheduled Salmon River (DFO 2012)	Priority Salmon and Char River (LISA Regional Planning Authority 2012)	Indicated hydroelectric potential (Mw) (Millan 1973)
Adlatok (Ugjoktok)	39,000	Y	Y	
Eagle	33,455	Y	N	983
Paradise	16,928 (240*)	Y	N	292
Pinware	14,007	Y	N	120
Hawke	13,910	Y	N	45
Flowers	8,725	Y	Y	
Hunt	7,397	Y	Y	
White Bear	6,668	Y	N	
Michael's	6,618	Y	Y	
Double Mer	5,851	Y	Y	
Pomiulik	4,465	N	Y	
Sandhill*	4,261	Y	N	
St. Lewis	4,117	Y	N	200
Big	3,264	Y	Y	230
Alexis	2,676	Y	N	143
Black Bear	2,376	Y	N	
St. Mary's	1,958	Y	N	
St. Charles	1,871	Y	N	
Makkovik	1,569	N	Y	
Tom Luscombe Brook	?	Y	Y	
Little Bay	?	Y	Y	

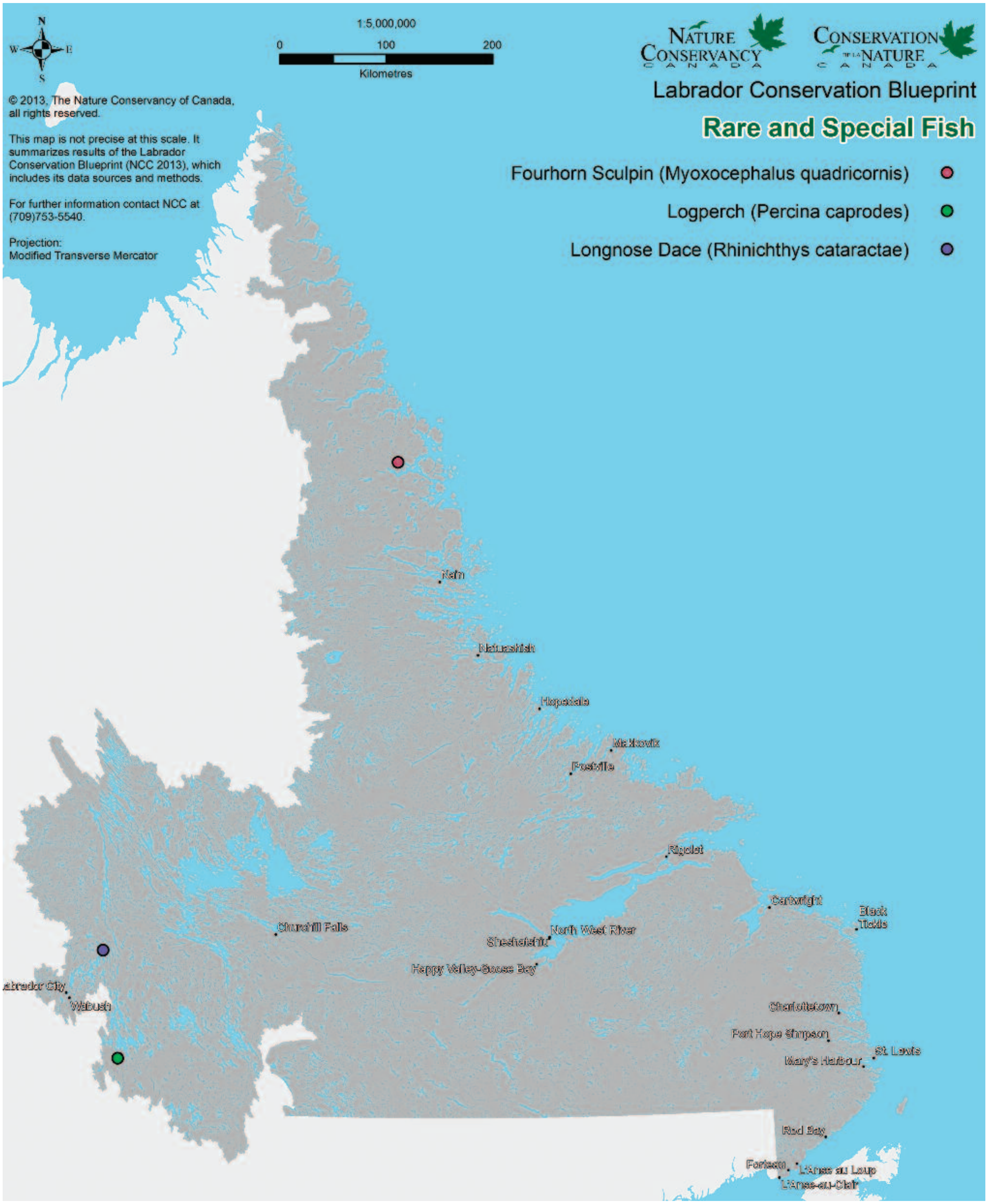
An asterisk (*) indicates data from DFO (2012b) counting fences.



Above: Atlantic Salmon fishing on the Flowers River.
Below: Fall colours, released Salmon.
Flowers River Lodge Ltd.



Data sources: Anderson 1985, NRCan 2007a.



Data source: ACCDC 2011a

Rare and Special Freshwater Fish

Seven species of freshwater fishes are of conservation interest in Labrador, based on rarity.

Common name	Scientific name	NatureServe Global Rank*	NatureServe Labrador Rank*	Population Status	SARA Status*	COSEWIC Status*	NL ESA Status*
American Eel	*Anguilla rostrata*	G4	S4	Unknown		TH	VU
Fourhorn Sculpin	*Myoxocephalus quadricornis*	?	?	Unknown	SC	DD	
Atlantic Sturgeon	*Acipenser oxyrinchus*	G3	SNA	Unknown			
Alewife	*Alosa pseudoharengus*	G5	S1S2	Unknown			
American Shad	*Alosa sapidissima*	G5	S1S2	Unknown			
Logperch	*Percina caprodes*	G5	SNR	Unknown			
Longnose Dace	*Rhinichthys cataractae*	G5	S4	Unknown			

* For definitions and sources, see page 28.

American Eel. Public domain

American Eel (*Anguilla rostrata*)

American Eel breed in the Sargasso Sea in the central Atlantic and migrate into freshwaters to grow and live, before returning to the Atlantic to breed again. Eel inhabit marine waters and estuaries during migration and freshwater rivers and lakes during other parts of its life. Individuals are part of a single breeding population that is declining, although trends in Labrador are unclear (COSEWIC 2006b).

Eel are present in southern Labrador, north to Hamilton Inlet and Lake Melville (COSEWIC 2006b), but are considered rare (Anderson 1985). A few have also been found in the English River. No abundance data are available (COSEWIC 2006b). (ACCDC 2011a: 0 records; 0 populations assessed.)

Fourhorn Sculpin. Public domain

Fourhorn Sculpin (*Myoxocephalus quadricornis*)

Freshwater Form

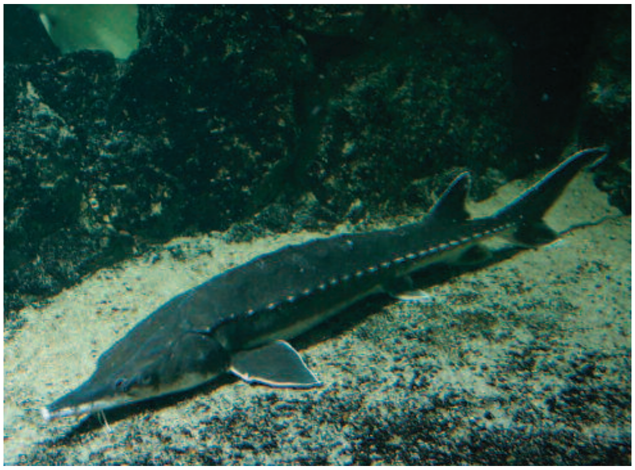
The Fourhorn Sculpin is a marine fish landlocked in deep, cold freshwater lakes, as a result of sea incursions following glaciation and subsequent isolation of lakes as the rose again (isostatic rebound). The freshwater form rarely exceeds 10 cm in length, and little is known of its ecology. A single specimen, collected in 1964 at Lake Sipukat, is known from Labrador (COSEWIC 2003b). (ACCDC 2011a: 1 record; 0 populations assessed.)

Atlantic Sturgeon (*Acipenser oxyrinchus*)

Atlantic Sturgeon is a very large fish that can grow up to 4.3 m long. They migrate from salt water to freshwater to spawn (anadromous). Sea-run adults move upstream in large rivers to spawn below rapids and waterfalls. They can also be found in coastal and estuarine areas on soft bottom when not breeding, as well as foraging in brackish waters (IUCN 2009, IUCN 2012). Anderson (1985) lists Atlantic Sturgeon as rare in Hamilton Inlet, where a specimen was obtained in 1950 near Tocoralak point (Backus 1951). (ACCDC 2011a: 0 records: 0 populations assessed.)

Alewife (*Alosa pseudoharengus*)

The Alewife is a small herring, with both anadromous and landlocked forms. Landlocked Alewife are smaller, on average 6 inches long. Anadramous Alewife migrate up rivers to spawn; returning to sea shortly after. Landlocked individuals move from deep water to shallow beaches in lakes to spawn. Alewife are reported as declining (IUCN 2009, IUCN 2012), and Anderson (1985) reports them as rare in southern Labrador and the Strait of Belle Isle. (ACCDC 2011a: 0 records; 0 populations assessed.)



Atlantic Sturgeon. Creative Commons, Alewife. John Burrows, Logperch. Daniel Schilling, Longnose Dace. National Park Service

American Shad (*Alosa sapidissima*)

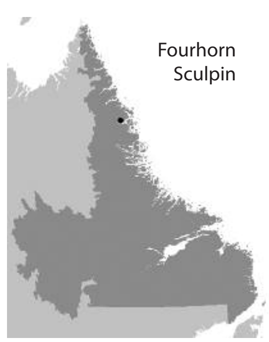
American Shad is an anadromous fish spending most of its life at sea but spawning in freshwater rivers and streams. Sandy or pebbly shallows are preferred breeding sites. Declines along the Atlantic coast have been documented (IUCN 2009, IUCN 2012). A single specimen is known from the Sandhill River on the south coast of Labrador, its most northern record (Hare and Murphy 1974). This species is considered rare by Anderson (1985). (ACCDC 2011a: 0 records; 0 populations assessed.)

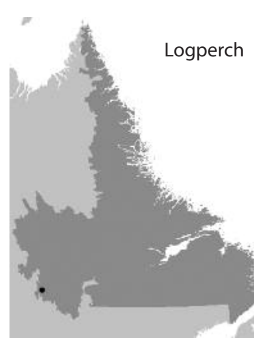
Logperch (*Percina caprodes*)

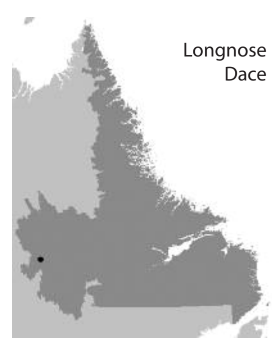
The Logperch is a darter that can grow up to 18 cm long. They spawn in shallow, rocky shoals during spring and summer, and prefer streams and lakes with clear, swift-flowing water, and a rocky or sandy substrate (IUCN 2009, IUCN 2012). There are two known records for Labrador, one in Ashunanipi Lake/ Kapitagas Channel, near the mouth of the Esquimaux River (Perry and Joyce 2003), and one from Atikonak Lake (Grant *et al.* 2001). (ACCDC 2011a: 1 record; 0 populations assessed.)

Longnose Dace (*Rhinichthys cataractae*)

Longnose Dace are small, freshwater minnows, typically less than 100 mm long, with a fleshy snout. They prefer moderately cool, shallow, fast-flowing streams and rivers and the edges of lakes. They have small home ranges and display high site fidelity (IUCN 2009, IUCN 2012). This species was collected from two locations in northeastern Lake Shabogamo, in the headwaters of the Churchill River drainage (Perry and Joyce 2003). Anderson (1985) also reports Longnose Dace as rare in Hamilton Inlet. (ACCDC 2011a: 2 records; 0 populations assessed.)







Northern Leopard Frog. Public domain/ Wikimedia

1.3.4 Amphibians

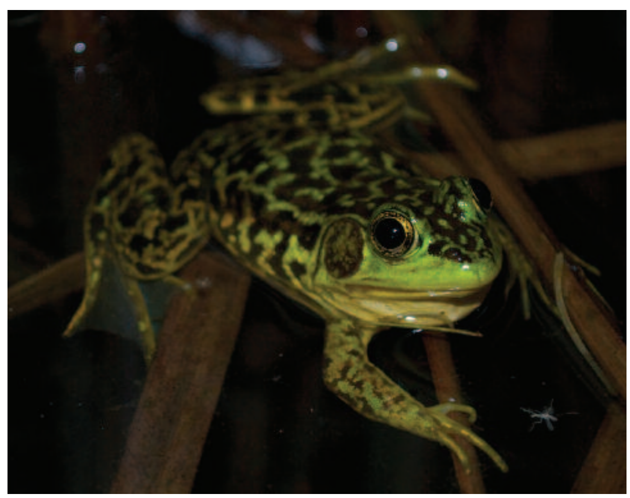
Seven species of amphibian occur in Labrador (ACCDC 2011a, Chubbs and Phillips 1998, NL DEC 2010a)

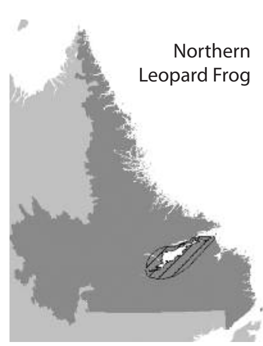
- Northern Two-lined Salamander (*Eurycea bislineata*)
- Blue-spotted Salamander (*Ambystoma laterale*)
- American Toad (*Bufo americanus*)
- Mink Frog (*Rana septentrionalis*)
- Wood Frog (*Rana sylvatica*)
- Northern Leopard Frog (*Rana pipiens*)
- Spring Peeper (*Pseudacris crucifer*)

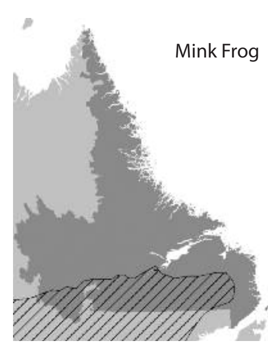
In 2010 the Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division designated six of these as 'Secure' species that are not at risk of extinction or extirpation, nor sensitive to exploitation or habitat loss. The Spring Peeper was assigned a status of 'Undetermined,' and is insufficiently documented at present (NL DEC 2010a).

In general, preferred habitats are moist areas, such as shallow ponds, lakeshores, streambanks, and wetlands (Meades 1990). No reptiles are present in Labrador (ACCDC 2011a, CARCNET 2012, NL DEC 2010a).

Mink Frog. Creative Commons







A Rare and Special Amphibian

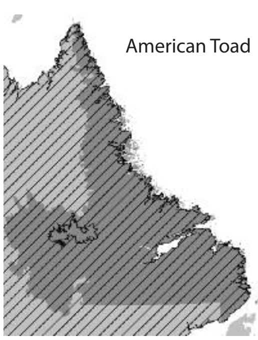
Spring Peeper (*Pseudacris crucifer*)

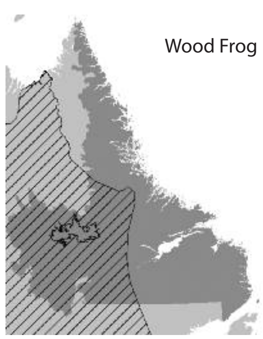
The presence of Spring Peeper in Labrador was first recorded by Bergman (1999) on the Goose River in Central Labrador. Maunder (1983, 1997) reported two earlier sites from western Labrador and on Toma's Brook, north of the 53rd parallel. Spring Peeper were also heard in wetlands and alder thickets along the margins of the lower Churchill River (Minaskuat Inc. 2008a,b,c). In general, breeding habitats include swamps and marshes with grassy or emergent vegetation at their edges (Bergman 1999).

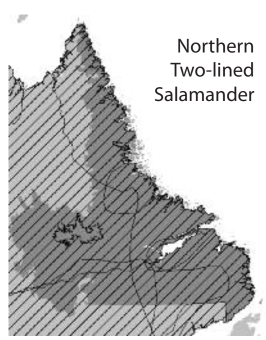
The conservation status of Spring Peeper is as follows: NatureServe Global Rank: G5; NatureServe Labrador Rank: S1S2; COSEWIC: n/a; SARA: n/a; NL ESA: n/a; (ACCDC 2011a, 0 records, 0 populations assessed.)

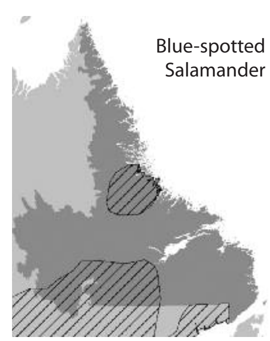
Spring Peeper. Public domain/ US Geological Survey

American Toad. Lindsay Notzl
Wood Frog. Sara McCarthy
Two-lined Salamander. Jean Marc Vallières
Blue-spotted Salamander. Jean Marc Vallières









Data source: NatureServe, and IUCN 2007b

Four Spotted Skimmer, Arctic Skipper. Creative Commons

1.3.5 Common Invertebrates

Globally, more than 90 per cent of living organisms are invertebrates (animals lacking a spine) including butterflies, dragonflies and damselflies, bees, beetles, flies, and freshwater mussels. Over 4,700 terrestrial insects have been recorded in Newfoundland and Labrador although our knowledge remains limited. Labrador's assemblage of insects uniquely reflects its geography at the intersection of arctic, sub-arctic and boreal habitats (NL DEC 2010a).

Butterflies

More is known about the butterflies of Labrador than any other group of invertebrates. Over 40 native species of butterfly are known, half of which have conservation statuses ranked as 'Secure', while the other half are 'Undetermined' (NL DEC 2010a). Common species include: Spring Azure (*Celastrina ladon*), Meadow Fritillary (*Boloria bellona*), Arctic Fritillary (*Boloria chariclea*), Polaris Fritillary (*Boloria polaris*), Silver-bordered Fritillary (*Boloria selene*), White-veined Arctic (*Oeneis bore*), Polixenes Arctic (*Oeneis polixenes*), Painted Lady (*Vanessa cardui*), Pelidne Sulphur (*Colias pelidne*), and Arctic Skipper (*Carterocephalus palaemon*) (Glassberg 1999, ACCDC 2011a).

Dragonflies and Damselflies

Over 20 dragonflies and damselflies, which rely on aquatic systems for early development, are known from Labrador. Common species include: Taiga Bluet (*Coenagrion resolutum*), Boreal Bluet (*Enallagma boreale*), Lake Darner (*Aeshna eremita*), Sedge Darner (*Aeshna juncea*), Azure Darner (*Aeshna septentrionalis*), Zigzag Darner (*Aeshna sitchensis*), American Emerald (*Cordulia shurtleffii*), Ringed Emerald (*Somatochlora albicincta*), Crimson-ringed Whiteface (*Leucorrhinia glacialis*), Hudsonian Whiteface (*Leucorrhinia hudsonica*), and Four Spotted Skimmer (*Libellula quadrimaculata*) (Dunkle 2000, ACCDC 2011a). Little is known about the abundance and distribution of species, and as such, the status of all species was considered 'Undetermined' in 2010 (NL DEC 2010a).

Tiger Beetles

Six species of Tiger Beetle are present in Labrador. These are the Twelve-spotted Tiger Beetle (*Cicindela duodecimguttata*), Hairy-necked Tiger Beetle (*Cicindela hirticollis*), Long-lipped Tiger Beetle (*Cicindela longilabris*), Common Shore Tiger Beetle (*Cicindela repanda*), and Oblique-lined Tiger Beetle (*Cicindela tranquebarica*). In 2010, the apparently endemic Goose Bay Blowout Tiger Beetle (*Cicindela limbata labradorensis*) was ranked as 'Sensitive', and the others were ranked 'Undetermined' (NL DEC 2010a, ACCDC 2011a).

Freshwater Mussels

One species, the Eastern Pearlshell (*Margaritifera margaritifera*), is documented for Labrador, and its status is considered 'Undetermined' (NL DEC 2010a, ACCDC 2011a). The group warrants additional survey effort.

Biting Insects

Although quantitative data from Labrador are lacking, the Black Fly and Mosquito would be acknowledged as the insects most frequently interacting with humans in Labrador.

Northern Mosquito, order Diptera, *Aedes nigripes*.
Northern Black Fly, order Diptera, *Simulium arcticum*.

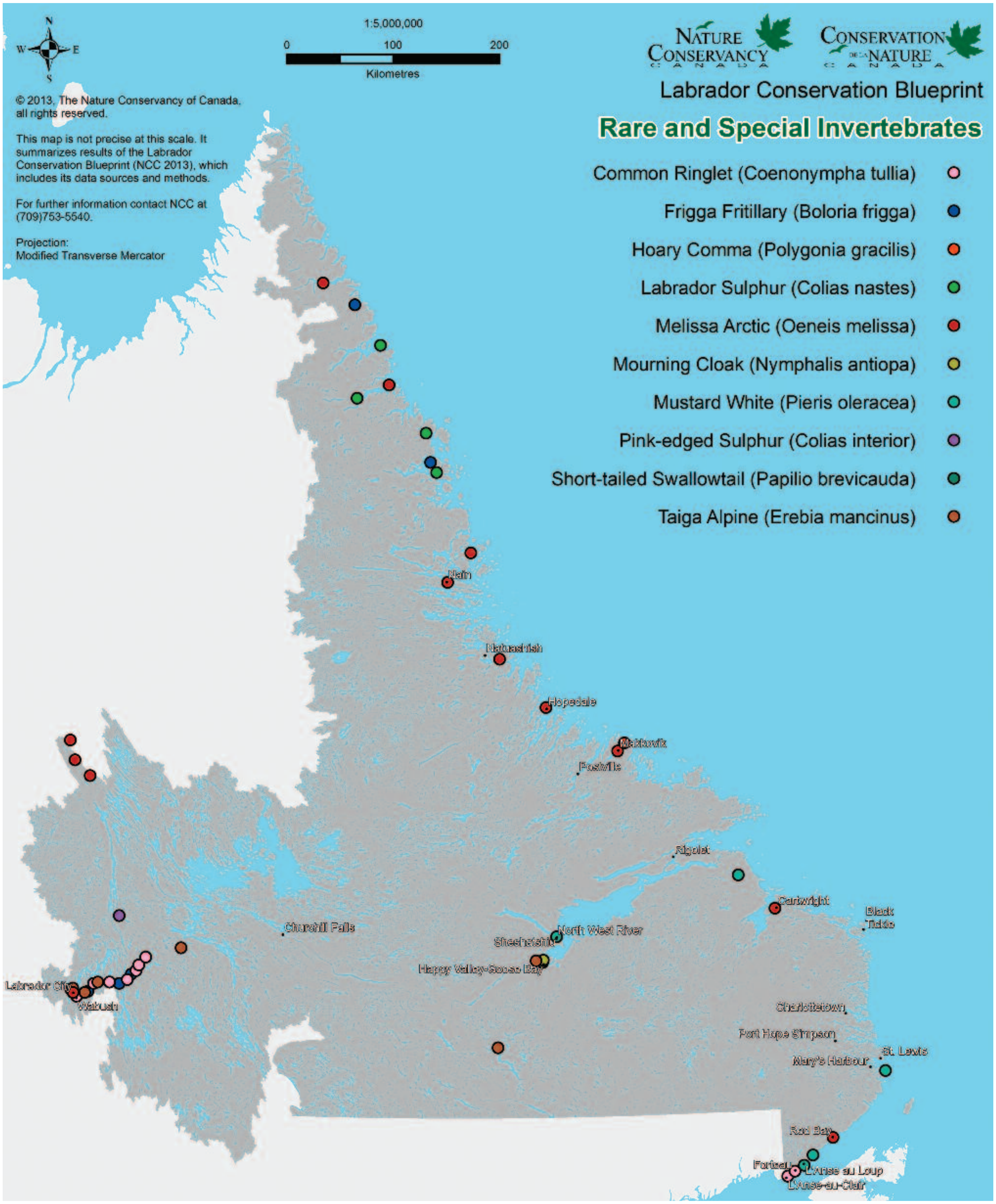
Rare and Special Invertebrates

Eighteen invertebrate species are of conservation interest based on their rarity in Labrador.

Common Name	Scientific name	NatureServe Global Rank*	NatureServe Labrador*	SARA Status*	COSEWIC Status*	NL ESA*
Labrador Snowfly	*Utacapnia labradora*	G2	SNR			
Tomah Mayfly	*Siphlonisca aerodromia*	G2G3	SNR			
A Mayfly	*Siphlonurus barbaroides*	G3	SNR			
A Mayfly	*Acentrella feropagus*	G3	SNR			
A Mayfly	*Baetisca rubescens*	G3	SNR			
A Caddisfly	*Limnephilus ademus*	G3	SNR			
Goose Bay Blowout Tiger Beetle	*Cicindela limbata labradorensis*	G4T1Q	S1			
Short-tailed Swallowtail	*Papilio brevicauda*	G3G4	SU			
Melissa Arctic	*Oeneis melissa*	S2S3	G5T2T3			
Pink-edged Sulphur	*Colias interior*	G5	S2S3			
Hoary Comma	*Polygonia gracilis*	G5	S2S3			
Labrador Sulphur	*Colias nastes*	G5	S3			
Frigga Fritillary	*Boloria frigga*	G5	S3?			
Common Ringlet	*Coenonympha tullia*	G5	S3?			
Taiga Alpine	*Erebia mancinus*	G5	S3?			
Mourning Cloak	*Nymphalis antiopa*	G5	S3?			
Mustard White	*Pieris oleracea*	G4G5	S3?			
Crowberry Blue	*Plebejus idas aster*		S3?			

Data sources: NL DEC 2010a, ACCDC 2011a.
* For definitions and sources, see page 28.

below: Swarmed by blackflies. Isabelle Schmelzer



Data source: ACCDC 2011a

Short-tailed Swallowtail. D. Gordon, E. Robertson, Creative Commons

Melissa Arctic. Jim P. Brock

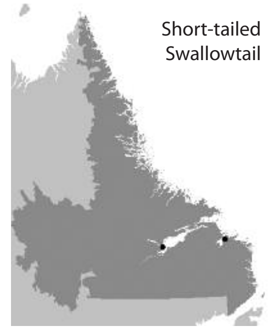
Melissa Arctic. Jim P. Brock

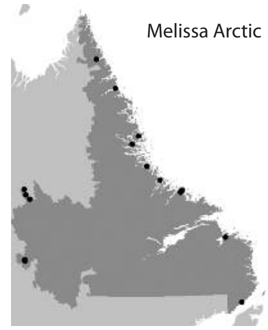
Pink-edged Sulphur. Cris Guppy

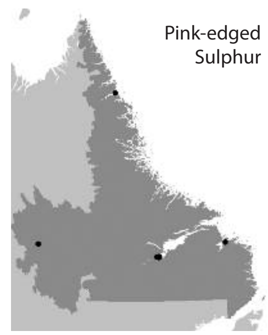
Labrador Sulphur. K.Davis, M.Stangeland, A.Warren

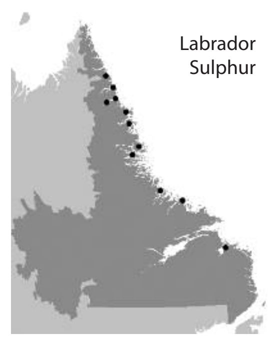
Blowout Tiger Beetle, *Cicincela limbata*. Doug Backlund

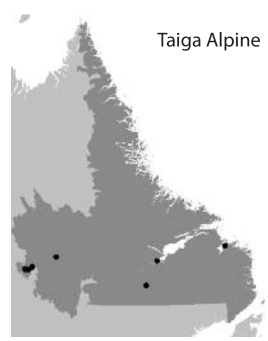
Taiga Alpine. Jim P. Brock











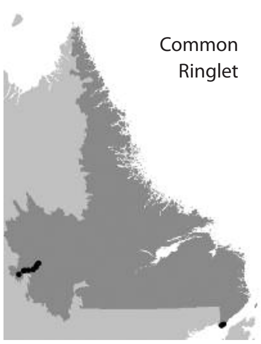
Butterfly on River Beauty. Lorraine Cooper

Common Ringlet. Jim P. Brock

Hoary Comma.
K.Davis, M.Stangeland, A.Warren

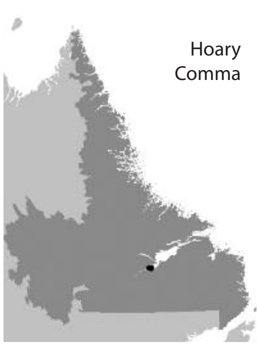
Frigga Fritillary. Jim P. Brock

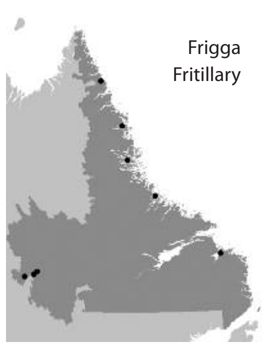
Mourning Cloak. Jim Porter

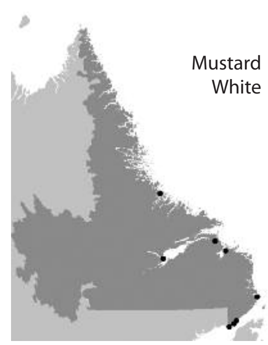


Mustard White. Jim P. Brock

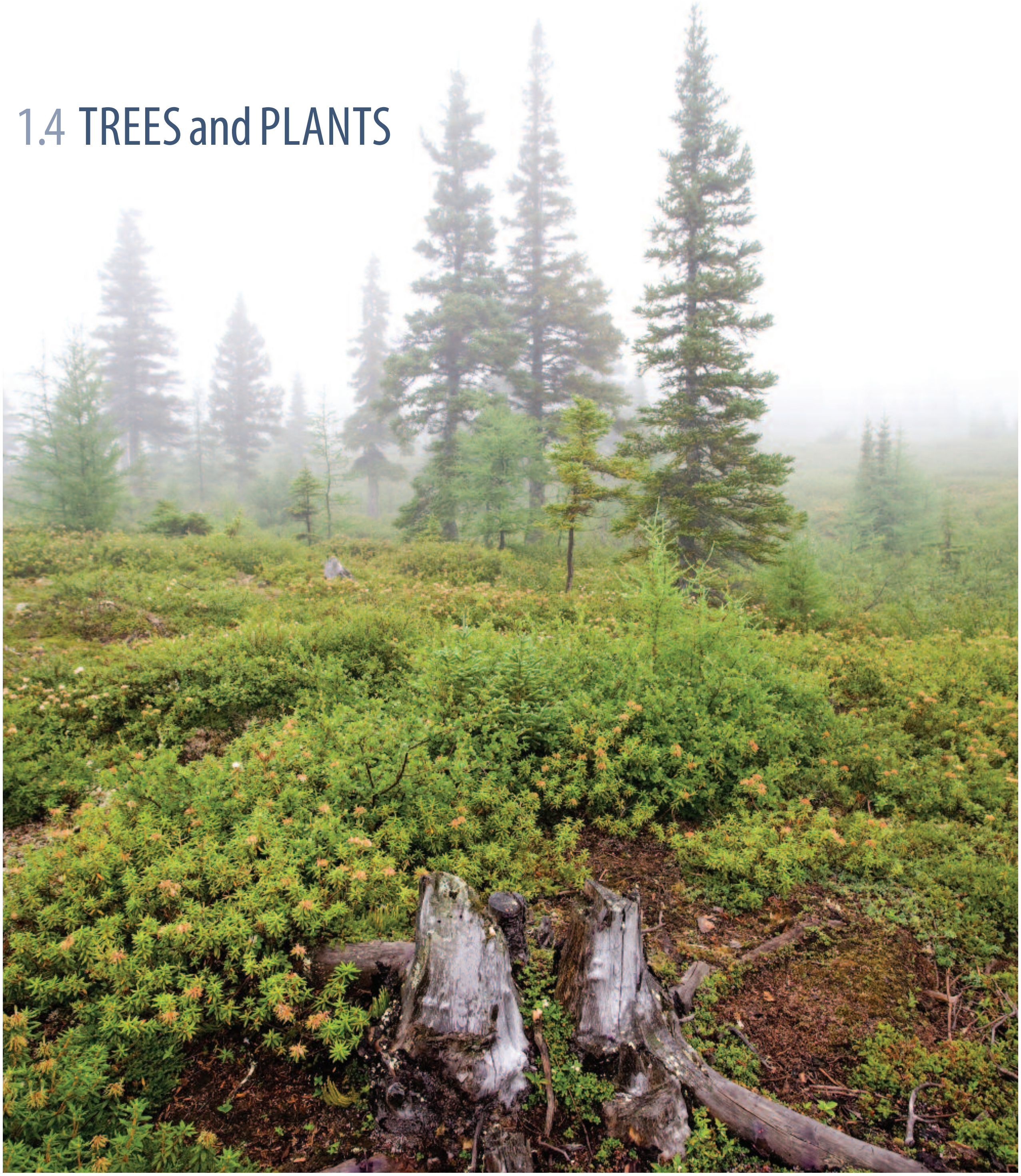
Crowberry Blue. Jim P. Brock







1.4 TREES and PLANTS



Spruce woodland. Chris P. Sampson

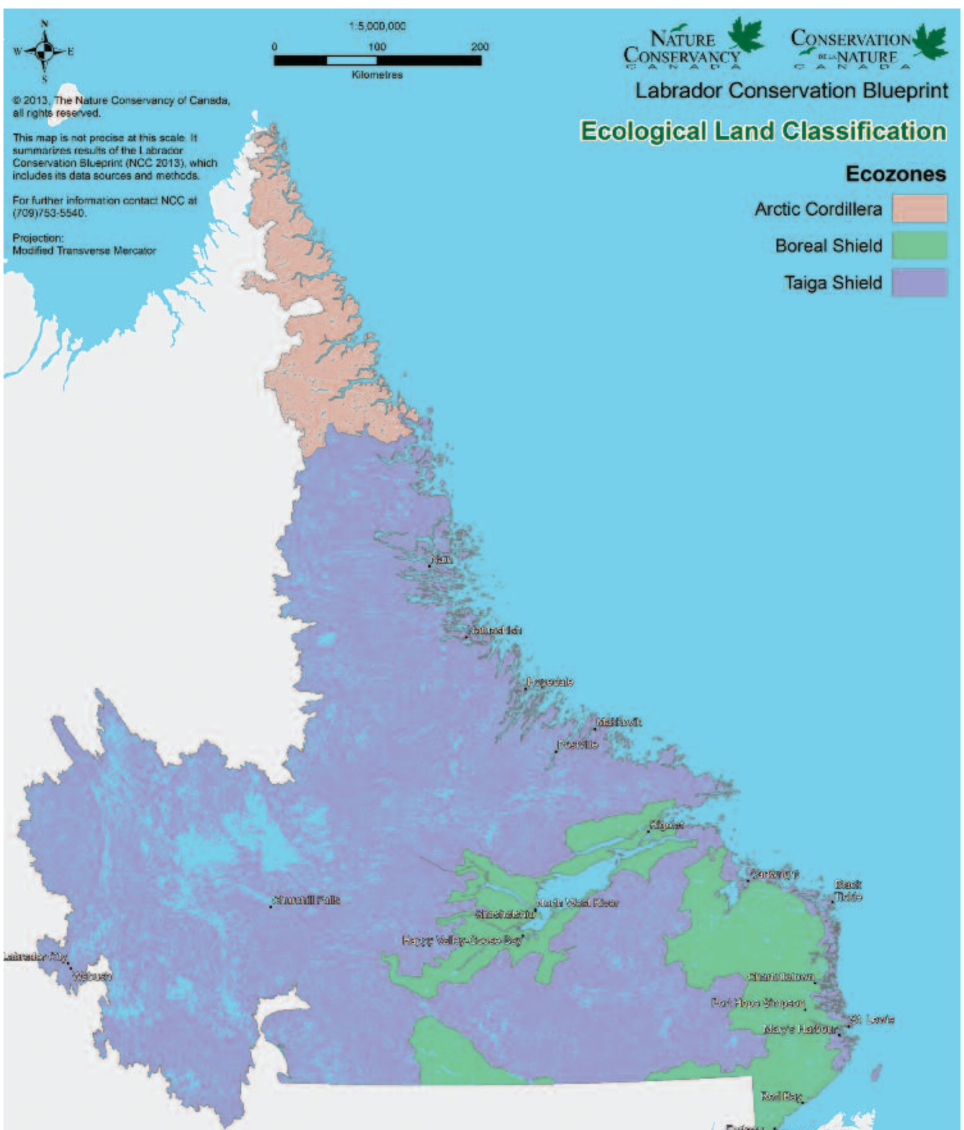
1.4.1 Trees

The distribution limits of Labrador's trees are part of what define the terrestrial ecozones of Labrador: the Arctic Cordillera, the Taiga Shield and the Boreal Shield (ESWG 1995, Meades 1990, Riley *et al.* 2013).

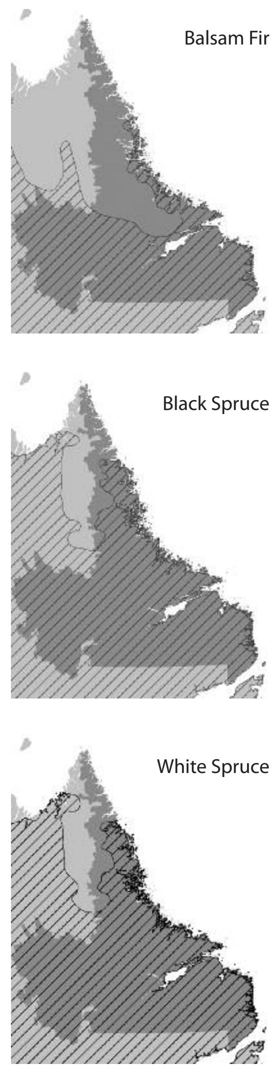
The northern limits of the treed boreal and taiga ecozones form the southern limits of the tundra, and there is a gradual transition — both latitudinally and in elevation — as tree growth declines and stops. Tundra is distinguished by its absence of trees, the prevalence of permafrost, and vegetation dominated instead by low-growing shrubs, herbaceous plants, mosses, and lichens (Walker *et al.* 2002). The tree limit reflects a prevailing climate unfavourable for tree growth, reproduction, and survival (Tuhkanen 1984). The treed landscapes to the south, dominated by conifer trees, are divided in North American into sub-zones based on their tree cover, usually into a northern region of thinly stocked woodlands (subarctic or hemiarctic), and a southern region of more closed forests, woodlands and wetlands (boreal or hemiboreal) (Brandt 2009, Hustich 1949a).The boreal and taiga zones circle the globe at high latitudes. They are dominated by conifers, the growth of which is frequently challenged by thin soils, rock barrens, sand plains, and wet peatlands. Common terms such as "taiga" in Russian, and "muskeg" in Cree, describe such terrain. Taiga is a term associated most often with extensive open woodlands with dominant understoreys of lichen (*Cladonia* and *Stereocaulon* spp.; Meades 1990), and muskeg is a term associated most often with wetter conifer swamps. Both are typical of the region, which occupies about 627 million hectares of Canada and Alaska, or 29 percent of the continent, an area also rich in treeless alpine areas, heathlands, wetlands, and freshwater habitats (Brandt 2009).

The dominant conifer trees are White Spruce (*Picea glauca*), Black Spruce (*Picea mariana*), Tamarack (*Larix laricina*), Balsam Fir (*Abies balsamea*), and Jack Pine (*Pinus banksiana*), with a more limited occurrence of shade-intolerant broadleaf trees like Trembling Aspen (*Populus tremuloides*), Balsam Poplar (*P. balsamifera*), and White Birch (*Betula papyrifera*). These species occur as pure stands and, more commonly, as mixed stands (Drieman 1993, Roberts *et al.* 2006). Of these, only Jack Pine is limited in its Labrador distribution, with Jack Pine stands known only from the Redfir-Kapitagas Channel Ecological Reserve in southwestern Labrador (Roberts *et al.* 2006).

These are the tree species that colonized the region following deglaciation, and they were not supplanted by later arrivals of more southern tree species (Sakai

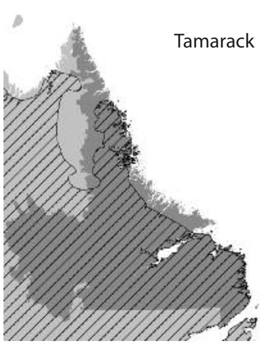


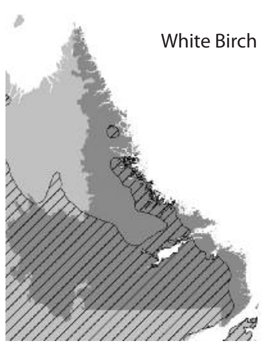
Data source: Riley *et al.* 2013.



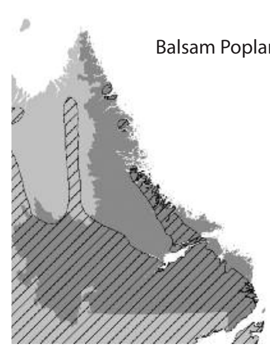
Data source: USGS 2013

Krummholz or tuckamore. Valerie Courtios





and Larcher 1987). Black and White Spruce are two particularly cold-hardy species. Black Spruce also benefits from a regeneration strategy by which wildfires trigger the release of seeds by cones, while White Spruce relies more on seed arriving from a distance after fire (Black and Bliss 1980). On the other hand, White Spruce is more tolerant of coastal salt and wind exposure, and is more frequent coastward than Black Spruce. Both species, when exposed to wind-snow abrasion on the coast or at high elevations, take the form of "krummholz", or "tuckamore," to better hold snow and thus keep beneath the zone of winter wind abrasion.



The tree line in Labrador forms, on level terrain, the boundary between the tundra biome (arctic) and the forested or wooded boreal and taiga zones. In montane areas, it similarly reflects the hardiness boundary between higher-elevation tundra and shrublands, and lower-elevation woodlands and forests. In the taiga zone, there are mountain ranges whose peaks lie above the tree limit,

Black Spruce blueberry forest Duley Lake. PNAD
Trembling Aspen. Valerie Courtois

such as the Mealy, Benedict, and Red Wine Mountains, as well as the uplands near Harp, Sims and Domagaya Lakes (Brandt 2009, Meades 1990, Lopoukhine 1978).

At lower elevations, in subarctic Quebec, Black Spruce has experienced increased radial growth and stem height over the last 100 years, suggesting warmer and snowier conditions related to climate warming. This was expressed as a shift from krummholz, or tuckamore, to more upright growth during the 1900s, and a shift in treeline northward (Lavoie and Payette 1994). In Labrador at sea level, the tree line is at Napaktok Bay (Elliott and Short 1979), but small patches of dwarf Trembling Aspen occur farther north (D. Whitaker, *pers. comm.*, 2013).

The lower Churchill River basin is an interior outlier of boreal conditions, with more productive tree growth and a richer mixture of tree species than the taiga highlands to the north and south of it (Meades 1990, Riley *et al.* 2013).

1.4.1 Plants

Rouleau recorded 854 species of flowering plants in Labrador (1978), and Brassard and Webber have recorded 348 species of mosses (1978). Ahti estimated at least 610 lichens to occur in the province, with most of them also likely in Labrador (1983). The diversity of lichens is attributable to the wide range of dry, unforested habitats, such as calcareous or acidic rocks, and of other habitats (such as saline seashores, intact conifer forest, alpine tundra and climatic conditions (such as oceanic or continental).

Labrador's flora includes (Meades 1990, Meades *et al.* 2000):

- Northern species (arctic, boreal, arctic-alpine; many occurring throughout the globe's northern latitudes);
- Disjunct species (cordilleran or amphi-atlantic);
- Endemic species; and
- Introduced, non-native species.

Common flowering plants include Labrador Tea (*Ledum groenlandicum*), Sheep Laurel (*Kalmia angustifolia*), Bunchberry (*Cornus canadensis*), Twinflower (*Linnea borealis*), Starflower (*Trientalis borealis*), Bluebead Lily (*Clintonia borealis*), Sweet Gale (*Myrica gale*), and Leatherleaf (*Chamaedaphne calyculata*).

Bunchberry. Valerie Courtois, Leatherleaf. John Maunder

Sheep Laurel. Valerie Courtois
Labrador Tea. Troy Mitchell
Bluebead Lily. John Maunder
Twinflower. John Maunder
Sweet Gale. John Maunder
Starflower. John Maunder

Many boreal plants also occur in tundra habitats, such as Black Crowberry (*Empetrum nigrum*), Partridgeberry (*Vaccinium vitis-idaea*), Alpine Bilberry (*Vaccimium uliginosum*), Bakeapple (*Rubus chamaemorus*), and Harebell (*Campanula rotundifolia*).

Arctic and arctic-alpine species occur north of the treeline and, on mountains, above the treeline. They must survive deep winter freezing, low summer temperatures, strong winds, low soil nitrogen, and low precipitation (Porsild 1951, Savile 1972). Species found in alpine tundra and calcareous barrens include: Diapensia (*Diapensia lapponica*), Purple Mountain Saxifrage (*Saxifraga oppositifolia*), Blue Mountainheath (*Phyllodoce caerulea*), Alpine Bearberry (*Arctous alpina*), Netvein Willow (*Salix reticulata*), Arctic Poppy (*Papaver radicatum*), Common Butterwort (*Pinguicula vulgaris*), Bigelow's Sedge (*Carex bigelowii*), and Glacier Sedge (*C. glacialis*).

Disjunct species are those that have major gaps in their natural distributions. For example, amphi-atlantic disjuncts occur on either side of the Atlantic Ocean (Hultén 1958). Examples are Highland Rush (*Juncus trifidus*), Moss Heather (*Harrimanella hypnoides*), Velvetbells (*Bartsia alpina*), and Norwegian Whitlowgrass (*Draba norvegica*). Cordilleran disjucts, some of which occur in coastal Labrador, have their primary distribution in western North America and a limited distribution in the northeast; Ovalleaf Bilberry (*Vaccinium ovalifolium*) is one example.

Bakeapple. Valerie Courtois, Alpine Bilberry, Harebell. John Maunder, Black Crowberry and Partridgeberry. Jean Francois Senecal




Diapensia, Blue Mountainheath, Purple Saxifrage, Alpine Bearberry. John Maunder

Endemic species are those that are restricted in their distribution. Gulf of St. Lawrence endemics are restricted to calcareous gravels in Newfoundland, Labrador's Strait of Belle Isle, Anticosti Island, Mingan Islands, and a small part of Quebec's Gaspé Peninsula. For example, the federally- and provincially-listed Fernald's Milk-vetch (*Astragalus robbinsii* var. *fernaldii*) occurs only around the Strait of Belle Isle, at the Blanc-Sablon River in Labrador, about 4600 individuals (EC 2011b).

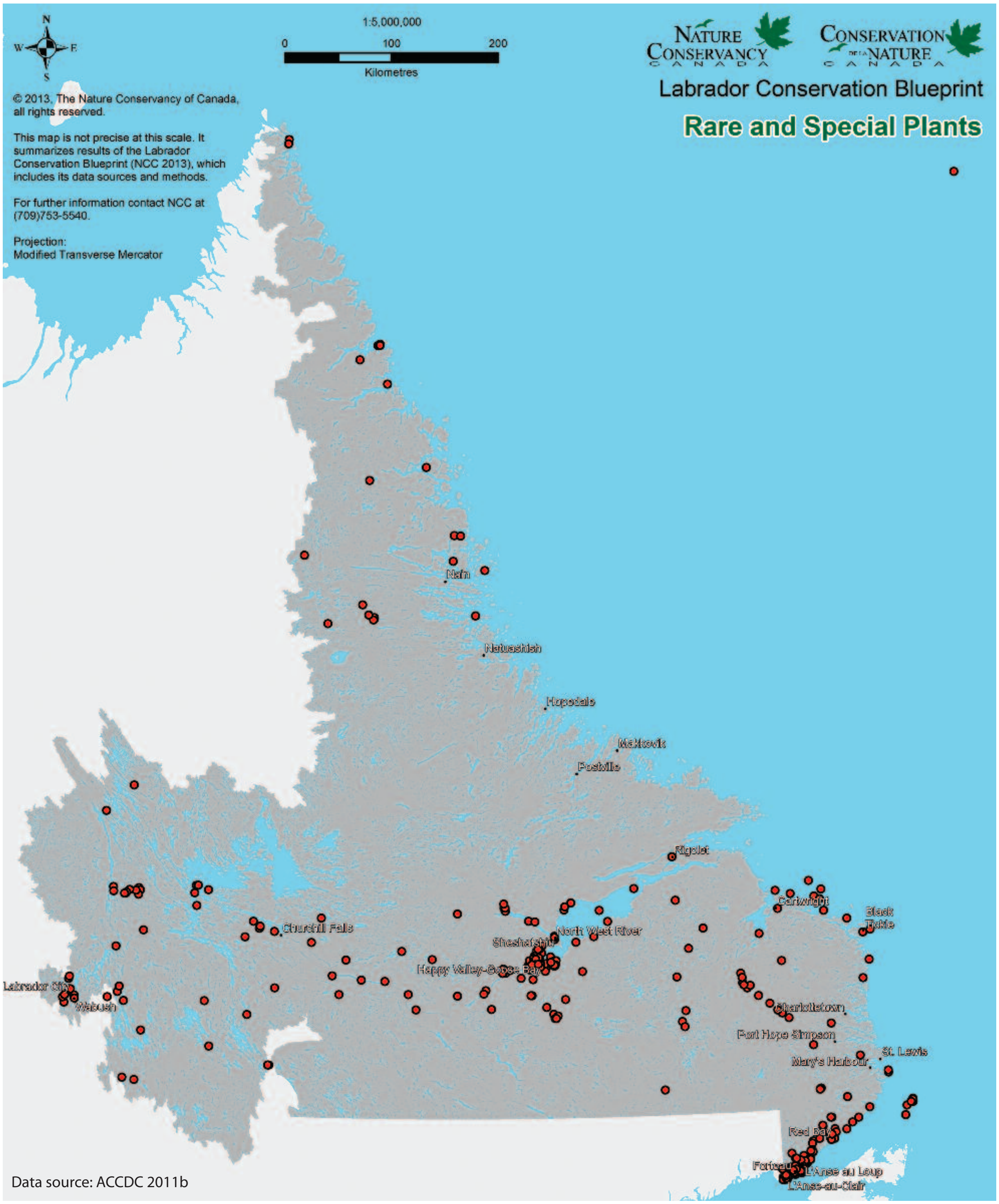
Relatively few non-native plant species have become naturalized in Labrador, either through deliberate or accidental human introductions. Worldwide, the dominance of a flora by native species is increasingly unusual. Examples of non-native plants include Butter-and-Eggs (*Linaria vulgaris*), Shepherd's Purse (*Capsella bursa-pastoris*), Sheep Sorrel (*Rumex acetosella*), Red Clover (*Trifolium pratense*) and Dandelion (*Taraxacum officinale*) (Meades 1990, Meades *et al.* 2000).



Fernald's Milk-vetch. John Maunder
Reindeer lichens. Jean-Francois Senecal
Lichens. Valerie Courtois,

Rare and Special Plants

A plant species is considered rare if it has only a small population in Labrador. The documentation of the occurrence of rare and at-risk plants in Labrador continues to evolve, with most records limited geographically to communities, roads and areas assessed as part of development proposals. Presently, more than 200 species of flowering plants are tracked by the Atlantic Canada Conservation Data Centre, most of them with fewer than 25 known occurrences (ACCDC 2011b; see Technical Appendix C for list of rare and at-risk species.)



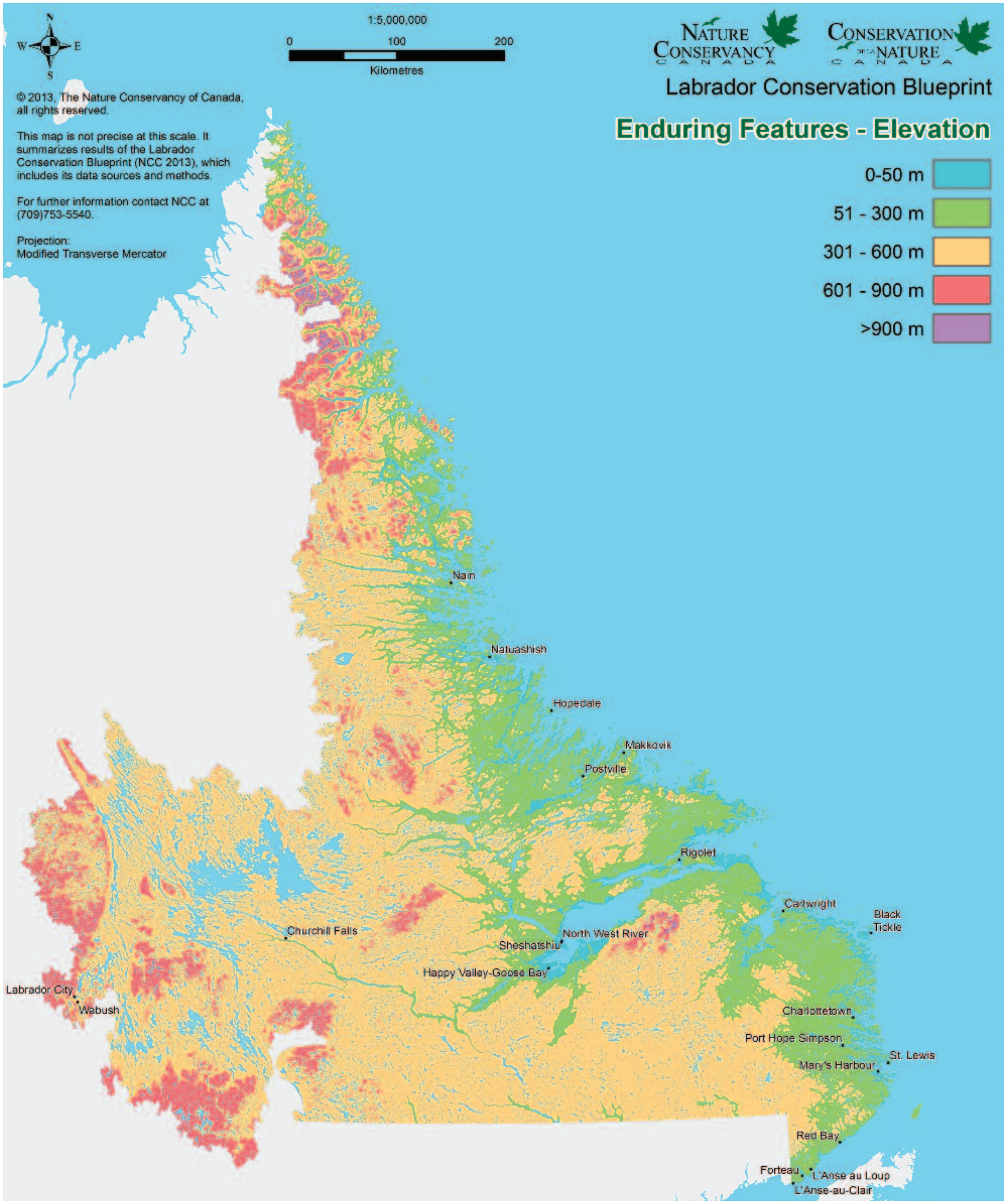
1.5 ENDURING FEATURES

Three characteristics of the non-living world — elevation, geology and landform — are referred to here as "enduring features." In combination with climate, they are important determinants of Labrador's biological diversity. In many ways they describe the ecological potential of the landscape. Combined into "ecological land units" or "ELUs," they uniquely characterize landscape variability (Anderson *et al*. 2006; see Application 2.2, and Technical Appendix D).

Eagle Plateau Bog. Valerie Courtois
Head of Fraser River. Geoff Goodyear

1.5.1 Elevation

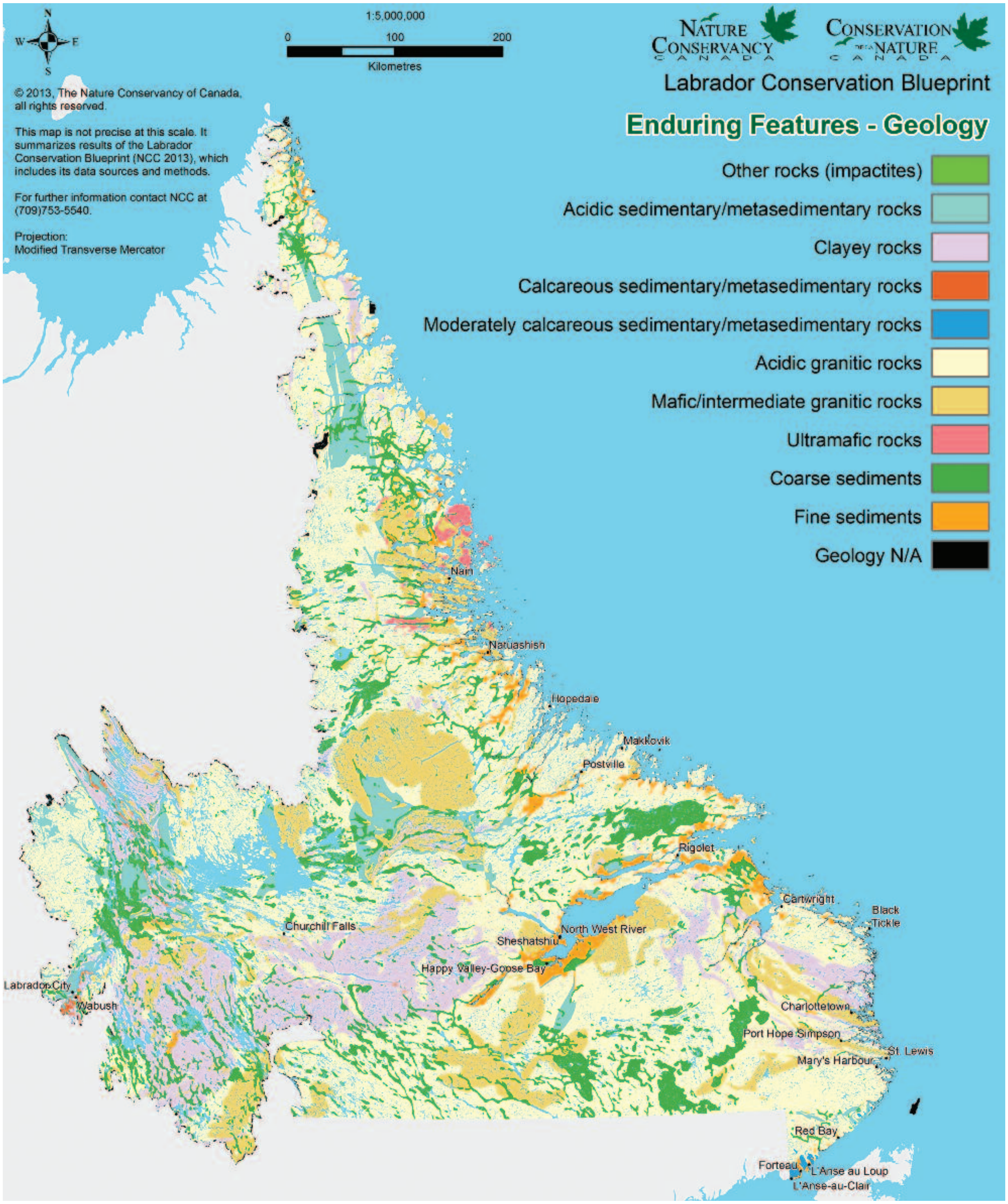
Elevation strongly influences microclimate. Where elevations are extreme, they confer topographic complexity that results in microclimates additionally complicated by exposure, aspect and steepness of slopes (Anderson *et al.* 2006).



Data source: NRC 2000

1.5.2 Geology

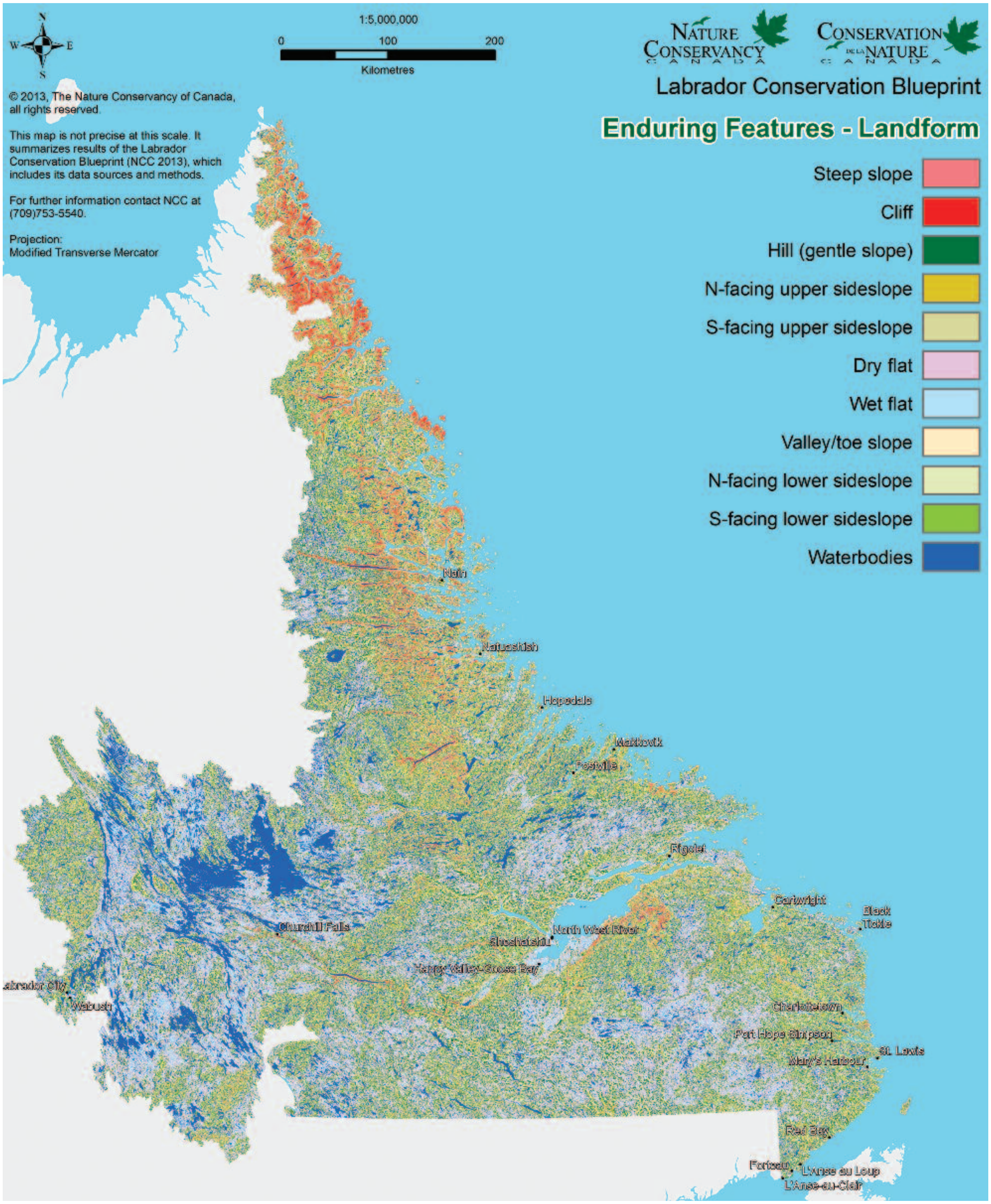
Bedrock geology is a contributing determinant of soil chemistry, texture, and nutrient availability. Many plant communities are associated with the chemistry and drainage of soils associated with particular bedrocks (Anderson *et al.* 2006, Tardif *et al.* 2005; see Technical Appendix D for details).



Data sources: Klassen *et al.* 1992, Wardle *et al*. 1997. See Technical Appendix D for details.

1.5.3 Landform

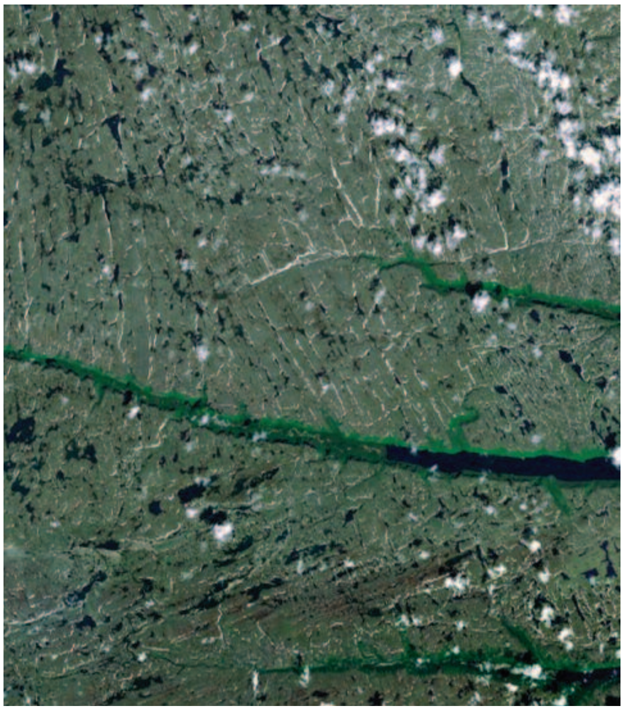
The form of the land, or topography, provides "the anchor and control of terrestrial ecosystems" (Rowe 1977).



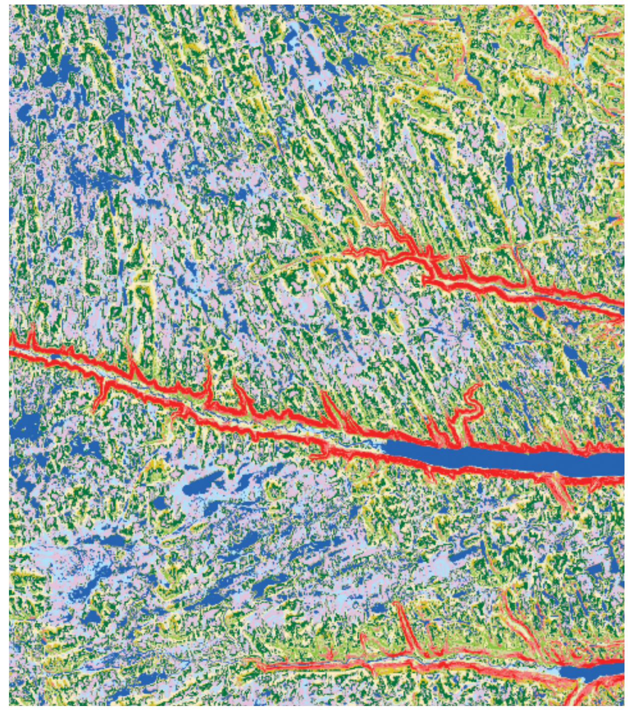
Data source: NRCan 2000. See Technical Appendix D for details.

Landforms vary in their in-coming solar radiation, soil development, wind exposure, water retention, and natural disturbance. They are a measure of elevation, slope, aspect, surface curvature, and upslope water catchment, and segment broad landscapes into local topographic units, many with distinct microclimates. Landforms thus influence species distributions and habitat productivity (Anderson *et al.* 2006; see Technical Appendix D for details).

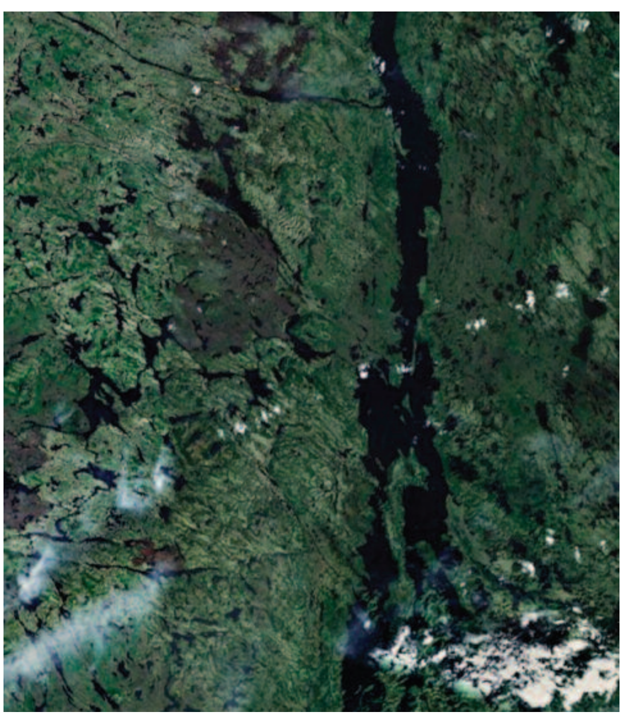
Topographic details that are masked at coarse scales become more apparent at finer scales. Below are examples illustrating the topography of the Fraser River Canyon, and the McPhayden Plateau and adjacent Labrador Trough. On the left are satellite images; on the right landforms, their colours corresponding to those of the Labrador-wide image above.



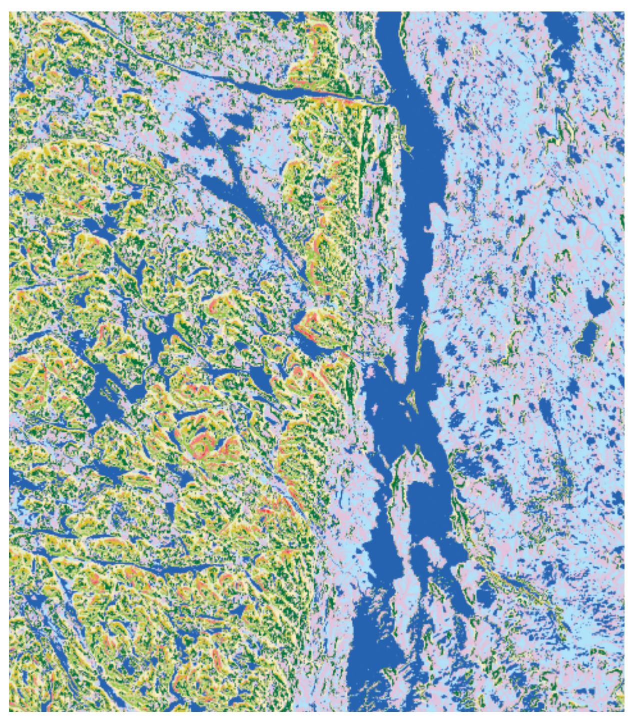
Satellite image, Fraser Canyon



Landform, Fraser Canyon



Satellite image, McPhayden Plateau and Labrador Trough



Landform, McPhayden Plateau and Labrador Trough

Jaynes Bay with Cape Chidley on left. Darroch Whitaker

1.6 LAND COVER

1.6.1 General Vegetation, or Habitat

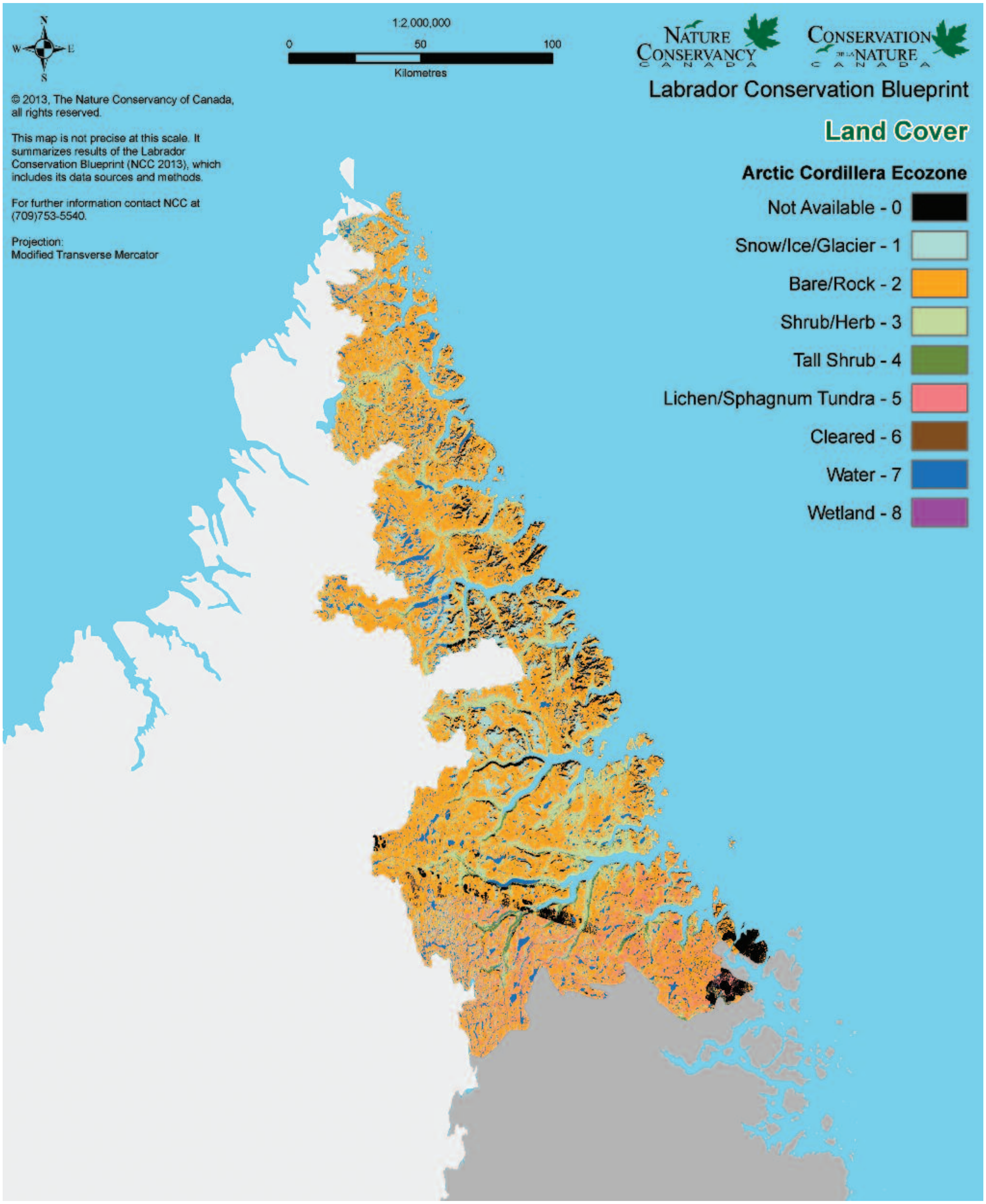
Land cover, or vegetation, largely defines habitat, both for resident species and for species that select and make use of various habitats for particular parts of their life cycle. Legend units correspond to generalized ecological systems.

Arctic Cordillera Ecozone

0 – Not Available. Land cover data was unavailable for six percent of Labrador's Arctic Cordillera Ecozone, due to cloud and snow cover obscuring satellite imagery.

1 – Snow/Ice/Glacier. Nine percent of the region supports year-round cover of snow and ice, including over 40 small glaciers in cirque valleys (NRCan 2012, Parks Canada 2011a)

2 – Bare/Rock. Nearly 56 percent of northernmost Labrador is exposed rock (Wulder *et al.* 2008). The vegetation at elevations exceeding 900 m ASL in the southern part of the ecozone, and at lower elevations farther north, have been called "polar deserts." Non-vascular plants cover at least 70 percent of the area, however, with Rock Moss (*Racomitrium laguminosum*) dominating. Crusts of cyanobacteria, algae and moss develop on moist sites. Flowering plants often cover less than 1 percent of the ground, as little as 0.1 percent, with common species the Northern Woodrush (*Luzula confusa*), Bittercress (*Cardamine bellidifolia*), Arctic Poppy, and Dwarf Willow (*Salix herbacea*). Haircap mosses (*Polytrichum* spp.) and lichens (*Stereocaulon glaucescens*, *Bryocaulon divergens*, *Bryoria pseudofuscens*, *Solorina crocea*) also occur (Ponomarenko and McLennan 2009).



Data sources: See Technical Appendix E for details

Diapensia, Arctic Poppy. John Riley, Arctic Bell-heather. John Maunder

3 – Shrub/Herb. This landcover class encompasses 17.5 percent of the region (Wulder *et al.* 2008). Dwarf shrub tundra occurs between 250 m to 600 m ASL, or up to 800 m on southeast and south-facing slopes. Dwarf shrubs, including Dwarf Labrador Tea (*Ledum decumbens*), Northern Bilberry (*Vaccinium uliginosum* ssp. *alpinum*), Arctic Bell-heather (*Cassiope tetragon*), Lapland Rosebay (*Rhododendron lapponicum*), Partridgeberry (*Vaccinium vitis-idaea* var. *minus*), Purple Crowberry, and Blue Mountainheath dominate, although Diapensia and Moss Campion, and ground lichens also play an important role. Common herbs include Redrattle (*Pedicularis flammea*), Alpine Bistort (*Polygonum viviparum*), Alpine Catchfly (*Lychnis alpina*), Narrowleaf Arnica (*Arnica angustifolia* ssp. *angustifolia*), and Arctic-alpine Fleabane (*Erigeron humilis*) (Ponomarenko and McLennan 2009).

4 – Tall Shrub. One percent of Labrador's arctic is comprised of tall shrub tundra (Wulder *et al.* 2008). Mountain Alder (*Alnus crispa*) and Planeleafed Willow (*Salix planifolia*) occupy moist areas along watercourses. Low shrub tundra is confined to very low elevations along a few southern river valleys, such as the Southern Arm, Nachvak Fjord and McCormick Brook. Common species include Dwarf Birch, Labrador Tea and Planeleafed Willow (Ponomarenko and McLennan 2009).

5 – Lichen/*Sphagnum* Tundra. High arctic tundra occupies 5 percent of Labrador's arctic (Wulder *et al.* 2008) at elevations between 600 to 900 m ASL. The main ground cover consists of lichens (*Flavocetraria nivalis*, *Stereocaulon glaucescens*), Haircap mosses (*Polytrichum* spp.), Bigelow's Sedge, and cushions of Moss Heather (*Cassiope hypnoides*) and Moss Campion (*Silene acaulis*). Dwarf Willow may also be present (Ponomarenko and McLennan 2009).

6 – Cleared. A negligible amount of Labrador's arctic has been cleared for development (NL DEC and NCC 2013). The majority of this ecozone is included in the Torngat Mountains National Park (Parks Canada 2009).

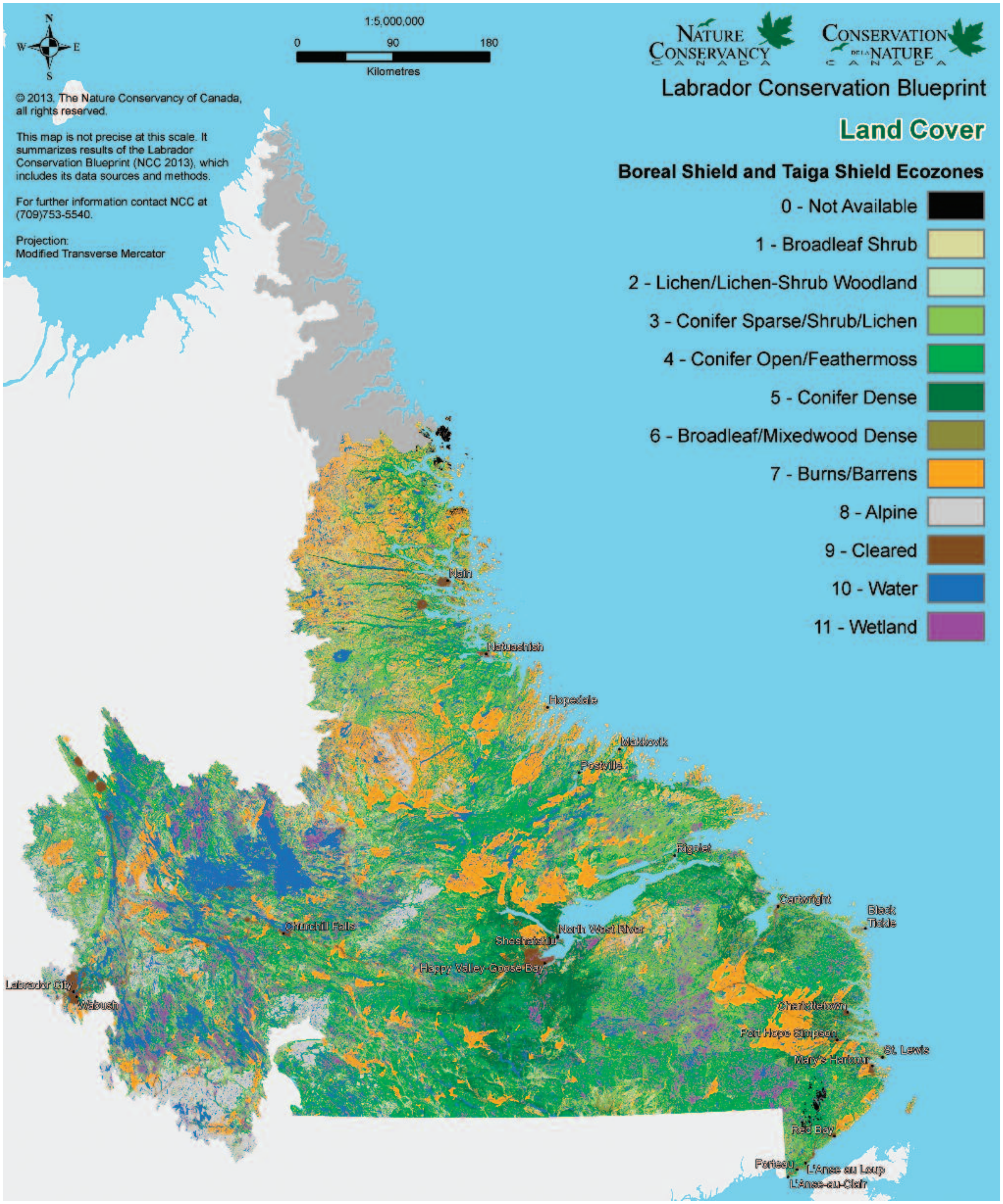
7 – Water. Overall, rivers and lakes occupy 5.5 percent of the region (NRCan 2012).

8 – Wetland. A small proportion of arctic Labrador is wetland (NRCan 2012). Marshes and marsh-meadows occur in river bottomlands. Common Mare's-tail (*Hippurus vulgaris*), Rock Sedge (*Carex saxatilis*), Wood Horsetail (*Equisetum sylvaticum*), Shortawn Foxtail (*Alopecurus aequalis*), and Water-starwort (*Callitriche palustris*) are typical species (Ponomarenko and McLennan 2009).

Boreal Shield and Taiga Shield Ecozones

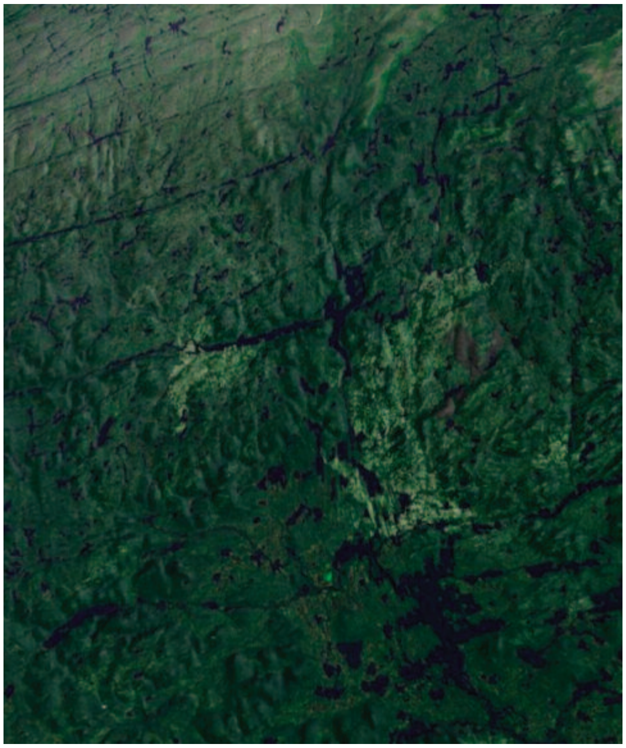
0 – Not Available. Land cover data were unavailable for 0.3 percent of Labrador's Boreal and Taiga Ecozones.

1 – Broadleaf Shrub. Areas dominated by tall shrubs are usually dense thickets of Willow (*Salix* spp.) and Alder (*Alnus* spp.), taller than 50 cm (Drieman 1993, NL DNR 2011a, NL DNR 1975). Other common shrubs include Sweet Gale, Red-osier (*Cornus stolonifera*), Red Raspberry (*Rubus idaeus*), Squashberry and Currant (*Ribes* spp.). Ground cover is frequently Blue-joint Reedgrass (*Calamagrostis canadensis*), Wood Reedgrass (*Cinna latifolia*), Dwarf Red Raspberry (*Rubus pubescens*), Tall Meadow-rue, Beech Fern (*Dryopteris phegopteris*), Swamp Aster (*Aster*

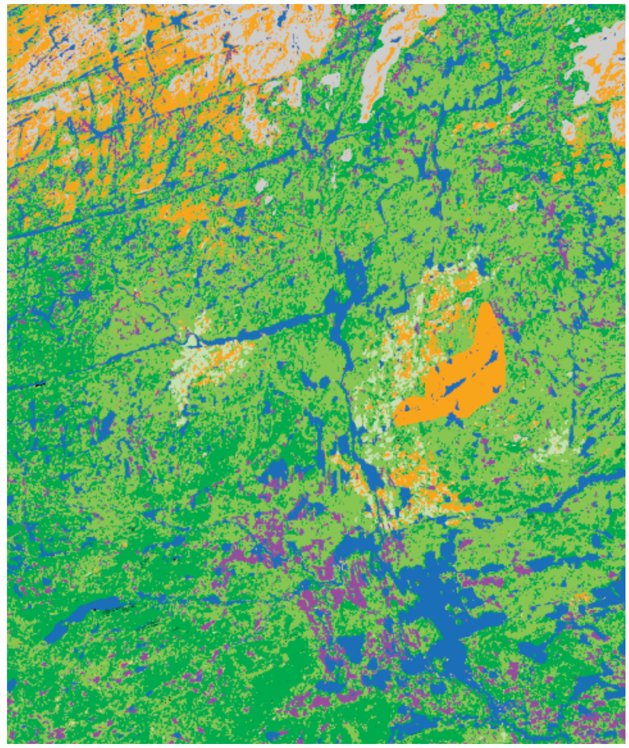


Data source(s): NRCan 2012, Schmelzer and Senecal 2012, NL DNR 2011, NL DNR 2012, Drieman 1993, NL DEC and NCC 2013.
(See Technical Appendix E for more details).

Land cover details that are masked at coarse scales become more apparent at finer scales. Below are examples illustrating the land cover of the Parke Lake area and the St. Paul area. On the left are satellite images; on the right are landcover types, their colours corresponding to those of the Labrador-wide image above.

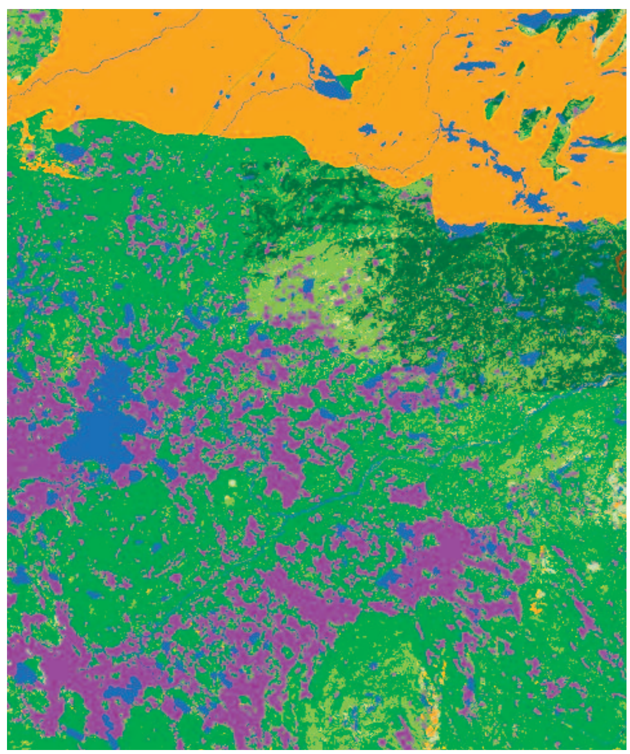


Satellite image, Parke Lake

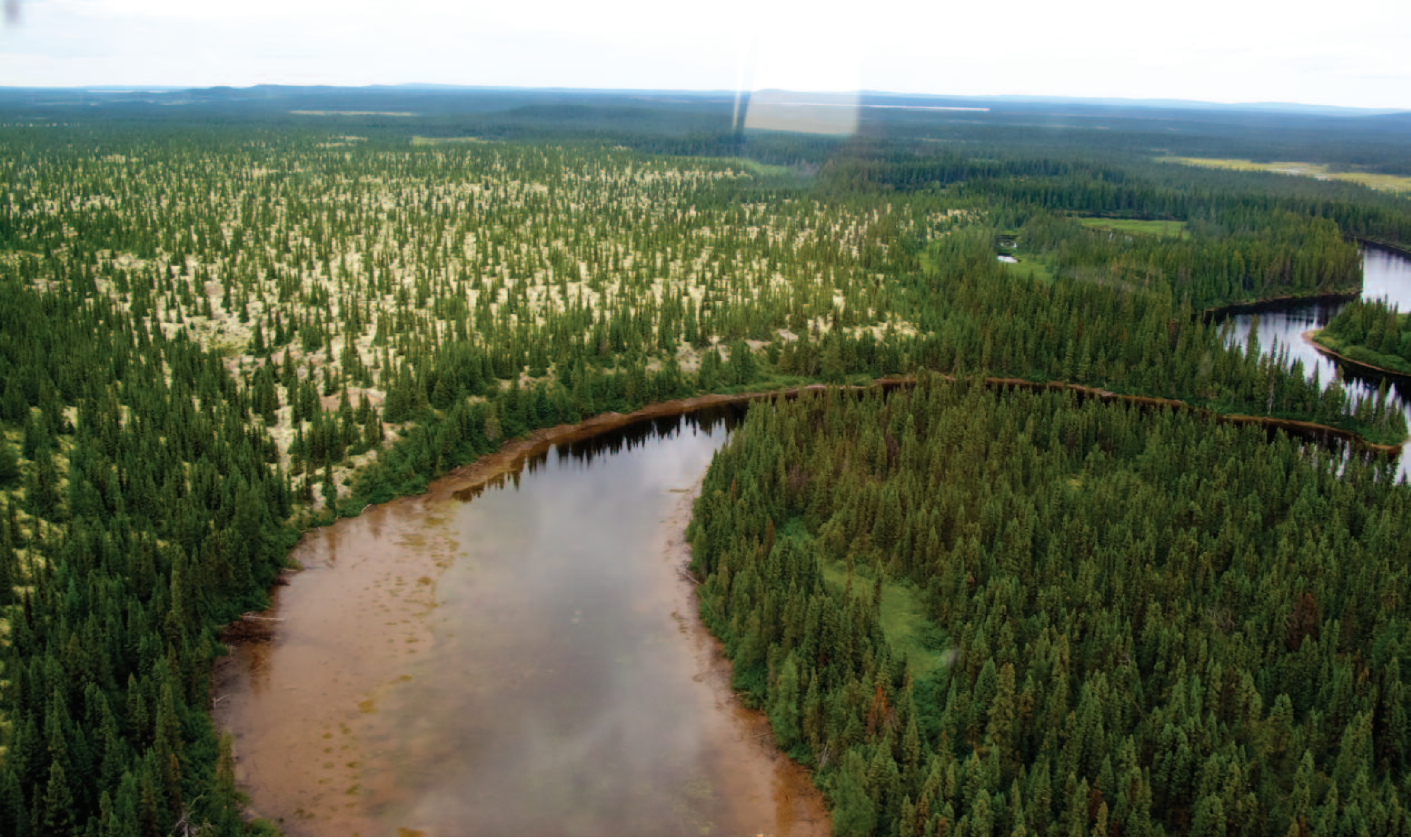


Landform, Parke Lake

Satellite image, St. Paul



Landform, St. Paul



Lichen shrub woodland, Lac Joseph. Isabelle Schmelzer

puniceus), Violets (*Viola* spp.), Bedstraw (*Galium* spp.) and various sedges (Minaskuat 2008e, Meades 1990). This habitat occurs mainly along riparian corridors with fluvial sediments, as well as on river islands (Foster and King 1986, NL DNR and Innu Nation 2012). Drainage ranges seasonally from poor to well-drained. Over time, shrub cover can succeed to forest depending on the frequency, timing and severity of high waters and ice-scour events (Minaskuat 2008e).

Habitats dominated by tall broadleaf shrubs occupy less than one percent of Labrador overall, and 0.2 percent (52,766 ha) of central and southern Labrador (Drieman 1993).

2– Lichen/Lichen-Shrub Woodland. Lichen woodlands and lichen-shrub woodlands have generally sparse Black Spruce, less than 25 percent crown closure (Drieman 1993, Schmelzer and Senecal 2012). However, they vary in individual tree spacing and shrub cover (Hustich 1954, Drieman 1993). Black Spruce can be replaced by White Spruce on northern sites, and Trembling Aspen can be locally abundant. The Black Spruce are bedded in thick carpets of the fruticose lichens *Cladonia rangiferina* and *C. stellaris. C. arbuscula, C. mitis, C. gracilis,* and *Stereocaulon paschale* can also be present. Low shrubs in the understorey can include Dwarf Birch (*Betula glandulosa*), Labrador Tea, and Blueberry. Sheep Laurel is only present in the south. Herbs and mosses are sparse, and Schreber's Moss (*Pleurozium schreberi*) grows at the base of spruces (Meades 1990, Minaskuat 2008e).

Lichen woodlands are typical of the northern boreal on dry, glaciofluvial deposits such as river terraces and eskers. They generally occur on flatter terrain, on well-drained to droughty, nutrient-poor, and sandy soils (Meades 1990, Minaskuat 2008e). Frequent fire maintains their predominance on the landscape (NL DNR and Innu Nation 2012) and even regenerating conifer forests can remain in open lichen woodland for a century (Foster 1983, 1985). Overall this land cover class occupies 5.4 percent of Labrador's total area.

3 – Conifer Sparse/Shrub/Lichen. This land cover type has low to moderate tree-cover densities (10-50 percent cover), with Black Spruce comprising more than three-quarters of conifer trees. The understorey is composed of lichens and shrubs, and ground cover is dominated by fruticose lichens or crustose lichens on rock. Lichen cover is dominated by *Cladonia rangiferina* and *C. stellaris,* and *C. arbuscula, C. mitis,* and *C. gracilis* can also be present. This class is particularly common in Labrador's northern taiga. Our study indicates it occupies 21.8% of Labrador (Meades 1990, Schmelzer and Senecal 2012, NL DNR 2011a, Drieman 1993).

4 – Conifer Open/Feathermoss. These species-poor woodlands have moderate-to-dense tree canopies (25-75 percent cover), with a moss-shrub understorey and generally low productivity. More than three-quarters of trees are conifer, mostly Black Spruce, with Balsam Fir, White Birch or Trembling Aspen also present (Meades 1990, NL DNR 2011a, Schmelzer and Senecal 2012). 'Non-commercial Black Spruce forest' has been previously estimated at 27.6 percent (7,564,092 ha) of central and southern Labrador (Drieman 1993); we estimate it at about 26.5 percent. Black Spruce/Feathermoss woodlands form nearly continuous cover across parts of southern and central Labrador. They occur on well to moderately well-drained sites, ranging from nutrient-poor to moderately nutrient-rich. The forest floor is covered by a thick mat of mosses, primarily Schreber's Moss. A sparse cover of low shrubs includes Labrador Tea, Blueberry (*Vaccinium angustifolium*, V. *myrtilloides*), Sheep Laurel, and Alder (*Alnus crispa*). The herb layer is poorly developed but scattered Bunchberry, Goldthread (*Coptis groenlandica*), Black Crowberry and Northern Comandra (*Geocaulon lividum*) do occur. Stair-step moss, Knight's Plume Moss (*Ptilium crista-castrensis*), Juniper Hair-cap Moss (*Polytrichum juniperinum*), Wavy Dicranum (*Dicranum polysetum*), and *Cladonia* lichens may also be present (Foster and King 1986, Meades 1990, Minaskuat 2008e). Black Spruce – *Sphagnum* woodlands are also found on infertile flats and around poorly drained depressions. They are transitional between conifer swamp and open peatlands and, where the peat substrates are more than 30-40 cm deep, are a type of peatland. Typical understoreys are Leatherleaf and Labrador Tea, *Sphagnum* moss, *Carex trisperma*, and Creeping Snowberry (Minaskuat 2008e).

5 – Conifer Dense. Labrador's denser conifer forests are dominated by Black Spruce and/or Balsam Fir, which account for more than 75 percent of tree cover. White Spruce and White Birch can also be present. Trees are generally taller (>12.6 m) and more mature (> 60 years). The canopies are more closed, with crown cover greater than 50 percent (NL DNR 2011a, Drieman 1993, NL DNR 1975, Schmelzer and Senecal 2012, Meades 1990).

These productive forests occur on uplands in rich to moderate soils. Landforms include glacial tills, colluvium, and glaciofluvial and glaciomarine deposits. Sites range from dry to moist, and can benefit from by seepage on mid to lower slopes. Shrubs are infrequent and ground cover is diverse; Bunchberry, Lily-of-the-Valley (*Maianthemum canadense*), Twinflower, Starflower, Creeping Snowberry (*Gaultheria hispidula*), Bluebead Lily, Partridgeberry, Naked Mitrewort (*Mitella nuda*), Wintergreen (*Pyrola* spp.), Indian Pipe (*Monotropa uniflora*), Large-leaved Goldenrod (*Solidago macrophylla*), Wood Fern (*Dryopteris spinulosa*), Beech Fern, Stair-step Moss (*Hylocomium splendens*), Schreber's Moss, Knight's Plume Moss, Shaggy Moss (*Rhytidiadelphus triquetrus*), and Broom Moss (*Dicranum scoparium*) (Meades 1990, Minaskuat 2008e, Foster 1984, Foster and King 1986). This is key habitat for furbearers like American Marten (NL DNR and Innu Nation 2012).

This forest type occupies a small overall proportion of Labrador. It is concentrated in Forest Management District (FMD) 19A around the lower Churchill River, and surrounding river valleys to the southeast (Hustich 1949b, Meades 1990, NL DNR and Innu Nation 2012). Previous studies estimated it covered less than 3 percent (707,483 ha) of central and southern Labrador (Drieman 1993, Roberts *et al.* 2006). Our study suggests it is about 4 percent.

6– Broadleaf/Mixedwood Dense

Broadleaf Forest. Labrador's broadleaf forests have canopies greater than 70 percent cover, with White Birch often dominant, along with Heart-leaved Paper Birch (*Betula cordifolia*), Trembling Aspen, Balsam Poplar, Balsam Fir, and White and Black Spruce. Broadleaf species comprise more than 75 percent of the trees (Drieman 1993, NL DNR 2011a, NL DNR 1975, Minaskuat 2008e). Species composition varies with available nutrients and moisture. Moist rich sites tend to be dominated by Balsam Poplar, and dry poor sites by Trembling Aspen (Minaskuat 2008e).

Broadleaf forests are scattered on hills and steep slopes with southern exposures. Birch is a pioneer species and can establish itself on unstable slopes. Landforms include glacial till, colluvium, and glaciofluvial and glaciomarine deposits. Birch prefers moderate to well-drained soils and benefits from the warm conditions of south-facing slopes. It is shade-intolerant and requires open sites, such as after wildfire, for regeneration. Regenerating broadleaf forests also occur near coastal settlements, where small logging operations have operated in the past (Foster and King 1986, Meades 1990, Minaskuat 2008e), as well as in areas with more extensive logging (e.g., Grand Lake). Alders, Pin Cherry (*Prunus pensylvanica*), Squashberry (*Viburnum edule*), Willow (*Salix* spp.), Showy Mountain Ash (*Sorbus decora*), Serviceberry (*Amelanchier bartramiana*) and Red-osier occur frequently in the understorey (Hustich 1949b, Foster and King 1986, Meades 1990, Minaskuat 2008e).

The groundcover is lush and species-rich. Species include Bunchberry, Twinflower, Lily-of-the-valley, Bluebead Lily, Goldthread, Wintergreen, Starflower, Haircap moss (*Polytrichum commune*), Bristly Clubmoss (*Lycopodium annotinum*), Wood Fern, and Oak Fern (*Gymnocarpium dryopteris*) (Foster and King 1986, Meades 1990, Minaskuat 2008e). Moisture and nutrients are enhanced by seeps, rivulets and streams (Foster and King 1986, Minaskuat 2008e).

Broadleaf forests are uncommon in Labrador (Roberts *et al.* 2006, Minaskuat 2008e). Areas of concentration include parts of the St Augustin, Alexis and Eagle River valleys (Foster and King 1986) as well as the lower Churchill River valley, particularly the hilly terrain north of Gull Island (Minaskuat 2008e).

Mixedwood Forest. Mixedwood forests also have dense canopies (>70 percent cover), with 25-75 percent of trees broadleaf and the remainder conifer. Trees include White Birch, Black Spruce, Balsam Fir, and occasionally Aspen (Drieman 1993, NL DNR 2011a, NL DNR 1975). When present, Aspen can form an emergent canopy more than 5 m above the canopy. Shrub understoreys may consist of tall shrubs (e.g., Willows, Alder, Squashberry) and young Balsam Fir and Black Spruce. Ground cover may include Schreber's Moss, Stair-step Moss, Knight's Plume Moss, Bunchberry and Twinflower (Foster and King 1986, Minaskuat 2008e). Mixedwood forests are typically found on moderately fertile sites with good to imperfect drainage. They occur in flat areas as well as midslope positions. Soils are similar to those found in broadleaf forests. Parent landforms include glacial till, colluvium, and glaciofluvial and glaciomarine deposits. Moisture and soil nutrients are enhanced by seepage inputs (Minaskuat 2008e).

Combined here as a single class are broadleaf and mixedwood forests of limited distribution. Drieman (1993) estimated these classes occupied only 0.05 percent (12,519 ha) of central and southern Labrador. The present estimate is 0.6 percent of the region. Richer slopes in FMD 19A are dominated by mixedwood forests, including the lower Churchill River valley and those of its tributaries (NL DNR and Innu Nation 2012, Minaskuat 2008e).

7– Burns/Barrens

Burns, Recent and Old. Wildfire is the primary natural disturbance in Labrador and the main driver of forest and woodland succession (Roberts *et al.* 2006). Recent burns include areas burned within the last 40 years, while older burns are those that occurred more than 40 years ago. Dense lichen cover, preferred winter forage for Woodland Caribou, begin to return 40 years after fire (EC 2011). Depending on fire intensity, standing and fallen dead trees, charred duff, seedlings, shrubs and herbs can be present on former burns (Foster 1984a). Overall, present data suggest that 7.4 percent of Labrador has burned over the period records have been kept (NL DNR 2012). Previous estimates were just over 5 percent of the region (Drieman 1993, Roberts *et al.* 2006). Combined, burns and barrens cover about 15.3 percent of Labrador.

Churchill River, Fall. Geoff Goodyear
Coastal Barrens. Lindsay Notzl

George River Caribou Calving highlands. Isabelle Schmelzer

Alpine valley. Isabelle Schmelzer

Barrens. Barrens (heathlands) are exposed, treeless areas, dominated by rock and very poor, shallow soils. Flowering plants, which generally cover less than 10 percent, are broad-leaved, evergreen, and adapted to exposure. *Empetrum* heath is found on exposed coastal sites and offshore islands (Drieman 1993, Hustich 1949b), and is dominated by carpets of Black or Pink Crowberry, Alpine Bilberry, Partridgeberry, Juniper (*Juniperus communis*), Three-toothed Cinquefoil (*Potentilla tridentata*), Bog Goldenrod (*Solidago uliginosa*), Heath Grass (*Deschampsia flexuosa*), Reed-bentgrass (*Calamagrostis pickeringii*), and *Cladonia* lichens (Meades 1990). *Kalmia* heath occurs in southern Labrador, dominated by Sheep Laurel in dense, closed thickets 30-50 cm in height, bedded in mosses and lichens. Typical species are Rhodora (*Rhododendron canadense*), Wild Raisin (*Vaccinium cassinoides*), Mountain Holly (*Ilex mucronata*), Labrador Tea, Serviceberry (*Amelanchier bartramiana*), Bracken Fern (*Pteridium aquilinium*), Schreber's Moss, Stair-step Moss, Knight's Plume Moss and lichens (Meades 1990).

Plants found in Labrador's Strait of Belle Isle, such as Alpine Sweetvetch (*Hedysarum alpinum*), Pendantpod Oxytrope (*Oxytropis deflexa* var. *foliolosa*), Alpine Meadowrue (*Thalictrum alpinum*), and Glacier Sedge, are typical of limestone heath (ACCDC 2011b, Meades 1990).

8 – Alpine. Alpine heath occurs at high altitudes and high latitudes (Drieman 1993, Meades 1990) and is composed of bare areas and low cushions of arctic-alpine

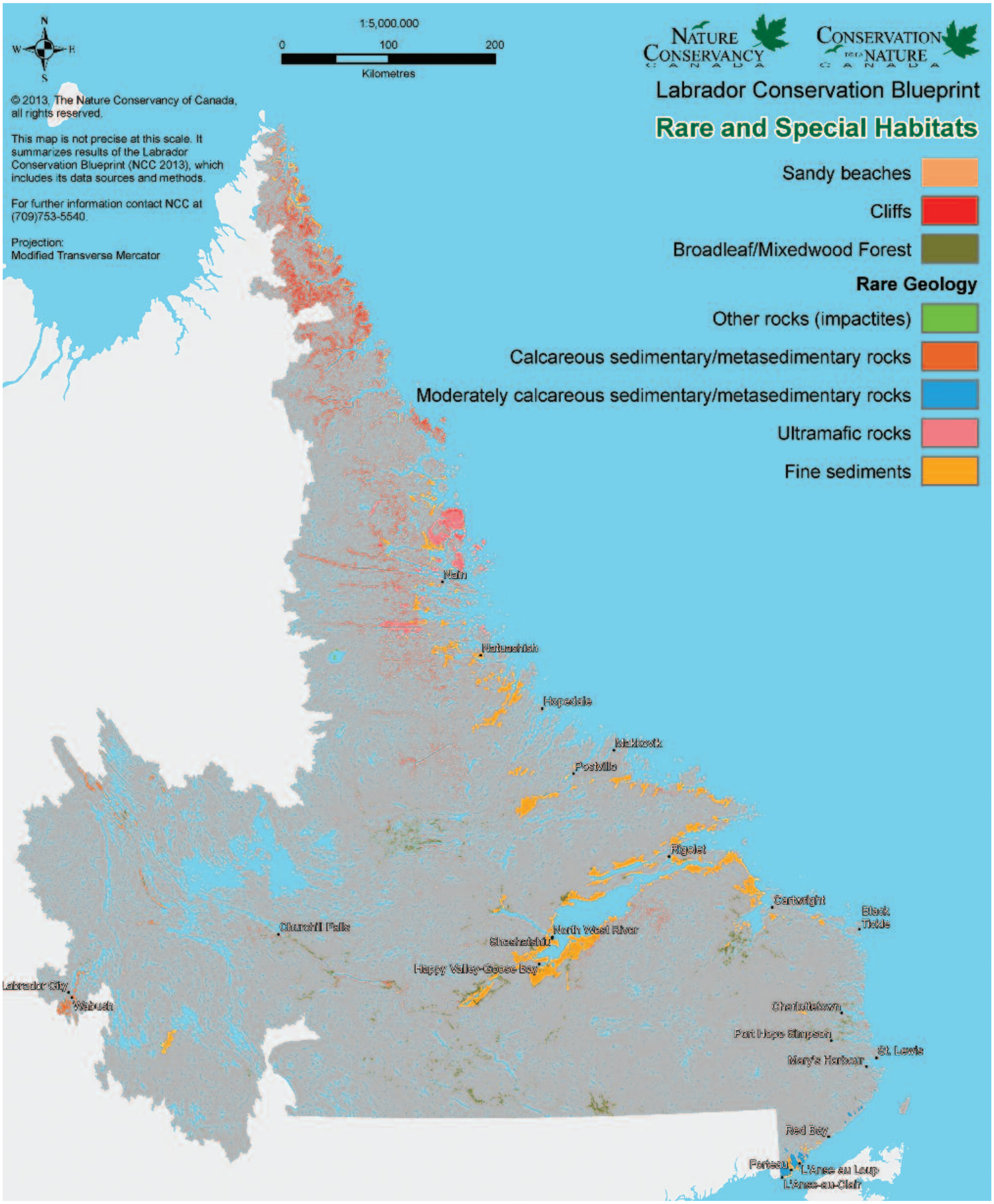
Rhodora plant, right: Rhodora flower, Labrador Tea flower, right: Labrador Tea plants. John Mauder

species such as Pink Crowberry (*Empetrum eamesii*), Purple Crowberry (*Empetrum nigrum* ssp. *hermaphroditum*), Diapensia, Alpine Azalea (*Loiseleuria procumbens*), Alpine Bearberry, Alpine Bilberry, Dwarf Birch, and lichens (e.g., *Cladonia* spp., *Cetraria nivalis*, *Stereocaulon alpinum*, *Alectoria ochroleuca*, *Ochrolechia frigida*) (Meades 1990, Munier *et al.* 2010). Rocky outcrops are common. The transition from krummholz to alpine-tundra vegetation occurs at ~600 m ASL (see Munier *et al.* 2010 for example). About 4.7 percent of Labrador's boreal and taiga consist of alpine habitats (NRCan 2000). Prominent examples include Harp Lake, the Benedict Mountains, the Red Wine Mountains, the McPhayden (Caniapiscau) Plateau, Sims Mountain, the Domagaya uplands, the Romaine Hills, and the Mealy Mountains (Brandt 2009, Lamb 1985).

9 – Cleared. This refers to areas where the predominant land-uses are residential, industrial, or commercial and roads (NL DNR 2011a, NL DNR 1975, Drieman 1992,). The Human Footprint for Labrador was used to define this land cover type, and is presented in Section 1.10. Less than one percent of Labrador has been converted for development, and Labrador remains one of the most intact landscapes in boreal and subarctic Canada (Roberts *et al.* 2006, NL DEC and NCC 2013).

10 – Water. Open, freshwater habitats (e.g., lakes and rivers) cover roughly 13 percent of Labrador's boreal and taiga (NRCan 2012). This land cover class is discussed in more detail in Section 1.8.

11 – Wetland. Wetlands include bogs, fens, swamps, mashes and shallow water (Mahoney *et al.* 2007). About 6 percent of Labrador is wetland habitat, mainly bogs and fens (NRCan 2012). Previous estimates indicated peatlands covered only 3.5 percent of the region (Drieman 1993, Roberts *et al.* 2006). Wetlands are discussed in more detail in Section 1.7.



Data sources: Drieman 1993b, Klassen *et al.* 1992, NL DEC 2009, NL DNR 2011, NRC 2000, NRC 2012, Wardle *et al.* 1997.

1.6.3 Rare and Special Habitats

COASTAL HABITATS

Sandy Beaches, Fine Sediments, Shores, and Marshes

Rare and special habitats include coastal systems such as sandy beaches and fine sediments, Important Bird Areas (IBAs), and sites known to support concentrations of breeding waterbirds. These features are used by the Atlas in the absence of standard descriptive data on coastal habitats that would permit any systematic assessment. For example, there is no available mapping of coastal marshes, either saltwater or freshwater.

The immediate coastal zone extends landward from low tide to the maximum extent of the influence of tides, storms and sea ice. Labrador's coastline is 7,885 km long (GNL 2001) and is characterized by rocky headlands, cliffs and, more rarely, beaches and dunes, salt marshes, and tidal flats. Such habitats occupy less than one percent of Labrador but support a greater proportion of its biological diversity, for example, its rare species and species at risk, concentrations of seabirds and waterfowl, and fisheries (Anderson *et al.* 2006, JWEL 1997b; see 1.3, above).

The distribution of coastal features is related to the angle of exposure to open water, and to wave energy. Much of the coast has high wave energy shorelines, where sediments are sparse or absent, with small, and raised cobble beaches. Lower energy shorelines occur in sheltered areas, where they support sandy beaches, salt marshes, and coarse deltaic deposits (Roberts and Robertson 1986, Rosen 1979, Gilbert *et al.* 1984).

Sandy Beaches, Dunes and Shorelines

Beaches are accumulations of water-borne, well-sorted, sands and pebbles deposited on a shore (Anderson *et al.* 2006). Some rare plants are restricted to Atlantic beaches, including American Beach Grass (*Ammophila breviligulata*), Sea Rocket (*Cakile edentula*), and Northern Gentian (*Gentianella amarella*) (Meades 1990).

The extent of sandy beaches in Labrador is not documented but data suggest an extent of only 52 km^2. Contiguous examples are small; the majority of the 1229 beaches mapped are less than 4 hectares in size (NRC 2012). In comparison to beaches farther south, Labrador's are small, seldom exceeding 20 m wide and 1-2 m in vertical rise (Gilbert *et al.* 1984).

The largest and most significant beach is the 40 km long Porcupine Strand, or *Wunderstrand* of Viking sagas, one of the longest uninhabited beaches on the Atlantic seaboard (Smith *et al.* 2003) and an important stop-over for migrating shorebirds (EC-CWS 2009). The Strand south of the Cape Porcupine headlands extends 15 km from Trunmore Bay to Duck Point and the Strand north of it is 25 km to Fish Cove Point (IBA Canada 2012).

Porcupine Strand. Destination Labrador

Dunes are windblown hills of sand, partially stabilized by plants. Dune plants include Dune-grass (*Leymus mollis*), Sea-beach Sandwort (*Honckenya peploides*), Seabeach Groundsel (*Senecio pseudoarnica*), Sea Lungwort (*Mertensia maritima*), Beach Pea (*Lathyrus japonicus*), Seaside Plantain (*Plantago maritima*), Seaside Sedge (*Carex maritima*), and Baltic Rush (*Juncus balticus*) (Meades 1990). Dune-grass and Sandwort often stabilize beach sands (Gilbert *et al.* 1984, JWEL 1997b).

Coastal dunes are usually low (<50 cm) and sparsely vegetated. Typical species include Red Fescue (*Festuca rubra*), Beach Wormwood (*Artemisia campestris*), Roseroot Stonecrop (*Rhodiola rosea*), Alpine Campion (*Lychnis alpina*), Black Crowberry, Long-stalked Stitchwort (*Stellaria longipes*), sedges (*Carex bigelowii*, *C. mackenziei*, *C. subspathacea*) and willows (Gilbert *et al.* 1984, JWEL 1997a). No region-wide mapping of sand dunes is available for Labrador, although examples have been mapped as part of Environmental Impact Statements (EISs). Future efforts should be made to survey and map them.

Coastal Wetlands and Marshes

Salt Marsh. Labrador's marshes are important breeding, feeding and staging areas for more than 75 species of migratory shorebirds and waterfowl, including 20,000 to 30,000 Black Duck and 1500 pairs of Common Eider. Salt marshes generate more food materials than other wetland systems (Wells and Hirvonen 1988, Roberts and Robertson 1986). Coastal marshes provide key foods for Canada Goose, such as Goose Grass (*Puccinellia phryganodes*), Eelgrass (*Zostera marina*), and sedges. Black Duck and Green-winged Teal feed on invertebrates on Eelgrass, Saltwater Cord-grass (*Spartina alternifolia*) and Orache (*Atriplex* spp.). The shoots of sedges (*Carex paleacea, C. mackenziei*) are also important food sources (Roberts and Robertson 1986). The Saltwater Cord-grass typical of Atlantic Canada's salt marshes is limited in Labrador to the southeast, such as Groswater Bay (Roberts and Robertson 1986). By contrast, Labrador marshes often have Glasswort (*Salicornia europaea*) as a dominant, which is encouraged by waterfowl grazing preferentially on *Carex mackenziei, C. glareosa*, and the tillers of *Spartina* and other species.

Salt marshes are subject to regular inundation, and grade from very little vegetation in the low marshes, to dense supratidal marshes only flooded by exceptional high tides. They are variously covered by more or less salt tolerant plants. Common plants that tolerate salt water include Arrowgrass (*Triglochin maritima*), Marsh Cinquefoil (*Potentilla palustris*), Egede's Silverweed (*Potentilla egedii*), *Carex maritima*, *C. subspathacea*, Baltic Rush, Sea Milkwort (*Glaux maritima*), Seabeach Sandwort, Dune-grass, Beach Pea, Seaside Crowfoot (*Ranunculus cymbalaria*), Glasswort, Spike-rush (*Eleocharis halophila*), Seaside Plantain (*Plantago maritima*), Saltmarsh Flat Sedge (*Scirpus rufus*), and Widgeon Grass (*Ruppia maritima*) (Meades 1990, Roberts and Robertson 1986).

Labrador's salt marshes are valuable and irreplaceable habitats sensitive to human disturbance (Wells and Hirvonen 1988, Goudie 2004). They are rare and small in size (Gilbert *et al.* 1984, JWEL 1997a). They are the least disturbed in Atlantic Canada, with natural disturbances still dominating, such as seasonal grazing by ducks and geese (Roberts and Robertson 1986). Brackish marshes often occur up streams and rivers from the coast, where fresh and salt water mix (Anderson *et al.* 2006). Salt marshes also occur in isolated pockets along Labrador's north coast, particularly on shores of sheltered coves. Arctic salt marshes are limited in species diversity and succession is relatively simple. Northern salt marshes are small in size, generally less that 5-10 m wide and less than 100 m long (Gilbert *et al.* 1984, JWEL 1997a), supporting— such as around Kaipakok Bay — Dune-grass, Arrowgrass, Seabeach Sandwort, Beach Pea, *Carex paleacea*, Baltic Rush, and Sea Milkwort (Meades 1990, Roberts and Robertson 1986). Salt marshes found near Nain were dominated by Goose Grass, Arrowgrass, Silverweed, Red Fescue, *Carex bipartita*, and *Salix humilis* (Gilbert *et al.* 1984, JWEL 1997a).

Carex paleacea. John Maunder, *Salicornia europaea*. Creative Commons

Red-tailed Hawk Chicks. Geoff Goodyear

The extent of salt marsh in Labrador is not documented but has been estimated at 200 km^2, with the largest of them about 13 km^2 (Roberts and Robertson 1986). Many have been mapped but the data are not available in a GIS-compatible format (B. Roberts, *pers. comm.*, 2010). Northern salt marshes are difficult to detect through air photo interpretation or remote sensing, and most have not been mapped (JWEL 1997a).

Known important areas are along the shallow waters of Sandwich Bay, Table Bay, inner Groswater Bay and Lake Melville. These are key habitats for waterfowl and breeding Common Eider (Goudie 2004). One of the largest northern occurrences, known as the Gooselands, is located east of the confluence of Reid Brook and Kogluktokoluk Brook (JWEL 1997a).

Intertidal Marshes and Mud Flats. Salt marshes grade into low, exposed tidal mud flats dominated by Eelgrass and various marine algae. Typical species include Seaside Plantain (*Plantago maritima*), Saltmarsh Spike-rush (*Eleocharis halophila*), Goose Grass (*Puccinellia phryganodes*), and Freshwater Cordgrass (*Spartina pectinata*), all typical of northern salt marshes in eastern Canada (Meades 1990, Roberts and Robertson 1986). Vast areas of mudflat can appear without vegetation and, at low tide, shorebirds congregate, sometimes in vast numbers, to feed on burrowing invertebrates (Anderson *et al.* 2006). This rich food source is essential, especially during fall migration, when birds need access to major enery sources to complete their southward journey (Donaldson *et al.* 2000). In the north, mud flats often develop behind one or more raised boulder beaches (Gilbert *et al.* 1984, Rosen 1979). Sites known to support concentrations of shorebirds during migration include Forteau Beach, Cartwright Harbour, and Table Bay (EC-CWS 2009).

CLIFFS – Fjords, Headlands and Rocky Shorelines

Cliffs. Cliffs and slopes exceeding 30-percent are most prominent in the Torngat Mountains and along the Nachvak, Saglek and Hebron Fjords, as well as the Kaumajet and Kiglapait Mountains. Steep-sided glaciated valleys run west-to-east from Natuashish to Nain, and canyons featuring steep walls include Kogaluk River, Konrad Brook, Anaktalik Brook, Fraser River, and Kingurutik River. Cliffs and steep slopes are less frequent southward but occur along the Adlatok (Ugjoktok) River, especially adjacent to Harp Lake, and in the Churchill River valley (Anderson 1985, Lopoukhine *et al.* 1978,

Forteau. Lindsay Notzl

Meades 1990, NRCan 2000). Cliff faces and steep slopes slough off rock and shed water, and accumulate talus, sediments and nutrient at their bases. Thus, the dry exposed bedrock faces, with little soil or nutrients, contrast with the more moist, nutrient-rich talus below (Anderson *et al.* 2006).

Vertical cliff faces are choice locations for Peregrine Falcon, Golden Eagle and Gyrfalcon, which nest among their ledges and overhangs (Anderson *et al.* 2006, JWEL 1997c). Other species that make use of cliffs for breeding include Merlin, Red-tailed Hawk, and Great Horned Owl (Minaskuat 2008d).

Peregrine Falcons usually select ledges of cliffs between 50 and 200 m in height and several kilometers in length (Holroyd and Banasch 2012). These birds of prey show a high degree of nest fidelity and can re-use nest sites year after year. Alternative nest sites may be located on nearby cliffs within the pair's territory. Six occupied nests were located inland along rivers and lakes in 2005 (COSEWIC 2007b, Holroyd and Banasch 2012).

The majority of Golden Eagle nests documented during extensive surveys in the 1990s were on major cliffs north of 55°N (JWEL 2000). They have also been observed in the Kingurutik River area preying on Harlequin Duck (Heath *et al.* 2001). Two territories are known to occur on cliff habitats within the Churchill River valley (Minaskuat 2008d).

Gyrfalcon breed in arctic and alpine habitats at low densities. Although their primary breeding range is north of 59°N, there are confirmed breeding records in northern Labrador (Todd 1963, Brodeur *et al.* 1995), only one observation in the ACCDC database (ACCDC 2011a).

Headlands, Fjords, and Rocky Shorelines. Labrador's rockbound coasts and fjords consist of moderately to steeply sloping bedrock shores (Gilbert *et al.* 1984), most abundant in areas of granite or mafic bedrock (Anderson *et al.* 2006). Subject to salt spray and wave pounding, these can be dramatic features while the intertidal zone is the haven of various species of algae, barnacles, snails and urchins (Gilbert *et al.* 1984). The lower shore zone, subject to long periods of tidal inundation, forms the habitat of rockweeds, seaweeds, and mussels (Anderson *et al.* 2006).

Coastal cliffs and rocky islands are the preferred nesting habitat of Atlantic Puffin, Razorbill, Black Guillemot, and Common and Thick-billed Murre. Important Bird Areas (IBAs) identified for colonial seabirds include the Bird Islands; Gannet Islands; Northeast Groswater Bay; Quaker Hat Island; and Offshore Islands Southeast of Nain (IBA Canada 2012, EC-CWS 2012). These sites regularly support ≥ 1 percent of the North American or global breeding population, or ≥ 20,000 individuals (≥ 10,000 pairs) of one or more waterbirds (BirdLife International n.d.).

BROADLEAF/MIXEDWOOD FORESTS

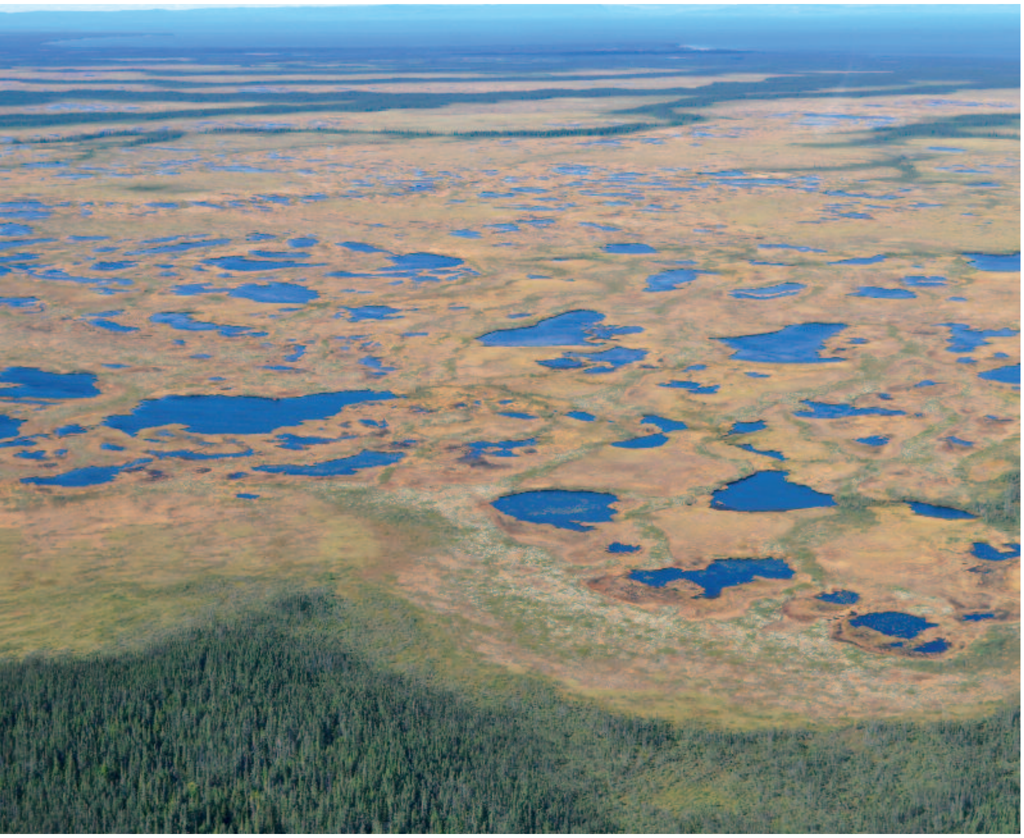
Broadleaf-dominated forests are relatively rare in Labrador (Roberts *et al.* 2006, Simon *et al.* 2000). Labrador's most productive forests occur in ecodstricts such as the Melville Valley, and elsewhere, on deep valley slopes and terraces where well-drained, organic-rich soils have developed. North-facing valleys are characterized by predominantly closed-crown, mixed spruce-fir forests but south-facing slopes support significant broadleaf forests of White Birch and Trembling Aspen, and mixedwood fir-spruce-birch forests. Beginning in the western Churchill Valley, and increasing in size eastward, broadleaf forest occurs on slopes facing south and east. Parts of the Churchill Valley such as downstream of Winokapau Lake and in the Gull Island area are dominated by broadleaf forests of Trembling Aspen, White Birch and Balsam Poplar, and are rich with wood ferns (*Dryopteris* spp.), Beech Fern, clubmosses, Mountain Maple, and Indian Pipe. These are Labrador's most species-diverse forests (Lopoukhine *et al.*1978, Meades 1990, Riley *et al.* 2013). Birds such as Yellow-bellied Flycatcher and Swainson's Thrush are most closely associated with broadleaf forests (Schwab *et al.* 2001, Simon *et al.* 2000). Significant patches of broadleaf forest also occur north of Seal Lake and west of Snegamook Lake, as well as within the Little Mecatina and St. Augustin river valleys, north of the Quebec-Labrador border. These features have been recognized for their uniqueness on the landscape (NL DNR and Innu Nation 2012).

RARE GEOLOGY

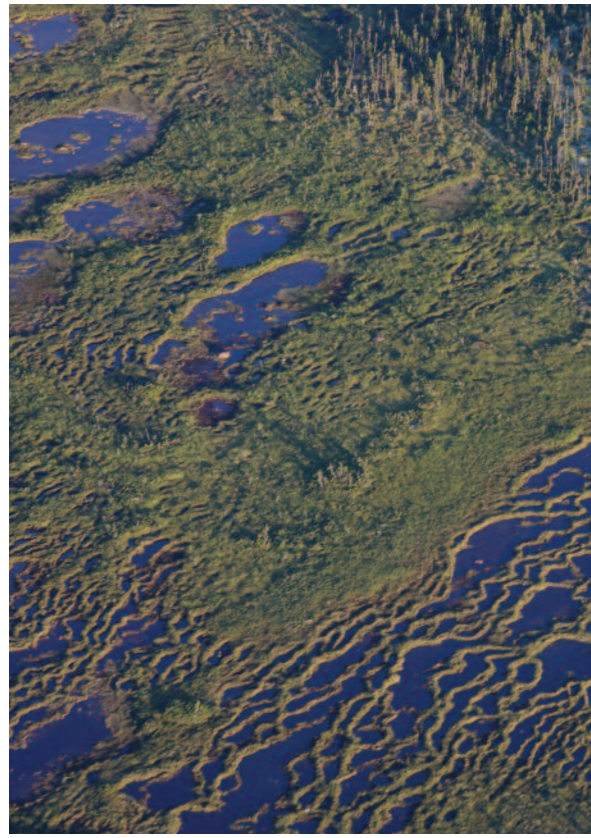
The L'Anse-Amour ecodistrict is defined by limestone barrens unique in Labrador, of Cambrian sandstone and limestone, which support a number of species at the northern limit of their ranges, or as endemics entirely, such as the Rock Vole (Banfield 1974) and rare plant species restricted to limestone substrates, like the provincially-listed Fernald's Milk-vetch. Other calciphiles found here include *Arabis drummondi*, *Asplenium trichomanes-ramosum*, *Astragalus robbinsii* var. *minor, Calamagrostis stricta* ssp. *inexpansa*, *Carex glacialis*, *Carex williamsii*, *Cerastium beeringianum*, *Erigeron elatus*, *Eriophorum brachyantherum*, *Festuca frederikseniae*, *Festuca saximontana* ssp. *saximontana*, *Gentianella propinqua* ssp. *propinqua*, *Hedysarum alpinum, Milium effusum* var. *cisatlanticum*, *Minuartia biflora*, *Oxytropis deflexa* var. *foliolosa*, *Ranunculus pedatifidus*, *Thalictrum alpinum*, *Viola nephrophylla,* and *Viola selkirkii* (ACCDC 2011b).

Forteau coast. Lindsay Notzl

Dolomite and other alkaline sedimentary bedrocks are rare in the interior. Exposures occur in the Wabush ecodistrict, where dolomite is extracted and crushed for use in pelletizing iron ore. Dolomite seams are often adjacent to ironstone deposits, which are actively mined in Labrador City-Wabush and Schefferville. Exposures are known from ridges in the Labrador Trough, where iron ore claims often include adjacent dolomite deposits. A small deposit also occurs within the upper Churchill River valley (Riley *et al.* 2013). These interior exposures have not yet been surveyed for any associated biological anomalies, although exposed shorelines along Attikamagen, Dyke, Marble and Astray Lakes are recommended for targeted surveys (C. Hanel, pers. comm., 2011). Survey work in 2011 found *Dasiphora fruticosa*, *Anemone parviflora*, *Salix vestita* and *Carex capillaris* present at exposed sites underlain by dolomite. Other calciphiles included *Juncus alpinus*, *Carex viridula* var. *viridula*, *Primula mistassinica,* and *Bartsia alpina* (Hanel 2011).



Peatlands, Eagle Plateau. Scott Taylor



Patterned fen, Labrador Trough. John Riley

1.7 WETLANDS

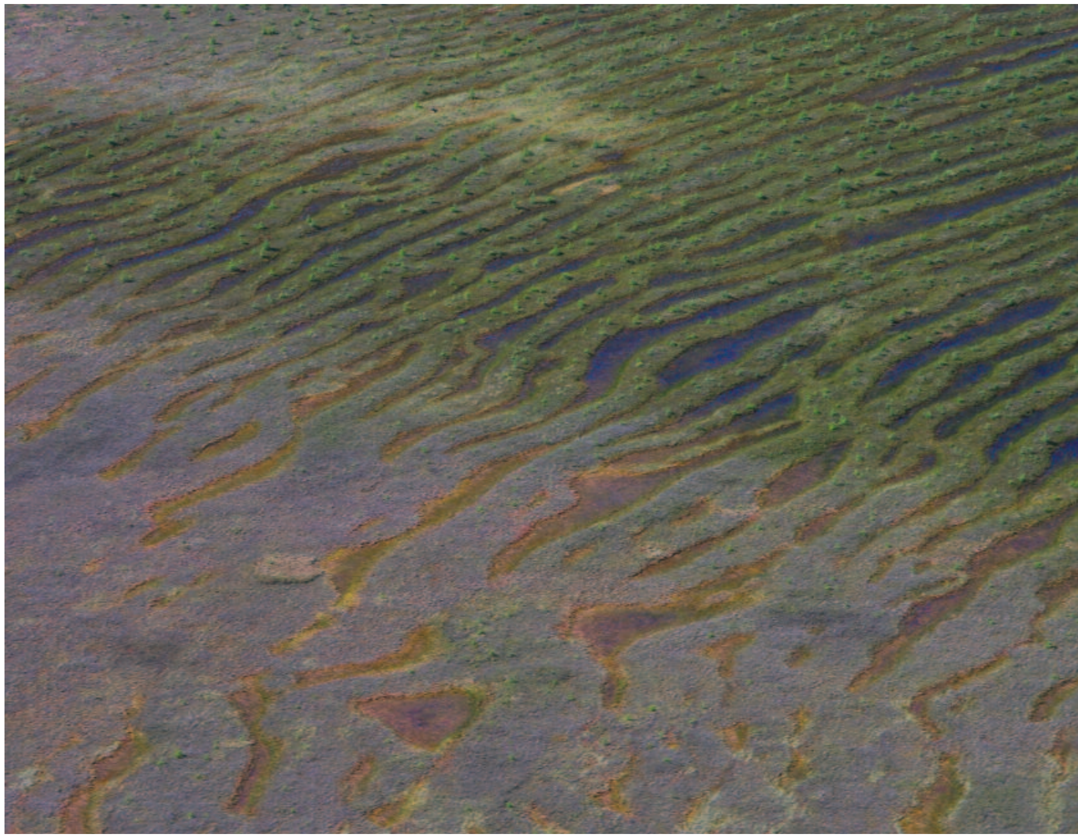
Wetlands are places where aquatic and terrestrial habitats meet. They are either permanently or seasonally wet, and support plants adapted to wet conditions (NWWG 1988). Labrador has large and widespread wetlands, especially peatland bogs and fens (NRC 2012), as well as smaller coastal and estuarine wetlands.

Ecodistricts rich in wetland habitats include St. Paul (20% of total area), Atikonak Lake (19%), Eagle Plateau (17%), Melville Lowland (14%), North Michikamau (13%), and Joseph Lake (12%) (Riley *et al.* 2013).

Wetlands are highly productive and biologically diverse habitats that provide ecological and economic services such as habitat for plants and animals, improved water quality, water storage, flood and erosion control, and carbon sequestration (Bond *et al.* 1992, DUC 2007). Wetlands are some of the most depleted ecosystems on earth; with over half of global wetlands already converted (Mitch and Gosselink 2000). Canada is the steward of about one-quarter of global wetlands (NWWG 1988, DUC 2007).

Five classes of wetlands occur in Labrador: bog, fen, marsh, swamp, and open water (NWWG 1997, Meades 1990). These can be further classified based on surface terrain, patterning, or physiognomy (NWWG 1997, Riley 2011).

Bog. Bogs are organic wetlands with thick accumulations of weakly decomposed peat at least 40 cm thick. They are nutrient-poor, receiving nutrients through atmospheric precipitation, and supporting fewer species than other wetland types (oligotrophic) (NWWG 1997, Meades 1990, Riley 2011). Bogs are dominated by red and brown *Sphagnum* mosses, such as *S. rubellum* and *S. fuscum*, ericaceous shrubs such as Sheep Laurel and Leatherleaf, and lichens of the genus *Cladonia* (Mahoney *et al.* 2007). The trees occurring on bogs are Black Spruce, with some Tamarack. Bog pools have even fewer vascular plants, such as Buckbean (*Menyanthes trifoliata*), *Carex limosa* and *C. oligosperma*, and black mosses (Goudie and Whitman 1987). Palsa bogs are found throughout the permafrost zone south to the Porcupine Strand. These ice-cored wetlands are vulnerable to disturbance, particularly trampling, which can damage the insulating moss and lichen layers, causing meltout and collapse (Goudie 2004).

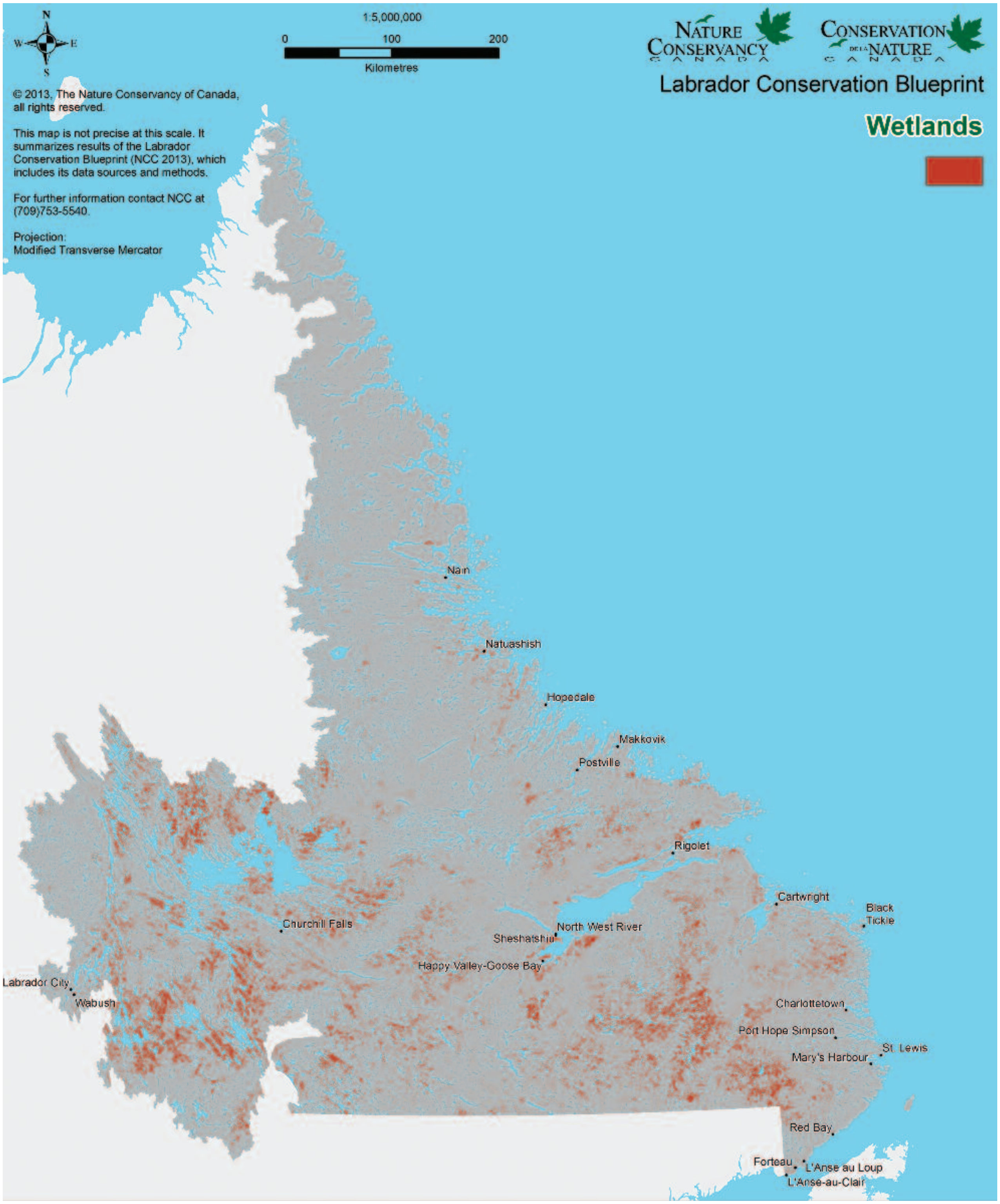


String fen north of Grand Lake. John Riley

Fen. Fens are more nutrient-rich and receive added nutrients through lateral seepage of waters in contact with the underlying sediments (minerotrophic) (Goudie 2004, Meades 1990). They occur as stand-alone peatlands or in combination with bogs, or along pond and lake margins (Goudie and Whitman 1987). Fens support more species than bogs and are often dominated by sedges and by "brown mosses," with fewer *Sphagnum* mosses than bogs. Typical plants include Newfoundland Dwarf Birch (*Betula michauxii*), Sweet Gale (*Myrica gale*), Bottle-brush (*Sanguisorba canadensis*), TaIl Meadow-rue (*Thalictrum polygamum*), New York Aster (*Aster novi-belgii*), Dwarf Raspberry (*Rubus acaulis*), Spatulate-leaved Sundew (*Drosera intermedia*), Bladderwort (*Utricularia vulgaris*), and Club Spikemoss (*Selaginella selaginoides)* (Goudie and Whitman 1987, Meades 1990, Wells and Hirvonen 1988).

Peatlands often contain both bogs and fens, and are difficult to map by remote means, because local patterns relate to subtle changes in basin microtopography and slope. Patterns include "string" and "pool" forms, with bogs occupying raised, ribbed and drier sites, and fens the lower, wetter sites (Mahoney *et al.* 2007). Linear hummocks are usually terraced perpendicular to basin slope (NWWG 1997). In Labrador, fens are particularly frequent north and west of the Smallwood Reservoir (Riley *et al.* 2013). Labrador peatlands are notable for their patterned fens and fen-bog complexes, which provide important breeding habitat for waterfowl and Canada Goose. Patterned fens also support higher diversity and densities of waterfowl (Goudie and Whitman 1987). Plants common to both bogs and fens include Bog Rosemary (*Andromeda glaucophylla*), Leatherleaf, Bog Laurel (*Kalmia polifolia*), Labrador Tea, Pitcher Plant (*Sarracenia purpurea*), Round-Ieaved Sundew (*Drosera rotundifolia*), Small Cranberry (*Vaccinium oxycoccos*), Buckbean (*Menyanthes trifoliata*), and Deer Grass (*Scirpus caespitosus*) (Meades 1990).

Fen Aster, *Aster radula.* John Riley



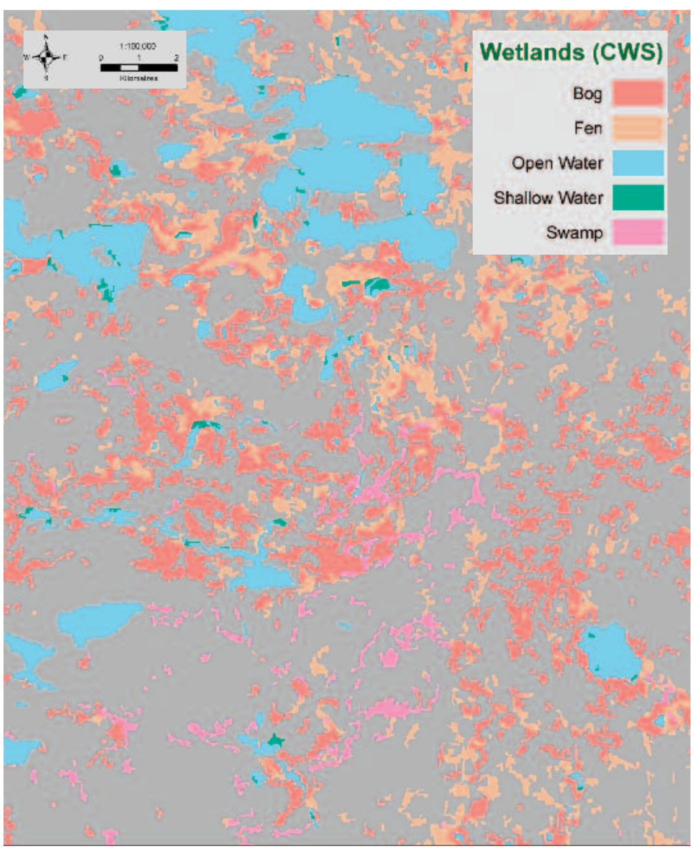
Data source: NRC 2012. (See Technical Appendix F for more details).

Iris versicolor, Equisetum palustre, Carex lasiocarpa, Carex utriculata, Myrica gale. John Maunder

Marsh. The focus here is freshwater marshes (see salt-marsh discussion above, section 1.6.3). Freshwater marshes are mineral wetlands with little or no peat accumulation. They are nutrient-rich, and are found next to periodically flooded rivers, ponds and bays. Marshes are mostly non-wooded, and vegetation is grassy in appearance, composed primarily of sedges, rushes, and grasses (Meades 1990). Plant species characteristic of freshwater marshes include Sweet Gale (*Myrica gale*), Red-Osier, Swamp Birch (*Betula pumila*), Blue Flag (*Iris versicolor*), Tall Meadow-Rue (*Thalictrum polyganum*), Blue-joint grass (*Calamagrostis canadensis*), Bur-reeds (*Sparganium* spp.), Horsetails (*Equisetum* spp.), and sedges (*Carex utriculata, C. lasiocarpa, C. oligosperma, C. aquatilis*) (Meades 1990).

Large freshwater marshes are limited in Labrador (NWWG 1997). They fringe the shores of Lake Melville (Lopoukhine *et al.* 1978), Smallwood Reservoir (Wells and Hirvonen 1988), and lake and river margins in the Eagle, White Bear, North, and English rivers and elsewhere in southern Labrador (Goudie 2004, Wells and Hirvonen 1988). Seasonal flooding often defines their extent, and they are also often created by beaver flooding. They are important for geese and dabbling ducks, especially the rich fluvial marshes of Flatwater Brook, which support hundreds of moulting male Black Duck (Goudie and Whitman 1987). This is one of only a few moulting sites for Black Duck identified in Labrador. Rich river deltas supporting extensive fluvial marshes occurring within the Seal Lake area, particularly Snegamook Lake, are also important for breeding and moulting waterfowl (Goudie 2004).

Satellite image, portion of Minipi Lakes area.



Wetland classification, same portion of Minipi Lakes area.

Data source(s): Mahoney *et al*. 2007.

Open water wetland, western Labrador. John Riley
Nuphar variegatum. Creative Commons
Myriophyllum alterniflorum. John Maunder

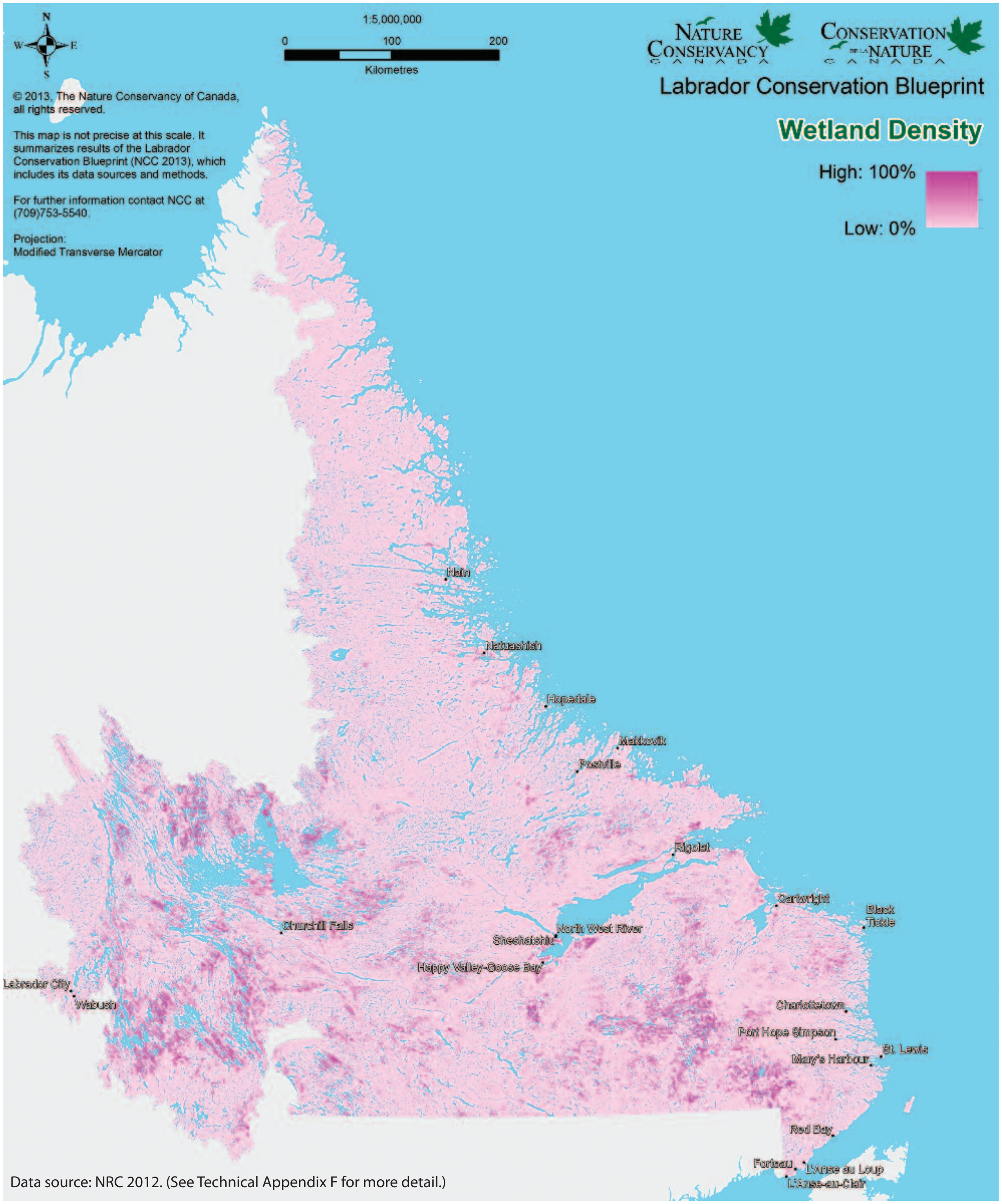
Shallow Water. These wetlands have submerged aquatic plants growing within a shallow waterbody (less than 2 m deep; Mahoney *et al.* 2007, Meades 1990). Vegetation includes totally submerged and/or floating-leaved species such as Yellow Pond Lily (*Nuphar variegatum*), Bladderwort, Mare's Tail (*Hippuris vulgaris*), Water Millfoil (*Myriophyllum alterniflorum*), Pondweeds (*Potamogeton* spp.), and Quillworts (*Isoetes* spp.) (Meades 1990).

Thicket swamp. Jon Feldgajer

Swamp. Swamps are nutrient-rich, mineral wetlands adjacent to seasonally inundated rivers, streams or ponds. They are dominated by Alder (*Alnus* spp.) and Willow (*Salix* spp.) and generally have rich herb understoreys. Other shrubs like Mountain Maple (*Acer spicatum*) are rare. Scattered trees can include Balsam Fir, White Spruce, White Birch, and Balsam Poplar. Conifer swamps are less common (Mahoney *et al.* 2007, Meades 1990). In Labrador, swamps are restricted in their overall extent. Important swamp areas flank the large rivers in the Seal Lake and Eagle River areas, and support rich habitat for breeding and moulting waterfowl. Extensive shrub swamps interspersed with fluvial marshes are found along the network of lakes, ponds and peatlands on the Eagle Plateau, especially along the Paradise River. Swamps are particularly abundant on lake deltas and river meanders (Goudie and Whitman 1987, Goudie 2004).

1.7.1 Wetland Density

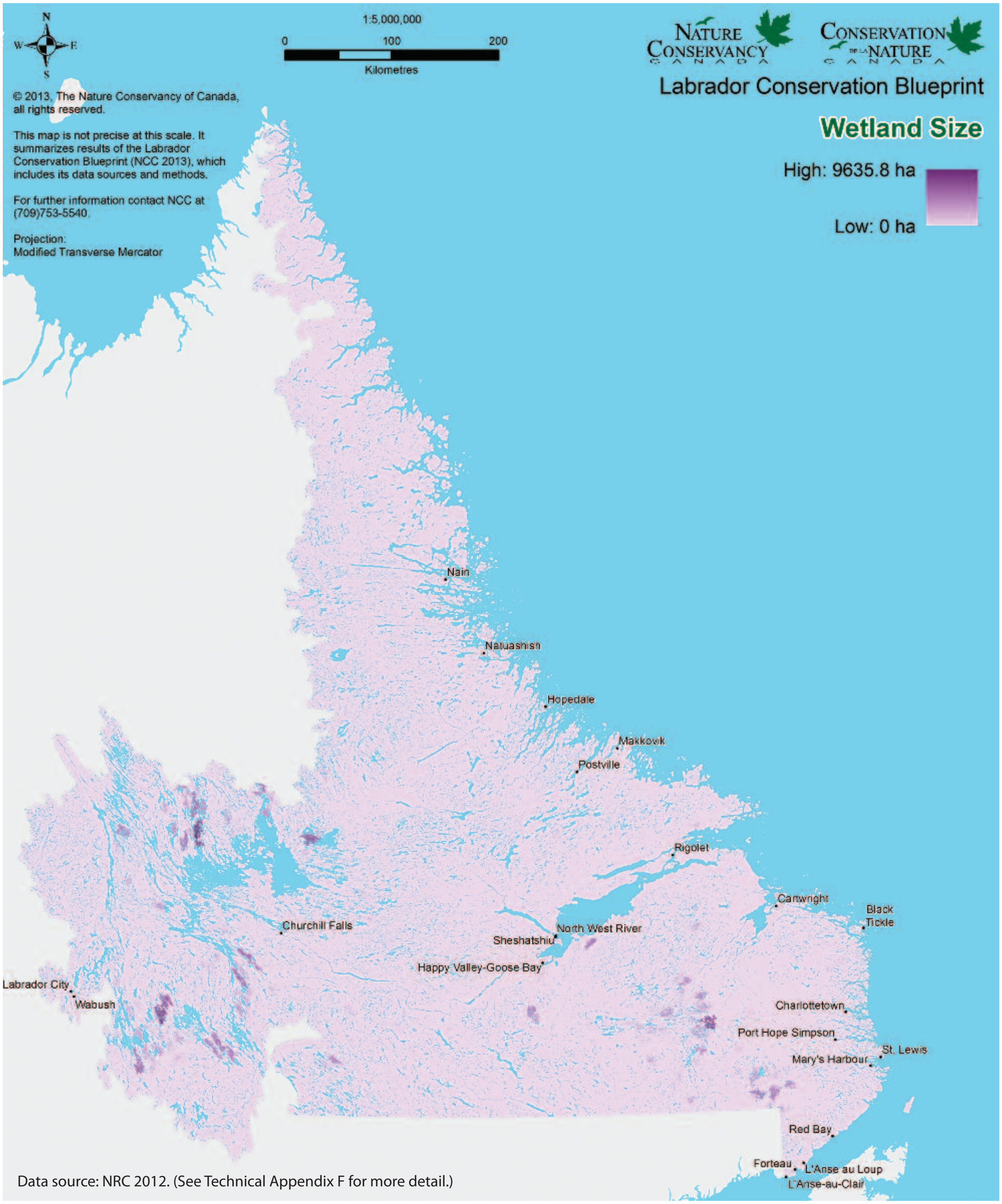
Wetland density is a measure of the extent of wetlands as a percentage of the total area (per km^2). Thus areas with a value of 100 percent are areas entirely occupied by wetlands, while those with a value of 0 percent have no wetlands at all. Ecodistricts with the highest wetland densities include: Eagle Plateau, St. Paul, North Michikamau, Atikonak Lake, Lac Joseph and Goose River (Riley *et al.* 2013).



Data source: NRC 2012. (See Technical Appendix F for more detail.)

1.7.2 Wetland Size

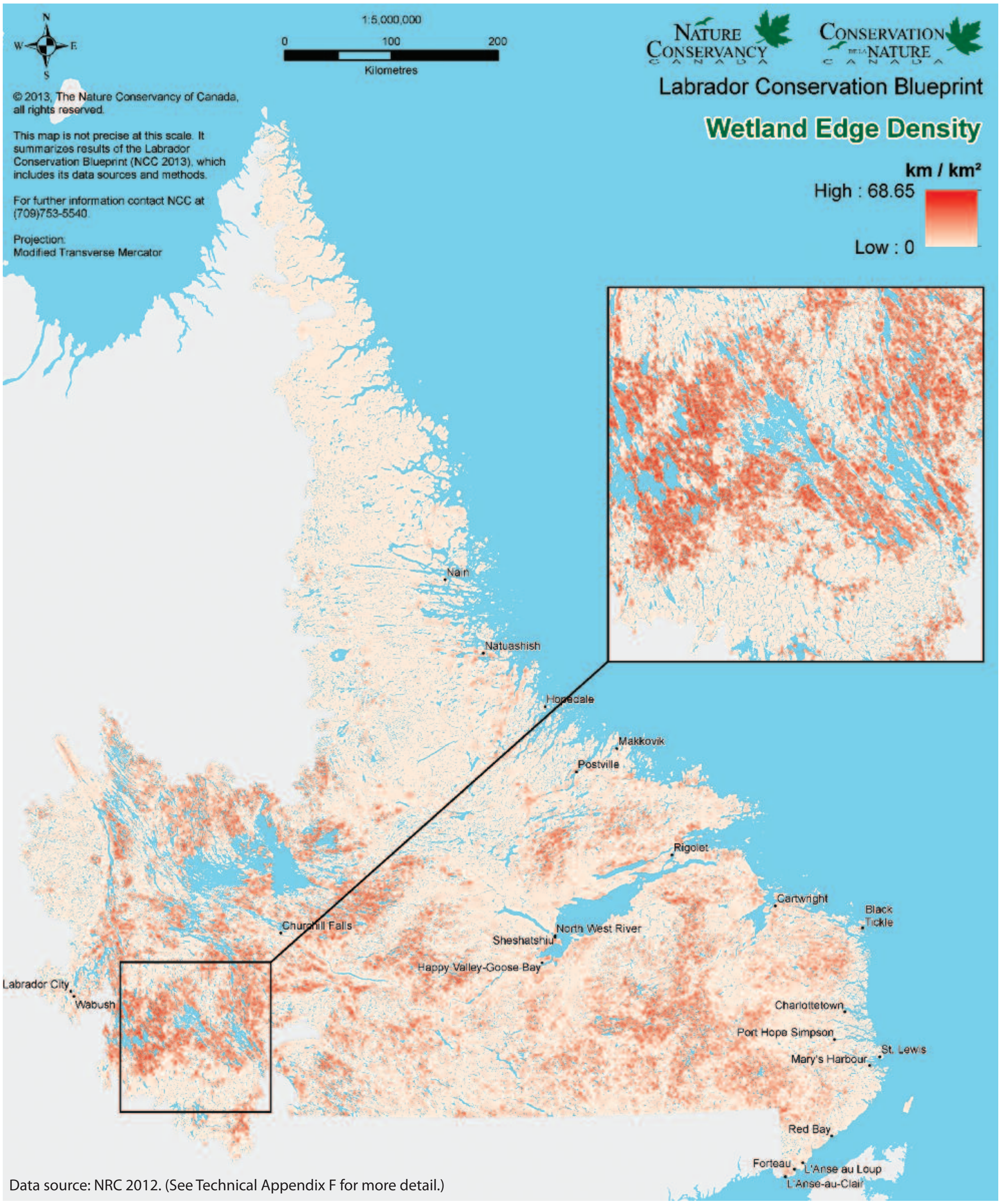
The largest wetland in Labrador occurs near Woods Lake, north of the Smallwood reservoir, and is 96 km² in size. However, overall, average wetland size is less than 1 km². Other large wetlands are found west of Lac Joseph (88 km²), south of Fraser Lake (76 km²), southeast of Ossokmanuan (65 km²), and in the Eagle (80 km²) and St. Paul River headwaters. These are also areas of high wetland density, with many wetlands adjacent to one another (NRC 2012).



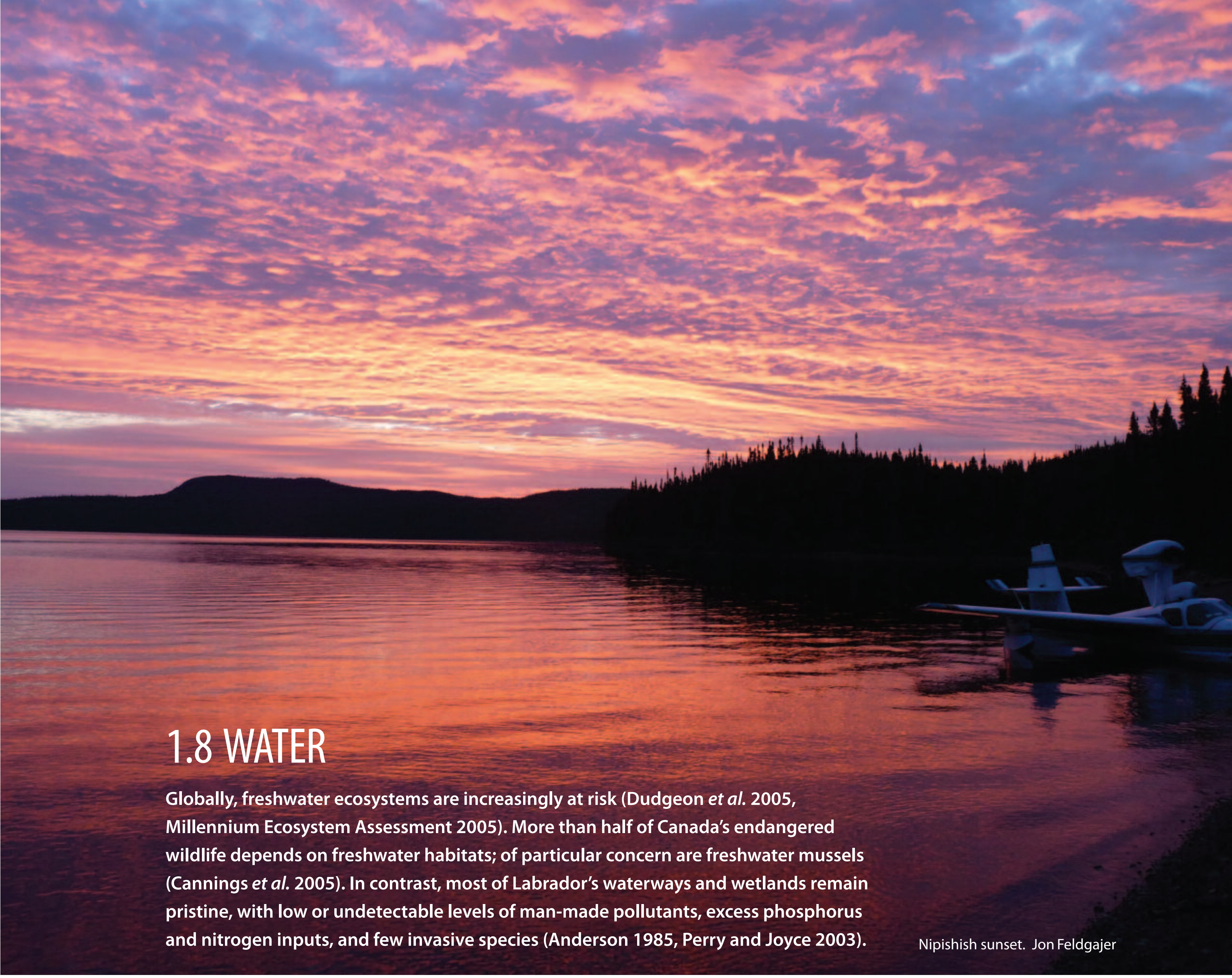
Data source: NRC 2012. (See Technical Appendix F for more detail.)

1.7.3 Wetland Edge Density

Wetland edge-density measures wetland edges, both the aquatic-terrestrial ecotones of the external edges of wetlands, as well as the internal edges created by pools of open water. Wetland edge-density is measured in km/km^2. The highest wetland edge-density in Labrador is nearly 69 km of edge per square kilometer. Biodiversity is often greatest at ecotones, and wetland edge-density may be a useful metric for biodiversity planning (NRC 2012).



Data source: NRC 2012. (See Technical Appendix F for more detail.)



1.8 WATER

Globally, freshwater ecosystems are increasingly at risk (Dudgeon *et al.* 2005, Millennium Ecosystem Assessment 2005). More than half of Canada's endangered wildlife depends on freshwater habitats; of particular concern are freshwater mussels (Cannings *et al.* 2005). In contrast, most of Labrador's waterways and wetlands remain pristine, with low or undetectable levels of man-made pollutants, excess phosphorus and nitrogen inputs, and few invasive species (Anderson 1985, Perry and Joyce 2003).

Nipishish sunset. Jon Feldgajer

Labrador represents a global opportunity to sustain and manage functioning aquatic ecosystems at large scales, conserve their rich biological diversity, and ensure the ecosystem services they provide continue to do so into the future (PEG 2011).

Canada's boreal forest is the most water-rich area in the world (PEG 2011). Large lakes over 10 km^2 in size include Mistastin (15,620 ha), Nipishish (10,100 ha), Kingurutik (8,910 ha) Snegamook (8,290 ha), Esker (4,320 ha), Michael (2,589 ha), Cabot Lake (2,440 ha), Iglusuataliksuak (2,410 ha), Shipiskan (2,330 ha), Tasiuyak Tasialua (2,330 ha), Umiakorvik (1,550 ha), Gilbert (1,296 ha), Tasialuk Lake (1110 ha), Umiakoviarusek (1,110 ha), and Komaktorvik (1,000 ha) (Anderson 1985).

In southern Labrador, the Pinware, St. Lewis, Alexis, Paradise, Eagle and North rivers each drain areas larger than 2,000 km^2 in size, while those of the Kanairiktok, Adlatok and Kogaluk Rivers to the north, exceed 5,000 km^2. Large rivers draining the Western Labrador plateau include the Crooked, Beaver and Goose. The Kenamu, Kenmich and English Rivers flow from the Mealy Mountains. Rivers north of Nain flow through steep valleys or gorges, some with vertical cliffs over 300 m high (Anderson 1985).

The majority of Labrador's rivers remain free-flowing, without obstructions to fish migration (Perry and Joyce 2003). Rivers impacted by dams and diversions include the Churchill, Naskaupi and Kanairiktok, whose headwaters were diverted to the Smallwood Reservoir in the early 1970s (Anderson 1985).

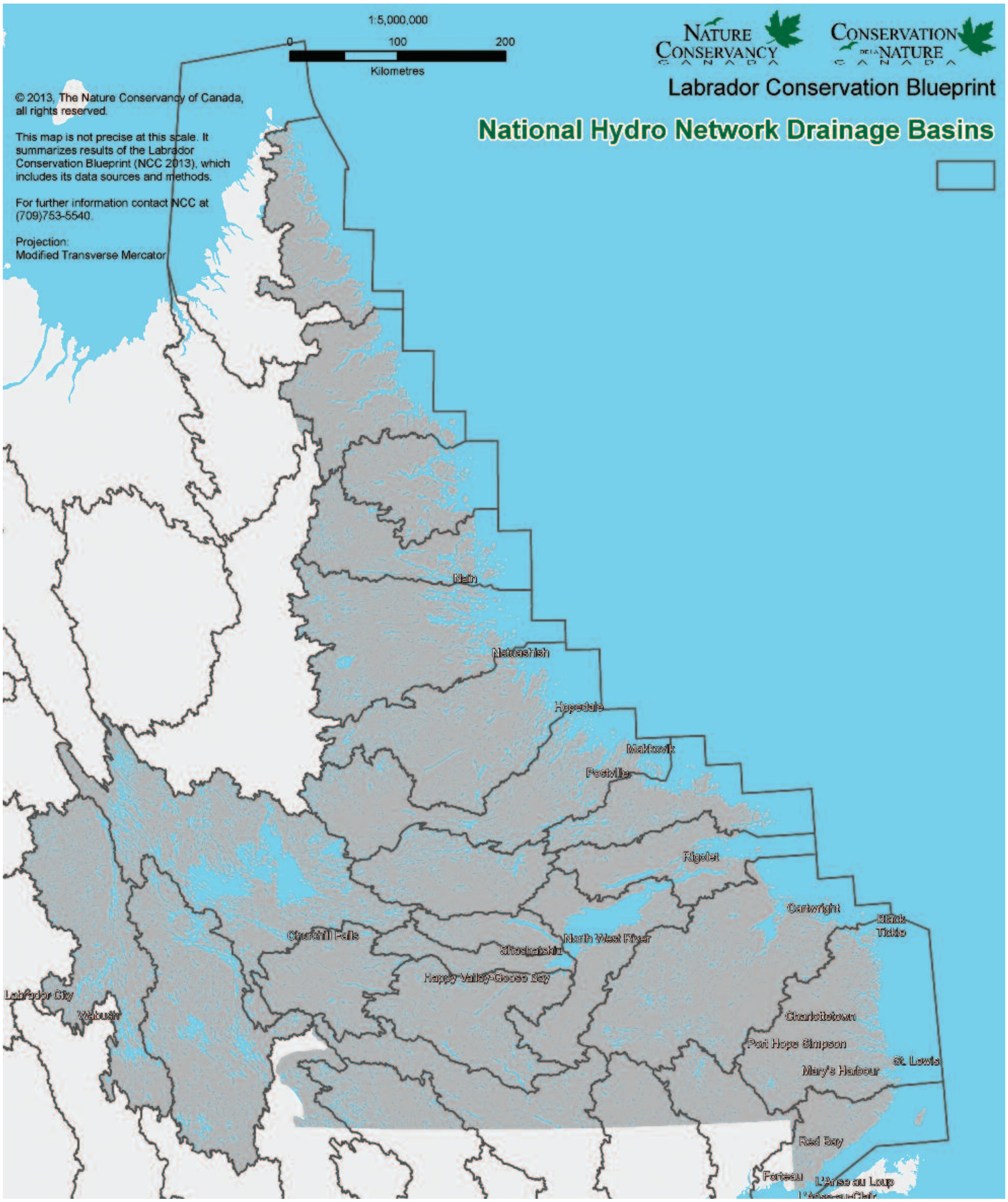
(The terms "basins" and "catchments" are often used interchangeably but they have clearly different meanings in aquatic sciences (Kang Tsung-Chang 2008). Here they are used to refer to their relative, nested scales in hydrological classification (Maidment 2002).)

Eagle River Rapids. Valerie Courtois

Lac Joseph. Isabelle Schmelzer

1.8.1 Drainage Basins

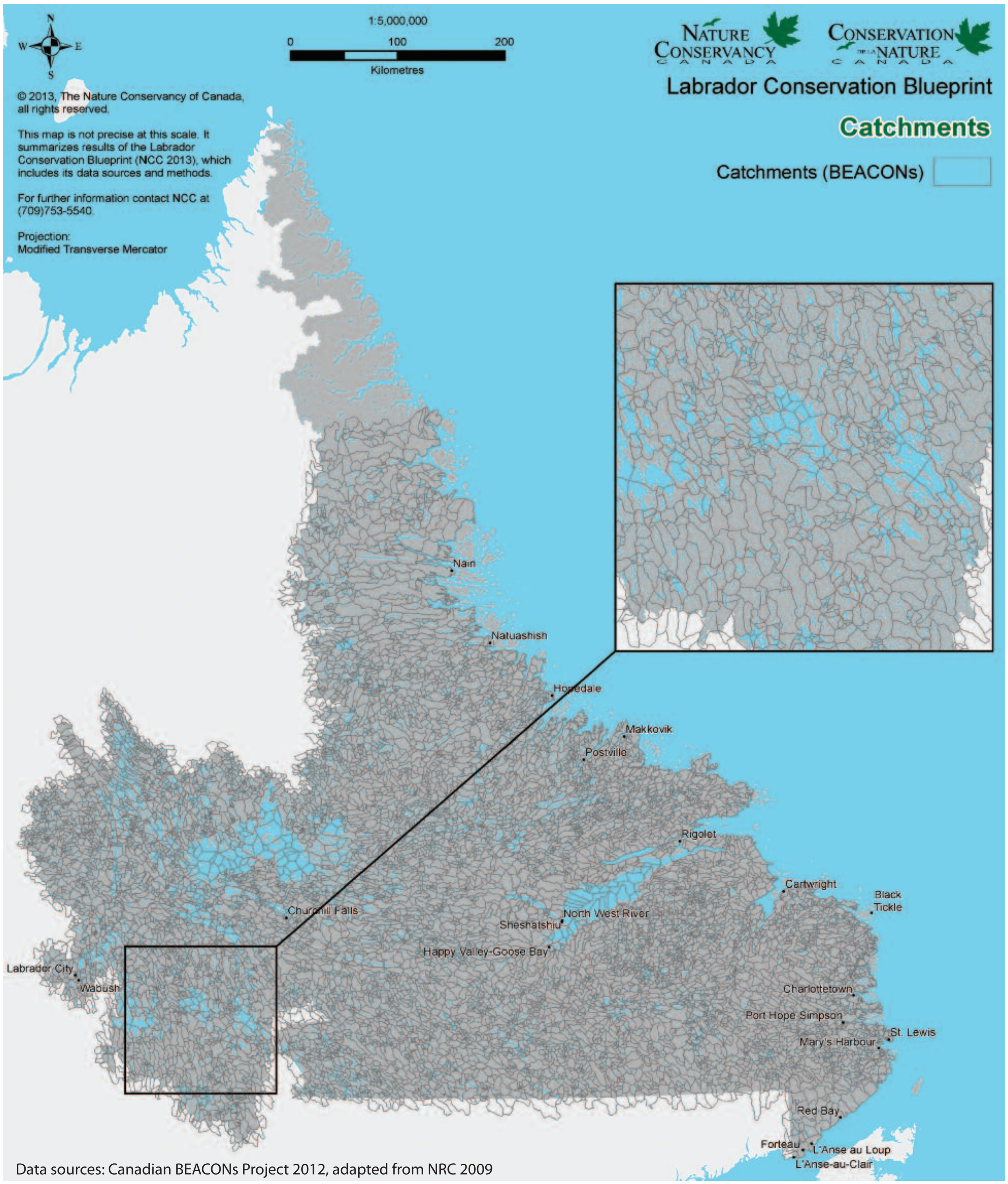
A drainage basin is an area where the surface runoff drains into a single major stream, river, reservoir, lake, or other waterbody (Kang Tsung-Chang 2008). Labrador has 34 large drainage basins draining into the Atlantic Ocean or the Gulf of St. Lawrence. They range in size from 3,963 km^2 (Grand Lake) to 31,463 (Little Mecatina which flows to Quebec's lower north shore). The Smallwood Reservoir drainage basin totals 30,408 km^2 (NRC 2007b). As many as eight stream orders can flow into a large river basin (Schindler and Lee 2010).



Data source: NRC 2007b

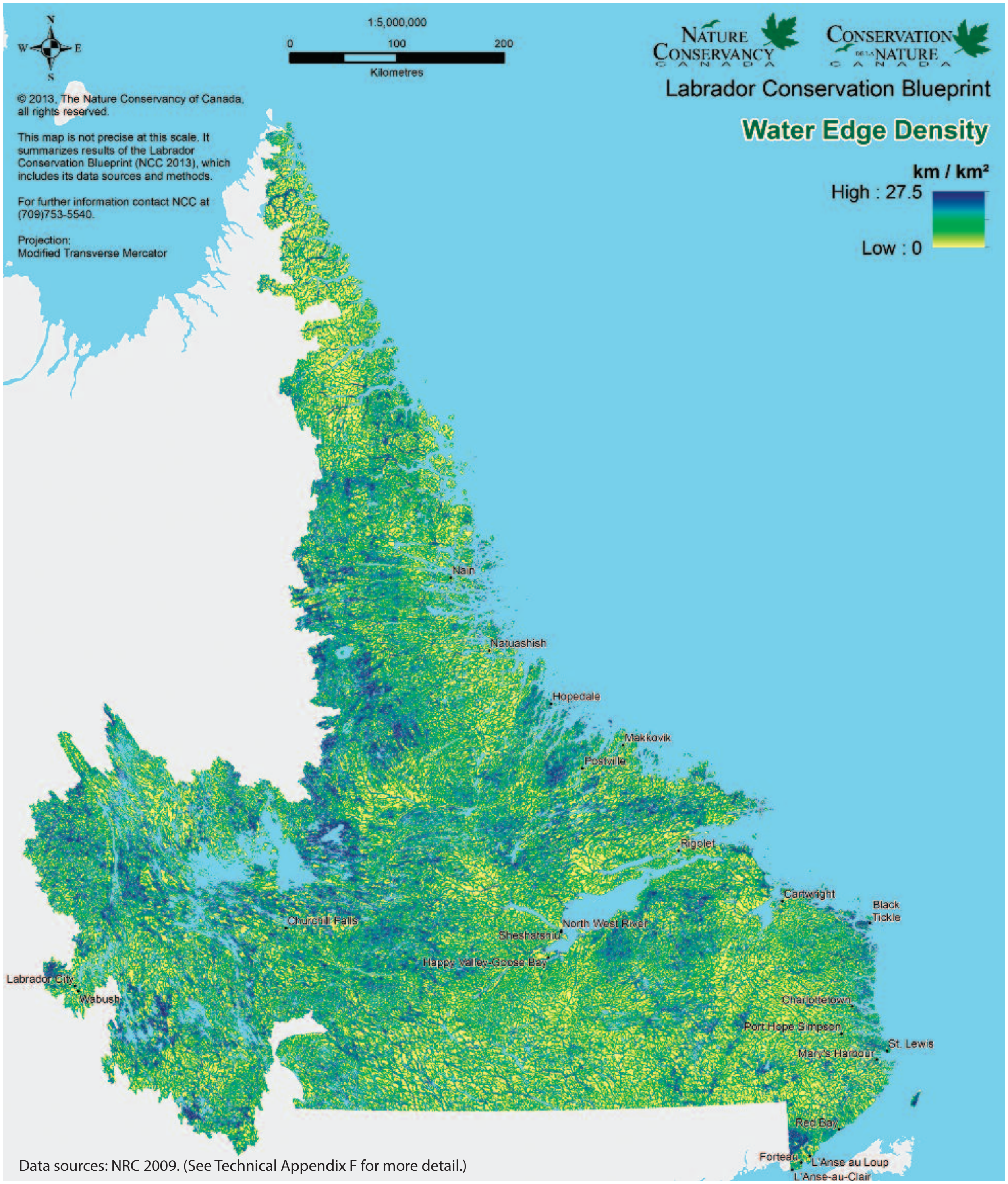
1.8.2 Catchments

A catchment is a limited drainage area located above the confluence of every individual stream segment (Kang Tsung-Chang 2008). Individual stream segments are separated along waterways by every stream junction. Water flow and aquatic diversity tend to increase as stream order increases, due to the inclusion of larger and more heterogeneous upstream catchments (Schindler and Lee 2010). Labrador's Boreal and Taiga Ecozones have 12,521 catchments, ranging in size from 1 km^2 to 501 km^2 (mean 23 km^2; BEACONs 2012). Conservation planning for boreal freshwater resources often focuses on catchment-level scales (BEACONs 2013).



1.8.3 Water's Edge

Water-edge density is a measure of "nearness-to-water" or "riparian-ness." It measures the land-to-water edge in kilometers per square kilometer. Riparian areas are biological "hot spots" and key areas for wildlife activity. They concentrate and provide nutrients, and control water, sediment and nutrient flows, which are important for fish and other aquatic organisms (NL DNR and Innu Nation 2012). Water-edge density varies across Labrador and the area with the highest water-edge density is Labrador has nearly 28 km of shoreline per square kilometer.



Data sources: NRC 2009. (See Technical Appendix F for more detail.)

Forest fire. NL Dept.of Natural Resources

1.9 NATURAL DISTURBANCE

1.9.1 Wildfire

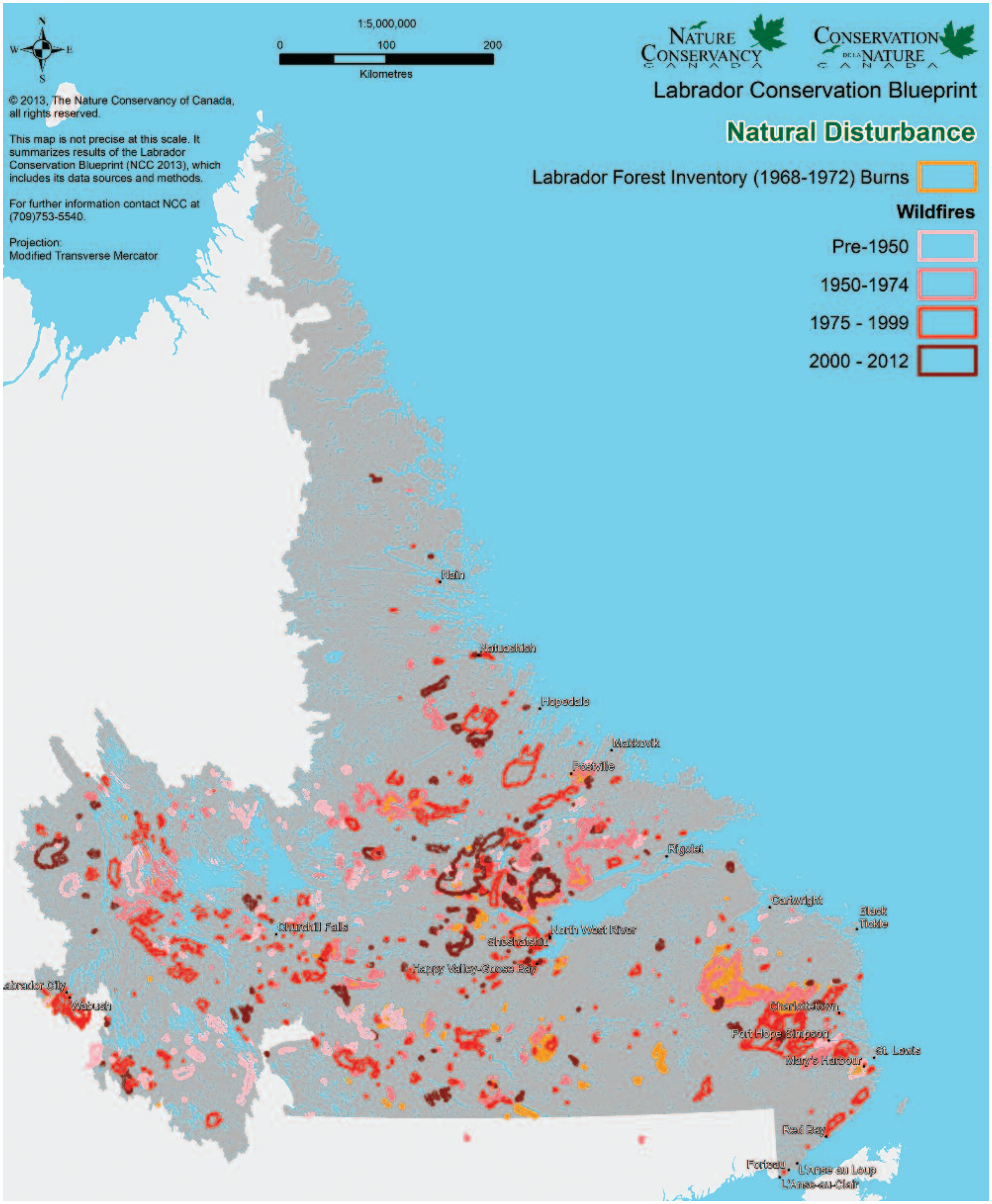
Wildfires burn freely in Labrador except where suppression is required around communities and infrastructure. Lightning is the ignition source, with the frequency of wildfires decreasing at higher latitudes and elevations.

Large fires may start as early as June, and, under favourable conditions, burn late into autumn, when they are extinguished by rain or snow (Foster 1983). The average fire size is 23 km^2; the largest recorded fire occurred west of Port Hope Simpson in 1958 burning 1,375 km^2. Roughly 7.4 percent of Labrador's land area has burned since 1950, including a few historical fires (NL DNR 2012a). The patterns and frequencies of wildfire help distinguish ecodistricts (see Riley *at al.* 2013).

Labrador's boreal forests and taiga woodlands depend on fire to regenerate (Foster 1983, Foster and King 1986). Although wildfires may be less frequent than in Canada's western boreal (Simard 1973), much of Labrador is dry terrain, of droughty rocklands, sand plains, and glaciofluvial deposits. Wildfire operates at multiple scales, controlled in extent, distribution, and effect by local weather events and by landform and biological features such as wetlands (Foster 1983, Sturtevant *et al.* 2009, Pham *et al.* 2004).

The fire-return interval (time between fires) has been estimated as long as 500 years in southeastern Labrador, which is 3 to 10 times longer than in drier parts of the boreal (Heinselman 1981, Foster 1983). The long fire rotation has been attributed to wetter maritime climates (Foster 1983, Foster and King 1986) but slow regeneration — and slow rebuilding of fuel levels — also contribute to long fire rotations.

Fire does not behave identically throughout Labrador. Areas with different landforms have different fire regimes. Areas such as the Eagle Plateau, which are blanketed by extensive peatlands and myriad lakes that serve as natural fire breaks, have a low fire incidence and a long fire rotation. Fires that do occur are small, patchily



Data sources: NL DNR 2012, NL DNR, and NCC 2012, aggregated and classified by date of burn

Lichen woodland ignites. Chris Griffin

Recent burn at Goose River. Isabelle Schmelzer

distributed, and of short duration. In areas where topography is varied and wetlands are scarce (such as the watersheds of the Alexis, Paradise, and St. Augustin rivers), fires exceeding 300 km^2 are common. Abundant and relatively large fires produce a pattern of re-burns at short time intervals. For example, large areas within the Paradise River watershed that burned in 1951 and 1959 had previously been burned in 1890. Re-burns often occur in open woodlands regenerating from previous burns rather than in mature, unburned forested areas (Foster 1983). Many Labrador sites, such as around Nipishish Lake, show evidence of up to 3 or 4 overlapping fire events (Riley *et al.* 2013). Wildfires exceeding 1000 km^2 are of ecological consequence where they occur. Some parts of Labrador have long periods of low fire incidence, which can be punctuated by "major fire years" when large fires burn immense areas (Foster 1983).

Deciduous and closed-canopy conifer forests, with moist, drought-resistant understoreys, are relatively resistant to fire and can act as firebreaks (Foster 1983). In contrast, lichen woodlands of open Black Spruce, scattered ericaceous shrubs, and nearly continuous cover of *Cladonia* lichens, are highly flammable. Fires can move selectively, seeking out most flammable areas (Foster 1983). Lichen woodlands and first-growth stands of White Birch and Trembling Aspen are correlated with areas burned within the last 130 years. Lichen woodlands can begin to develop 40-90 years after fire, leading to eventual dominance by *Cladonia mitis*, *C. rangiferina*, and *C. stellaris*. As tree canopy closes, lichens are overgrown by feather mosses and *Sphagnum* species. Birch can persist as the canopy tree for up to 80 to 100 years, after which they are replaced by fir and Black Spruce (Foster 1983).

1.9.2 Insect Disturbance and Wind

Insect outbreaks and wind also play a role in forest succession. As well, when the fire interval exceeds the lifespan of trees, individual trees die off, and sites are more prone to wind damage, creating large or small canopy gaps (Pham *et al.* 2004). Infestations by insects such as Spruce Budworm (*Choristoneura fumiferana*) and Larch Sawfly (*Pristiphora erichsonii*) cause tree mortality on an episodic basis (Blais 1983). The Larch Sawfly is an introduced pathogen, and the future effects of introduced tree pathogens, climate change and forest harvesting are uncertain (Sturtevant *et al.* 2009).

Spruce Budworm. DNR

Nunatsiavut. Chris P. Sampson

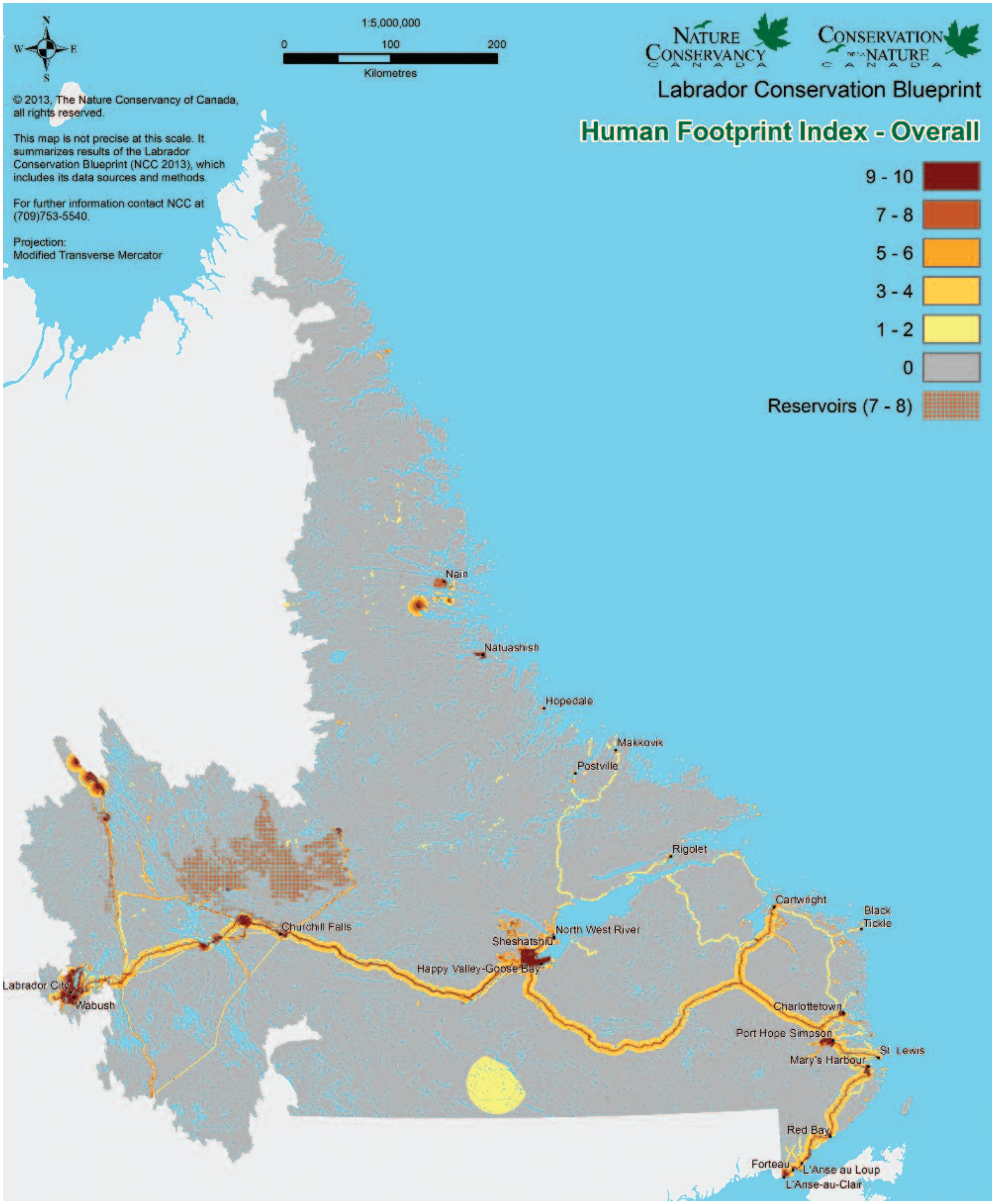
1.10 HUMAN FOOTPRINT

To estimate the extent of human influence, human activities that significantly affect the natural landscape were mapped for Newfoundland and Labrador.

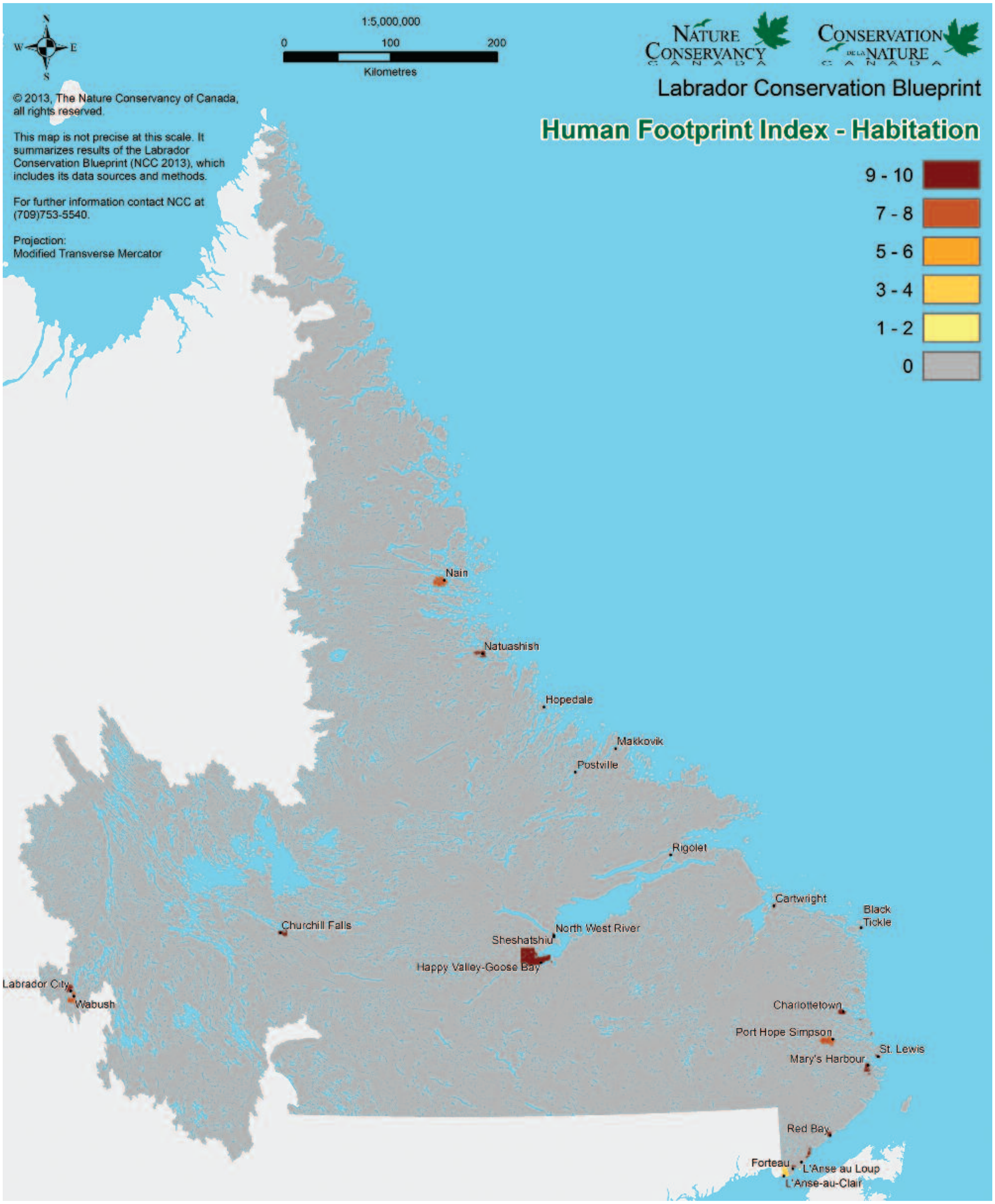
The NL Human Footprint includes five general categories of land uses and activities:

1. Human habitation
2. Access roads and trails
3. Power generation and distribution
4. Resource development activities
5. Military/Aviation/Communications (Labrador only)

For each of the five categories, scores were assigned that range from zero (no influence) to 10 (high impact). For some land uses, there are zones of decreasing effect away from land use itself. To map these, buffers of different widths were extended outward from the land use and assigned a decreasing score. For example, roads were assigned a maximum score for the road bed, where the land has been converted. Within 100 to 500 metres of the road, where there are associated noise, water and pollution effects, a lesser score was assigned. From 500 to 1000 metres from the road, where indirect impacts may occur from fishing, hunting and firewood cutting, a lower score was assigned. Where more than one type of land use overlapped, such as where an area adjacent to a road is part of an urban area, the scores were added up to a maximum score of 10. It is important to note that such generalized mapping cannot be considered accurate at local, fine scales.



Source: NL DEC and NCC 2013. The methods, data and scoring system for the analysis are available from NL Parks and Natural Areas Division (webpage: www.gov.nl.ca/parks). (Labrador study completed by Randal Greene and Lindsay Notzl, NCC.) (See Technical Appendix H for detail.)



Data sources: Statistics Canada 2006, NL Statistics Agency 2006

South coast community. Jon Feldgajer

The Human Footprint for Labrador illustrates the general level of human influence on the natural landscape as of 2012, based on estimates of influence by human habitation, access, power generation/distribution, resource development, and military, aviation and communication activities. A score of 0 indicates no human influence, while a score of 10 indicates areas entirely converted to human uses, such as open pit mines; NL DEC and NCC 2013).

1.10.1 Human Habitation

Labrador's total population is less than 26,000 people. 'Urban' population centres are Happy Valley-Goose Bay (7,552) and Labrador City-Wabush (11,089; Statistics Canada 2011). Parts of Labrador City have both the highest housing density (1409/km^2) and population density (3389/km^2). L'Anse-au-Clair has the lowest housing density (2/km^2) and population density (4/km^2). Urban areas received a score of 10, while rural areas with less than 9.5 inhabitants/km^2 or less than 6 dwellings/km^2 were assigned scores less than 10 (NL DEC and NCC 2013).

1.10.2 Access (Roads and Trails)

The road and trail network in Labrador includes the Trans-Labrador Highway, paved roads, forest access roads, and registered ATV and snowmobile trails, but only those that have been mapped. The Trans Labrador Highway was scored 10 with a maximum zone of influence out to 5000 m, a distance reflecting its heavier use. Other paved roads scored 8 with a zone of influence to 1000 m. Forest access roads were scored 6, and trails 4 (NCC and NL DEC 2013).

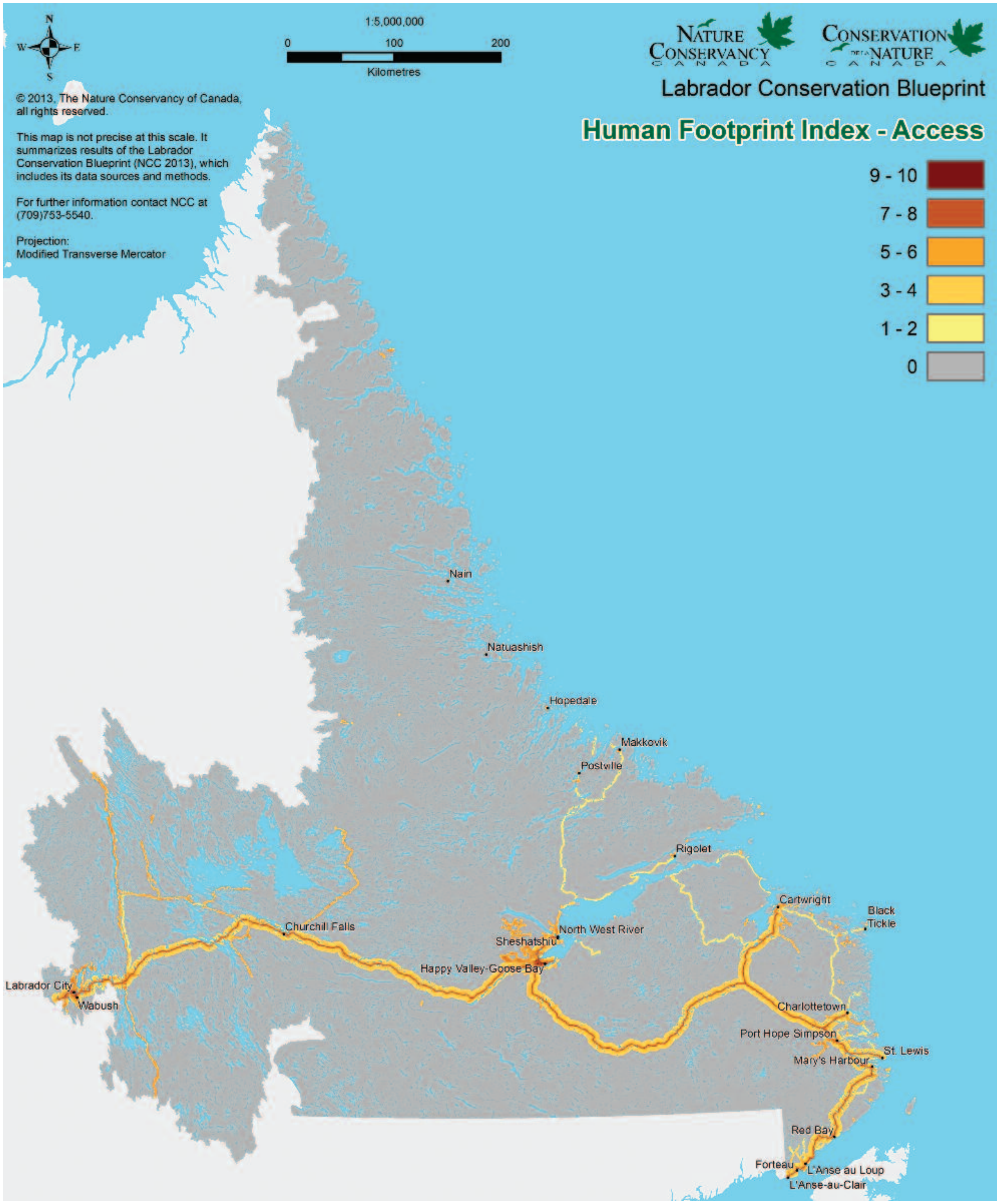
Caribou on Trans-Labrador Highway. Isabelle Schmelzer

Paradise River, Natuashish aerial. Valerie Courtois, Labrador City, Quebec North Shore Railway. Tina Leonard

1.10.3 Power Generation and Distribution

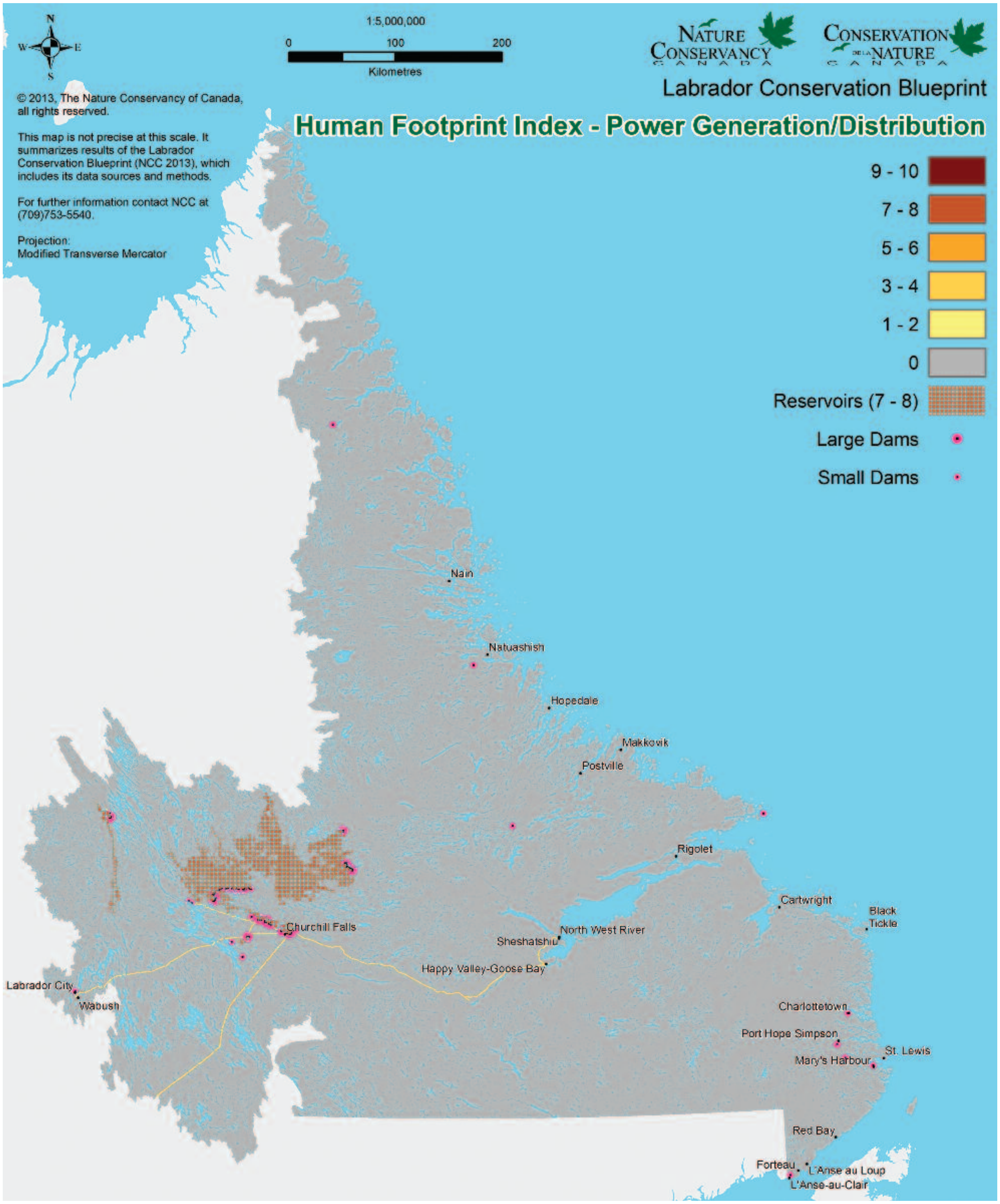
Power developments in Labrador, except for small diesel installations, are hydroelectric. The watersheds of the Upper Churchill, Menihek, Ossokmanuan, and Naskaupi Rivers are affected by dams and diversions. The Upper Churchill Falls site has 88 dykes, which total 62 km in length and average 9 m in height. The Smallwood Reservoir is 6527 km^2 in size (Bazjak and Roberts 2011a,b,c). The Menihek site provides power to western Labrador. Another site, at Twin Falls, is no longer operational. Transmission lines from Churchill Falls supply power to Happy Valley-Goose Bay, Northwest River, Sheshatshiu, Labrador City and Wabush. The largest lines deliver power to Quebec. Muskrat Falls, on the Lower Churchill River is under development (Nalcor 2013), and other sites have hydroelectric potential (Millan 1973). Various small dams supply community drinking water (NCC and NL DEC 2013).

Churchill Falls. John Riley, Smallwood Reservoir drawdown., Greg Locke control structure. Lindsay Notzl

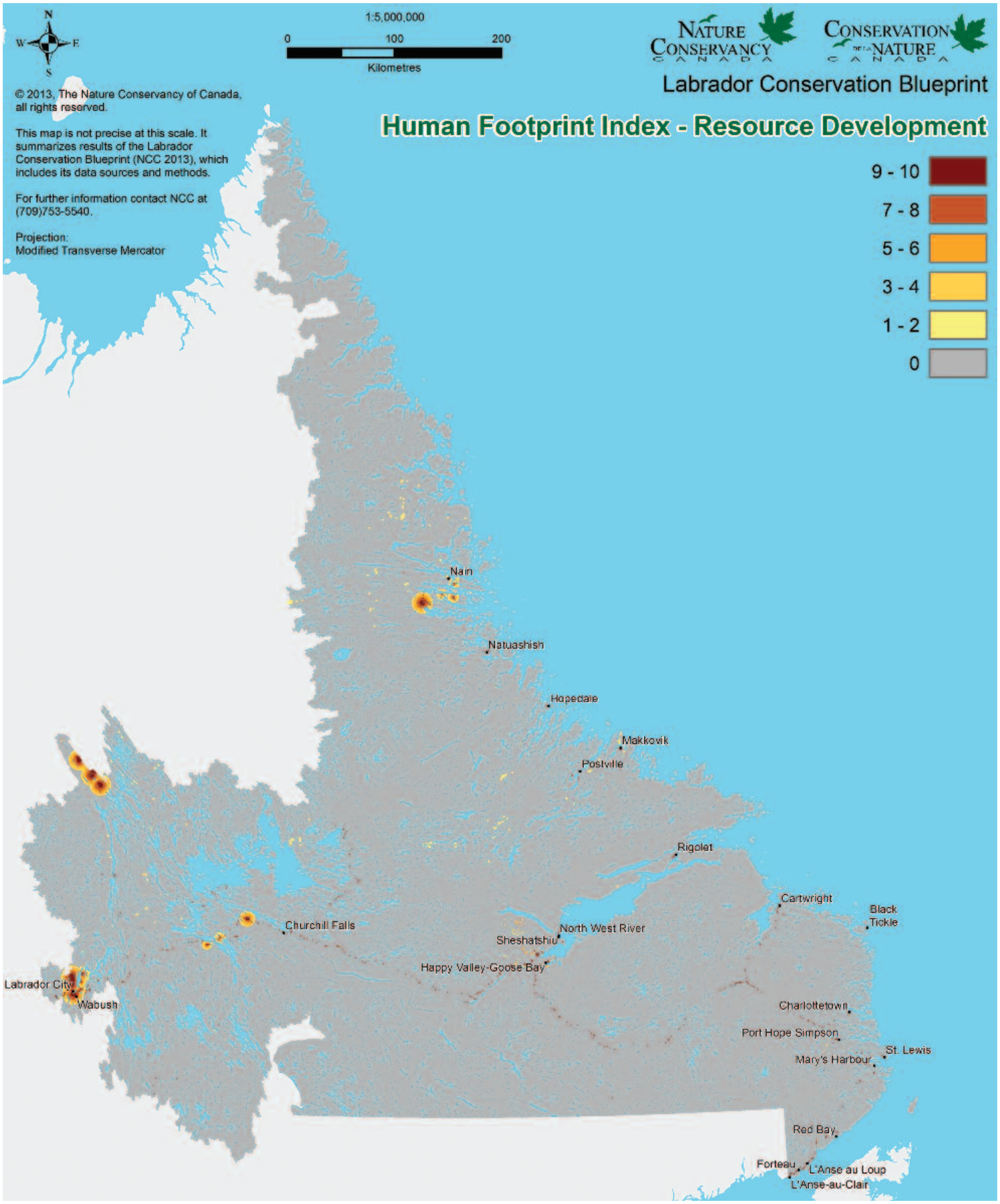


Data sources: LMSA 2010, NL DEC 2011, NL DNR 2011, NRC 2007b

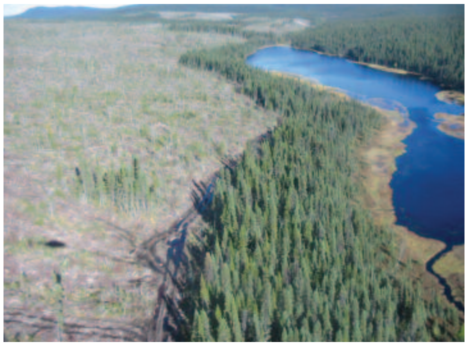
1.10.3 Power Generation and Distribution

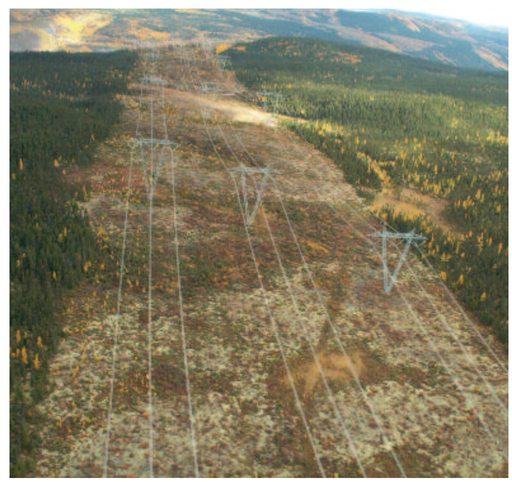


Data sources: GFWC 2010, NL DEC 2011a,b
1.10.4 Resource Development Activities



Data sources: Innu Nation 2012, NG 2012, NL DNR 2011A,C,D, NL TCR 2011, TBCS 2011





Harvested area off Grand Lake Road. NL Department of Natural Resources, Lobstick control structure. Lindsay Notzl
Forest harvesting. NL Department of Natural Resources, Mine in Labrador City. Tina Leonard, Transmission line. Jean-Francois Senecal

1.10.4 Resource Development Activities

Resource activities include forestry, agriculture, mineral extraction, and tourism and outdoor recreation activities.

Forestry. The extent of forest harvesting and silviculture (including thinning and plantations) is relatively local. Tree growth is slow in Labrador and the impact of forest harvesting was scored a 6.

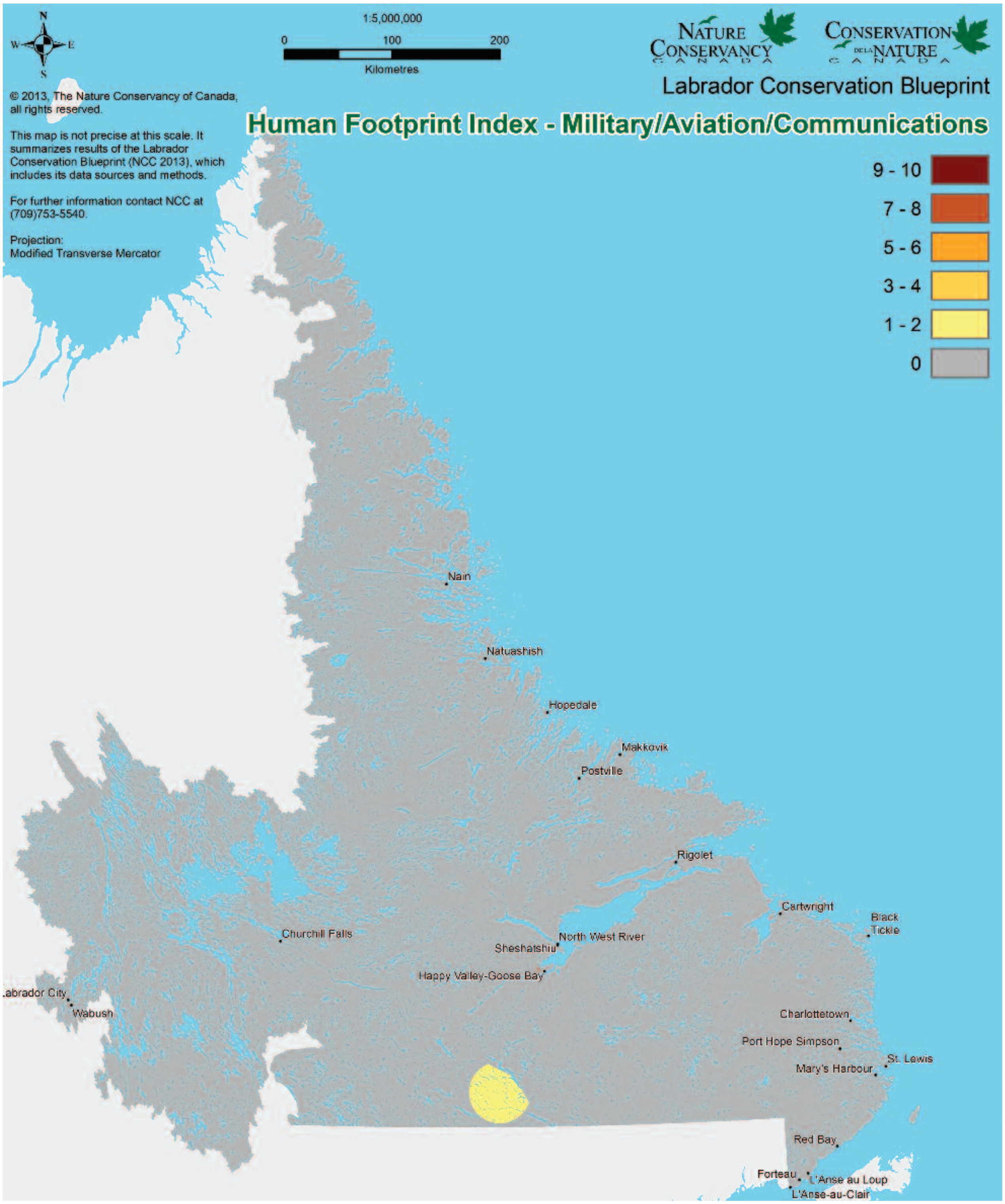
Agriculture. Agricultural lands, including fur farms, are limited in Labrador, with most activities occurring within community boundaries such as Happy Valley-Goose Bay.

Mining and Mineral Exploration. Mines themselves were scored 10, and an associated affected area related to waste deposition, air and water pollution, noise, and human influence was scored up to 10 km for large open-pit mines. Mineral-exploration data were not included but density of drill-site locations was used as a proxy.

Tourism and Outdoor Recreational Development. Cabins, cottages and camps associated with tourist outfitting were included, as were registered cabins. An affected area of 500 m was scored around them. Ski hills and golf courses are located within the vicinity of Happy Valley-Goose Bay and Labrador City.

1.10.5 Military, Aviation and Communication

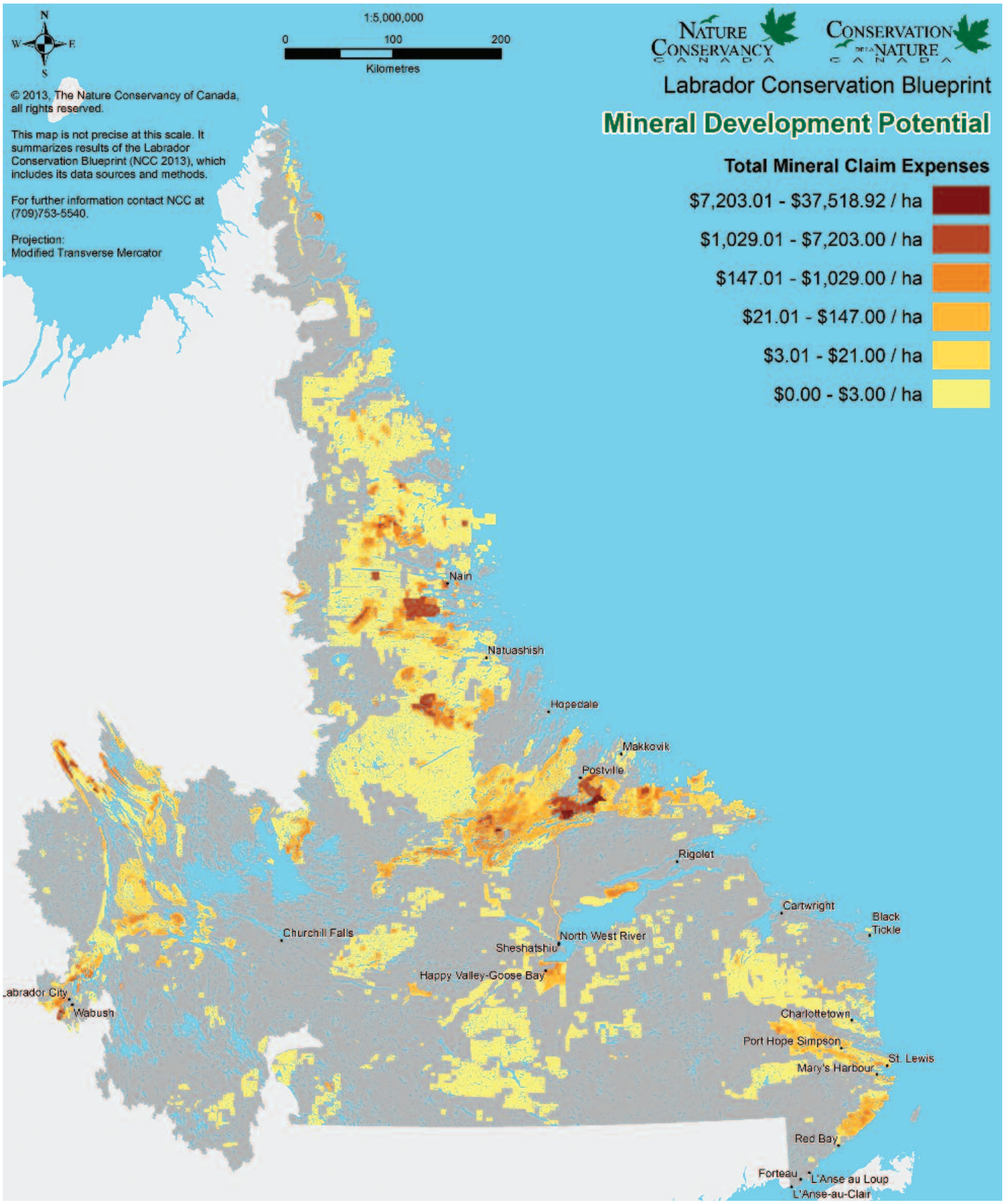
Mapped data in this category included the Department of National Defense's Practice Target Area and Safety Template Area, which was scored relatively low. Runways, military camera targets, and Northern Warning System sites (including former Pine Tree sites) are very small but some of the latter polluted local areas. Communication sites(towers, dishes, etc.) and fuel storage sites were added because of their clearings and risks of fuel contamination.



Data source: DND 2011 NavCanada 2011, Wikipedia 2011

1.10.6 Mineral Potential

Current and historical staking claims in Labrador, based on the total amount expended in each claim over time, may be considered a proxy for potential future mineral development. These data were not used in the calculation of the Human Footprint, which depicts only existing impacts of actual development.



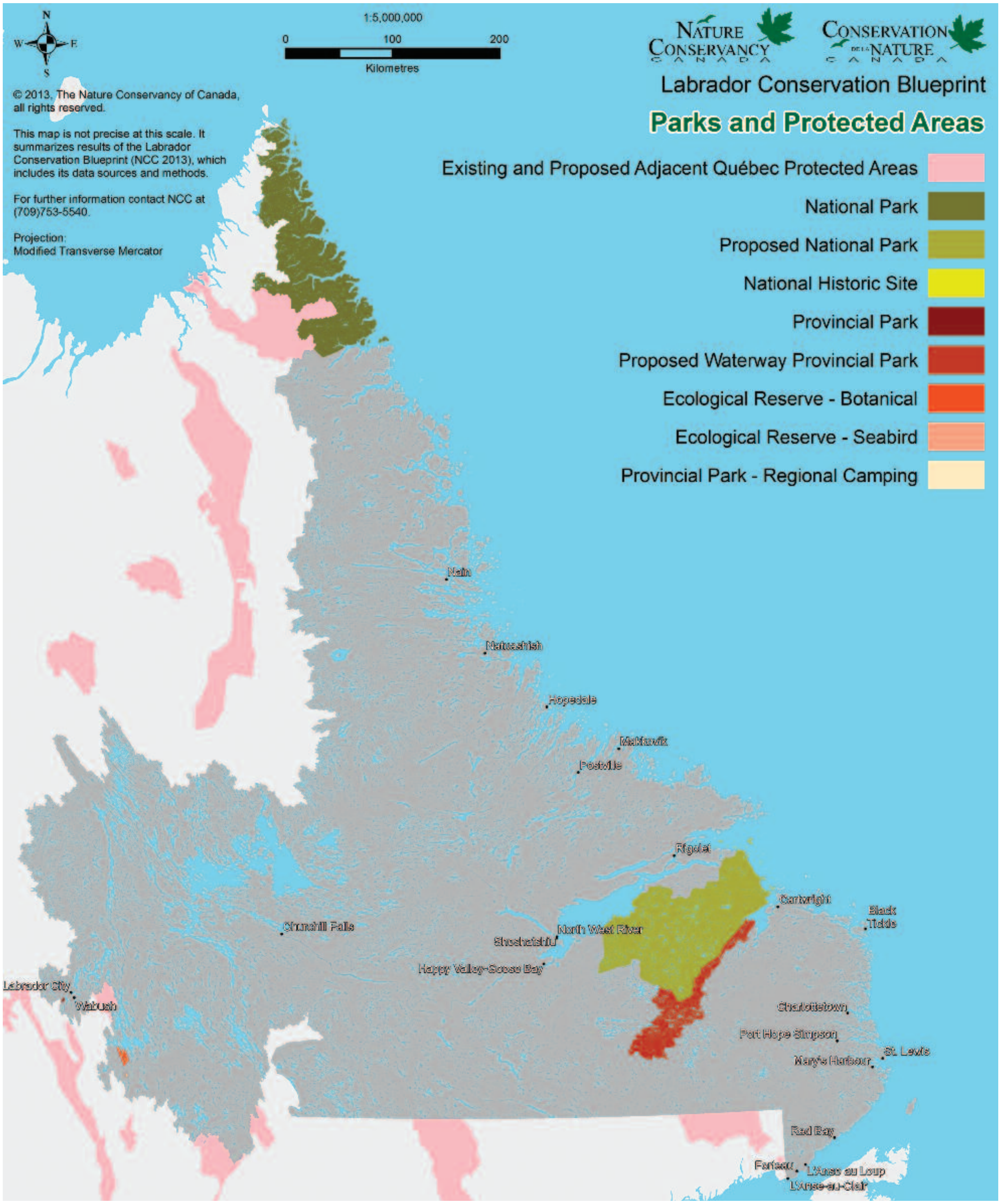
Data source: NL DNR 2011

1.11 PROTECTED AREAS and CONSERVATION LANDS

Valley leading Into Ramah Bay. Geoff Goodyear

1.11.1 Parks and Protected Areas

In Newfoundland and Labrador, protected areas and other conservation lands take many forms. Currently, about 3.33 percent of Labrador and 7.72 percent of the Island of Newfoundland fall within parks and protected areas (NL DEC 2012). The establishment of the Mealy Mountains National Park Reserve and companion Eagle River Waterway Provincial Park will raise this figure to roughly 8 percent of Labrador (NL DEC 2010).



Data sources: CEC 2010, NL DEC 2009, Parks Canada 2009.

Pinware Provincial Park. Lindsay Notzl, below: Red Fir Lake-Kapitagas Channel. Darren Jennings

A protected area is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008: 8-9). Newfoundland and Labrador's protected areas represent its natural and cultural heritage and provide opportunities for biodiversity conservation, scientific research, environmental education, outdoor recreation, and ecotourism (NL DEC 2012). Newfoundland and Labrador has six types of protected area under provincial jurisdiction, two of which occur in Labrador (NL DEC 2012):

- Ecological Reserves *
- Provincial Parks *

* Managed by Department of Environment and Conservation, Parks and Natural Areas Division

Ecological Reserves include Gannet Islands (22 km^2, of which 20 km^2 is marine), seven islands off the coast of Cartwright, and Redfir Lake-Kapitagas Channel (92 km^2) in a remote part of southwest Labrador. Provincial Parks include Duley Lake (7.8 km^2), near Labrador City, and Pinware River (0.6 km^2), just outside the town of Pinware (NL DEC 2012). The proposed Eagle River Waterway Provincial Park (3,000 km^2) is adjacent to the Mealy Mountains National Park Reserve (NL DEC 2010).

There are also seven types of protected areas under federal jurisdiction, three of which occur in Labrador:

- National Parks †
- National Historic Sites †
- Marine Protected Areas ‡

† Managed by Parks Canada
†† Managed by Environment Canada – Canadian Wildlife Service

National Parks include the Torngat Mountains (9,700 km^2) in northern Labrador and the Mealy Mountains National Park Reserve (10,700 km^2), now in the process of establishment (NL DEC 2010). The Red Bay National Historic Site (0.4 km^2) and UNESCO World Heritage Site includes a 16th century Basque whaling site (Parks Canada 2011b).The Gilbert Bay Marine Protected Area (47 km^2), near William's Harbour, protects a distinct resident population of "golden" Atlantic cod (DFO 2013). There are currently no National Marine Conservation Areas, Migratory Bird Sanctuaries, National Wildlife Areas, or Marine Wildlife Areas in Labrador.

Red Bay. Lindsay Notzl

1.11.2 Conservation Lands

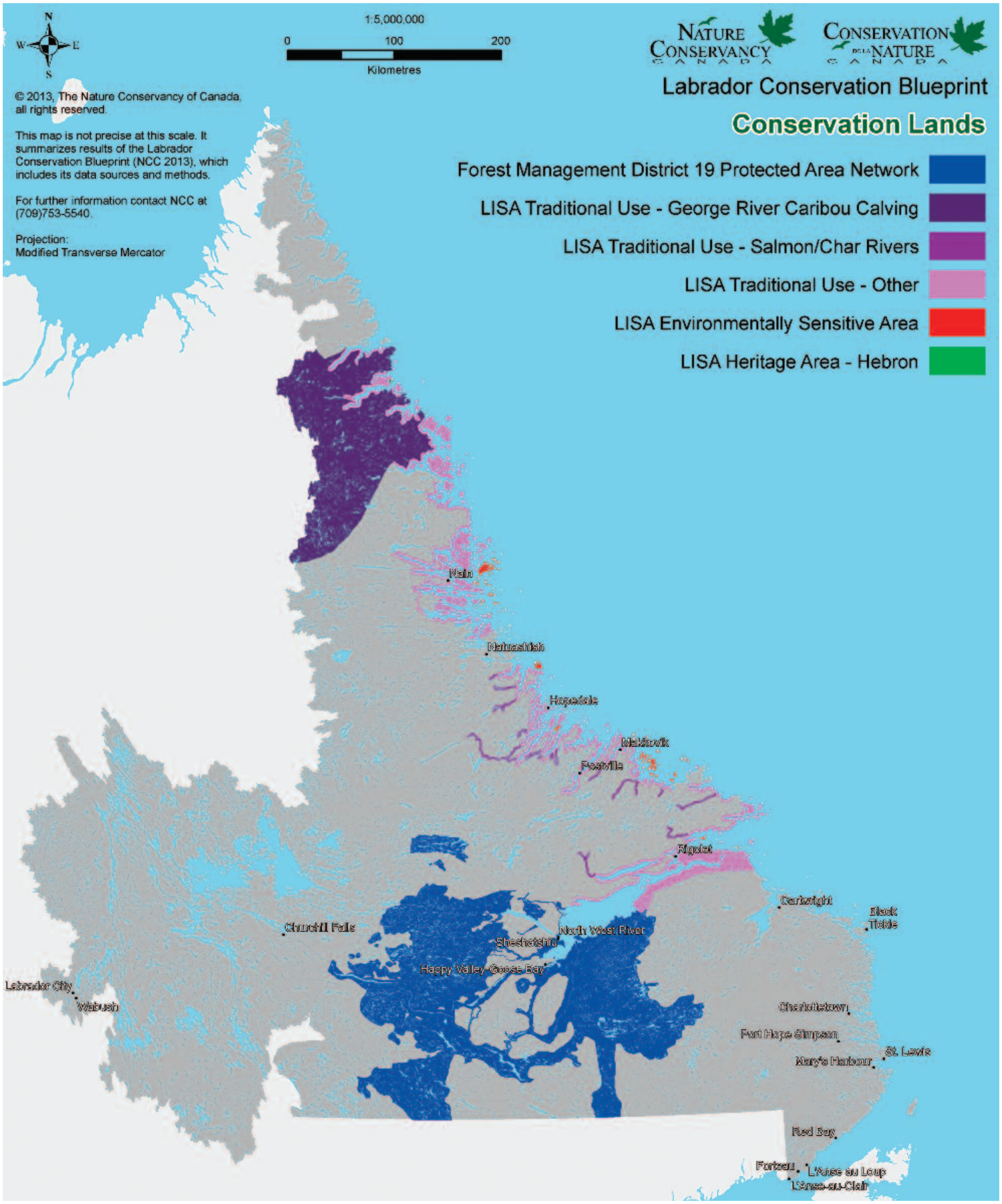
Labrador Inuit Settlement Area (LISA) Land Use Plan

The Labrador Inuit Settlement Area (LISA) Land Use Plan "guide[s] the use of land, water and natural resources; and optimize[s] social, cultural and economic benefits for Labrador Inuit and other residents of LISA" (LISA Regional Planning Authority 2012:2). The Land Use Plan provides direction on where development and conservation should occur over a ten year period, to be reviewed every five years (LISA Regional Planning Authority 2012). The plan maps six land-use designations:

- National Park Designation (Torngat Mountains National Park, Mealy Mountains National Park Reserve)
- Environmentally Sensitive Areas
- Community (Hopedale, Postville, Makkovik, Nain and Rigolet)
- Heritage Area (Hebron, Okak, Nutak, Zoar and Ailik)
- Traditional Use (incl. Special Policy Areas)
- General Use

The General Use and Community designations promote development. Heritage Areas apply to important cultural, archaeological, and spiritual sites. Development is limited to restoring buildings and tourism activities. The Traditional Use Designation applies a 2-km buffer along the coast, designed to support Inuit traditional activities. Permitted uses include cabins and Aullasimavet; domestic tree harvesting; fish, wildlife and forest management; flood and erosion control; and agriculture, hunting, fishing, and gathering. Forestry, quarries, mineral exploration, and infrastructure would be permitted by ministerial discretion. In the Traditional Use Designation, there are 'Special Policy Areas' to conserve the George River Caribou Calving Area (14,255 km^2) and a 100-m buffer on either side of important Salmon, Char and Trout spawning rivers. Outfitters and tourism, and road and transmission lines are discretionary permitted uses near Salmon and Char Rivers. Environmentally Sensitive Areas limit activities to traditional hunting, fishing and gathering, winter trails, and repair of existing cabins and Aullasimavet. This designation applies to sensitive ecosystems and wildlife habitats, such as coastal areas and the Nain Coastline, Offshore Islands Southeast of Nain, Quaker Hat Island, Goose Brook, Northeast Groswater Bay, South Groswater Bay Coastline, The Backway and part of Tumbledown Dick and Stag Islands IBAs, and areas where waterfowl and marine mammals concentrate (LISA Regional Planning Authority 2012).

The Nunatsiavut Government approved the portion of the Plan for the Labrador Inuit Lands (LIL). The NL Minister of Municipal Affairs is responsible for approving the Plan within LISA (LISA Regional Planning Authority 2012).



Data sources: LISA Regional Planning Authority 2012, Innu Nation and NL DNR 2013.

Mealy Mountains. Valerie Courtois

Forest Management District (FMD) 19

In 2012 the second five-year Operating Plan for Forest Management District (FMD) 19 was adopted. This was the result of ten years of work between the Province and Innu Nation to develop a management plan that accounts for the ecological, cultural and economic values of Labrador's closed-canopy spruce-fir forest (71,000 km^2). The plan includes a "protected areas network" (PAN), by which commercial harvest activities are restricted in over 50 percent of the district. The PAN was designed to protect ecologically functioning and representative ecosystems at the scales of landscapes, watersheds, and forest stands. Core habitat for Threatened Woodland Caribou and linkages to ensure landscape connectivity are identified at the landscape scale. At the watershed scale, targets are riparian habitats, slopes and unique ecological features. Stand-level work identifies wildlife dwellings, small streams, wetlands, and important micro-habitats. A companion network of cultural protected areas conserves Aboriginal and non-Aboriginal cultural sites and land values (NL DNR and Innu Nation 2012).

The PAN comprises five 'Core Reserves' and three 'Linkages':

- CR- 1: Mealy Mountain National Park Reserve;
- CR- 2: Seal Lake (unique area of striated geology, long narrow lakes, and broadleaf forest);
- CR- 3: Churchill River Uplands-West (most westerly stands of semi-closed canopy forest);
- CR- 4: Complex Habitat Matrix-Southwest (conifer forest, open waters, shores, wetlands and lichen woodland, extending south to Quebec border);
- CR- 5: Red Wine Caribou Reserve (key areas of open lichen woodland and peatlands supporting caribou;
- LK-1: Churchill River (unique and rich ecosystems on the slopes and floodplain of the Churchill River);
- LK- 2: Dominion Lake-Minipi Lake (large lakes and rivers); and
- LK- 3: Eagle Plains-Quebec (area of old fires and broadleaf forest) (NL DNR and Innu Nation 2012).

Torngat Mountains (McKornick River Valley). Geoff Goodyear

Protected Areas and Conservation Lands by Ecodistrict

See Map of Ecodistricts in Section 2.1

ECODISTRICT	A-01	A-02	A-03	A-04	A-05	B-01	B-02	B-03	B-04	C-01
Parks & Protected Areas (% district)										
Existing	100.0	99.0	99.0	2.0	2.7	0.0	0.0	0.0	0.1	0.0
Proposed	0.0	0.0	0.0	0.0	0.0	0.0	0.6	71.9	0.3	0.0
TOTAL	**100.0**	**99.0**	**99.0**	**2.0**	**2.7**	**0.0**	**0.6**	**71.9***	**0.4**	**0.0**
Conservation Lands (% district)										
LISA Land Use Plan FMD 19 Protected	0.0	0.0	0.3	98.0	97.3	58.4	52.6	58.1	0.0	32.7
Areas Network	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.3**	**98.0**	**97.3**	**58.4**	**52.6**	**58.1***	**0.0**	**32.7**
Protected Areas & Conservation Lands TOTAL	**100.0**	**99.0**	**99.3**	**100.0**	**100.0**	**58.4**	**53.2**	**100.0***	**0.4**	**32.7**

Figures with a * reference overlapping land use designations with existing protected areas, which total area contained within protected areas and conservation lands to exceed 100%.

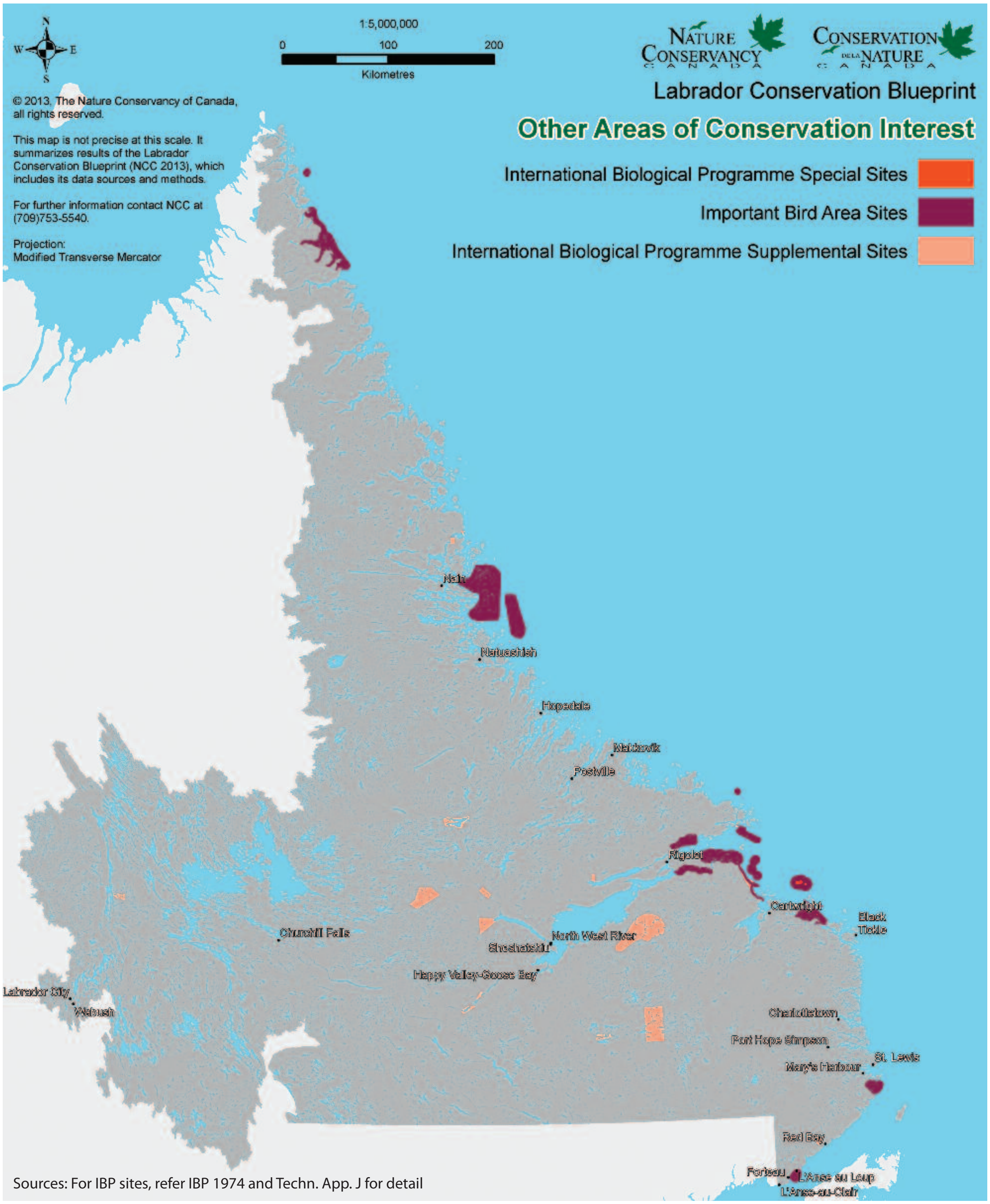
ECODISTRICT	C-02	C-03	C-04	C-05	D-01	D-02	E-01	E-02	E-03	E-04
Parks & Protected Areas (% district)										
Existing	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Proposed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**
Conservation Lands (% district)										
LISA Land Use Plan	20.5	0.0	0.0	0.0	0.0	0.0	12.4	0.2	0.0	0.0
FMD 19 Protected Areas Network	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.1	0.0
TOTAL	**20.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**12.4**	**8.7**	**0.1**	**0.0**
Protected Areas & Conservation Lands TOTAL	**20.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**12.4**	**8.7**	**0.1**	**0.0**

ECODISTRICT	E-05	E-06	E-07	F-01	F-02	F-03	F-04	G-01	G-02	G-03
Parks & Protected Areas (% district)										
Existing	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proposed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0
TOTAL	**0.0**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.4**	**0.0**
Conservation Lands (% district)										
LISA Land Use Plan	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0
FMD 19 Protected Areas Network	0.0	0.0	0.0	0.2	2.9	51.4	92.9	30.9	32.4	0.0
TOTAL	**0.0**	**0.0**	**0.0**	**2.0**	**2.9**	**51.4**	**92.9**	**30.9**	**32.4**	**0.0**
Protected Areas & Conservation Lands TOTAL	**0.0**	**0.6**	**0.0**	**2.0**	**2.9**	**51.4**	**92.9**	**30.9**	**34.8**	**0.0**

ECODISTRICT	H-01	H-02	I-01	I-02	I-03	J-01	K-01	K-02	K-03
Parks & Protected Areas (% district)									
Existing	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Proposed	82.2	45.1	0.0	0.0	0.0	15.8	7.8	4.3	0.0
TOTAL	**82.2***	**45.1**	**0.0**	**0.0**	**0.2**	**15.8**	**7.8**	**4.3**	**0.0**
Conservation Lands (% district)									
LISA Land Use Plan	8.9	0.0	0.0	0.0	0.0	0.0	36.6	9.3	0.0
FMD 19 Protected									
Areas Network	65.6	41.9	10.8	0.0	0.0	0.0	0.0	65.7	52.0
TOTAL	**74.5***	**41.9**	**10.8**	**0.0**	**0.0**	**0.0**	**36.6**	**75.0**	**52.0**
Protected Areas & Conservation Lands TOTAL	**100.0***	**87.0**	**10.8**	**0.0**	**0.2**	**15.8**	**44.4**	**79.3**	**52.0**

1.11.3 Other Areas of Conservation Interest

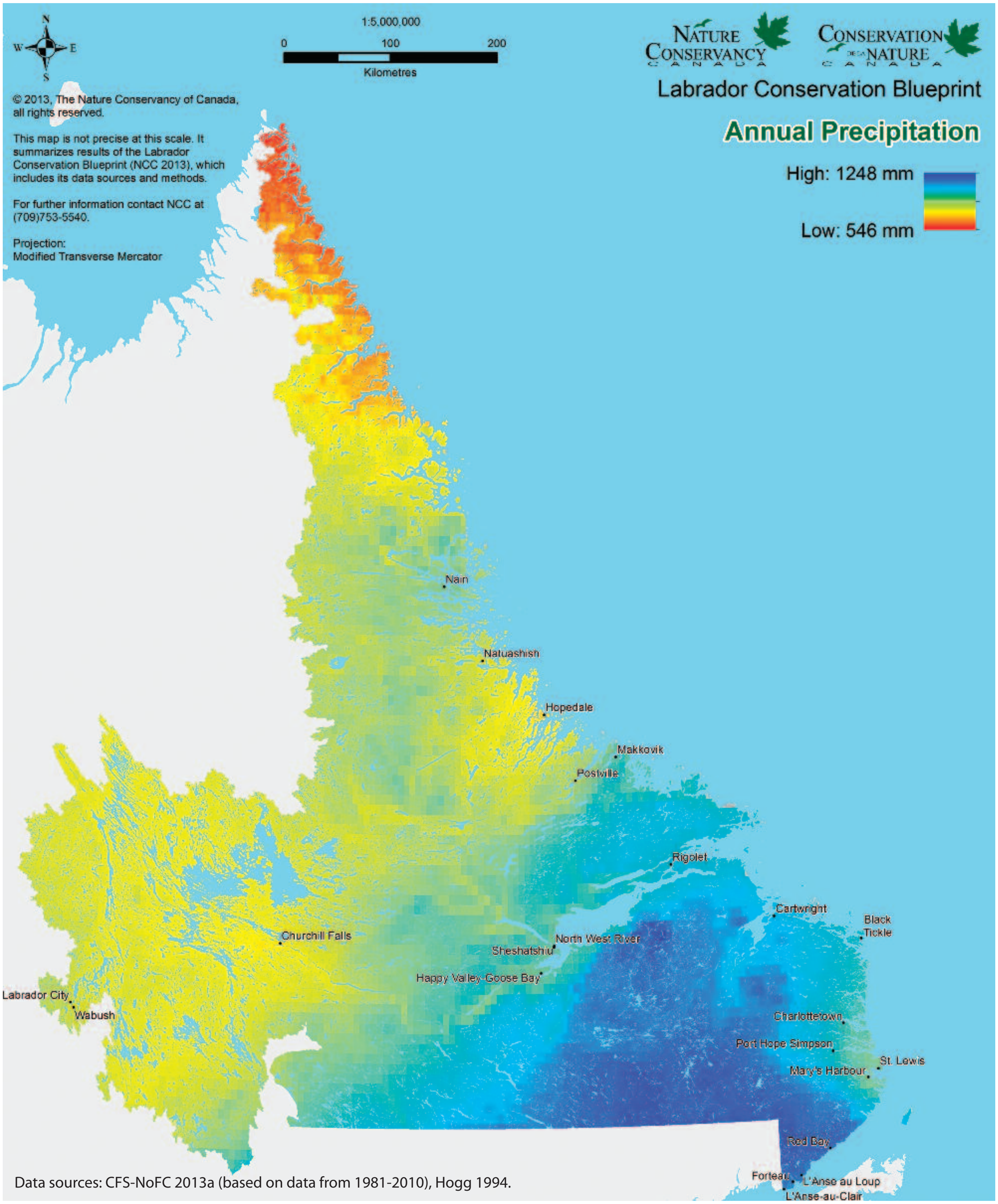
Other areas of conservation interest include International Biological Program (IBP) sites and Important Bird Areas (IBAs). See page 54, Secton 1.3.2, Waterbirds, for listing of IBA sites. See page 192, Appendix J, for list of IBP sites.



1.12 CLIMATE

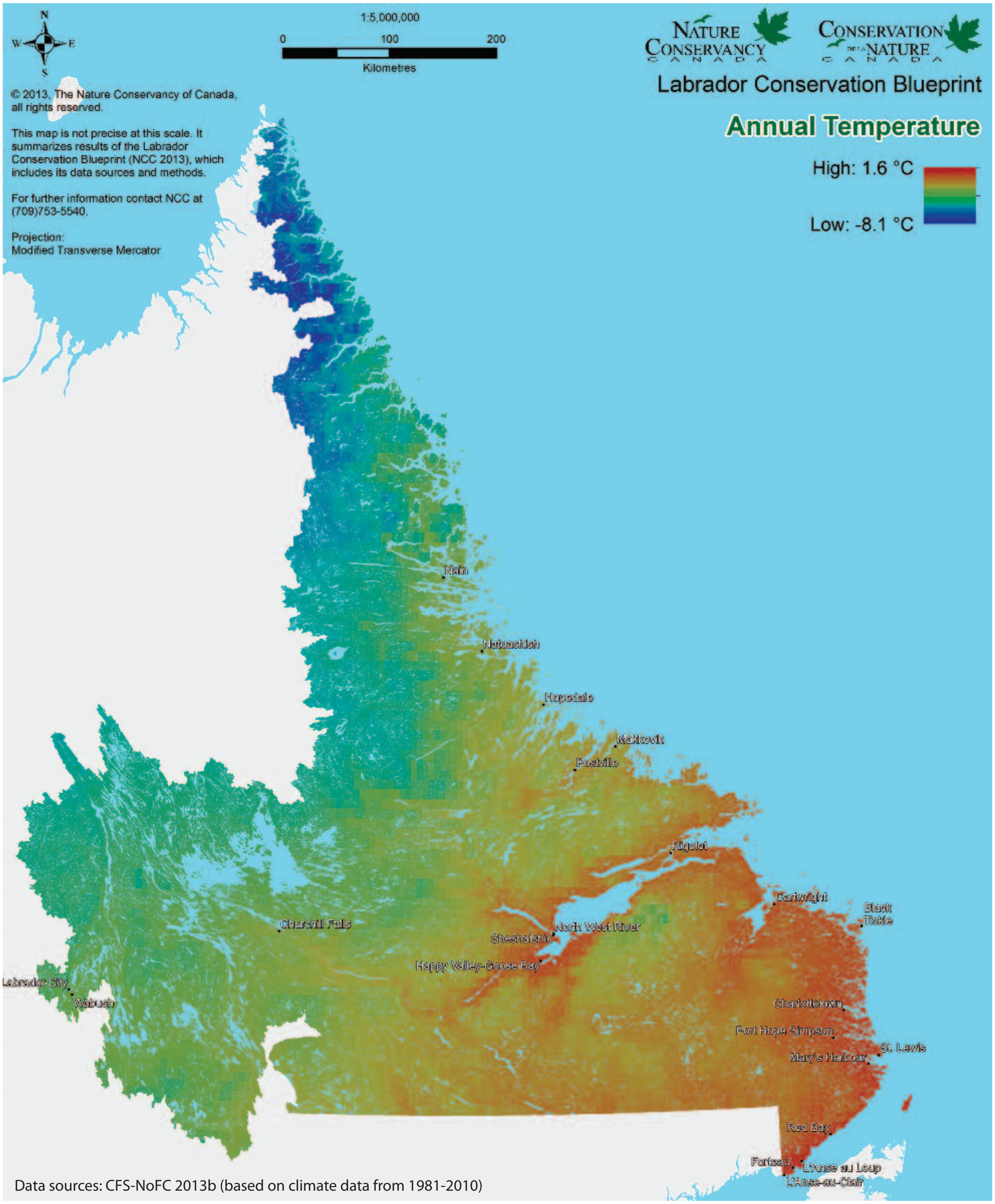
1.12.1 Precipitation

Average annual precipitation in the Arctic Cordillera Ecozone ranges from a low of 546 mm in the Cape Chidley Ecodistrict to a high of 835 mm in the Saglek Ecodistrict. In the Taiga and Boreal Shield Ecozones, ranges are 739 mm in the Hopedale Coast Ecodistrict to 1248 mm in the Mealy Mountains Ecodistrict (Riley *et al.* 2013).



1.12.2 Temperature

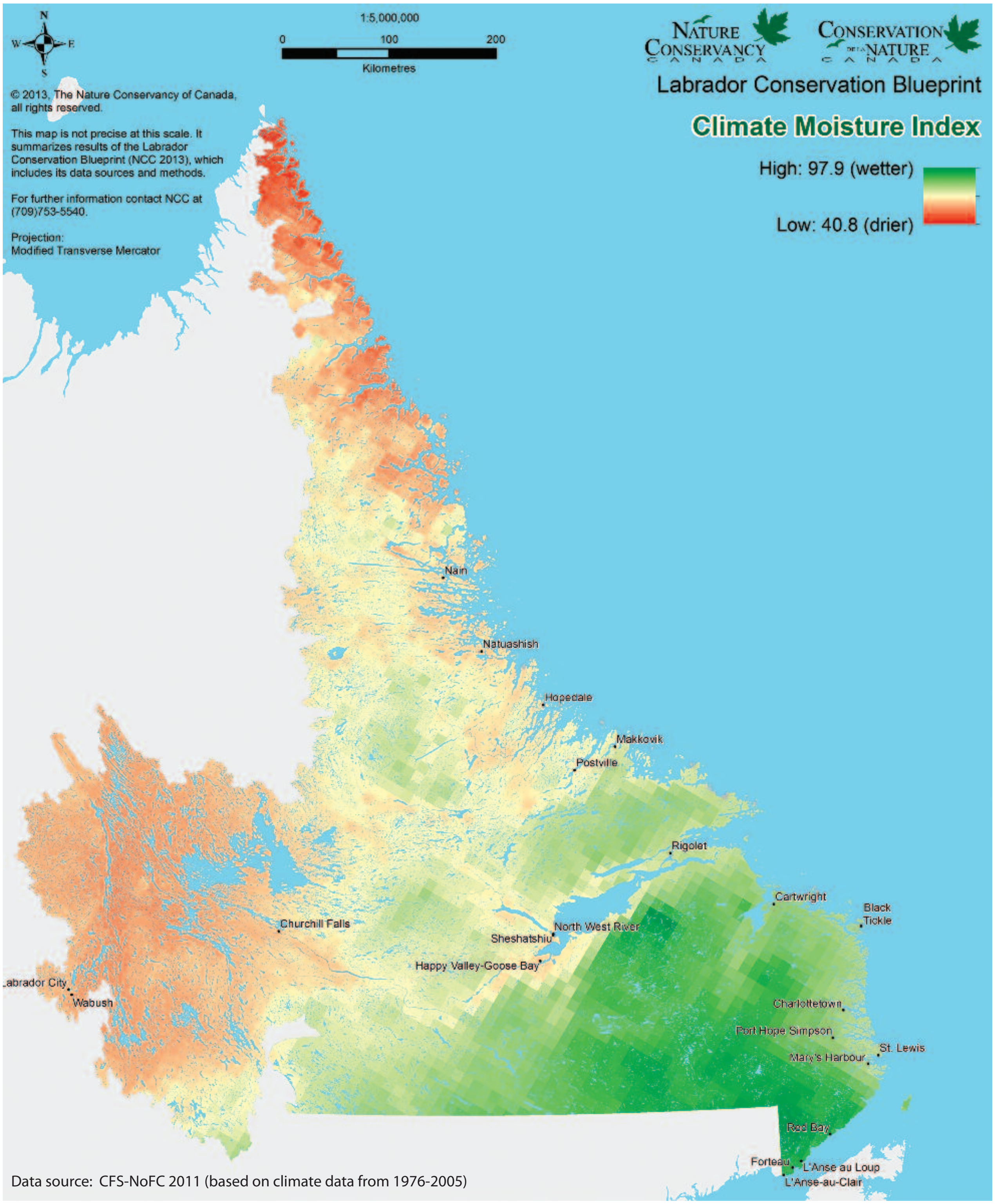
Average annual temperatures in Labrador's Arctic Cordillera range from highs of -3.0 ˚C in the Saglek Ecodistrict to lows of -8.1˚C in the Torngat Mountains Ecodistrict. In the Taiga and Boreal Shield Ecozones, highs are 1.6˚C in the L'Anse Amour Ecodistrict, while lows are -5.9˚C in the Fraser River Ecodistrict (Riley *et al.* 2013).



Data sources: CFS-NoFC 2013b (based on climate data from 1981-2010)

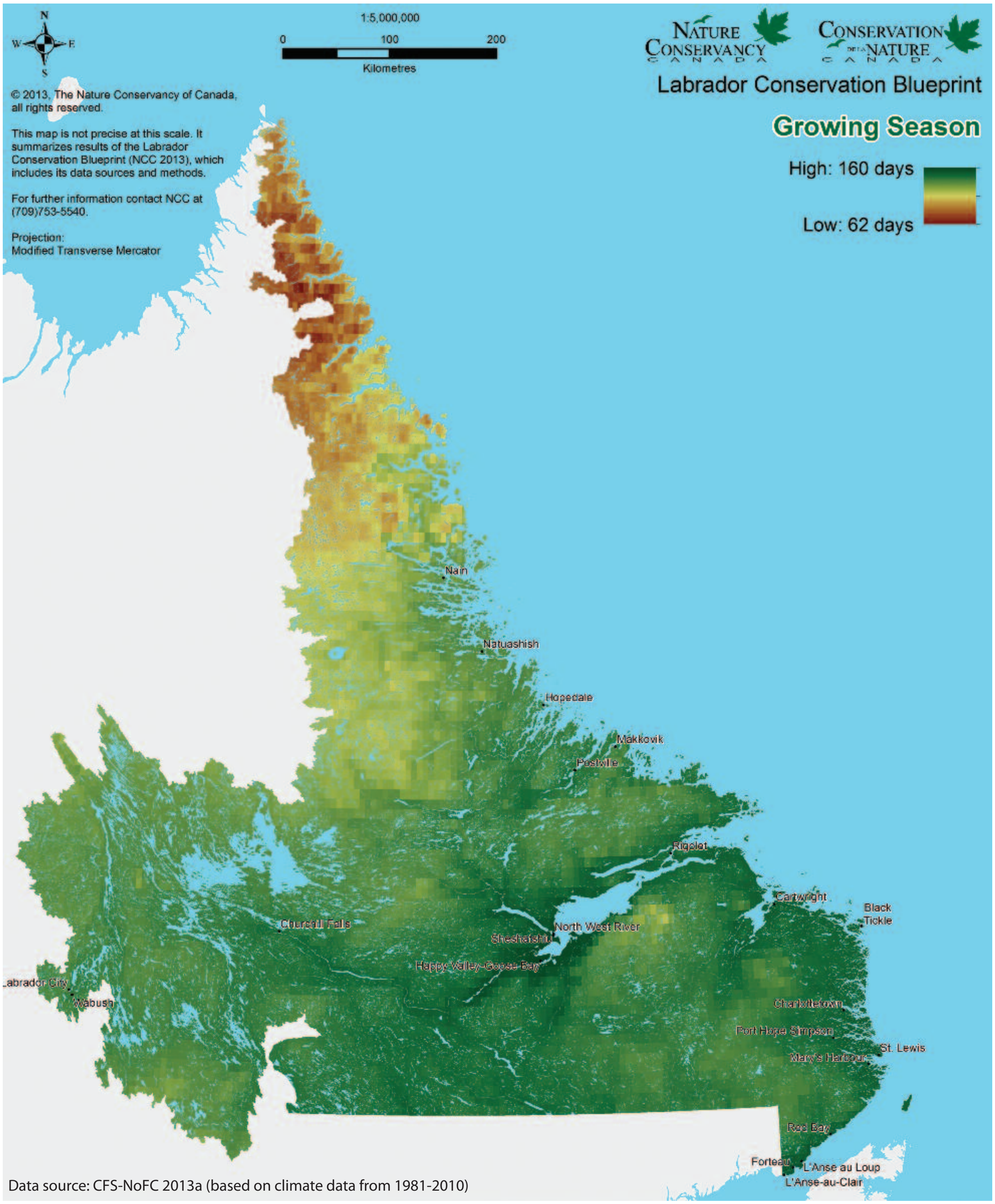
1.12.3 Climate Moisture Index

The Climate Moisture Index for Labrador is a measure of average annual precipitation (rain and snow melt) minus annual potential evapotranspiration. Units are measured in centimetres per year (BEACONs n.d.b). According to this metric, the driest ecodistrict in Labrador's arctic is Cape Chidley at 40.8 cm (408 mm) and the wettest is the Domes at 52.6 cm (526 mm). In the Boreal and Taiga, the driest ecoregion is the Labrador Trough at 55.7 cm (557 mm) while the wettest is the Mealy Mountains at 97.9 cm (979 mm; Riley *et al.* 2013).



1.12.4 Growing Season

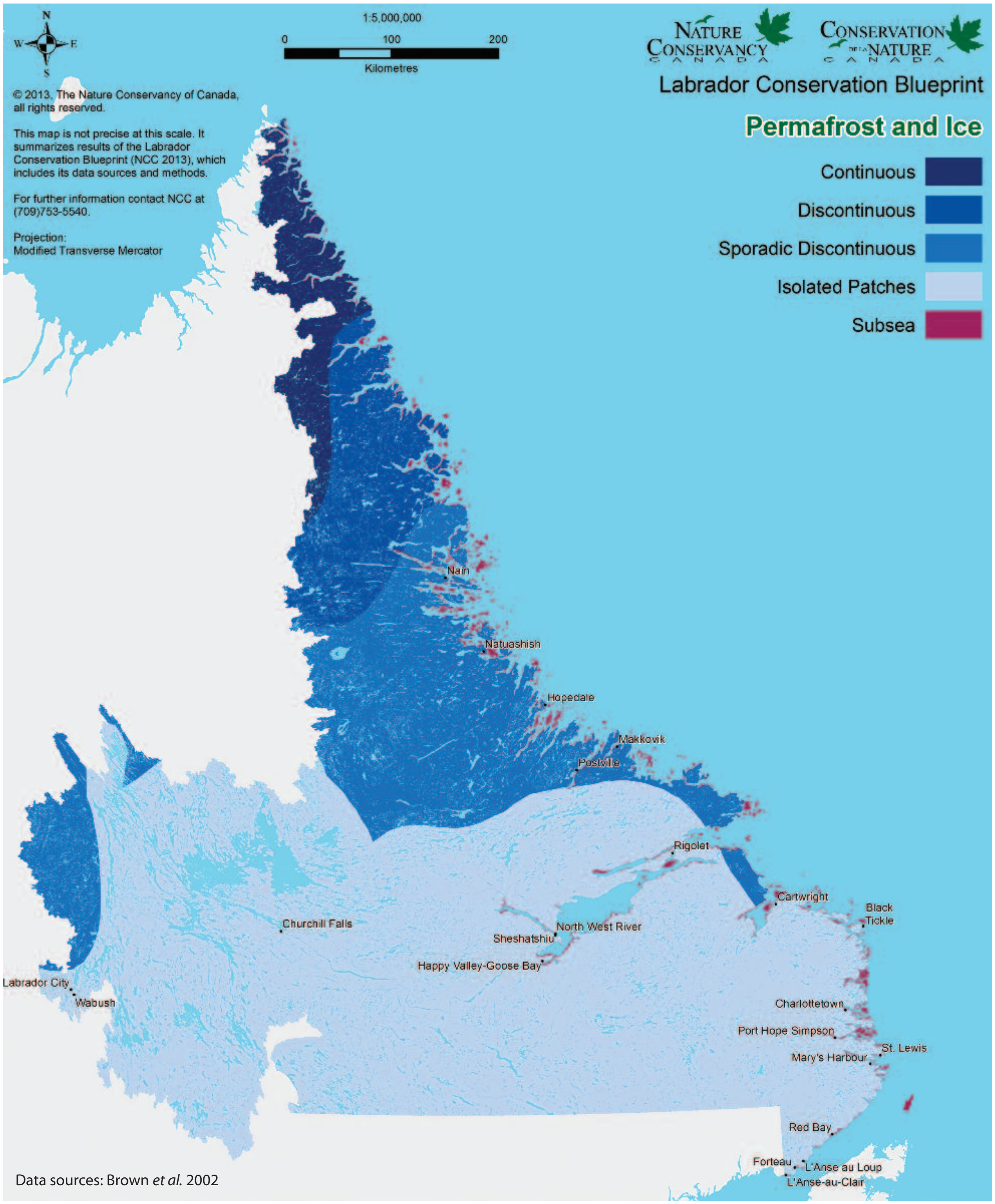
The growing season map of Labrador uses average climate data over 30 years to assess the suitability of temperature conditions for plant growth. For plants to grow, a certain base temperature must be reached. Although this varies by species and for particular plant growth stages, 5˚C is used as the standard threshold (NRC2013).



Data source: CFS-NoFC 2013a (based on climate data from 1981-2010)

1.12.1 Permafrost

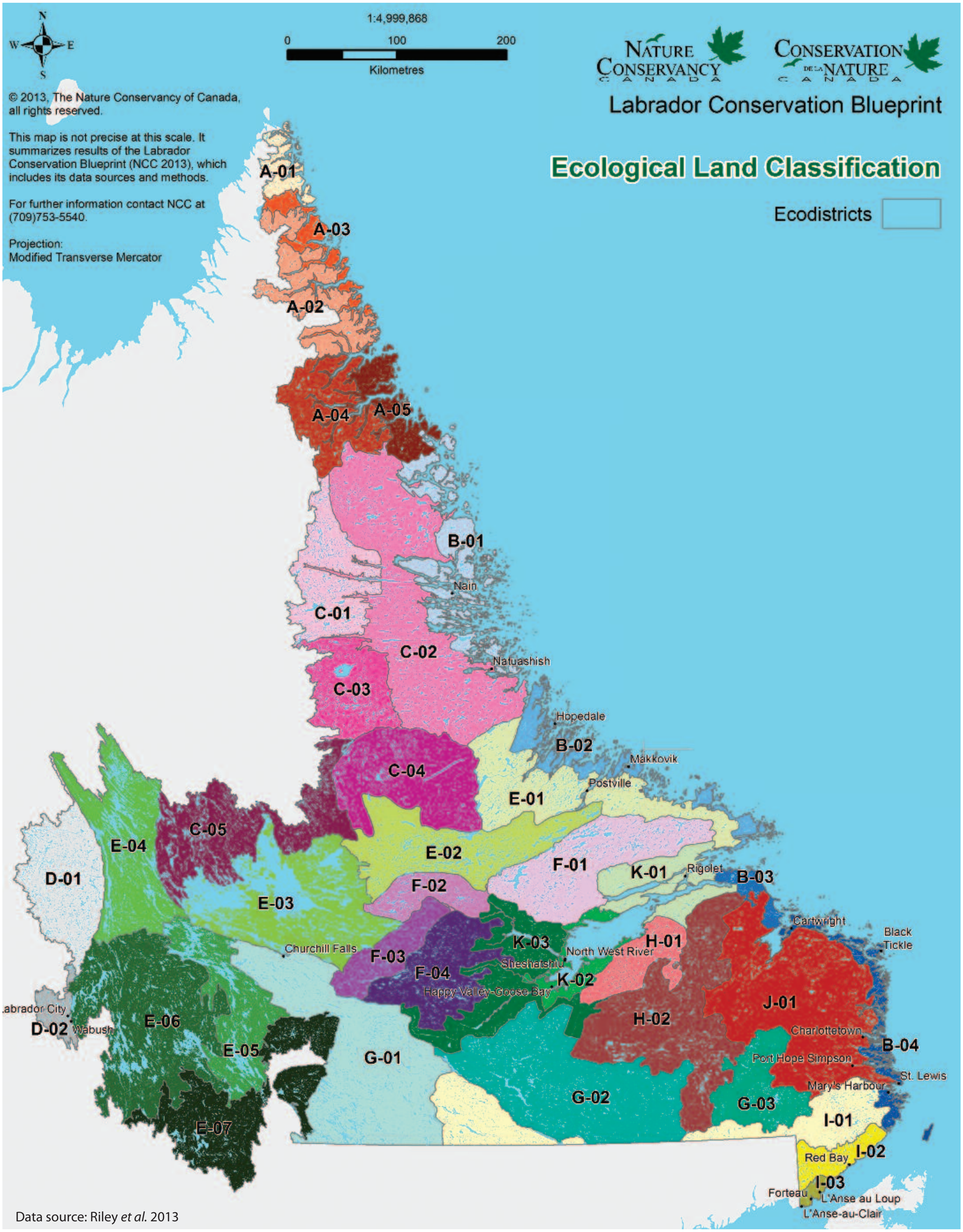
"Permafrost, or permanently frozen ground, is substrate (soil, sediment or rock) that remains at or below 0°C for at least two years" (NSDIC 2012). It occurs on land and offshore beneath arctic continental shelves (*ibid.*). In Labrador, permafrost mainly occurs in isolated patches in central and southern Labrador. It is continuous in northernmost Labrador, discontinuous north of Nain and Mistastin Lake, and sporadic north of Postville and on the McPhayden plateau. Subsea permafrost occurs off the coast (Brown *et al.* 1997).



Data sources: Brown *et al.* 2002

Bald Eagle, Smallwood Resevoir. Geoff Goodyear

2.0 Applications



Data source: Riley *et al.* 2013

2.1 Ecological Land Classification
Ecozones, Ecoregions and Ecodistricts

Ecological land classifications distinguish areas with overall similarities in their physical and biological eatures. Ecozones, ecoregions and ecodistricts reflect unique combinations of climate, geology, landform, land cover, and water.

These land units are mapped as landscapes of overall similarity and, as such, they provide a useful template for approximating the diversity of nature, its various potentials, and its responses to change, for example to climate change over time. A re-examination of these areas is the subject of Vol. Two of the *Labrador Nature Atlas* (Riley *et. al.* 2013).

The landscapes of Labrador have been mapped and classified in previous studies, which this treatment builds on. In 1978 Environment Canada completed an initial *Ecological Land Classification of Labrador,* integrating many of the elements of landscape variation (Lopoukhine *et al.* 1978). In 1990 Susan Meades completed a synthesis describing the *Natural Regions of Newfoundland and Labrador,* based on the work of many studies and contributors.

Ecozone	Ecoregion		Ecodistrict	
Arctic Cordillera	A	Torngat	A-01	Cape Chidley
	A		A-02	Torngat Mountains
	A		A-03	Seven Islands
	A		A-04	The Domes
	A		A-05	Saglek
Taiga Shield	B	Coastal Barrens	B-01	Nain Coast
	B		B-02	Hopedale Coast
	B		B-03	Porcupine Strand
	B		B-04	Harbour
	C	Kingurutik – Fraser	C-01	Upper Kingurutik
	C		C-02	Fraser River
	C		C-03	Mistastin Lake
	C		C-04	Harp Lake
	C		C-05	North Michikimau
	D	McPhayden Plateau	D-01	McPhayden River
	D		D-02	Wabush
	E	Michikamau – Smallwood	E-01	Benedict Mountains
	E		E-02	Seal Lake-Postvlle
	E		E-03	Smallwood Reservoir
	E		E-04	Labrador Trough
	E		E-05	Atikonak Lake
	E		E-06	Joseph Lake
	E		E-07	Domagaya Lake
	F	Nipishish – Goose	F-01	Nipishish Lake
	F		F-02	Upper Naskaupi
	F		F-03	Red Wine Mountains
	F		F-04	Goose River
	G	Mecatina River	G-01	Churchill Falls
	G		G-02	Minipi
	G		G-03	St. Paul
	H	Eagle Plateau – Mealy Mountains	H-01	Mealy Mountains
	H		H-02	Eagle Plateau
Boreal Shield	I	North St. Lawrence	I-01	Border
	I		I-02	Forteau Barrens
	I		I-03	L'Anse Amour
	J	Paradise River	J-01	Paradise River
	K	Lake Melville	K-01	Rigolet
	K		K-02	Melville Lowlands
	K		K-03	Melville Valleys

In 1993 Environment Canada released a provisional *Ecoregions of Canada* (ESWG 1993), which proposed ecological regions for Labrador and, in 1995, Environment Canada revised its mapping of ecological land units based on jurisdictional studies, expert input and a standard framework. This treatment follows that *National Ecological Framework for Canada*, and its regional details build on the earlier work by Lopoukhine and Meades, as well as by the World Wildlife Fund (1999) and Quebec's informal 2010 update of ecological land units, some of which straddle the Quebec-Labrador boundary. The present treatment is fundamentally informed by the new information and mapping assembled for the *Labrador Conservation Blueprint*.

In 1999 a revised *National Ecological Framework* described three levels of nested land units for Labrador; ecozones (3), ecoregions (17) and ecodistricts (43). The treatment described here includes ecozones (3), ecoregions (11) and ecodistricts (39). These ecological land units are hierarchical (or nested) in their organization, and range from the broad scale of *zones* to the finer scale of *districts*. At these three scales, land units are useful for illustrating and communicating the variability of nature and the observed changes in the character of different landscapes. They have also been widely used as the appropriate frameworks for assessing land-use, nature conservation, and adaptation to change.

Ecozone

An ecozone is an area of the earth's surface that shares characteristic geology and climate, expressed as a distinctive mosaic of landforms, vegetation, plants, wildlife and human activities.

Ecoregion

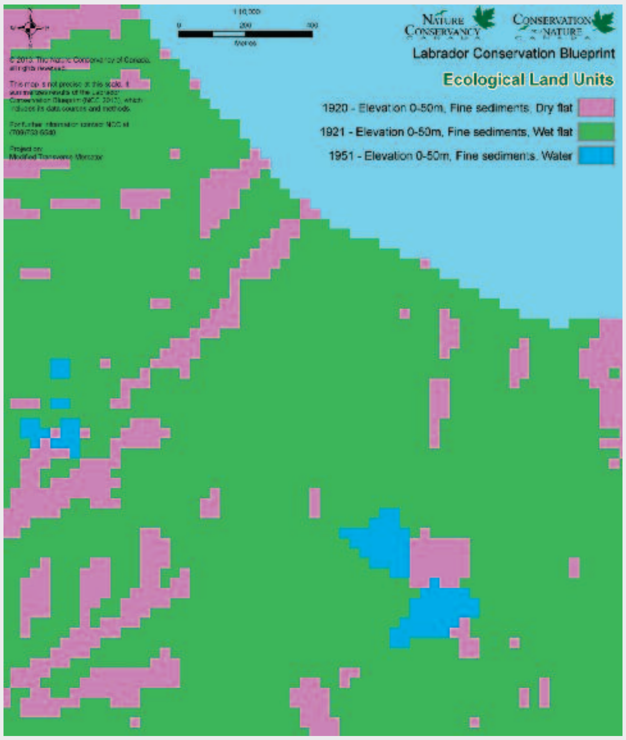
An ecoregion is a portion of an ecozone characterized by distinctive regional ecological characteristics of climate, physiography, vegetation, soils, water and fauna.

Ecodistrict

An ecodistrict is a portion of an ecoregion characterized by distinctive local patterns of relief, landforms, soils, vegetation, water bodies and fauna.

2.2 Ecological Land Units (ELUs)

Ecological Land Units (ELUs) are mapped areas that combine three non-living (abiotic) characteristics of the land: elevation, bedrock and surficial geology, and landform. In this way, ELUs illustrate the "ecological potential" of Labrador's landscape.



Source: L.Notzl and R.Greene, NCC

2.3 Conservation Analysis

To support the work of the Newfoundland and Labrador Department of Environment and Conservation, Parks and Natural Areas Division (PNAD), NCC undertook a conservation assessment for Labrador based on the provincial Framework for a Protected Areas Strategy. The Framework identifies conservation priorities at three nested spatial scales:

- **Component 1** reserves capture large contiguous areas (≥ 1,000 km^2 in size) with a high degree of ecological integrity, and low levels of industrial disturbance. They include important seasonal habitats for Caribou, as well as those for other wide-ranging animals and species-at-risk.
- **Component 2** reserves are between 50 and 1,000 km^2 in size and capture defining or representative features of an ecodistrict.
- **Component 3** reserves are less than 50 km^2 in size, and protect sites with rare and unique natural elements (e.g. seabird colonies, rare plants, fossils). (http://www.env.gov.nl.ca/env/parks/apa/pas/framework.html).

The Labrador analysis focussed primarily on scenario modelling to support the identification of areas representative of Labrador's natural diversity (Component 2). The analysis used freely available software (*i.e.*, Benchmark Builder and Ranker) developed by the Canadian BEACONs Project (Boreal Ecosystems Analysis for Conservation Networks), Dept. of Renewable Resources, University of Alberta (www.beacons project.ca/toolbox). Benchmark Builder uses catchments (or subwatersheds) as the basic units of analysis, and aggregates relatively intact catchments until a particular size is reached. The Labrador analysis used catchments that were >75% intact based on the "human footprint" analysis. Benchmark Builder prioritizes upstream catchments before searching downstream, to emphasize inclusion of headwaters. It also aggregates catchments along stream networks to reduce edge-effects, and attempts to confine areas selected to single drainage basins. Size criteria were based on the Estimated Maximum Fire Size, or the largest fire event predicted to occur based on previous fire events. In Labrador, five fire-size zones were established, ranging from 401 to 6,886 km^2. All areas south of the Arctic Cordillera Ecozone were considered, regardless of their regulatory or ownership status[1].

Ranker is a tool designed to assess and rank the "representativity" of potential areas output by Benchmark Builder. Representativity is assessed based on the distribution of biophysical attributes, mapping environmental variation across the landscape. The distribution of attributes inside areas selected by Builder is compared against their broader regional distribution using statistical dissimilarity metrics. Mapped data and information used in the analysis are included in this volume of the *Labrador Nature Atlas* and are available online at www.nlnatureatlas.ca, including:

- Climate (precipitation minus potential evapotranspiration, a measure of moisture and temperature);
- Geology (the underlying substrate);
- Landform (the combination of slope, aspect and curvature of the land);
- Land cover (the vegetation as a measure of wildlife habitat and site productivity);
- Land and water edge (the areas of higher relative productivity and ecosystem services)
- Density of wetlands/peatlands (wet habitats, as a measure of wildlife productivity, water retention, and carbon storage); and
- Ecodistricts.

Ranker allows for the development of multiple scenarios depending on inputs defined by the user. Areas identified can satisfy either a total percent of the region (*e.g.*, 17%) or a specified number of areas (*e.g.*, three). It can also incorporate analysis of the representivity of existing parks and protected areas, which can either be "locked in" or considered by not "locked in." By request of Parks and Natural Areas Division (PNAD), scenario runs were completed for:

- 12% of Labrador, with existing/proposed protected areas "locked in";
- 17% of Labrador, excluding existing/proposed protected areas;
- 17% of Labrador, with existing/proposed protected areas not "locked in", and including important areas for Caribou;
- 17% of Labrador, with existing/proposed protected areas "locked in", and including important areas for Caribou;
- 30% of Labrador, with existing/proposed protected areas "locked in", and including important areas for Caribou; and
- 50% of Labrador, with existing/proposed protected areas "locked in", and including important areas for Caribou.

The data and maps produced by these runs were provided to PNAD as part of a conservation assessment of Labrador. Maps produced also show the "irreplaceability" of areas selected as well as catchments that occur most often within the top 100 best candidate networks. Results illustrate networks of areas that represent the biological diversity of Labrador landscapes. For additional information on the Labrador conservation analysis, please contact PNAD.

[1] Fire-size thresholds are not available for the Arctic Cordillera Ecozone and no analysis was undertaken for that area, which includes the Torngat Mountains National Park.

Technical Appendices

Atlantic Puffins, Gannet Islands.
PNAD

A. Seabird Colonies

Below is a listing of Important Bird Areas (IBAs) for seabird colonies surveyed by EC–Canadian Wildlife Service. IBAs support ≥ 1 percent of the North American or global population, or ≥ 20,000 individuals of one or more waterbirds (BirdLife International n.d.). Colonies/islands located in an IBA that meet the criteria are highlighted in green. In blue are other some colonies/islands meeting these criteria but not yet identified as IBAs.

Atlantic Puffin

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Bird Island (S. Labrador)	Bird Island	16,200	0.1%	2.2%	2.3%
Gannet Clusters	Gannet Islands	69,224	0.6%	9.2%	9.9%
Outer Gannet Island	Gannet Islands	8,108	0.1%	1.1%	1.2%
	Species in IBAs Total	77,332	0.6%	10.3%	11.0%
Herring Islands	Northeast Groswater Bay	26,400	0.2%	3.5%	3.8%
North Green Island (Lab)	Northeast Groswater Bay	8,338	0.1%	1.1%	1.2%
Puffin Islands (Lab)	Northeast Groswater Bay	1,184	0.0%	0.2%	0.2%
Puffin Islands (Lab), uni just S of	Northeast Groswater Bay	34	0.0%	0.0%	0.0%
The Doughboy, uni e. of Pompey Island	Northeast Groswater Bay	348	0.0%	0.0%	0.0%
Tinker Island, nr. Indian Hr.	Northeast Groswater Bay	10	0.0%	0.0%	0.0%
	Species in IBAs Total	36,314	0.3%	4.8%	5.2%
Kidlit Islands	Offshore Islands Southeast of Nain	4,400	0.0%	0.6%	0.6%
Ukallik Island	Offshore Islands Southeast of Nain	540	0.0%	0.1%	0.1%
	Species in IBAs Total	4,940	0.0%	0.7%	0.7%
Quaker Hat	Quaker Hat Island	4,200	0.0%	0.6%	0.6%
Bacalhao	Non-IBA	60	0.0%	0.0%	0.0%
East Big Island	Non-IBA	44	0.0%	0.0%	0.0%
Katauyak Island	Non-IBA	220	0.0%	0.0%	0.0%
Nunaksuk Island	Non-IBA	6,800	0.1%	0.9%	1.0%
Roundhill Island	Non-IBA	12,000	0.1%	1.6%	1.7%
Western Bird Island (Lab. S)	Non-IBA	3,000	0.0%	0.4%	0.4%
	Species in Non-IBAs Total	22,124	0.2%	2.9%	3.2%

Razorbill

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Bird Island (Lab. S)	Bird Island	3,060	0.3%	4.0%	4.0%
Gannet Islands	Gannet Islands	28,658	2.4%	37.7%	37.9%
Outer Gannet Island	Gannet Islands	944	0.1%	1.2%	1.2%
	Species in IBAs Total	29,602	2.5%	38.9%	39.2%
Herring Island 1	Northeast Groswater Bay	764	0.1%	1.0%	1.0%
Herring Island 2	Northeast Groswater Bay	3,336	0.3%	4.4%	4.4%
Herring Island 3	Northeast Groswater Bay	1,638	0.1%	2.2%	2.2%
North Green Island (Lab)	Northeast Groswater Bay	700	0.1%	0.9%	0.9%
Puffin Islands (Lab)	Northeast Groswater Bay	238	0.0%	0.3%	0.3%

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Puffin Islands (Lab), uni just E of	Northeast Groswater Bay	240	0.0%	0.3%	0.3%
Puffin Islands (Lab), uni just S of	Northeast Groswater Bay	184	0.0%	0.2%	0.2%
The Doughboy, uni e. of Pompey Island	Northeast Groswater Bay	292	0.0%	0.4%	0.4%
Tinker Island, nr. Indian Hr.	Northeast Groswater Bay	326	0.0%	0.4%	0.4%
	Species in IBAs Total	7,718	0.6%	10.2%	10.2%
Kidlit Islands	Offshore Islands Southeast of Nain	400	0.0%	0.5%	0.5%
Ukallik Island	Offshore Islands Southeast of Nain	240	0.0%	0.3%	0.3%
	Species in IBAs Total	640	0.1%	0.8%	0.8%
Quaker Hat	Quaker Hat Island	900	0.1%	1.2%	1.2%
Bacalhao Island	Non-IBA	30	0.0%	0.0%	0.0%
East Big Island	Non-IBA	26	0.0%	0.0%	0.0%
Katauyak I.	Non-IBA	130	0.0%	0.2%	0.2%
Little Bird Island (Lab. S)	Non-IBA	600	0.1%	0.8%	0.8%
Nunaksuk Island	Non-IBA	380	0.0%	0.5%	0.5%
Tinker Island, nw, of Holten Island	Non-IBA	6	0.0%	0.0%	0.0%
Twin Islands, east	Non-IBA	388	0.0%	0.5%	0.5%
Twin Islands, west	Non-IBA	602	0.1%	0.8%	0.8%
U. I. W. of Lost Island	Non-IBA	46	0.0%	0.1%	0.1%
	Species in Non-IBAs Total	2,208	0.2%	2.9%	2.9%

Common Murre

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Gannet Islands	Gannet Islands	35,228	0.2%	0.5%	3.5%
Outer Gannet Island	Gannet Islands	27,112	0.2%	0.4%	2.7%
	Species in IBAs Total				
Herring Island 1	Northeast Groswater Bay	318	0.0%	0.0%	0.0%
Herring Island 2	Northeast Groswater Bay	2,230	0.0%	0.0%	0.2%
Herring Island 3	Northeast Groswater Bay	1,518	0.0%	0.0%	0.2%
North Green Island (Lab)	Northeast Groswater Bay	50	0.0%	0.0%	0.0%
Puffin Islands (Lab), uni just S of	Northeast Groswater Bay	76	0.0%	0.0%	0.0%
The Doughboy, uni e. of Pompey Island	Northeast Groswater Bay	522	0.0%	0.0%	0.1%
	Species in IBAs Total				
Kidlit Islands	Offshore Islands Southeast of Nain	80	0.0%	0.0%	0.0%
The Castle	Offshore Islands Southeast of Nain	94	0.0%	0.0%	0.0%
	Species in IBAs Total				
Quaker Hat	Quaker Hat Island	1,296	0.0%	0.0%	0.1%
Little Bird Island (Lab. S)	Non-IBA	1,450	0.0%	0.0%	0.1%
Nunaksuk Island	Non-IBA	400	0.0%	0.0%	0.0%
Twin Islands, east	Non-IBA	2	0.0%	0.0%	0.0%
Twin Islands, west	Non-IBA	2	0.0%	0.0%	0.0%
Western Bird Island (Lab. S)	Non-IBA	100	0.0%	0.0%	0.0%
	Species in Non-IBAs Total				

Thick-billed Murre

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Gannet Islands	Gannet Islands	2,966	0.0%	0.1%	4.8%
Outer Gannet Island	Gannet Islands	726	0.0%	0.0%	1.2%
	Species in IBAs Total	3,692	0.0%	0.1%	6.0%
Herring Island 2	Northeast Groswater Bay	678	0.0%	0.0%	1.1%
Herring Island 3	Northeast Groswater Bay	52	0.0%	0.0%	0.1%
	Species in IBAs Total	730	0.0%	0.0%	1.2%
Kidlit Islands	Offshore Islands Southeast of Nain	3,072	0.0%	0.1%	5.0%
The Barbican	Offshore Islands Southeast of Nain	710	0.0%	0.0%	1.1%
The Castle	Offshore Islands Southeast of Nain	3,770	0.0%	0.1%	6.1%
	Species in IBAs Total	7,552	0.0%	0.3%	12.2%
Quaker Hat	Quaker Hat Island	252	0.0%	0.0%	0.4%
Pyramid Islands (2)	Non-IBA	2,860	0.0%	0.1%	4.6%

Black Guillemot

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Gannet Islands	Gannet Islands	3	0.0%	0.0%	0.0%
Outer Gannet Island	Gannet Islands	8	0.0%	0.0%	0.0%
	Species in IBAs Total	11	0.0%	0.0%	0.0%
Seniartlit Islands, eastermost of the	Nain Coastline	36	0.0%	0.0%	0.1%
Seniartlit Islands, westermost of the	Nain Coastline	26	0.0%	0.0%	0.1%
Nuasurnak Island	Nain Coastline	150	0.0%	0.1%	0.3%
Amatut Islands	Nain Coastline	5	0.0%	0.0%	0.0%
Karl Oom Islands, uni E of	Nain Coastline	6	0.0%	0.0%	0.0%
Karl Oom Islands, east Island of	Nain Coastline	30	0.0%	0.0%	0.1%
Bald Island, uni W of	Nain Coastline	3	0.0%	0.0%	0.0%
Bald Island (Lab. N)	Nain Coastline	5	0.0%	0.0%	0.0%
Imilikiluk Island	Nain Coastline	50	0.0%	0.0%	0.1%
Gull Islands, west Island of the	Nain Coastline	2	0.0%	0.0%	0.0%
Chronicle Island, unis E of	Nain Coastline	24	0.0%	0.0%	0.0%
	Species in IBAs Total	335	0.0%	0.2%	0.7%
Kidlit Islands	Offshore Islands Southeast of Nain	3	0.0%	0.0%	0.0%
Ukallik Island	Offshore Islands Southeast of Nain	450	0.1%	0.3%	0.9%
	Species in IBAs Total	453	0.1%	0.3%	0.9%
Spotted Island, uni N of	Non-IBA	6	0.0%	0.0%	0.0%
Little Black Island	Non-IBA	68	0.0%	0.0%	0.1%
North Duck Island	Non-IBA	2	0.0%	0.0%	0.0%
White Bear Island (Lab. S)	Non-IBA	14	0.0%	0.0%	0.0
Brig Harbour Island	Non-IBA	5	0.0%	0.0%	0.0%
Flat Island, uni S of	Non-IBA	5	0.0%	0.0%	0.0%
Teapot Island, uni N of	Non-IBA	36	0.0%	0.0%	0.1%
Cape Rouge, uni E of (2)	Non-IBA	3	0.0%	0.0%	0.0%
Cape Rouge, uni E of (1)	Non-IBA	3	0.0%	0.0%	0.0%

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
False Cape, uni E of	Non-IBA	33	0.0%	0.0%	0.1%
Sloop Cove, uni E of	Non-IBA	17	0.0%	0.0%	0.0%
Double Island, N tip of	Non-IBA	3	0.0%	0.0%	0.0%
Dog Island, uni E of	Non-IBA	39	0.0%	0.0%	0.1%
Conical Island	Non-IBA	50	0.0%	0.0%	0.1%
Ragged Islands, uni in the (1)	Non-IBA	8	0.0%	0.0%	0.0%
Ragged Islands, uni in the (2)	Non-IBA	59	0.0%	0.0%	0.1%
Ragged Islands, uni in the (3)	Non-IBA	11	0.0%	0.0%	0.0%
Ragged Islands, westermost of the	Non-IBA	6	0.0%	0.0%	0.0%
Tikaoralik Islet, uni NE of	Non-IBA	9	0.0%	0.0%	0.0%
Ragged Islands (1)	Non-IBA	20	0.0%	0.0%	0.0%
Adlavik Islands (2)	Non-IBA	30	0.0%	0.0%	0.1%
Adlavik Islands (1)	Non-IBA	3	0.0%	0.0%	0.0%
Ragged Islands (2)	Non-IBA	77	0.0%	0.0%	0.2%
Long Tickle, uni NE of	Non-IBA	6	0.0%	0.0%	0.0%
Double Island, northeast part of	Non-IBA	2	0.0%	0.0%	0.0%
Ironbound Islands	Non-IBA	3	0.0%	0.0%	0.0%
Belle Island	Non-IBA	12	0.0%	0.0%	0.0%
Bay of Islands, uni in (bloc 959 - 5)	Non-IBA	6	0.0%	0.0%	0.0%
Bay of Islands, uni in (bloc 959 - 6)	Non-IBA	3	0.0%	0.0%	0.0%
Bay of Islands, uni in (bloc 959 - 3)	Non-IBA	2	0.0%	0.0%	0.0%
Kidlialuit Island, north point of	Non-IBA	2	0.0%	0.0%	0.0%
Kanairiktok Bay, uni 3 in	Non-IBA	3	0.0%	0.0%	0.0%
Kanairiktok Bay, uni 2 in	Non-IBA	8	0.0%	0.0%	0.0%
Turnavik Island	Non-IBA	2	0.0%	0.0%	0.0%
Windsor Harbour Island, uni S of	Non-IBA	6	0.0%	0.0%	0.0%
Kikkertavak Island, uni SW of (2)	Non-IBA	18	0.0%	0.0%	0.0%
Burnt Island, uni E of	Non-IBA	2	0.0%	0.0%	0.0%
Nuvutsuakulluk Island, uni NW of	Non-IBA	8	0.0%	0.0%	0.0%
Umiatoriak Island, uni N of (2)	Non-IBA	5	0.0%	0.0%	0.0%
Illuviktalik Island	Non-IBA	5	0.0%	0.0%	0.0%
Crab Island (Labrador)	Non-IBA	3	0.0%	0.0%	0.0%
Anniowaktook Island	Non-IBA	3	0.0%	0.0%	0.0%
Oganiovik Island, uni E of	Non-IBA	2	0.0%	0.0%	0.0%
Tessiujalik Island, uni NE of	Non-IBA	3	0.0%	0.0%	0.0%
Kikkertaksoak Island, uni S of	Non-IBA	5	0.0%	0.0%	0.0%
Kikkertaksoak Island	Non-IBA	30	0.0%	0.0%	0.1%
Windy Tickle, uni N of	Non-IBA	3	0.0%	0.0%	0.0%
Nanuktok Island	Non-IBA	105	0.0%	0.1%	0.2%
Akpalik Island	Non-IBA	30	0.0%	0.0%	0.1%
Ukasiksalik Island, uni in Bay of	Non-IBA	24	0.0%	0.0%	0.0%
Kasungatak Island, uni N of	Non-IBA	100	0.0%	0.1%	0.2%
Nunaksuk Island	Non-IBA	3	0.0%	0.0%	0.0%
Koriavvik Island, uni SE of	Non-IBA	8	0.0%	0.0%	0.0%
Koriaravik Island, uni W of	Non-IBA	6	0.0%	0.0%	0.0%
Koriarvik Island	Non-IBA	42	0.0%	0.0%	0.1%
Koriarvik Island, uni NW of	Non-IBA	3	0.0%	0.0%	0.0%
Takpanayok Bay, Point on S side of (1)	Non-IBA	14	0.0%	0.0%	0.0%

Colony/Island Name	IBA Name	# Individuals	Proportion World Pop	Proportion N.Am. Pop	Proportion Atl. Pop
Spracklins Island, uni W of	Non-IBA	90	0.0%	0.1%	0.2%
Takpanayok Bay, Point on S side of (2)	Non-IBA	60	0.0%	0.0%	0.1%
North Tunvungayukuluk Island	Non-IBA	3	0.0%	0.0%	0.0%
Akpiktok Island	Non-IBA	11	0.0%	0.0%	0.0%
Kiuvik Island, uni S of (3)	Non-IBA	33	0.0%	0.0%	0.1%
Iglosiatik Island, uni E of (1)	Non-IBA	3	0.0%	0.0%	0.0%
Iglosiatik Island, uni E of (3)	Non-IBA	93	0.0%	0.1%	0.2%
Sungilik Island, uni S of	Non-IBA	8	0.0%	0.0%	0.0%
Ukallik Island, uni NW of	Non-IBA	5	0.0%	0.0%	0.0%
Nuasurnak Island, uni S of	Non-IBA	39	0.0%	0.0%	0.1%
Kiuvik Island, uni N of	Non-IBA	6	0.0%	0.0%	0.0%
Nochalik Island	Non-IBA	84	0.0%	0.1%	0.2%
Kikkertavak Island	Non-IBA	2	0.0%	0.0%	0.0%
Saint John's Island, unis E of	Non-IBA	3	0.0%	0.0%	0.0%
Barham Island, unis S of	Non-IBA	5	0.0%	0.0%	0.0%
Barham Island	Non-IBA	308	0.0%	0.2%	0.6%
Barham Island, uni E of	Non-IBA	3	0.0%	0.0%	0.0%
David Island	Non-IBA	5	0.0%	0.0%	0.0%
Barnes Island	Non-IBA	63	0.0%	0.0%	0.1%
Kaiktuinak Island	Non-IBA	14	0.0%	0.0%	0.0%
Coopers Island (1)	Non-IBA	6	0.0%	0.0%	0.0%
Opingivik Island	Non-IBA	158	0.0%	0.1%	0.3%
Schneider Island	Non-IBA	66	0.0%	0.0%	0.1%
Drachard Island	Non-IBA	24	0.0%	0.0%	0.0%
	Species in Non-IBAs Total	2,060	0.3%	1.3%	4.2%

B. Rare Fauna

Native species in Labrador were assessed in relation to a range of criteria related to conservation concern (Groves *et al.* 2000):

- Designated as Threatened or Endangered nationally or provincially (regulated under federal *Species at Risk Act*, or provincial *Endangered Species Act*)[2]
- Globally rare, with fewer than 100 known populations (ranked G1-G3 by NatureServe)[2];
- Rare in Labrador (sub-nationally rare), with fewer than 100 known populations (ranked S1-S3 by NatureServe)[2];
- Endemic, or with a global distribution limited to the region;
- Population declining; or extremely wide-ranging individuals, requiring conservation of habitat at very large scales. (Data sources: ACCDC 2011a).

Common Name	Scientific Name	COSEWIC	SARA	NL ESA	S-Rank (Lab)	N-Rank	G-Rank	General Status (2010)	Number of records
Mammals									
Wolverine	*Gulo gulo*	EN	EN	EN	S1		G4	At risk	0
Woodland Caribou - Boreal pop.	*Rangifer tarandus* pop. 14	TH	TH	TH	S2S3		G5TNR	May be at risk	0
Caribou - George River Herd	*Rangifer tarandus* pop. 7							Secure	0
Caribou - Torngat Mountains	*Rangifer tarandus*							Secure	0
Polar Bear	*Ursus maritimus*	SC	SC	VU	S2S3	N3N4	G3G4	Sensitive	953
Rock Vole	*Microtus chrotorrhinus*				S1	N4	G4	Sensitive	12
Woodland Jumping Mouse	*Napaeozapus insignis*				S1?	N5	G5	Undetermined	5
Pygmy Shrew	*Sorex hoyi*				S1?	N5	G5	Undetermined	6
Water Shrew	*Sorex palustris*				S1?	N5	G5	Undetermined	1
Birds									
Common Nighthawk	*Chordeiles minor*	TH	TH	TH	S2B	N5B	G5	May be at risk	4
Olive-sided Flycatcher	*Contopus cooperi*	TH	TH	TH	S2S3	N5B	G4	Secure	4
Short-eared Owl	*Asio flammeus*	SC	SC	VU	S3S4B	N3N,N4B	G5	Secure	56
Barrow's Goldeneye (moulting & staging)	*Bucephala islandica*	SC	SC	VU	S2S3B?	N5B,N5N	G5	Sensitive	9
Rusty Blackbird	*Euphagus carolinus*	SC	SC	VU	S3S4B	N4B	G4	Secure	25
Peregrine Falcon	*Falco peregrinus* ssp. *anatum*	SC	TH	VU	S3B	N3B	G4T4	Sensitive	212
Harlequin Duck - Eastern pop.	*Histrionicus histrionicus*	SC	SC	VU	S4B	N3N4	G4T4	Secure	2634
Gray-cheeked Thrush	*Catharus minimus*			VU	S4B	N5B	G5	Secure	11
Surf Scoter	*Melanitta perspicillata*				S5B		G5	Secure	13
Black Scoter	*Melanitta americana*				S2S3B,S3M		G5	Secure	1
White-winged Scoter	*Melanitta fusca*				S5N		G5	Secure	0
Amphibians									
Spring Peeper	*Pseudacris crucifer*				S1S2		G5	Undetermined	0

[2] Full NatureServe definitions, see: < http://www.natureserve.org/explorer/ranking.htm#globalstatus >
Full COSEWIC definitions, see < http://www.cosewic.gc.ca/eng/sct2/sct2_6_e.cfm >
Full SARA definitions, see < http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm#tbl5>
Full NL ESA definitions, see < http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/index.html >

Common Name	Scientific Name	COSEWIC	SARA	NL ESA	S-Rank (Lab)	N-Rank	G-Rank	General Status (2010)	Number of records
Freshwater Fish									
American Eel	*Anguilla rostrata*	TH		No Status	VU	S4	G4	Secure	0
Fourhorn Sculpin	*Myoxocephalus quadricornis*	Data Deficient	SC					Undetermined	1
Atlantic Sturgeon	*Acipenser oxyrinchus*				SNA		G3	Accidental	0
Alewife	*Alosa pseudoharengus*				S1S2		G5	Vagrant	0
American Shad	*Alosa sapidissima*				S1S2		G5	Vagrant	0
Logperch	*Percina caprodes*				SNR		G5	Undetermined	1
Longnose Dace	*Rhinichthys cataractae*				S4		G5	Secure	2
Invertebrates									
Labrador Snowfly	*Utacapnia labradora*				SNR		G2		0
Tomah Mayfly	*Siphlonisca aerodromia*				SNR		G2G3		0
A Mayfly	*Siphlonurus barbaroides*				SNR		G3		0
A Mayfly	*Acentrella feropagus*				SNR		G3G4		0
A Mayfly	*Baetisca rubescens*				SNR		G3G4		0
A Caddisfly	*Limnephilus ademus*				SNR		G3G4		0
Short-tailed Swallowtail	*Papilio brevicauda*				SAN	N3N4	G3G4	Undetermined	2
Sandy Tiger Beetle	*Cicindela limbata labradorensis*				S1		G4T1Q		0
Melissa Arctic	*Oeneis melissa*				S2S3		G5T2T3	Secure	19
Pink-edged Sulphur	*Colias interior*				S2S3	N5	G5	Undetermined	6
Hoary Comma	*Polygonia gracilis*				S2S3	N5	G5	Undetermined	3
Labrador Sulphur	*Colias nastes*				S3	N5	G5	Undetermined	11
Frigga Fritillary	*Boloria frigga*				S3?	N5	G5	Secure	8
Common Ringlet	*Coenonympha tullia*				S3?	N5	G5	Undetermined	10
Taiga Alpine	*Erebia mancinus*				S3?	N5	G5	Secure	8
Mourning Cloak	*Nymphalis antiopa*				S3?	N5	G5	Secure	5
Mustard White	*Pieris oleracea*				S3?	N4N5	G4G5	Sensitive	8
Crowberry Blue	*Plebejus idas aster*				S3?				0

C. Rare Flora

Note: Blue denotes a species that has been reported but specimens have not been confirmed; grey refers to species that are confirmed but no records are present in the ACCDC database. (For definitions and references for G rank and S rank, refer to page 162.)

Vascular Plants of Conservation Interest

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Agrostis geminata	Hairgrass	G5	S2S4	16	Boreal NA	
Agrostis stolonifera	Creeping Bentgrass	G5	S2S4	13	Circumboreal (disjunct)	
Alchemilla filicaulis (typ.)	Thinstemmed Lady's Mantle	G4T3?	S2S4	10	Boreal amphi-Atlantic	
Alopecurus alpinus	Alpine Foxtail		SNR	0	Arctic-alpine circumpolar	
Ammophila breviligulata	American Beachgrass	G5	S1S2	1	Coastal, nTemp. eNA & St. Lawrence River Valley	
Arabis drummondii	Drummond's Rockcress	G5	S2	6	Boreal NA	calciphile
Arethusa bulbosa	Dragon's Mouth, Swamp Pink	G4	S1	1	nTemp. Boreal eNA	
Arnica angustifolia (typ.)	Narrowleaf Leopardbane	G5T5	S2S3	0	Arctic-alpine NA	calciphile
Asplenium trichomanes-ramosum	Green Spleenwort	G4	S1	4	Circumboreal (disjunct)	calciphile
Astragalus fernaldii	Fernalds' Milkvetch	G5	S1	369	Strait of Belle Isle endemic	calciphile
Astragalus robbinsii var. *minor*	Robbins' Milkvetch	G5T5	S1	17	Cordilleran wNA; disjunct in nwNfld. & seLab	calciphile
Athyrium alpestre var. *americanum*	American Alpine Ladyfern	G4G5	S1	2	Alpine, cordilleran disjunct	snowbeds
Atriplex glabriuscula	Northeastern Saltbush	G4	S2S3	3	Coastal amphi-Atlantic	halophyte
Botrychium lanceolatum var. *lanceolatum*	Lanceleaf Grapefern	G5T4	S1	1	Boreal NA (disjunct)	mainly coastal
Botrychium matricariifolium	Matricary Moonwort	G5	S1	3	Boreal NA (mainly amphi-Atlantic)	
Botrychium minganese	Mingan Moonwort	G5	S1	8	Boreal NA	
Botrychium multifidum	Leathery Grapefern	G5	S1	5	Circumboreal	
Botrychium virginianum	Rattlesnake Fern	G5	S1	3	Temp. Boreal NA	
Brachyelytrum septentrionale	Northern Short-husk		SNA	0	Temp.-sBoreal eNA	
Braya glabella	Smooth Rockcress	G5T5?	S1	1	Arctic circumpolar	calciphile
Cakile edentula (typ.)	American Searocket	G5T5	S2S3	6	Coastal NA	
Calamagrostis deschampsioides	Circumpolar Reedgrass		SNA	0	Arctic circumpolar (disjunct)	halophyte
Calamagrostis lapponica	Lapland Reedgrass	G5	SNR	1	Arctic-alpine circumpolar	
Calamagrostis pickeringii	Pickering's Reedgrass	G4	SNR	2	Boreal eNA	
Calamagrostis stricta ssp. *inexpansa*	Pond Reedgrass	G3Q	SU	29	Boreal NA	often calciphile, serpentine
Calla palustris	Wild Calla, Water Arum	G5	SNR	7	Circumboreal	
Caltha palustris	Marsh-marigold	G5	S1	4	Circumboreal (disjunct)	

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Calypso bulbosa var. *americana*	Fairyslipper Orchid, Calypso	G5T5	SNA	1	Circumboreal	mainly calciphile
Carex adelostoma	Circumpolar Sedge	G4	S1S2	1	Boreal alpine NA (disjunct)	
Carex adusta	Lesser Brown Sedge	G5	SNR	1	sBoreal NA	
Carex arcta	Northern Clustered Sedge	G5	SNR	3	Boreal NA	
Carex arctata	Drooping Woodland Sedge		SNR	0	Boreal NA	
Carex argyrantha	Hay Sedge		SNR	0	Temp.-Boreal NA	acidophile
Carex aurea	Golden-fruit Sedge	G5	S1S2	0	Boreal NA	calciphile
Carex bebbii	Bebb's Sedge	G5	SNR	2	Boreal NA	calciphile
Carex bicolor	Bicoloured Sedge		SNR	0	Arctic-alpine circumpolar (disjunct)	calciphile
Carex canescens ssp. *disjuncta*	Silvery Sedge		SNR	5	Circumboreal	
Carex castanea	Chestnut-colored Sedge	G5	S1S2	0	Boreal eNA	calciphile
Carex concinna	Beautiful Sedge	G5	S1S2	1	Boreal NA	calciphile
Carex diandra	Lesser Panicled Sedge	G5	S2S4	5	Circumboreal	
Carex deweyana var. *deweyana*	Dewey's Sedge	G5T5	SNR	1	Boreal NA	
Carex flava	Yellow Sedge		SNA	0	nTemp. NA (disjunct)	calciphile
Carex garberi	Garber's sedge		SNR	0	Boreal NA	calciphile
Carex glacialis	Alpine Sedge	G5	S2S3	9	Arctic-alpine circumpolar	calciphile
Carex gynandra	Nodding Sedge		SNR	0	sBoreal eNA	
Carex heleonastes	Hudson Bay Sedge		SNR	0	Circumboreal (disjunct)	calciphile
Carex houghtoniana	Houghton's Sedge		SNA	0	Temp. NA (disjunct)	acidophile
Carex interior	Inland Sedge	G5	S2S4	5	Boreal NA	
Carex intumescens	Greater Bladder Sedge	G5	S1S2	1	Temp. eNA	
Carex lasiocarpa ssp. *americana*	Slender Sedge, Woollyfruit Sedge	G5T5	SNR	1	Boreal NA	
Carex leptonervia	Finely-nerved Sedge	G4	S2S3	8	nTemp. eNA	
Carex mackenziei	Mackenzie's Sedge	G4?	S2S3	8	Coastal arctic-alpine NA	halophyte
Carex maritima	Seaside Sedge	G4G5	S1S2	4	Coastal, arctic amphi-Atlantic	hal., calc.
Carex media	Closed-head Sedge	G5	S2S4	5	Circumboreal	
Carex membranacea	Fragile-seed Sedge	G5	S1S2	0	Arctic NA	calciphile
Carex michauxiana	Michaux's Sedge	G5	S2S4	7	Boreal eNA	
Carex microglochin	False Uncinia Sedge	G5?	S1S2	1	Arctic-alpine circumpolar (disjunct)	calciphile
Carex recta	Cuspidate Sedge	G4	SNR	4	Boreal amphi-Atlantic; coastal	halophyte
Carex rotundata	Roundfruit Sedge		SNR	0	Arctic-alpine circumpolar	
Carex nardina	Nard Sedge	G4G5	S2S3	1	Arctic-alpine amphi-Atlantic	calciphile
Carex rupestris	Rock Sedge	G5	S2S3	1	Arctic-alpine circumpolar	calciphile
Carex salina	Salt-marsh Sedge	G5	S2S3	6	Boreal amphi-Atlantic	halophyte
Carex stipata var. *stipata*	Stalk-grain Sedge	G5T5	S2S3	6	Boreal NA	

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Carex subspathacea	Hoppner's Sedge	G4	SNR	1	Coastal, arctic circumpolar	halophyte
Carex tonsa var. *tonsa*	Deepgreen Sedge	G4T4T5	S1S2	4	Boreal NA (disjunct)	
Carex umbellata	Hidden Sedge	G5	S1S3	3	Boreal NA	
Carex ursina	Bear Sedge	G4G5	S1S2	0	Arctic circumpolar	halophyte
Carex utriculata	Bottle Sedge	G5	SNR	2	Circumboreal	
Carex viridula (typ.)	Little Green Sedge	G5T5	S1	3	Temp.-Boreal NA	
Carex williamsii	Williams' Sedge	G4	S2S4	8	Circumboreal (disjunct), subarctic	calciphile
Catabrosa aquatica var. *laurentiana*	Water Hairgrass	G5	S2S4	15	Boreal NA	halophyte
Cerastium beeringianum	Newfoundland Chickweed	G5T5	S2S4	13	Arctic-alpine NA (disjunct)	calciphile
Cerastium cerastioides	Starwort Chickweed, Mountain Chickweed	G4	S2S3	2	Circumpolar	snowbeds
Chrysosplenium tetrandrum	Northern Golden-carpet	G5	SNR	0	Arctic-alpine circumpolar	nitrophile
Cochlearia tridactylites	Limestone Scurvy-grass	G3G5	S4	15	Gulf of St. Lawrence endemic	calc., hal.
Comandra umbellata (typ.)	Umbellate Bastard Toad-flax	G5T5	S1	0	Boreal NA	calciphile
Corydalis sempervirens	Pale Corydalis	G4G5	S2S3	9	Boreal NA	
Crepis nana (typ.)	Dwarf Alpine Hawk's-beard	G5T5	S2	0	Arctic-alpine NA	calciphile
Cryptogramma stelleri	Steller's Rockbrake	G5	S1S2	5	Boreal NA (disjunct)	calciphile
Cypripedium acaule	Pink Ladyslipper		SNA	0	Temp.-Boreal NA	
Cystopteris montana	Mountain Bladder Fern	G5	S1S2	3	Boreal cordilleran; disjunct in nwNfld	calciphile
Danthonia intermedia	Timber Oatgrass	G5	SNR	4	Boreal NA	serpentine
Danthonia spicata	Poverty Oatgrass	G5	SNR	2	Temp.-Boreal NA	
Diervilla lonicera	Northern Bush-honeysuckle	G5	S1S2	0	Temp. eNA	
Dryopteris fragrans	Fragrant Woodfern	G5	S2	4	Circumpolar (disjunct)	often calc.
Eleocharis nitida	Slender Spikerush, Quill Spikerush	G3G4	SNR	1	Boreal eNA	
Eleocharis palustris	Creeping Spikerush, Small's Spikerush	G5	S2S4	9	Circumboreal	
Eleocharis parvula	Dwarf Spikerush	G5	SNR	3	Temp.	halophyte
Eleocharis quinqueflora	Fewflowered Spikerush	G5	SNR	1	Boreal NA	calciphile
Eleocharis uniglumis	Onescale Spikerush	G5?	SNR	1	Circumboreal	
Elymus trachycaulus (typ.)	Slender Wheatgrass	G5T5	SNR	32	Boreal NA	often calc., serpentine
Equisetum palustre	Marsh Horsetail	G5	S1	3	Circumboreal	
Equisetum pratense	Meadow Horsetail	G5	S2S3	25	Circumboreal	
Erigeron elatus	Tall Bitter Fleabane	G4?	S1	13	Cordilleran disjunct	calciphile
Eriocaulon aquaticum	White Buttons, Sevenangled Pipewort	G5	SNR	1	Boreal eNA	
Eriophorum brachyantherum	Close-sheathed Cottongrass	G5T5	SNR	5	Arctic circumboreal	calciphile
Eriophorum callitrix	Sheathed Cotton-grass	G5	S2S4	8	Arctic NA	calciphile

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Eriophorum gracile	Slender Cottongrass	G5	SNR	7	Circumboreal	
Eriophorum scheuchzeri	Scheuchzer's Cottongrass	G5	S2S4	13	Arctic circumpolar	calciphile
Eriophorum tenellum	Rough Cottongrass	G5	S2S4	5	Temp. eNA	
Eriophorum virginicum	Tawny Cottongrass	G5	SNR	2	Boreal eNA	
Eutrema edwardsii	Edward's Eutrema	G4	S1	0	Arctic circumpolar	
Festuca altaica	Rough Fescue	G5	S1S2	2	Alpine amphi-Beringian, eNA (disjunct)	calciphile, serpentine
Festuca frederikseniae	Viviparous Fescue	G3G4Q	S2S4	21	Arctic amphi-Atlantic	calciphile often coastal
Festuca prolifera	Prolific Fescue, Proliferous Red Fescue	G5T4	SNR	2		
Festuca richardsonii	Richardson's Fescue	G5	SNR	2	Arctic-alpine NA;	
Festuca saximontana (typ.)	Rocky Mountain Fescue	G5T5	S1	2	Mainly boreal-alpine wNA, disjunct in eNA; disjunct in nLab	calciphile
Galium trifidum ssp. *halophilum*	Small Bedstraw	G5T3T5	S2S4	16	Circumboreal	
Gentianella amarella ssp. *acuta*	Autumn Dwarf Gentian	G5T5	S2S3	10	Boreal NA (mainly cordilleran)	
Gentianella propinqua (typ.)	Four-part Gentian	G5T5?	S2	6	Boreal NA, mainly nwNA	
Glyceria canadensis	Rattlesnake Mannagrass	G5	S1S3	3	Temp. eNA	
Goodyera repens	Dwarf Rattlesnake Plantain	G5	S2S3	6	Circumboreal	
Hedysarum alpinum	Alpine Sweet-vetch	G5	S2	10	Arctic-alpine	calciphile
Hordeum brachyantherum (typ.)	Meadow Barley	G5	S1S2	3	Boreal cordilleran	halophyte
Hordeum jubatum (typ.)	Foxtail Barley, Squirreltail Grass	G5T5	S2S4	8	Boreal NA	halophyte
Juncus articulatus	Jointed Rush		SNA	0	Circumboreal (disjunct)	
Juncus bufonius (typ.)	Toad Rush	G5T5	S2S4	11	Circumboreal	
Juncus canadensis	Canada Rush	G5	SH	1	Temp. eNA	
Juncus dudleyi	Dudley's Rush		SNA	0	Temp.-Boreal NA	
Juncus pelocarpus	Brownfruit Rush	G5	SNR	2	Boreal eNA	
Juncus stygius var. *americanus*	Moor Rush	G5T5	S2S4	16	Boreal NA	
Juncus subtilis	Creeping Rush	G3	SNR	2	Boreal eNA	
Juncus tenuis	Path Rush, Slender Rush	G5	S2S3	5	Temp.-Boreal NA; disjunct in cLab.	
Kobresia simpliuscula	Arctic Kobresia	G5	SNR	4		
Limosella australis	Mudwort	G4G5	S1	3	Temp. eNA	halophyte
Listera auriculata	Auricled Twayblade	G3G4	S1S2	5	sBoreal eNA	
Listera borealis	Northern Twayblade		SNA	0	Boreal NA (disjunct)	calciphile
Luzula arctica	Arctic Woodrush	G5	SNR	1	Circumpolar	
Luzula groenlandica	Greenland Woodrush	G4	SNR	1	Subarctic-alpine NA	halopyhte
Luzula multiflora (typ.)	Common Woodrush	G5	S2S4	2	Circumpolar	

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Luzula multiflora ssp. *frigida*	Common Woodrush	G5T5	S2S4	17	Circumpolar	
Lycopodiella inundata	Bog Clubmoss	G5	S2S4	2	Boreal NA (disjunct)	acidophile
Maianthemum stellatum	Starry False Solomon's-seal	G5	S2S3	17	Boreal NA	
Malaxis unifolia	Green Addersmouth	G5	S1S3	2	Temp. Boreal eNA	
Milium effusum var. *cisatlanticum*	Tall Millet Grass	G5TNR	S1S2	5	nTemp. eNA	calciphile
Minuartia biflora	Mountain Stitchwort	G5	S1S2	6	Arctic-alpine circumpolar	calciphile
Muhlenbergia uniflora	Bog Muhly, Lateflowering Dropseed	G5	SNR	2	Boreal eNA	
Myriophyllum farwellii	Farwell's Water-milfoil	G5	S1S2	3	nTemp. eNA	aquatic
Omalotheca norvegica	Norwegian Cudweed	G5	S2S3	1	Arctic-alpine amphi-Atlantic	
Omalotheca supina	Alpine Cudweed	G5	S2S3	4	Arctic-alpine amphi-Atlantic	
Omalotheca sylvatica	Woodland Cudweed, Heath Cudweed	G4	SNR	4	Arctic-alpine amphi-Atlantic	
Osmorhiza depauperata	Blunt-fruit Sweet-cicely	G5	S2	4	Boreal, cordilleran disjunct	
Osmunda claytoniana	Interrupted Fern	G5	S2S3	6	Temp. eNA	
Oxalis acetosella	Irish Shamrock	G5	S1	0	nTemp. eNA	
Oxytropis campestris var. *johannensis*	St. John's Oxytrope	G5T4	S1	7	Boreal eNA	
Oxytropis deflexa var. *foliolosa*	Pendent-pod Crazyweed	G5T3T5	S1	1	Arctic-alpine NA (disjunct)	calciphile
Oxytropis podocarpa	Gray's Point-vetch	G4	S1	0	Arctic-alpine NA, Cordilleran disjunct	calciphile
Pedicularis hirsuta	Hairy Lousewort	G5?	S2S4	0	Arctic amphi-Atlantic	
Pedicularis palustris	Marsh Lousewort	G4G5	SNR	3	Temp.-Boreal amphi-Atlantic	
Pinguicula villosa	Hairy Butterwort	G4	S2	4	Arctic-alpine circumpolar (disjunct)	
Pinus banksiana	Jack Pine	G5	S1	0	Boreal eNA (disjunct in wLab)	
Piptatherum canadense	Canada Mountainrice	G5	SNR	2	Temp.-Boreal NA	often calc., serpentine
Platanthera aquilonis	Norther Green Orchid	G5	S2S3	7	Boreal NA	
Platanthera huronensis	Huron Green Orchid, Tall Northern Green Orchid	G5T5?	SNR	6	nTemp. eNA	
Pleuropogon sabinei	Sabine-grass	G4G5	S1	0	Arctic amphi-Atlantic	
Poa pratensis ssp. *alpigena*	Kentucky Bluegrass	G5T5	SNR	14	Arctic-alpine circumpolar-boreal	
Poa pratensis ssp. *irrigata*	Kentucky Bluegrass	G5TU	SNR	2	Arctic-alpine circumpolar-boreal	
Polygonum buxiforme	Small's Knotweed	G5	S1S2	0	Circumboreal	halophyte
Polypodium virginianum	Rock Polypody	G5	S2S3	3	Temp.-Boreal NA,	
Polystichum braunii	Braun's Hollyfern	G5	S1	1	Boreal w/eNA (disjunct), disjunct in wLab.	
Potamogeton alpinus	Alpine Pondweed, Northern Pondweed	G5	S2S4	9	Circumboreal	aquatic

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Potamogeton confervoides	Alga Pondweed, Tuckerman's Pondweed	G4	SNR	1	Boreal eNA, disj. in cLab.	acidophile, aquatic
Potamogeton gramineus	Variableleaf Pondweed	G5	SNR	9	Circumboreal	aquatic
Potamogeton oakesianus	Oakes' Pondweed	G4	SNR	2	Boreal eNA;	acidophile, aquatic
Potamogeton perfoliatus	Claspingleaf Pondweed	G5	S1S3	4	Temp.-Boreal eNA, disj. in cLab	aquatic, often brackish
Potamogeton praelongus	Whitestem Pondweed	G5	SNR	2	Circumboreal; disj. in wLab	aquatic, often calciphile
Potamogeton pusillus ssp. *tenuissimus*	Berchtold's Pondweed, Slender Pondweed	G5T5	S1S3	3	Circumboreal; disj. in cLab	aquatic
Potamogeton richardsonii	Richardson's Pondweed	G5	S1S3	2	Boreal NA	aq., calciphile
Potentilla pulchella (typ.)	Pretty Cinquefoil	G4G5T4T5	S1S2	1	Arctic amphi-Atlantic	calciphile
Primula mistassinica	Bird's-eye Primrose	G5	S2	7	Boreal NA	calciphile
Puccinellia distans ssp. *borealis*	Weeping Alkali-grass	G5T5?	SNR	2	Coastal amphi-Atlantic	halophyte, calciphile
Puccinellia lucida	Shining Alkali-grass		SNA	0	Coastal arctic eNA	halophyte
Puccinellia pumila	Dwarf Alkali-grass		SNR	5	Coastal arctic NA (disj.)	halophyte
Puccinellia tenella ssp. *langeana*	Lange's Alkali-grass	G4?	SNR	2		
Pyrola chlorantha	Green-flower Wintergreen	G5	S2S3	7	Circumboreal	
Ranunculus allenii	Allen's Buttercup	G3G4	S2S3	3	Arctic-alpine neNA	snowbeds
Ranuculus gmelinii	Gmelin's Buttercup		SNA	0	Boreal NA (disj.)	aquatic
Ranunculus lapponicus	Lapland Buttercup	G5	S2S3	23	Circumpolar	acidophile
Ranunculus macounii	Macoun's Buttercup	G5	S1	2	Boreal NA (disjunct)	
Ranunculus nivalis	Snowy Buttercup	G5	S2	0	Circumpolar	snowbeds
Ranunculus pedatifidus	Northern Buttercup	G5	S2S3	9	Arctic-alpine circumpolar	calciphile
Ranunculus pedatifidus var. *affinis*	Northern Buttercup	G5T5	S2S3	0	Arctic-alpine circumpolar; disjunct in wLab	calciphile
Ranunculus pensylvanicus	Bristly Crowfoot	G5	S1	6	Boreal-nTemp. NA	
Ranuculus recurvatus	Hooked Crowfoot		SNA	0	Temp. eNA	
Ranunculus sulphureus	Sulphur Buttercup	G5	S1S2	0	Circumpolar	
Ranuculus trichophyllus			SNA	0	Circumpolar	
Rhynchospora alba	White Beakrush	G5	S1S3	4	Borear NA (disj.)	
Ribes hirtellum	Smooth Gooseberry	G5	S1	1	Boreal eNA	
Sagina caespitosa	Tufted Pearlwort	G5	S1	2	Arctic amphi-Atlantic	
Salix cordata	Sand Dune Willow	G4	S1	9	Boreal eNA	calciphile
Sambucus racemosa (typ.)	Red Elderberry	G5	S1	2	Boreal NA (disjunct)	
Saxifraga foliolosa	Leafy Saxifrage	G4	S2S4	1	Arctic circumpolar	snowbeds
Saxifraga stellaris	Star Saxifrage	G3G4	S1S2	0	Arctic-alpine amphi-Atlantic	
Saxifraga tricuspidata	Prickly Saxifrage	G4G5	S1S3	1	Arctic NA	calciphile

Scientific Name	Common Name	G rank	S rank (2010)	Number of records	Distribution	Habitat association
Schzachne purpurascens	Purple Oat	G5	S2S4	10	Boreal NA	
Schoenoplectus subterminalis	Water Clubrush	G4G5	SNR	1	Temp. NA (disj.)	
Scirpus microcarpus	Small-fruit Bulrush	G5	S2S4	17	Boreal NA; disjunct in cLab	
Sium suave	Hemlock Water-parsnip	G5	S1	1	Boreal NA	
Sisyrinchium montanum	Mountain Blue-eyed Grass	G5	SNR	5	Boreal NA	
Sparganium emersum	Unbranched Bur-reed	G5	S2S4	10	Circumboreal	aquatic
Sparganium fluctuans	Floating Bur-reed	G5	SNR	8	nTemp. NA (mainly eastern)	aquatic
Sparganium glomeratum	Clustered Bur-reed, Northern Bur-reed	G4?	S1S3	2	Boreal NA (disjunct)	aquatic
Sparganium natans	Small Bur-reed, Least Bur-reed	G5	SNR	3	Circumboreal; disj. w/n/clab	aquatic
Spartina alterniflora	Saltwater Cordgrass, Smooth Cordgrass	G5	SNR	1	Coastal eNA	
Streptopus lanceolatus	Rosy Twisted-stalk	G5T5	S1S2	8	Boreal eNA	
Taraxacum laurentianum	St. Lawrence Dandelion	G1Q	SNR	0	Gulf of St. Lawrence endemic	calciphile
Tephroseris palustris	Marsh Ragwort	G5	S1	3	Circumpolar	
Thalictrum alpinum	Alpine Meadowrue	G5	S2S3	16	Circumboreal (disjunct)	calciphile
Tofieldia glutinosa	Sticky Tofieldia, Glutinous Tofieldia	G3G5	S1S3	3	Boreal NA	
Torreyochloa pallida var. *fernaldii*	Fernald's False Mannagrass	G5T4Q	SNR	1	Boreal eNA	
Triglochin gaspensis	Gaspe Arrowgrass	G3G4	SNR	1	eCanada	
Vahlodea atropurpurea	Mountain Hairgrass	G5	S2S4	14	Boreal amphi-Atlantic	snowbeds
Valeriana dioica ssp. *sylvatica*	Wood Valerian	G5T4T5	S1	4	Boreal NA	
Veratrum viride (typ.)	American False Hellebore	G5TNR	S1	3	Temp. eNA	
Viola nephrophylla	Northern Bog Violet	G5	S1	3	Boreal NA	often calc.
Viola selkirkii	Great-spurred Violet	G5?	S2S4	6	Circumboreal (disjunct)	calciphile
Woodsia alpina	Alpine Cliffbrake, Northern Woodsia	G4	S1	2	Arctic-aipine circumpolar	calciphile
Woodsia glabella	Smooth Cliffbrake	G5	S2S3	1	Arctic-aipine circumpolar	calciphile
Zostera marina	Eelgrass, Seawrack		SNR	0	Coastal NA	aquatic, halophyte

Full NatureServe definitions, (S-Rank, G-Rank),
see < http://www.natureserve.org/explorer/ranking.htm#globalstatus >

D. Ecological Land Units (ELUs)

The variation in environmental characteristics across the landscape are fundamental to land and resource planning at all scales. In the absence of survey-based information about the distribution of living (biotic) organisms and communities for Labrador, the physical (abiotic) features can serve as representative surrogates for biological diversity. Research shows strong linkages between ecosystem patterns and, for example, climate, geology, soils and topography (Anderson *et al.* 2006).

ELUs combine "enduring features" like elevation, bedrock and surficial geology, and landform into one comprehensive layer that describes the "ecological potential" of the landscape (Anderson *et al.* 2006). ELU values are summed values for elevation zone, geology, and landform codes for each 30 m cell. For example, a cell at 350 metres a.s.l (elevation class 3000) on acidic granitic bedrock (geology class 500) in a wet flat (landform class 21) is coded 3521. The ELU grid for Labrador comprises 384 potential combinations of elevation, geology, and landform. *Note that the ELU dataset itself carries no information about actual land use or land cover.*

Table: How the 4-digit ELU code is calculated

Elevation class (m)	+ Substrate class	+ Landform
1000 (0-50)	0 Other rocks (impactites)	4 steep slope
2000 (51-300)	100 acidic sed/metased	5 cliff
3000 (301-600)	200 acidic shale	12 Hill (gentle slope)
4000 (601-900)	300 calc sed/metased	13 N-facing upper sideslope
5000 (> 900)	400 mod. calc sed/metased	14 S-facing upper sideslope
	500 acidic granitic	20 Dry flat
	600 mafic/intermed granitic	21 Wet flat
	700 ultramafic	22 Valley/toe slope
	800 coarse sediments	23 N-facing lower sideslope
	900 fine sediments	24 S-facing lower sideslope
		51 Waterbodies

ELEVATION

Elevation zones depict the influence of altitude on the distribution of plant communities across Labrador. Elevation is a key factor that influences the distribution of vegetation communities, as temperature, precipitation, and exposure vary with changing altitude (Anderson *et al.* 2006). Labrador spans 10 degrees of latitude (51° N to 61° N) and encompasses 3 terrestrial ecozones: the Arctic Cordillera, the Taiga Shield and the Boreal Shield (Riley *et al.* 2013). Meaningful biotic zones would be defined with quite different elevation cut-offs in the northern and southern parts of the region. As such, class ranges necessarily approximate critical ecological values.

In the Arctic Cordillera ecozone, broad vegetation shifts are visible as elevation increases by approximately 300 metres. Each 300 m shift corresponds to a decrease of about 3°C in July temperatures. Lowland wet and mesic community types occur at roughly 100 m above sea-level (Gould *et al.* 2002). McLennan and Ponomarenko (2009) suggest the following patterns in the vegetation-elevation gradient:

Table: Ranges for elevation zone classes in the Arctic Cordillera

Zone	Metres (m)	Characteristic vegetation type
A	> 900	Polar Desert (Lichen Herb Zone)
B	600-900	High Arctic Tundra (Herb Lichen Cushion Zone)
C	300 - 600	Low Arctic Tundra (Dwarf Shrub Tundra)
D	50 - 300	High Hypoarctic Tundra (Low Erect Shrub – Dwarf Shrub Tundra)
E	0-50	Low Hypoarctic Tundra (Low Erect Shrub Tundra)

*Note: North of Nachvak classes D & E do not exist and zones A to C occur at lower altitudes (McLennan and Ponomarenko 2009)

Labrador's tree limit is highly variable along both altitudinal and latitudinal gradients. Lamb (1985) found that "tree limit rises from 140m in the northeast to ~600m in the south over a distance of 300km" (a one degree shift from 55 to 56 degrees north). In the Mealy Mountains, Munier *et al.* (2010) found the transition from open-canopy forest and alpine tundra vegetation occurs at approximately 550–650 m a.s.l. Our classes relied on data collected by Cogbill and White (1991) across mountain ranges of eastern North America. Because this study was not focussed on Labrador, tthese numbers are to be used

Table: Ranges for elevation classes in the Taiga and Boreal Shield

Zone	Metres (m)	Characteristic vegetation type
A	> ~ 1100	Alpine tundra
B		Krummholz
C	> 760	Spruce phase
D	> 340	Spruce-fir phase
E	> 200-400	Deciduous forest phase

A digital elevation model (DEM) was assembled from 1:50,000 Canadian Digital Elevation Data (NRC 2000). It was then compared with vegetation data from the "Earth Observation for Sustainable Development of Forests" (EOSD) (Wulder *et al.* 2008) by degrees latitude, using the ArcGIS Zonal Statistics function. Results compared favorably with patterns outlined in the literature (sensu Cogbill and White 1991). Final ELU elevation classes are outlined below. These classes capture shifts in vegetation patterns at broad spatial scales; heterorgenaeity within classes is to be expected at finer scales.

Table: ELU Elevation classes for Labrador

Elevzone	Class	Metres (m)	Typical vegetation associated with elevation zone
1000	Very Low	0 - 50	Riparian thickets; deciduous and mixedwood forest types
2000	Low	51 - 300	Spruce-Fir forest types
3000	Moderate	301 - 600	Black Spruce forest types
4000	High	601 - 900	Krummholz
5000	Very High	> 900	Alpine tundra

GEOLOGY

A bedrock geology classification was developed to reflect biologically-relevant characteristics, including hardness (or susceptibility to weathering), permeability, and mineral composition (pH) of parent bedrock. This approach maps the aspects of geology most relevant to ecological communities, particularly herbaceous associations (Anderson *et al.* 2006; Tardif *et al.* 2005). 1:1,000,000 data bedrock (originally 83 legend units) and surficial geology data (7 legend units) was obtained from the NL GeoScience Online portal (http://gis.geosurv.gov.nl.ca/).

In many places, surficial deposits blanket the bedrock. For example, glaciofluvial sediments fill the bottoms of many valleys. These deposits — their texture, compactness, moisture-holding capacity, nutrient availability, and ability to anchor vegetation — override the influence of the underlying bedrock (Anderson *et al.* 2006). Surficial geology was thus mapped as part of overall geology (discussed below), in appropriate locations. For example, sandy, coarse sediments are common in broad basins and valley/toe slope, and fine marine sediments in these same settings in addition to low hills and sideslopes (Anderson *et al.* 2006).

Eroded, brecchiated maltrock at Mistasin Lake. Nestor Lewyckyj

Table: Bedrock and surficial geology classes

Geology class	Lithotypes	Meta-equivalents	Comments
0: OTHER ROCKS Impactites, etc.	Meltrocks		
100: ACIDIC SEDIMENTARY / METASEDIMENTARY fine- to coarse-grained, acidic sed/metased rock	Shale, siltstone, sandstone, conglomerate, breccia, arkose, ironstone.	(Low grade:) pelitic gneiss, pelitic phyllite; (Moderate- high grade:) pelitic schist, quartzite, meta-ironstone, meta-sediment, meta-sedimentary gneiss, meta-sedimentary rocks	Low to moderately resistant rocks relatively impermeable to water. Gravels accumulate at base of steep slopes or strong currents (energetic streams, high-energy coasts); glacial and landslide deposits
200: CLAYEY ROCKS	Shales		Low resistance: produces unstable slopes of fine talus
300: CALCAREOUS SEDIMENTARY / META-SEDIMENTARY basic/alkaline, soft sed/metased rock with high calcium content	Limestone, dolomite, chert	Marble, dolomite marble, calc-silicate rock	Soils are thin alkaline clays, high calcium, low potassium; very susceptible to chemical weathering
400: MODERATELY CALCAREOUS SEDIMENTARY / METASED Neutral to basic, moderately soft sed/metased rock with some calcium but less so than above	Calc siltstones, calc sandstones		Generally susceptible to chemical weathering
500: ACIDIC GRANITIC: Acidic rocks composed almost entirely of light-colored silicates – quartz and feldspar	Granite, granitoid, rhyolite, felsic volcanoclastic rocks, felsic volcanic rocks, felsic pyroclastic rocks	Granitic gneiss, granitoid gneiss, charnockite, quartzose gneiss, monzogranite gneiss	Resistant, quartz-rich rock, weathers to thin coarse soils (sandy nutrient-poor)
600: INTERMEDIATE/MAFIC: quartz-poor alkaline to slightly acidic rock, weathers to clays **(Andesitic):** Rocks with a composition between granitic and basaltic **(Basaltic)**: Rocks that contain substantial dark silicate minerals and calcium-rich plagioclase feldspar (but no quartz); contain a high percentage of ferromagnesian minerals	**(Intermediate):** Granodiorite, dacite, monzonite, quartz monzonite, quartz diorite, tonalite; syenite, alkaline syenite, andesite, diorite, leucogabbro, norite **(Basic):** Basalt, alkalic basalt, gabbro, gabbroid, gabbronorite, diabase, mafic pyroclastic rocks, pillow basalt **(Ultrabasic):** anorthosite	Amphibolite, amphibolite gneiss, quartz diorite gneiss, tonalite gneiss, granodiorite gneiss, metatonalite, syenite gneiss Mafic granulite, mafic granulite gneiss, metabasalt, metagabbro	Moderately resistant; quartz-poor plutonic rocks weather to thin clay soils, alkaline to slightly acidic, high in magnesium, low in potassium
700: ULTRAMAFIC magnesium- rich alkaline rocks	Peridotite, ferrodiorite, ultramafite, troctolite		Iron-rich soils toxic to many species, high magnesium to calcium ratios favor adapted flora
800: COARSE SEDIMENTS	Glaciofluvial, ablation drift, rogen moraine		
900: FINE SEDIMENTS	Glaciolacustine, glaciomarine and marine		
10000: NO DATA	Till undifferentiated, drift poor		

LANDFORM

Landform accounts for much of the local variation in solar radiation, soil development and susceptibility to wind and other disturbances. It is a compound measure of elevation, slope, aspect, surface curvature, and upslope catchment area. Landform is "the anchor and control of terrestrial ecosystems" (Rowe 1977). It breaks up broad landscapes into local topographic units, and provides for meso- and microclimatic expression of broader climatic patterns. It is also tied to rates of erosion and deposition, and therefore to soil depth, texture, and nutrient availability. These are, with moisture, primary controllers of plant productivity and species distributions. If the other influences on soil formation (climate, time, parent material, and biota) are constant over a given space, it is variation in landform that drives the distribution and composition of natural communities (Anderson *et al.* 2006).

To distinguish the landforms for Labrador, we employed an approach developed by Fels and Matson (1997) and modified it to suit the Labrador landscape. Landforms were distinguished by combining slope and landscape position to segregate topographic units such as ridges, cliffs, sideslopes, and flats.

Slope and landscape position index (LPI) grids were derived from 1:50,000 Canadian Digital Elevation Data (NRCan 2000). Discrete slope classes were created by visualizing histograms and referencing slope classifications used by the NL Department of Natural Resources in forest management planning (Darren Jennings, pers. comm., 2010). We remapped slopes to create classes of 0-2˚ (0.0-3.5%), 2-6˚ (3.5–10.5%), 6-17˚ (10.5–30%), 17-28˚ (30-53%), and > 28˚ (> 53%) (vertical axes of Figure 2). Values 1-5 were assigned to each slope class.

Landscape position index (LPI) is a unitless measure of the position of a point on the landscape surface in relation to its surroundings. It is a measure of the difference between a cell elevation value and the average elevation of the neighbourhood around that cell (Jenness 2006). It is calculated, for each elevation model point, as a distance-weighted mean of the difference in elevation between that point and all other points within a user-specified radius.

The formula used to calculate the LPI:

Where z_o = elevation of the focal point whose LPI is being calculated,

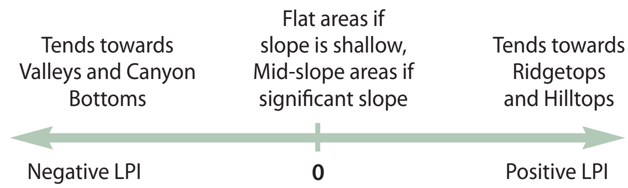
z_i = elevation of point i of n model points within the specified search radius of the focal point,

d_i = horizontal distance between the focal point and point i, and

n = the total number of model points within the specified search distance.

Positive values mean the cell is higher than its surroundings, indicating a convex topographic position, while negative values mean it is lower, indicating a concave position (Jenness 2006). Thus, if the point being evaluated is in a valley, surrounding model points will be mostly higher than the focal point and the index will have a positive value. Negative values indicate the focal point is close to a ridge top or summit, and values approaching zero indicate low relief or a mid-slope position (Figure 1 below).

Figure 1: Landscape Position Index (LPI) Range of Values



A representative search distance was determined for each sub-region across Labrador. This assists in the evaluation of landscape position by attempting to limit calculations to the typical size of a single landform. A search distance is best calculated by taking half of the average ridge-to-stream distance in areas sharing similar topography (Anderson *et al.* 2006). Lopoukhine *et al.* (1976) Land Regions (27 total) were used to separate sub-regions, and ridge-to-stream distances were calculated for each region.

To sample stream-to-ridge distance values, sample points were generated at 50 m intervals along a stream network. Using Hawth's Analysis Tools for ArcGIS (http://www.spatialecology.com/htools/tooldesc.php) we randomly selected 10% of the generated points (the lowest number of sample points was 39 points in Region W, while the highest was 339 points in Region C). The next step was to identify ridges on the landscape. The "curvature" function of ArcGIS uses the DEM to calculate change in slope ("slope of the slope"), with high values representing ridges (Anderson *et al.* 2006). We selected out grid cells with high curvature values and converted them to a point layer. Using Hawth's Tools we generated a random set of points along all ridges. Finally, we calculated the distance from each random stream point to the nearest ridge point. Stream-to-ridge distances, which ranged from 210 m to 660 m, were used to select a neighbourhood distance in LPI calculations for Lopoukhine land regions.

Using -0.0001 as a threshold, we selected 2 LPI values to model landforms for Labrador. All negative LPI values (concave topographic position) were assigned a value of 10, while all positive LPI values (convex topographic position) were assigned a value of 20. LPI classes were then combined with slope classes to generate descriptiveland-forms based on their combined slope and landscape position, producing classes from 11-15 and 21-25. We collapsed all units in slope classes 4 and 5 (*i.e.* 14, 24, 15 and 25) into "steep" and "cliff" units, respectively. The ecological significance of these units, which are generally small and thinly distributed, lies in their very steepness, regardless of where they occur on the landscape.

Stream-to-Ridge Distances used in Landscape Position Index (LPI), for Lopoukhine Land Regions (LRs)

Land Region	Metres	Land Region	Metres
A	240	O	480
B	300	P	540
C	210	Q	570
D	450	R	390
E	210	S	480
F	300	T	360
G	210	U	270
H	270	V	480
I	330	W	660
J	480	X	540
K	240	Y	510
L	360	Z	480
M	600	AA	540
N	420		

"Flats" (0-2°, originally coded 11 and 21), were collapsed into one class with a value of 21. Recognizing the ecological importance of separating occurrences of flats into dry and moist areas, we calculated a simple moisture index that maps variation in moisture accumulation and soil residence time.

The formula for the moisture index:

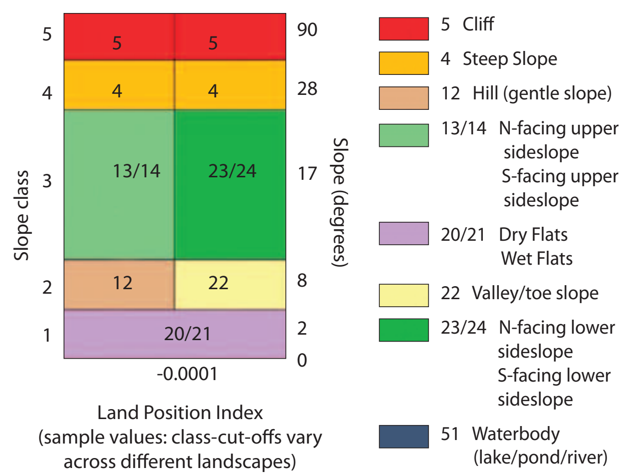
Moist_index=ln [(flow_accumulation+1) /(slope + 1)]

Grids for both flow accumulation and slope were derived from the DEM using ArcGIS functions of the same names. For the purpose of a first draft we identified two moisture index threshold values (0 and 1000). The low value will likely produce an over-estimate of wet flats, and the high moisture index will likely produce and under-estimate of wet flats. Unfortunately, no comprehensive Wetland Inventory currently exists for Labrador which limits our ability to test model accuracy. However, wet flat classification was further improved by applying the best available wetland data, extracted from National Topographic Database (NTDB) and available forestry inventory data, to the wet flats code. Wet flats were then recoded to 20 and dry flats to 21.

Side slopes (*i.e.*13 and 23) support different biotic species based on their aspects. South-facing slopes receive more radiation as a result of the earth's tilt and sun angle. Therefore we separated north- and south-facing aspects for upper and lower sideslopes. N-facing upper sideslopes were assigned a value of 13, and S-facing upper sideslopes a value of 14. Similarly, N-facing lower sideslopes were assigned a value of 23, and S-facing lower sideslopes 24.

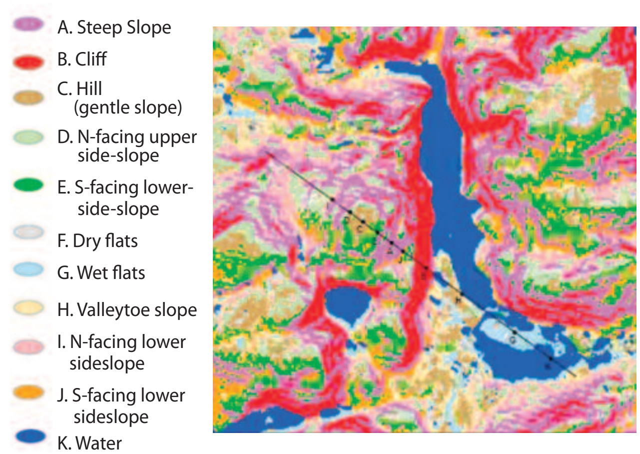
Figure 2: Landform units for an area of varied topography in the Mealy Mountains, Labrador

Landform matrix: Landform numeric codes are the sum of land position class and slope class (except for the steep landforms, whose codes are simply their slope classes).



Waterbodies from 1:50,000 NTDB data were "burned" into the landform layer and cells recoded to 51 (lakes, ponds, and reservoirs). Single-line stream and river arcs were not incorporated into the landform grid, only those river reaches that are mapped as polygons. Final landform classification codes are depicted as in Figure 3 below.

Figure 3: Landform units for an area of varied topography in the Mealy Mountains, Labrador



E. Land Cover

Land cover, or vegetation, describes general habitat, both for resident species and for the species that select and make use of different habitats for parts of their life cycle. Labrador includes more than 8 degrees of latitude, and portions of 3 different Ecozones — Arctic Cordillera, Taiga Shield and Boreal Shield (see Section 2.1) — each of which exhibits major differences in vegetation. Consistent classification and mapping of vegetation and of surface characteristics of non-vegetated areas are central to conservation planning and other land-use management activities. The *Labrador Conservation Blueprint* needed Labrador-wide land-cover data to describe ecoregions and ecodistricts, and to conduct representation analyses of areas of high conservation value. Land cover is used by computer-based modeling software, such as those developed by BEACONs, including RANKER.

All available land cover data were examined for extent of coverage, resolution, and accuracy, as summarized in the table below. Major limitations included: 1) coverages restricted to small portions of Labrador; 2) too-coarse resolution among those with sufficient geographic scope; and 3) limits to use of proprietary datasets at fine scales developed for project-level Environmental Impact Statements (EISs). Of available datasets, only EOSD (Earth Observation for Sustainable Development of Forests), developed by Natural Resources Canada, had full geographic coverage of Labrador at useful scales. Unfortunately, ground-truthing proved some of its vegetation classes to be inaccurate.

The geographic extent of datasets used in developing land-cover mapping is described below for each dataset. The land-cover types applied here derive from a variety of sources, which were compared against each other for areas with overlapping coverage, and assessed for their accuracy against the most accurate coverages. Statistical comparisons of classes were made to corroborate classes and extend their geographic coverage. ArcGIS software was used to compare one to another.

The contributing data layers integrated here, in order of reliability, were: 1) Wildlife Habitat (NL DNR, Wildlife Division, I. Schmelzer, pers. comm., 2012); 2) Forest Resource Inventory 1975; 3) Drieman-Curtis Index; and 4) Earth Observation for Sustainable Development of Forests (EOSD). These are outlined below.

Table: Existing Land Cover Datasets for Labrador (excluding localized datasets developed for EIS project)

Land Cover Dataset	Purpose	Resolution/Scale	Note	Reference
Various project-specific datasets	Project planning and environmental assessment		Not available	
AVHRR Canada	General use	1:2,000,000	Derived from AVHRR US sensor data; too coarse for regional planning	http://geogratis.cgdi.gc.ca/geogratis/en/collection/detail.do?id=C898CC10-3DAE-9BA0-92BC-30E7545342AF
BEACONs LCC 2005	Conservation planning	250 m / pixel	Derived from NRCan (originally developed for change characterization and monitoring)	http://www.nrcan.gc.ca/earth-sciences/geography-boundary/remote-sensing/optical/2208
Earth Observation for Sustainable Development (EOSD)	Nation-wide, standardized forest cover	25 m/pixel	Derived from Landsat imagery; classification issues in northern areas; dataset not smoothed (isolated classes)	http://cfs.nrcan.gc.ca/pages/337
Forest Resource Inventory (1975-present)	Forestry management	1:15,000	Derived from aerial photography; coverage limited to most productive forest areas	Contact NL Department of Natural Resources

Land Cover Dataset	Purpose	Resolution/Scale	Note	Reference
Global Forest Inventory (1968-1972)	Forestry management	1:20,000 1:50,000	Derived from aerial photographs; at 2 different scales; no coverage in Arctic Cordillera ecozone; some missing tiles in Boreal/Taiga ecozones; circa 1970 (based on earlier aerial photos); forestry oriented; inconsistent scale of inputs	nlnatureatlas.ca
Drieman-Curtis Index	Forestry research	30 m/pixel	Derived from Landsat imagery; coverage in central/southern Labrador only	Drieman 1993
Wildlife Habitat	Caribou and habitat management	30 m/pixel	Derived from Landsat imagery; coverage in central/southern Labrador only	Contact NL Department of Environment and Conservation
Canvec (Water, Wetland, Glacier datasets)	General use	1:50,000	Part of comprehensive, nation-wide dataset	http://www.geogratis.ca/geogratis/en/product/search.do?id=5460AA9D-54CD-8349 -C95E-1A4D03172FDF
DNR Burns	Forestry management	1:15,000	Derived from aerial imagery; georeferencing issues with some burn polygons; some missing data; post-1950 fires	Contact NL Department of Natural Resources
CWS Minipi Wetlands	Wetlands and waterfowl management		Derived from Radarsat; based on the Canadian Wetlands Classification System, 2nd edition (1997)	Contact Environment Canada - Canadian Wildlife Service
Human Footprint Index (HFI)	Cumulative human impacts	30 m/pixel	Developed as component of Labrador Conservation Blueprint; complete coverage	Contact NL Department of Environment and Conservation

ARCTIC CORDILLERA

Refer Atlas Section 1.6.1, for map.

Table: Arctic Cordillera Ecozone – Total Area by Land Cover Class

Land Cover Class	Area (ha)	Total %
Bare/Rock	1,046,841	55.9%
Shrub/Herb	326,712	17.5%
Snow/Ice/Glacier	170,318	9.1%
Not Available	113,000	6.0%
Water	102,979	5.5%
Lichen Tundra	92,740	5.0%
Tall Shrub	18,873	1.0%
Cleared Land	457	0.0%
Wetland	146	0.0%
Total	**1,872,065**	

The consolidated land-cover mapping for the Arctic Cordillera Ecozone combines the most accurate elements of several constituent datasets:

Circumpolar Arctic Vegetation Mapping (CAMV)

The Circumpolar Arctic Vegetation Mapping project (CAVM) was an effort by an international group of scientists to develop global Geographical Information System (GIS) dataset for circumpolar vegetation at the 1:7,500,000 scale (Gould *et al.* 2002). In Labrador, its coverage is limited to the Arctic Cordillera Ecozone. The dataset combines information on soils, bedrock and surficial geology, hydrology, and remotely-sensed vegetation characteristics. Its vegetation characteristics were derived from photo-interpretation of 1:4,000,000 AHVRR false colour infrared imagery. The CAMV dataset is designed for comprehensive and consistent mapping of arctic vegetation, and its primary purpose is to model coarse vegetation change at circumpolar latitudes (Gould *et al.* 2002). Unfortunately, its resolution was too coarse for use in the *Labrador Blueprint.*

Land Cover Map of Canada (LCC 2005)

The Land Cover Map of Canada 2005 (LCC 2005) was produced by the Canadian Centre for Remote Sensing, and includes complete data coverage for Labrador. Data were derived from MODIS imagery at a 250 m spatial resolution. It contains 39 different vegetation classes (legend units) grouped into those dominated by trees, shrubs, herbs, and nonvascular plants (lichen, mosses), based on national classification standards. It was intended as a national land cover dataset to support users interested in environmental information at national and regional scales (Latifovic *et al.* 2005). Its resolution was also too coarse to be of use.

Earth Observation for Sustainable Development of Forests (EOSD)

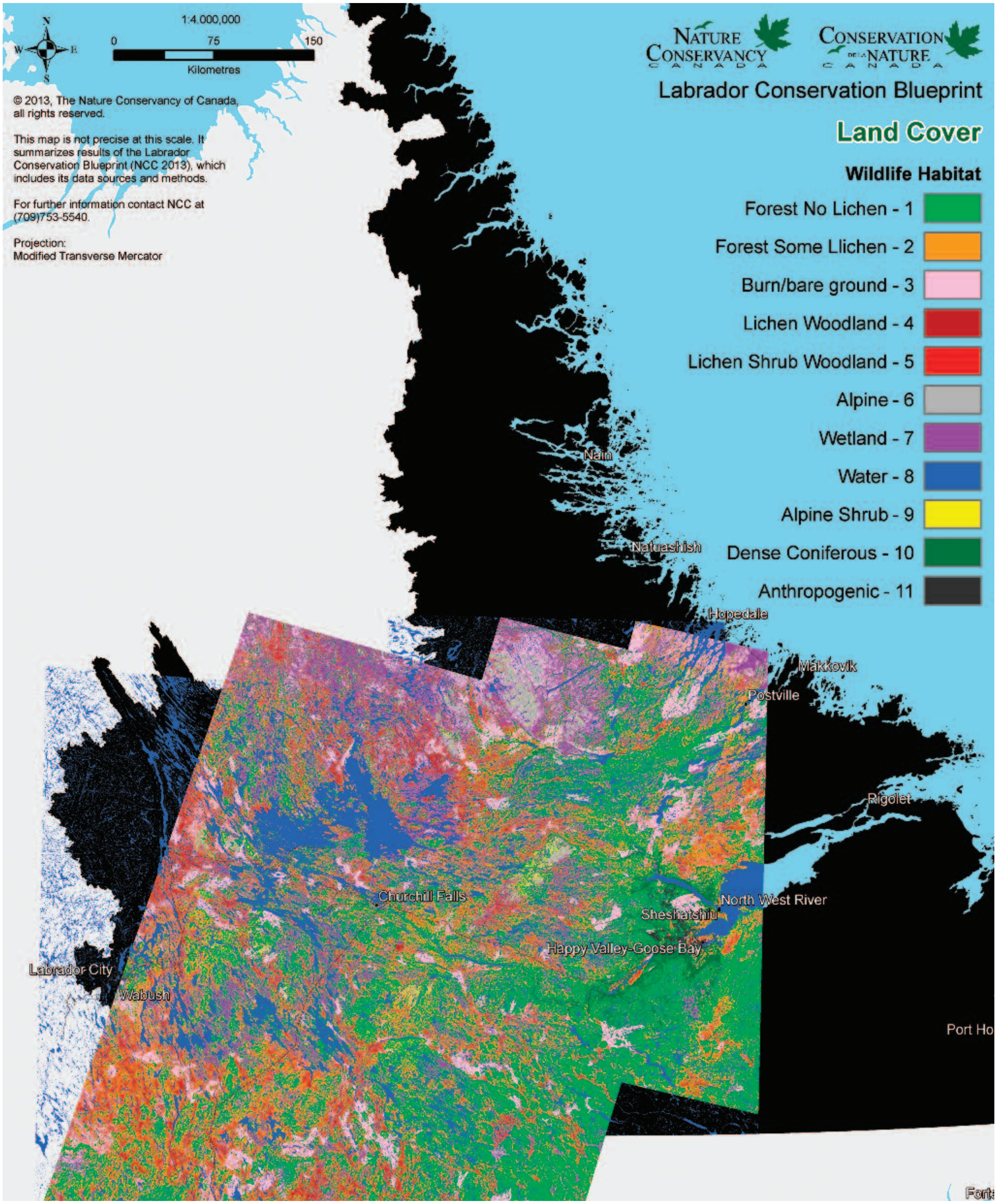
The Earth Observation for Sustainable Development of Forests (EOSD) dataset was developed through a partnership between the Canadian Forest Service (CFS) and the Canadian Space Agency (CSA). Its purpose was to map Canada's forests in support of national and international reporting requirements, such as climate change monitoring, carbon accounting, and sustainable forest management (Wulder *et al.* 2008). Coverage for Labrador is complete. Data were derived through the interpretation of Landsat-7 Thematic Mapper Plus (ETM+) 30 m orthoimages reflecting vegetation classes circa year 2000. EOSD contains 23 land cover classes designed to be compatible with the National Forest Inventory vegetation classes. The classification approach was based on unsupervised hyperclustering, cluster merging, and cluster labelling. Validation involved cross-referencing results with ancillary information from Forest Resource Inventory data, field data from provincial and territorial governments, and interpretation of aerial photographs. The final dataset was then re-sampled to a 25 m resolution (Wulder *et al.* 2008).

Woodland Caribou: Mealy Mountains. Valerie Courtois

(Both the LCC 2005 and EOSD datasets cover the Boreal and Taiga Shield Ecozones as well as the Arctic Cordillera (Latifovic *et al.* 2005, Wulder *et al.* 2008).

Wildlife Habitat

Isabelle Schmelzer and Jean-Francois Senecal developed this classification for the Wildlife Division to evaluate habitat selection for Threatened populations of boreal Woodland Caribou. Baseline information in Labrador was limited in spatial extent and omitted transitional classes such as burns, regenerating forests or anthropogenic disturbances, features which affect caribou distribution and habitat use. Collectively these factors constrained a functional analysis of habitat selection for caribou populations, an essential element of a conservation plan. The goal was to undertake a classification which reflected cover types important to caribou over a region of 250,000 km^2 below the treeline. Eleven LANDSAT 5 TM (Bands 2, 4, 5) scenes were mosaicked into 4 cloud-free scenes based on a common collection date spanning 4 days in July /August in 2005, 2006 and 2010. A correction factor to account for radiometric distortions between scenes taken at different times was calculated based on a linear regression between pseudoinvariant features (such as lakes) in overlapping areas of each of the 4 scenes. Field sampling, consisting of ~ 700 aerially-based rapid assessment points and 45 ground plots distributed throughout 12 main cover types was undertaken. Field data targeted representative habitats and focussed on overlapping areas between images. Classes included closed-canopied forests with a moss or shrub understory, lichen woodlands, burns, regenerating burns, alpine areas, lichen-shrub tundra and wetlands. A supervised classification was completed using 400 field stations to 'train' the classifier; the remaining field data was withheld for validation purposes. The final classification included 11 cover types, and had an overall accuracy of 84.1% (the number of correctly classified reference stations), and a Kappa of 0.81. Ancillary data on burns, elevation, and anthropogenic disturbances were added to the classified raster. The final raster was smoothed using a majority filter on a 3x3 pixel window. To retain natural heterogeneity, if no cover type predominated, underlying cover types (pixels) were retained. The final raster was subjected to a pixel-by pixel cross-correlation with EOSD imagery. Results indicate that the final classification better captured cover types previously partitioned among several EOSD classes and had a higher capacity to explain observed patterns of caribou use.


1:4,000,000
0 75 150
Kilometres
© 2013, The Nature Conservancy of Canada, all rights reserved.
This map is not precise at this scale. It summarizes results of the Labrador Conservation Blueprint (NCC 2013), which includes its data sources and methods.
For further information contact NCC at (709)753-5540.
Projection:
Modified Transverse Mercator
Nature Conservancy Canada
Conservation de la Nature Canada
Labrador Conservation Blueprint
Land Cover
Wildlife Habitat
Forest No Lichen - 1
Forest Some Llichen - 2
Burn/bare ground - 3
Lichen Woodland - 4
Lichen Shrub Woodland - 5
Alpine - 6
Wetland - 7
Water - 8
Alpine Shrub - 9
Dense Coniferous - 10
Anthropogenic - 11
Nain
Natuashish
Hopedale
Makkovik
Postville
Rigolet
Churchill Falls
North West River
Sheshatshiu
Happy Valley-Goose Bay
Labrador City
Wabush
Port Ho

BOREAL SHIELD AND TAIGA SHIELD

Refer to Section 1.6.1, for map.

Table: Boreal and Taiga Shield Ecozones – Total Area by Land Cover Class

The consolidated mapping of land cover of the Boreal Shield and Taiga Shield ecozones combined the most accurate elements of several constituent datasets.

Land Cover Class	Area (ha)	Total %
Bare/Rock	1,046,841	55.9%
Conifer Open-Sparse (*Sphagnum* understorey)	7,294,091	26.5%
Conifer Open-Sparse (Shrub-Lichen understorey)	6,015,666	21.8%
Burn/Barrens	4,209,073	15.3%
Water	3,666,424	13.3%
Wetland	1,673,414	6.1%
Lichen/Lichen-Shrub Woodland	1,497,645	5.4%
Alpine	1,298,042	4.7%
Conifer Dense-Open	1,110,721	4.0%
Cleared Land	270,566	1.0%
Broadleaf Shrub	259,899	0.9%
Broadleaf/Mixedwood Dense	158,723	0.6%
Not Available	96,423	0.3%
Total	27,547,120	

Drieman-Curtis Index

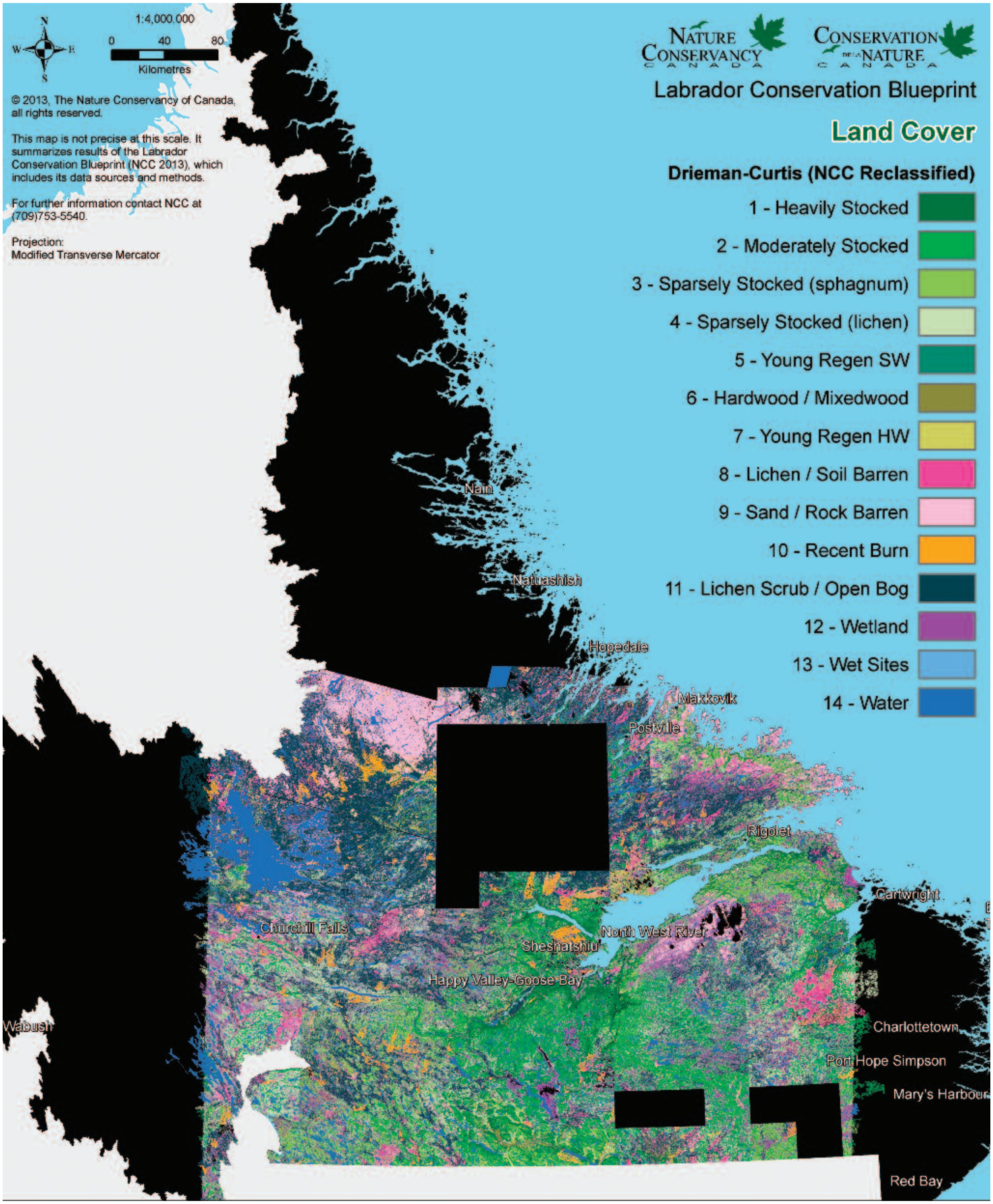
The Drieman Curtis Index was developed through a contract with the NL Department of Natural Resources, Forestry Services Branch in the early 1990s. Land cover classification was completed through interpretation of 1: 1,000,000 scale Landsat Thematic Mapper (TM) colour composite transparencies at a spatial resolution of 30 m. Cover types identified include forests, peatlands, recent burns and harvested areas. Coverage is limited to the southern and central portions of Labrador, extending from the Labrador-Quebec border to approximately 56 latitude. The dataset was originally developed to fill the need for a regional perspective of the forested areas of Labrador (Drieman 1993a,b).

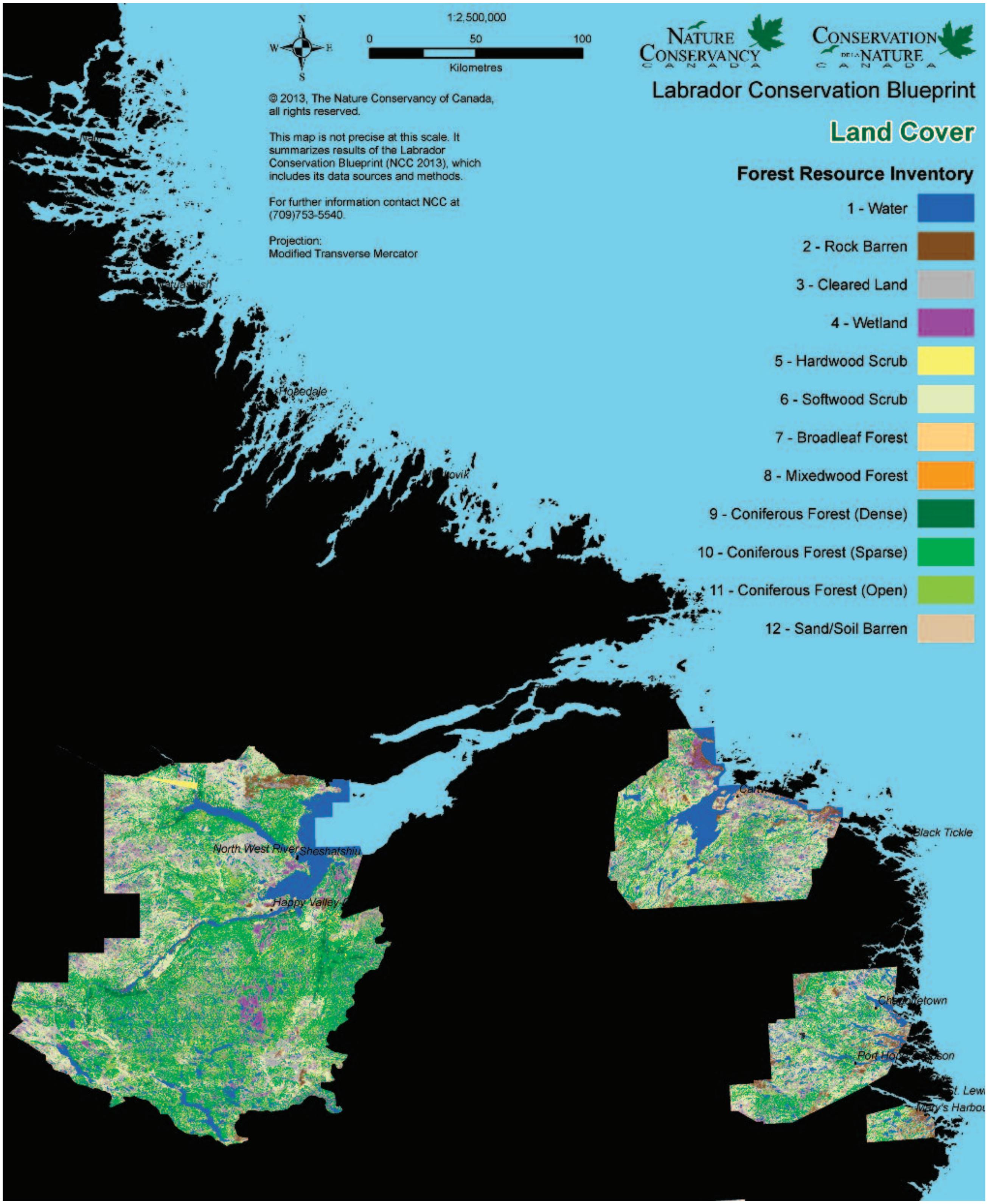
Forest Resource Inventory (1975 - current)

The Forest Resource Inventory (FRI) follows standard national protocols and is maintained by the Newfoundland and Labrador Department of Natural Resources, Forestry Services Branch. It is the most recent information on forest potential, and describes "the location, extent, condition, composition, structure and volume of the forest resource" (Power and Gillis 2001: 1) at a specific point and time. Stand maps are delineated based on photo-interpretation of 1:12,500 aerial photography, while timber volume estimates are based on field sampling. The primary purpose of the dataset is for provincial forest management (Power and Gillis 2001). Data coverage is limited to parts of Labrador considered to support merchantable forest stands and those close to communities, including Forest Management Districts (FMD) 19a, portions of FMD 20 and 21, and a small part of FMD 22 around Labrador City (NL DNR 2011).

Global Forest Inventory (1968-1972)

The 1968-1972 Global Forest Inventory (GFI) produced forest cover maps and area/volume estimates of timber resources for all of Labrador south of 56° N. Measured were percent conifer; spruce/fir content; tree height; crown cover; disturbance and severity; and data on non-forested systems such as wetlands and barrens (NL DNR 1975). In 2010-2011, hardcopy maps were digitized through a partnership between the NL Department of Natural Resources, the Nature Conservancy of Canada, and the Model Forest of Newfoundland and Labrador. Maps were of two types: "intensive" areas classified using 1:20,000 aerial photography; and "extensive" areas using 1:50:000 photography. Gaps remain in coverage due to missing map sheets (NL DNR and NCC 2012). These digitized data were compared to more recent datasets and used in combination with EOSD data where other data were unavailable.


1:4,000,000
0 40 80
Kilometres
© 2013, The Nature Conservancy of Canada, all rights reserved.
This map is not precise at this scale. It summarizes results of the Labrador Conservation Blueprint (NCC 2013), which includes its data sources and methods.
For further information contact NCC at (709)753-5540.
Projection:
Modified Transverse Mercator
Labrador Conservation Blueprint
Land Cover
Drieman-Curtis (NCC Reclassified)
1 - Heavily Stocked
2 - Moderately Stocked
3 - Sparsely Stocked (sphagnum)
4 - Sparsely Stocked (lichen)
5 - Young Regen SW
6 - Hardwood / Mixedwood
7 - Young Regen HW
8 - Lichen / Soil Barren
9 - Sand / Rock Barren
10 - Recent Burn
11 - Lichen Scrub / Open Bog
12 - Wetland
13 - Wet Sites
14 - Water
Nain
Natuashish
Hopedale
Makkovik
Postville
Rigolet
Cartwright
Churchill Falls
North West River
Sheshatshiu
Happy Valley-Goose Bay
Wabush
Charlottetown
Port Hope Simpson
Mary's Harbour
Red Bay



N
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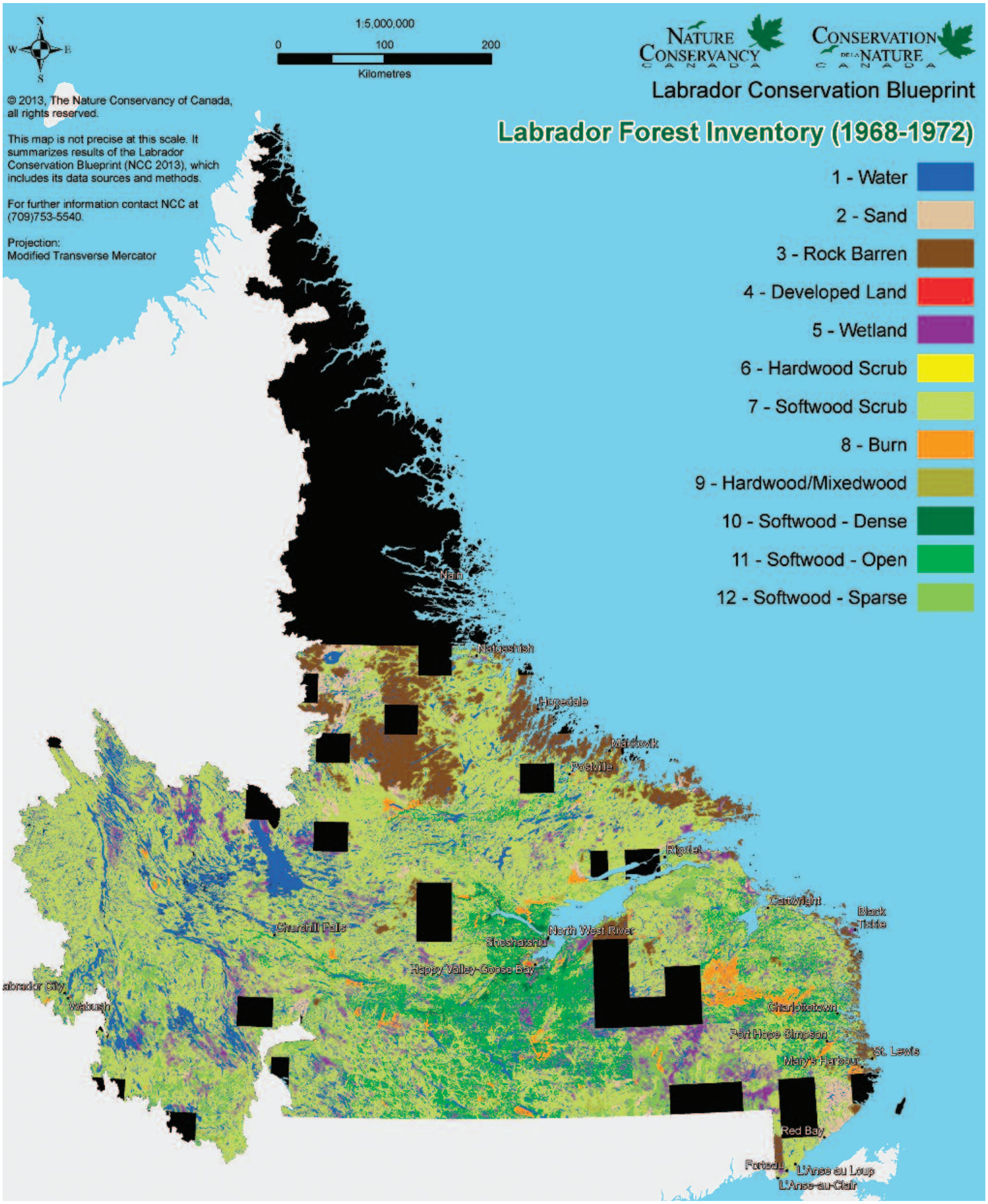
1:2,500,000
0
50
100
Kilometres
NATURE CONSERVANCY CANADA
CONSERVATION DE LA NATURE CANADA
Labrador Conservation Blueprint
Land Cover
© 2013, The Nature Conservancy of Canada, all rights reserved.
This map is not precise at this scale. It summarizes results of the Labrador Conservation Blueprint (NCC 2013), which includes its data sources and methods.
For further information contact NCC at (709)753-5540.
Projection: Modified Transverse Mercator
Forest Resource Inventory
1 - Water
2 - Rock Barren
3 - Cleared Land
4 - Wetland
5 - Hardwood Scrub
6 - Softwood Scrub
7 - Broadleaf Forest
8 - Mixedwood Forest
9 - Coniferous Forest (Dense)
10 - Coniferous Forest (Sparse)
11 - Coniferous Forest (Open)
12 - Sand/Soil Barren
Hopedale
North West River
Sheshatshiu
Happy Valley
Black Tickle



Data source: NL DNR and NCC 2012

Labrador Trough. John Riley

F. Wetlands

No full wetland inventory is available for Newfoundland and Labrador. Some data have been collected through Environmental Impact Statements (EIS) but are often out of date (Mahoney *et al.* 2007). Many researchers note the need for a comprehensive wetland classification (Société Duvetnor Ltée 2001, Giroux *et al.* 2003, Goudie 2004).

Mapping such as the Earth Observation for Sustainable Development of Forests (EOSD) (Wulder *et al.* 2008) and the Forest Resource of Labrador (Drieman 1993a) include broad wetland classes but these are not a focus of that inventory (Mahoney *et al.* 2007). In 2007 the Canadian Wildlife Service surveyed an area of the Eagle Plateau, east of Minipi Lake, identifying swamp, shallow water, fen, bog (*ibid.*). Mineral wetlands were identified but only for a small area. A comparison between this work and other landcover datasets identified that none accurately identified swamps and marshes, whose extent is notably undermapped and underestimated. Conifer swamp is a major element of boreal wetlands, but further work must be done in Labrador to map its extent. In the case of salt marsh, some mapping has been completed but is not yet available digitally (B. Roberts, pers. comm., 2010). Digitizing these data would be a valuable contribution.

In the absence of detailed wetland surveys, but applying findings from other boreal regions, wetlands of particular conservation interest should include, at a minimum, wetlands that are distinctive, diverse and productive, including salt marsh, freshwater marsh, open fen, and thicket swamp (Mahoney *et al.* 2007, Riley 2011). Quebec uses waterfowl abundance as an indicator of wetlands of conservation interest. Habitat data have been combined with 15 years of Eastern Waterfowl Survey (EWS) data on breeding waterfowl to predict important areas in the southern boreal (see Lemelin *et al.* 2008), work that could be usefully replicated for Labrador. Other metrics related to high-value wetlands are watershed-level intactness, or the absence of human disturbance, wetland size, and wetland density. Large wetland complexes and landscapes dominated by such complexes (such as parts of the Labrador Trough) are of interest. These metrics are mapped, below, based on available data (NRCan 2012).

Wetlands data was derived from 1: 50,000 CanVec data (ftp://ftp2.cits.rncan.gc.ca/pub/canvec/50k_shp/), which contains 'Wetland', 'String Bog' and 'Palsa Bog' feature classes. 'Wetland', 'String Bog' and 'Palsa Bog' polygons were merged to create one comprehensive 'Wetlands' dataset for all of Labrador. Provincial forest fire polygons were then overlaid on the merged dataset and wetland polygons found within the boundaries of burn polygons were removed. The 'Wetland' dataset was overlaid on a DEM and all wetland polygons found above 600 m in elevation were identified using the Intersection tool and removed.

String bogs with Mealies in the distance. Valerie Courtois

Wetland Size

Once the merged 'Wetland' dataset was created and erroneous polygons removed, adjacent wetland polygon boundaries were dissolved to create continuous polygons, each with an area (in m^2) attribute. 'Wetland' polygons were converted to a 30 m raster using area as the raster value. Transition areas were smoothed using focal statistics to calculate mean size using a circular neighborhood search radius of 67.7 m (the radius of a circle whose area is the same as a 120 m grid cell). Results indicate that in Labrador, wetlands range in size from less than 1 hectare to 9,636 hectares.

Wetland Density

Next, a 120 m "fishnet" of rectangular cells was generated. The fishnet was then intersected with the Wetlands dataset. The area of wetland within each fishnet polygon was summed, and results were joined to the fishnet to calculate the percent wetland as WetlandArea/FishnetArea (*i.e.* how much wetland is contained within each 120 m fishnet square). 'WetlandFishnet' polygons were converted to a 30 m raster using 'WetlandDensity' as the raster value. Finally, the 'WetlandDensity' dataset was smoothed using focal statistics mean with a circular neighbourhood of 67.7 m radius. Results were calculated as decimal values between 0 and 1, with 1 representing 100% of a raster cell being occupied by wetland.

Wetland- Edge Density

To calculate Wetland-Edge Density, merged wetland polygons were converted to lines. Line density was then calculated per 30 m pixel using line statistics with a circular neighbourhood of 67.7 m search radius. This results in a value representing the length of wetland perimeter in km per km^2. Values ranged from 0 to 68.65 km/km^2 throughout Labrador.

G. Water-edge Density

Waterbodies data was derived from 1: 50,000 CanVec data (ftp://ftp2.cits.rncan.gc.ca/pub/canvec/50k_shp/), including all lakes, ponds and rivers mapped as polygons, merged for all of Labrador. The ArcGIS 'PolygonToLine' tool was used to convert polygons to polylines. A 1000 m (10 x 10 m) rectangular grid, or fishnet, was created using the 'CreateFishnet' tool. We wanted to calculate the length per unit area of water edges that fall within a search radius of each cell. We used the 'LineDensity' tool to calculate Water-Edge Density using a moving window with a circular neighbourhood of 564.2 m (*i.e.*, the radius of a circle whose area is equal to a 1000 m grid cell). This calculates the density of water edges in km per km^2, which in Labrador, range from 0 to 27.5km/ km^2. Results were then exported to raster.

H. Human Footprint Index

Nature conservation must consider ecological integrity at landscape scales to be effective. Ecological integrity implies the maintenance of ecological and evolutionary patterns and processes, disturbance regimes, and viable populations of species (Grumbine 1994). It "implies that ecosystem structures and functions are unimpaired by human-caused stresses" (Woodley 1993). One way to estimate ecological integrity is to map areas of human influence as a proxy. Areas with significant human disturbance are thus assumed to be less likely to retain high degrees of ecological integrity, while areas free of human disturbance are more likely to retain such values.

Human Footprint analysis identifies and maps the extent and degree of human activities at various scales (see Sanderson *et al.* 2002, Woolmer *et al.* 2008). This approach identifies and maps human activities that significantly disturb natural systems, including such categories of impact as: (*i*) human access, (*ii*) human settlement, (*iii*) human land use change, and (*iv*) energy infrastructure. Scores, representing relative landscape influence are assigned and summed to produce a composite human footprint map (Sanderson *et al.* 2002, Woolmer *et al.* 2008).

The Human Footprint for Newfoundland and Labrador uses the same basic approach as Woolmer *et al.* (2008), with some adjustment to terms, layers and scoring to better reflect local conditions and data availability. The five major categories of impact include: (*i*) Human Access, (*ii*) Human Habitation, (*iii*) Energy (i*v*), Resource Development and (*v*) Military, Aviation and Communications. These categories are further divided into sub-categories (e.g. Energy is broken into Transmission Lines and Dams). Dataset extent was defined as the extent of influence (e.g. Census boundaries, quarries, cutovers), which underestimates the indirect impact of disturbances on the surrounding area. Appropriate buffers, representing zones of influence, were added wherever possible (e.g. roads, mines). Influence scores reflect the best judgment of regional experts consulted with respect to the severity and permanence of human activities. Satellite imagery was used compare the actual on-the-ground "footprint" of roads, transmission lines, and mines and assist in developing scores. Scores ranged from a minimum of 0 (no visible human impact) to 10 (high degree of human impact). Analysis layers were often created by combining multiple sources of data, due to incomplete information. Scores from each of the five categories were summed to produce a composite Human Footprint score with a maximum value of 10. All influences are additive, but the maximum impact was capped at a value of 10 (Keough 2008, NL DEC and NCC 2013).

The first table below shows the layer categories and subcategories, as well as the scoring system used for Labrador. Is also lists data sources in the righthand column. Layer combination protocols are shown in the second table below.

Now dry Churchill River bed. John Riley

Table: Human Footprint scoring system

ACCESS	**ROADS AND TRAILS**		Buffer (m)											**Source(s)**
			0-100	101-500	501-1000	1000-5000								
	Trans-Labrador Highway, Paved Local Roads	line	10	8	6	4								National Road Network (NRCan Geobase), Canvec (NRCan Geogratis), NL DEC PNAD
	Railways, Unpaved Roads, Forest Access Roads	line	8	6	4									National Road Network (NRCan Geobase), Canvec (NRCan Geogratis), Gov NL Internal (DEC PNAD), Forest Resource Roads (DNR Forestry)
	ATV Trails	line	6	4	2									Crown Titles Database (DEC Crown Lands)
	Snowmobile Trails	line	4	2	1									Lake Melville Snowmobile Association
HABITATION	**POPULATION DENSITY**		Population per square kilometre											
			0-0.5	0.5-1.5	1.5-2.5	2.5-3.5	3.5-4.5	4.5-5.5	5.5-6.5	6.5-7.5	7.5-8.5	8.5-9.5	>9.5	
	Population Density	polygon	0	1	2	3	4	5	6	7	8	9	10	StatCan (with NCC adjustments to DA boundaries)
	URBAN AREAS		Extent of polygon											
	Urban Areas	polygon	10											StatCan (with NCC adjustments to DA boundaries)
ENERGY	**TRANSMISSION LINES**		Buffer (m)											
			0-100	101-500	Extent of polygon									
	Transmission Lines	line	5	2										Canvec (NRCan Geogratis)
	Transformers	point	5	2										Canvec (NRCan Geogratis)
	Transformer Yards	polygon			8									Canvec (NRCan Geogratis)
	DAMS		Buffer (m)											
			0-50	1/2 crest length		Extent of polygon								
	Dams – large	point		10										Large Dams and Reservoirs of Canada (GFWC), Canadian Database of Large Dams (WWF)
	Dams – small	point	10											National Hydrographic Network (NRCan Geobase), Provincial Dams Database (DEC Water Resources)
	Large Reservoirs	polygon				7								Large Dams and Reservoirs of Canada (GFWC)
RESOURCE DEVELOPMENT	**FORESTRY**		Extent of polygon											
	Cutovers	polygon	6											Forest Resource Inventory (DNR Forestry)
	Plantations (non-native species)	polygon	4											Forest Resource Inventory (DNR Forestry)
	Plantations (native species)	polygon	2											Forest Resource Inventory (DNR Forestry)
	Silviculture	polygon	1											Forest Resource Inventory (DNR Forestry)

	AGRICULTURAL		Buffer (m)	Extent of polygon							
	DEVELOPMENT AREAS		0-100								
	Agricultural Land Use	polygon		6							Crown Titles Database (DEC Crown Lands)
	Fur Farms	point	8								Crown Titles Database (DEC Crown Lands)
	MINERAL EXPLORATION		Buffer (m)						Extent ofpolygon	Density	
	AND EXTRACTION		0-500	501-1500	1501-2500	2501-5000	5001-7500	7501-10000			
	Mines - large, open pit	point	10	10	10	8	6	4			DNR Mines
	Mines - medium, open pit	point	10	10	8	6	4				DNR Mines
	Mines - small, open pit	point	10	8	6	4					DNR Mines
	Quarries	point	10						10		GeoScience Online (DNR Mines)
	Mineral Exploration Areas (drill sites)	point								drill site density within 1000 m	GeoScience Online (DNR Mines)
	TOURISM AND OUTDOOR		Buffer (m)		Extent of polygon						
	RECREATIONAL DEVELOPMENT		0-100	101-500							
	Outfitter Cabins	point	4	2							DTCR Tourism, Crown Titles Database (DEC Crown Lands)
	Remote Cottages, Cabins	point	2								LIL Applications (Nunatsiavut Gov't, Crown Titles Database and Camps (DEC Crown Lands)
	Golf Courses	polygon			8						Canvec (NRCan Geogratis)
	Ski hills	polygon			6						Canvec (NRCan Geogratis)
MILITARY/	**MILITARY**		Buffer (m)			Extent of polygon					
AVIATION/			0-15	0-100	101-500						
COMMUNICATIONS	Practice Target Area (PTA)	polygon				2					DND
	Safety Template Area (STA)	polygon				1					DND
	Camera Targets	point	1								DND, Directory of Federal Real Property (TBCS)
	Northern Warning Systems Sites	point		8	4						Directory of Federal Real Property (TBCS), Wikimedia Toolserver KML
	AVIATION		Extent of Polygon								
	Runways	polygon	8								Nav Canada, Canvec (NRCan Geogratis)
	COMMUNICATIONS AND OTHER INFRASTRUCTURE		Buffer (m) 0-15	0-200		Extent of polygon					
	Communication Sites	point	2								Directory of Federal Real Property (TBCS), Canvec (NRCan Geogratis)
	Fuel Tanks	point		8							Canvec (NRCan Geogratis)
	Other Remote Sites	point				4					Directory of Federal Real Property (TBCS)

Table: Human Footprint Layer Combination Protocol

Input Name	Primary Input Layer (Field)	Secondary Input Layer (Field)	Final Input Layer (Raster 0-10)	Combined Layer 1 (MAX)	Combined Layer 2 (SUM with max 10)	Combined Layer 3 (SUM with max 10)
HUMAN ACCESS				hfaccess	->	hfoverall
Paved roads, Trans-Labrador Highway	AllRoadsTrails (ClassCode=2)	roadtraild2	hfroadtrail2			
Unpaved roads, woods roads	AllRoadsTrails (ClassCode=3)	roadtraild3	hfroadtrail3			
ATV trails	AllRoadsTrails (ClassCode=4)	roadtraild4	hfroadtrail4			
Snowmobile trails	AllRoadsTrails (ClassCode=5)	roadtraild5	hfroadtrail5			
HUMAN HABITATION				hfhabitation	->	
Population Density	ModifiedDAs	ModifiedDAs (HFIPopDens)	hfpopdens			
Urban Areas	UrbanAreas (HFIUrban)		hfurban			
ELECTRIC POWER GENERATION AND TRANSMISSION					hfpower	
Transmission				hftrans		
Transmission Lines	TransLines	translinesd	hftranslines			
Transformers	Transformer Point	transpointd	hftranspoint			
Transformers Yards	TransformerArea (HFITransArea)		hftransara			
Dams				hfdams		
Dams - large	LargeDams (HalfCrest)	LargeDamsBuffer (HFILargeDams)	hfdamslg			
Dams - small	SmallDams	SmallDamsBuffer (HFISmallDams)	hfdamssm			
Large Reservoirs	LabradorReservoirs (HFI)		hflargeres			
Watershed Impacts - large dams	Watersheds1M (VolPerSqKm)	Watersheds1M (HFLargeDams)	hfwatershedlg			
Watershed Impacts - small dams	Watersheds1M (SmallDamsPerSqKm)	Watersheds1M (HFSmallDams)	hfwatershedsm			
RESOURCE DEVELOPMENT					hfresdev	
Forestry				hfforestry		
Cutovers	ForestCutovers (HFI)		hfforestcut			
Silviculture	ForestSilvilculture (HFI)		hfforestsil			
Plantations	ForestPlantations (HFI)		hfforestpla			
Agricultural Development Areas				hfagdev		
Agricultural Land Use	Agriculture (HFIAgriculture)		hfagricult			
Fur Farms	FurFarms	FurFarmsBuffer (HFI)	hffurfarm			

Input Name	Primary Input Layer (Field)	Secondary Input Layer (Field)	Final Input Layer (Raster 0-10)	Combined Layer 1 (MAX)	Combined Layer 2 (SUM with max 10)	Combined Layer 3 (SUM with max 10)
Mineral Exploration and Extraction				hfmining	->	
Mines - large, open pit	Mines (Size=large)	MinesLargeBuffer (HFIMines)	hfmineslg			
Mines - medium, open pit	Mines (Size=medium)	MinesMediumBuffer (HFIMines)	hfminesmd			
Mines - small open pit	Mines (Size=small)	MinesSmallBuffer (HFIMines)	hfminessm			
Quarries	Quarries	QuarryBuffer (HFIQuarries)	hfquarries			
Mineral Exploration Areas (drill sites)	DrillSites	DrillSiteDens	hfminerexpl			
Tourism and Outdoor Recreational Development				hftourism	->	
Outfitter Cabins	OutifttersCabins	OutifttersCabinsBuffer (HFI)	hfcabinsoutf			
Remote Cabins and Cottages	RemoteCabins	RemoteCabinsBuffer (HFI)	hfcabinsrem			
Golf Courses	GolfCourses (HFI)		hfgolf			
Ski Hills	SkiHills (HFI)		hfski			
MILITARY, AVIATION AND COMMUNICATIONS					hfmilavcom	hfoverall
Military				hfmilitary	->	
Practice Target Area	PTA (HFI)		hfpta			
Safety Template Area	STA (HFI)		hfsta			
Camera Targets	CameraTargets (HFI)		hfcamtarget			
Northern Warning Systems Sites	NorthernWarningSystemSites	NorthernWarningBuffer (HFI)	hfwarning			
Aviation				hfaviation	->	
Runways	Runways (HFI)		hfrunways			
Communications and Other Infrastructure				hfotherinfr	->	
CommunicationsSites	Communications Sites (HFI)		hfcomm			
FuelTanks	Fuel Tanks	FuelTanksBuffer (HFI)	hffuel			
OtherRemoteSites	Other Remote Sites	OtherRemoteBuffer (HFI)	hfremote			

I. Occurrences of Species of Conservation Interest in Protected Areas and Other Conservation Lands

Common Name	Scentific Name	ACCDC Number. of Observations	Observations inside Protected Areas and Conservation Lands	Observations outside Protected Areas and Conservation Lands
Mammals				
Polar Bear	*Ursus maritimus*	956	127	829
Birds				
Short-eared Owl	*Asio flammeus*	55	14	41
Rusty Blackbird	*Euphagus carolinus*	25	1	24
Peregrine Falcon	*Falco peregrinus* ssp. *anatum* and *tundrius*	213	77	136
Harlequin Duck	*Histrionicus histrionicus*	2641	517	2124
Gray-cheeked Thrush	*Catharus minimus*	11	4	7
Invertebrates				
Melissa Arctic	*Oeneis melissa*	18	2	16
Pink-edged Sulphur	*Colias interior*	6	1	5
Labrador Sulphur	*Colias nastes*	11	3	8
Frigga Fritillary	*Boloria frigga*	8	1	7
Mustard White	*Pieris oleracea*	8	1	7
Vascular Plants				
Common Woodrush	*Luzula multiflora* (typ.)	13	1	12
Newfoundland Chickweed	*Cerastium beeringianum*	12	2	10
Limestone Scurvy-grass	*Cochlearia tridactylites*	14	3	11
Interrupted Fern	*Osmunda claytoniana*	6	1	5
Hairy Butterwort	*Pinguicula villosa*	4	2	2

J. Other Areas of Conservation Interest – IBP sites

As part of the 1964-1974 International Biological Program (IBP), areas were surveyed as representative or significant sites for conservation. In Labrador, "Supplemental sites" (17) were selected to represent vegetation communities, while "Special" sites (7) were identified as rare and unique habitats (e.g., seabird colonies, nesting areas for raptors, and habitats of species at risk). Priorities were areas vulnerable to human disturbance. In Labrador, efforts were hampered by limited accessibility and resources (IBP 1974). See Section 1.11.3, page 144, for map.

Site #	Name	Area (km²)	Description
SUPPLEMENTAL SITES			
37	Menihek Lake	35	Lichen forest (White Spruce-*Vaccinium-Cladonia*) forest on glacial drift and peatland.
38	Red Bay Barrens	18	Coastal barrens (*Empetrum* heath), krummholz and peatland on limestone.
48	Lower Churchill River	–	Lichen forest (Black Spruce-*Cladonia*) on stabillzed sand dunes.
49	Susan and Beaver Rivers	71	Rich forest (Black Spruce, Balsam Fir and birch) on alluvial deposits.
50	Gull Island Lake	73	Rich Black Spruce forest on sandy alluvial soil, *Oxalis montana* site.
51	Smaller Partridge River	65	White Spruce and Poplar forest, abundant Spruce Grouse.
–	Lac Joseph Forest	–	Not visited.
53	Eagle River Headwaters	520	Extensive string fens at headwaters of Lake Melville, Gulf of St. Lawrence and Atlantic drainage systems. Black Spruce forest on hills. Nesting Osprey and Bald Eagle.
–	Seven Islands Bay Valleys	–	Not visited.
55	Red Wine River Mountains	234	Lichen forest (Black Spruce- *Cladonia*), Caribou wintering grounds.
56	Mealy Mountains	1,040	Barrens with many rock outcrops and small ponds. Caribou wintering and breeding grounds.
–	Lac Joseph	–	Not visited.
–	Okak Bay Palsa Bog	–	Not visited.
–	Jack Pine Lake Palsa Bog	–	Not visited.
61	East Pompey Island	2	Coastal vegetation and barrens (*Empetrum*) with abundant Arctic Hare.
64	Cape Porcupine Strand	20	Long sand beach on either side of Cape Porcupine. Strand Vegetation without dunes, Black Spruce forest behind.
65	Naskaupi River	40	Black Spruce and Balsam Fir forest. Fossil concretions of unknown origin being eroded out of streambank.
66	No Name Lake	65	Black Spruce forest and string fens. Nesting sites for Osprey and Bald Eagle.
67	Tinker Harbour	4	Intertidal mud, strand vegetation, Black Spruce forest.
68	Snegamook Lake	195	Black Spruce forest and fen surrounding lake. Nesting site for Osprey, moulting area for Canada Goose and Black Duck.
70	Thomas Falls	–	Not visited.
76	Refuge Bay	40	Illustrates vegetation changes in vegetation with changes in elevation from sea level with spruce forest (262 years) to the summit (994 m) with barrens.
SPECIAL SITES			
39	Seven Plumes Falls	0.05	Spray zone (meadow and Black Spruce forest) adjacent to waterfalls.
41	Upper Fraser River Canyon	2	Conifer forest (Black Spruce) isolated in canyon. Without history of fire.
57	Churchill Falls	30	A complex of forest and fen developed under the influence of the spray from Churchill Falls.
62	Devil's Lookout Island	0.81	Small island with precipitous cliffs on east. Coastal barrens (*Empetrum*) with krummholz. Peregrine Falcon nests.
63	Bird Islands	0.18	Two small islands with nesting colonies of Puffins, Razorbills, and Thick-billed and Common Murres. Vegetation sparse and consists of coastal plants.
8	Shell Island	0.5	Coastal barrens (*Empetrum* heath), peatland and coastal vegetation on shell deposits.
79	Gannet Islands	0.81	Coastal barrens with large nesting colonles of Puffin.

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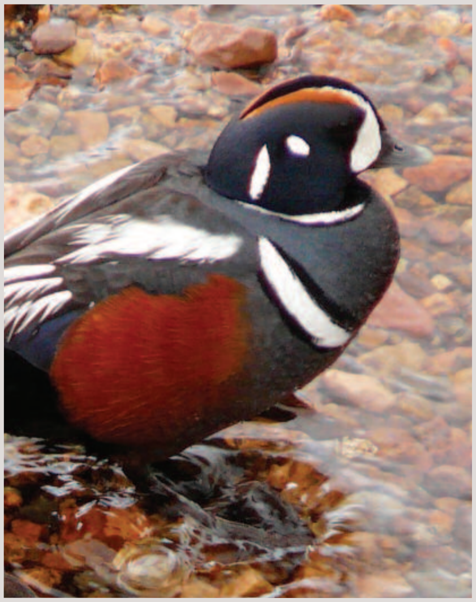

Boreal Chickadee. *Darroch Whitaker*
Polar Bear, Torngat Mountains. *Chris P. Sampson*
Harlequin Duck. *Darroch Whitaker*

The *Labrador Nature Atlas* is a product of the *Labrador Conservation Blueprint,* a private-public partnership from 2009 to 2013 led by the Nature Conservancy of Canada (NCC).

Its goal was to assemble, map and share the highest-quality, best-available information on the geography and biological features of Labrador; to describe the ecological diversity of Labrador; to support superior resource stewardship and conservation; and to share project results widely with interested audiences. This report summarizes map-based information that describes the natural geographic variability of Labrador.

Labrador is larger than the combined area of Nova Scotia, New Brunswick, Prince Edward Island, and the island of Newfoundland. It supports 26,000 residents, and is one of the largest relatively undeveloped landmasses in boreal and subarctic Canada. Less than one percent has been cleared or developed. Fifty-five percent of the "Big Land" is open woodland or closed forest (or land recovering from past wildfires), and 20 percent is rockland, tundra, talus, sand barrens and steep slopes. Lakes and rivers occupy fifteen percent, and another ten percent is wetland, predominantly peatlands. The datasets assembled and mapped for Labrador include first-ever Labrador mapping of many of its features, such as wildlife, landform, wetlands, and ecological land units, and updates of other themes, such as geology, climate, protected areas, conservation lands, and special features of conservation concern.

A partnership between NCC and Memorial University provides interactive on-line access to the Newfoundland and Labrador Nature Atlas through the Grenfell Campus, Memorial University of Newfoundland, on-line at **nlnatureatlas.ca**.

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