NEW BRUNSWICK NORTHUMBERLAND STRAIT HABITAT CONSERVATION STRATEGY

A Report Submitted to Environment and Climate Change Canada March 2018

EXECUTIVE SUMMARY

This Habitat Conservation Strategy (HCS) was developed through collaboration among member organizations of the Eastern Habitat Joint Venture (EHJV) New Brunswick Steering Committee and partner conservation groups. This HCS is part of a series planned to encompass the entire geographic area of New Brunswick.

HCSs are intended to respond to the need to better communicate, coordinate, and inform conservation actions taken by regional and local conservation organizations. In addition to providing decision support for these groups, following an ecosystem approach, it is hoped that HCS development will create opportunities to enhance partnerships, recognizing that each organization is guided by its own particular mission, vision, and/or guiding principles.

A Shared Approach

HCSs and their bioregional boundaries are based on meaningful ecological units and important watershed boundaries. HCS bioregions are scaled in a way that captures regional conservation context, priorities, threats and conservation actions. They also are scaled to facilitate the implementation of conservation actions, from land securement to stewardship.

In the first section, each HCS presents descriptions, in general terms, of the spatial extent and ecological significance of the bioregion, the dominant ecological systems found within the bioregion, and the processes that shape them. Each HCS also presents the significance of important habitats for identified species of conservation significance, with a focus on species at risk and other rare taxa, including Bird Conservation Region 14 priority birds (and also bird species making use of adjacent Marine Biogeographic Units, if applicable). The approach taken in the development of the narrative is meant to be thorough but not exhaustive, emphasizing references to more detailed work and in-depth studies. The second section presents habitat prioritization based on uniqueness, representivity, and patch size. It also presents different perspectives on species-based prioritization by looking at various assemblages of species. Species-based prioritization relies on relative abundance maps derived from best available occurrence data for each species. The reader is cautioned that best available occurrence data for most species remains incomplete, to varying degrees, with availability being a function of survey timing and survey effort, leading to variable, but important bias in some related maps. As such, multi-species composite maps and all other maps derived from the individual species maps also are vulnerable to bias.

Ultimately, the habitat prioritization map (composite of all habitats) and species prioritization map (composite of all species) are combined to yield a Conservation Value Index (CVI) map of the bioregion. For various reasons, including introduced bias, the CVI map, priority habitat maps and various multispecies composite maps can present contrasting perspectives on spatial priorities. This is expected and also reflects the reality that contrasting approaches to conservation may be required for the conservation of different species and the habitats that host them (i.e. land acquisition versus stewardship).

The second section also presents threats to conservation priority habitats and species. These are identified, assessed, and where possible, mapped at the bioregional scale. In the third section, each HCS presents conservation and stewardship actions that organizations plan to undertake to mitigate identified threats and contribute to the conservation of habitats (and the species they host) over the

course of a 5-year planning period. Though they cannot be considered comprehensive, actions are presented for each partner organization within a matrix structured according to IUCN categories.

In addition to presenting avenues for collaboration in the implementation of actions, this matrix presents gaps that can be interpreted as potential opportunities for development of new complementary conservation actions. It should be noted that conservation groups seeking government funding to undertake conservation actions within the bioregion (e.g., Aboriginal Fund for Species at Risk, Habitat Stewardship Fund for Species at Risk, National Conservation Plan – National Wetland Conservation Fund, New Brunswick Environmental Trust Fund, and New Brunswick Wildlife Trust Fund) are strongly encouraged to make specific reference to relevant information contained within the appropriate HCS.

No single map can provide decision support that aligns fully with all priorities of all conservation partners. As such, users of this and all other HCSs thus are encouraged to carefully consider the full suite of maps and information presented to obtain the decision support that is most appropriate to their needs.

Goals

The conservation goals that have been identified to guide the development of this HCS are:

1. Identify areas of importance for conservation priority habitats and species.
2. Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3. Maintain healthy, intact, and fully-functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
4. Protect and support the management of habitat corridors between existing protected areas and other conservation lands through land securement, partnerships, and community outreach.
5. Support the recovery of species at risk through the conservation actions of partner organizations, supported and enhanced by federal and provincial knowledge and guidance on species at risk.
6. Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7. Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

Vision

The NB Northumberland Strait Bioregion is an ecologically-diverse and species-rich landscape of high conservation value. The diverse habitat types and number of species of conservation concern found here are the result of region's unique topography, geography, and Maritime climatic influences. Rich and productive coastal regions (including tidal flats, estuaries, coastal islands, and beaches and dunes) provide important breeding and staging habitat for many migratory species of birds, such as the Piping Plover. In addition, the Eastern Lowlands Ecoregion (which is contained within the NB Northumberland Strait Bioregion) boasts the largest percentage of freshwater wetlands for any ecoregion in the province (Zelazny 2007). Research, conservation land securement, and continued sustainable management will

lead to a better understanding of the environment and species of the NB Northumberland Strait bioregion and to improved ecosystem health.

Ecological Context

The bioregion encompasses 570,638 ha (approximately 5,706 km^2) and is a low elevation landscape characterized by meandering rivers, peat bogs, barrier beaches, dunes and associated fringing salt marsh, and extensive river estuaries. The forests of the bioregion have a boreal-like aspect due to a long fire history and to the poorly drained acidic soils. The eastern boundary lies along the warm waters of the Northumberland Strait, a tidal water body between Prince Edward Island and the coast of eastern New Brunswick and northern Nova Scotia. A high concentration of suspended red silt and clay in the turbulent waters led early French colonists to name the strait "la mer rouge" (red sea). The low relief of the region and friable sandstone bedrock makes southeastern New Brunswick particularly prone to increasing rates of long-term flooding and coastal erosion and sensitive to climate change impacts such as rising sea levels and larger storm surges.

The New Brunswick Northumberland Strait bioregion has high ecological significance primarily because of the coastal ecological system (beaches, dunes, salt marshes and coastal islands). Coastal habitats in this bioregion provide nationally significant bird habitat, recognized through the designation of three Important Bird Areas (IBA). This coast is also significant in the migration of several species of shorebirds and waterfowl including Barrow's Goldeneye (*Bucephala islandica*), a federally listed Species at Risk (SAR). The sandy beaches are home to endemic plants and butterflies and provide critical breeding habitat for 25 percent of New Brunswick's population of the nationally endangered Piping Plover (*Charadrius melodus*). The coastal islands also host provincially sensitive Red Oak (*Quercus rubra*) forest communities.

In addition to the IBAs, this bioregion contains one national park, Kouchibouguac National Park, as well as seven provincial PNAs.

Conservation Priority Habitat Types

Eight priority habitat types were identified as the habitat types containing all species of conservation priority in the bioregion.

1. Beaches, Dunes, and Cliffs
2. Freshwater Wetlands
3. Riparian
4. Acadian Forest Mosaic
5. Grasslands and Agro-ecosystems
6. Salt Marsh
7. Tidal Flats/Estuaries
8. Coastal Islands

Maps was generated depicting the spatial location of overall conservation priority habitats based on habitat uniqueness, representivity, and patch size. The scores generated through development of the priority habitat composite, in combination with the priority species composite (using the full list of priority species) yielded a conservation value index for the NB Northumberland Strait bioregion, presented in Figure 25. This conservation priority habitats map also does not include the Grasslands and

Agro-ecosystems priority habitat type; it is the opinion of scientific experts that the potentially extreme year-to-year variations in amount and location of this habitat, coupled with it's primarily anthropogenic influence, makes it impossible to accurately map at this time.

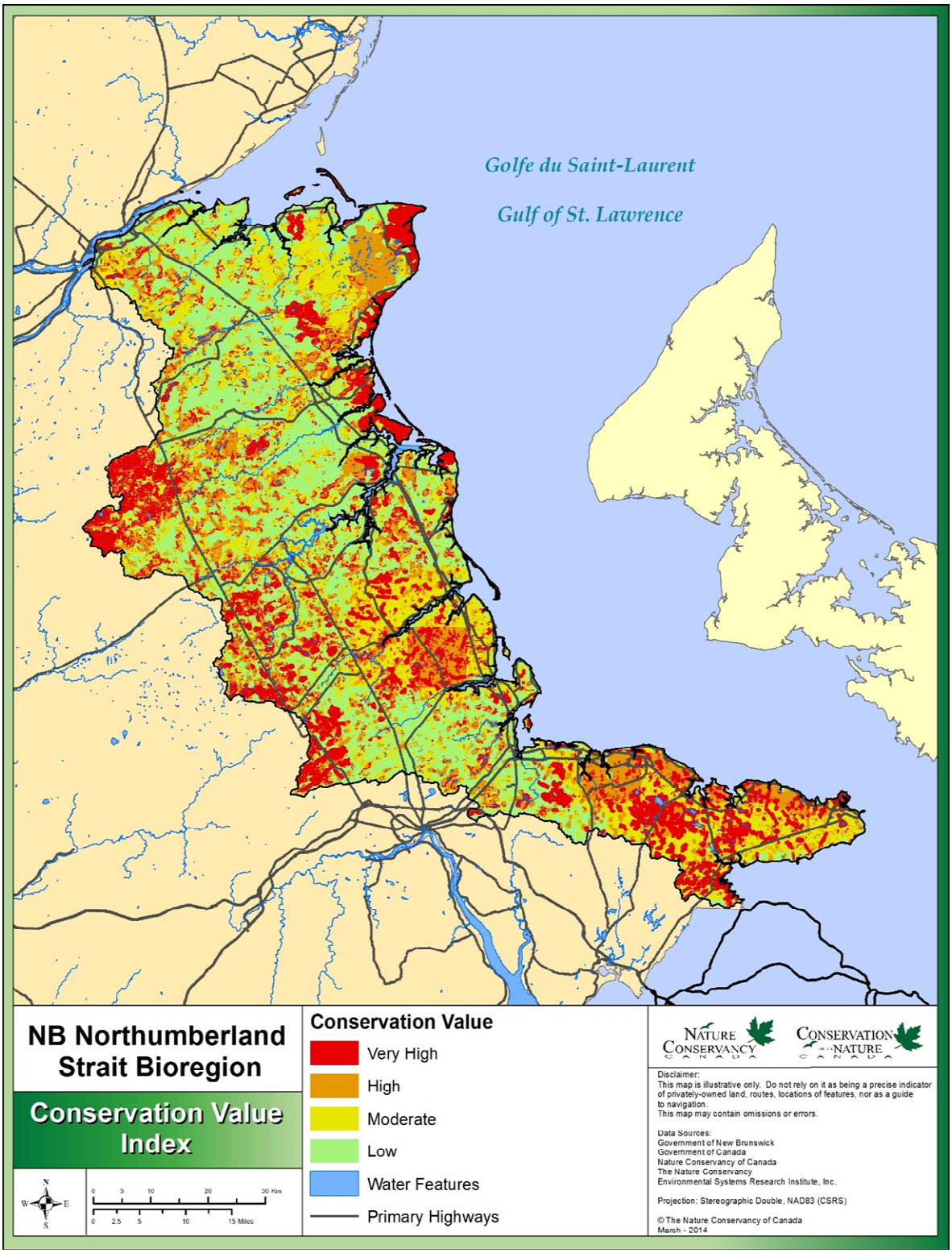

Figure 25. Conservation Value Index (CVI) for the New Brunswick Northumberland Strait bioregion (excluding Grasslands and Agro-ecosystems habitat type).

Different perspectives on species-based prioritizations are presented in the priority species composite maps in Figures 14-24 (p. 58-68) which illustrate the distribution of priority species assemblages derived from best available occurrence data for each species. The reader is cautioned that best available occurrence data for most species remains incomplete, to varying degrees, with availability being a function of survey timing and survey effort, leading to variable, but important bias in some related maps. As such, multi-species composite maps and all other maps derived from the individual species maps are also vulnerable to bias.

The integration of priority habitat data (the priority habitat composite) and priority species information (the priority species composite for all priority species) results in the Conservation Value Index (CVI) map for the Bioregion (Figure 32). This map was developed to identify sites within the NB Northumberland Strait Bioregion that have the highest conservation value in terms of priority habitat attributes and priority species, given the available data. Given that no single map can be expected to provide one 'best' answer, the reader is advised to compare and contrast the priority habitat composite map with the Conservation Value Index (CVI) map when using this document for decision support. To supplement these figures Appendix D presents a summary of the species presented in each map.

Goals

The conservation goals that have been identified to guide the development of this HCS are:

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2. Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3. Maintain healthy, intact, and fully-functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
4. Protect and support the management of habitat corridors between existing protected areas and other conservation lands through land securement, partnerships, and community outreach.
5. Support the recovery of species at risk through the conservation actions of partner organizations, supported and enhanced by federal and provincial knowledge and guidance on species at risk.
6. Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7. Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

Threats

The following threats were identified and classified using IUCN nomenclature. The majority have been assessed as either Low or Medium for the bioregion.

1. Residential and Commercial Development
    1.1 Housing, Cottage and Rural Development (Threat Status: Medium)
    1.3 Tourism and Recreation Areas (Threat Status: M)
2. Agriculture and Aquaculture
    2.1 Annual and Perennial Non-Timber Crop and 2.3 Livestock Farming and Ranching (Threat Status: L)
    2.2. Wood and Pulp Plantations (Threat Status: Low)

2.4 Marine Aquaculture (Threat Status: Low)
4. Transportation and Service Cooridors
4.1 Roads and Railroads (Threat Status: Medium)
5. Biological Resource Use
5.2 Gathering Terrestrial Plants (Threat Status: Medium)
5.3 Logging and Wood Harvesting (Incompatible Forestry Practices): (Threat Status: Medium
6. Human Intrusions and Disturbance
6.1 Recreational Activities (Threat Status: L)
7. Natural System Modifications
7.2. Dams and Water Management/Use (Threat Status: Low)
7.3 Other Ecosystem Barriers (e.g Coastline Hardening) (Threat Status: Medium)
8. Invasive & Other Problematic Species, Genes & Diseases
8.1 Invasive Non-Native/Alien Species/Diseases (Threat Status: Low)
9. Pollution
9.1 Domestic and Urban Waste Water (Threat Status: Low)
9.3 Agriculture and Forestry Effluents (Nutrients, Pesticides, and Herbicides) (Threat Status: Medium)
11. Climate Change
11.1 Habitat Shifting and Alteration (Threat Status: Medium)
11.3 Temperature Extremes (Threat Status: M)
11.4 Storms and Flooding (Threat Status: H)

Conservation Actions

Conservation actions to address threats and conserve and protect species and priority habitats within the bioregion were identified and developed through input from conservation partners. A summary of major conservation actions associated with partner organizations is presented below. A more detailed list of conservation actions structured according to IUCN categories, including threats addressed by each action and priority habitat to which the action is focused, is presented in Table 13 (p. 74).

<u>Environment and Climate Change Canada</u>

- Contribute to Marine Protected Area Network planning within the Gulf marine bioregion, and to the identification and description of Ecologically and Biologically Significant Areas and other habitat classification schemes toward the goal of protecting 10% of coastal and offshore marine areas by 2020.
- Inform and implement the North American Waterfowl Management Plan (NAWMP) and conduct waterfowl surveys as required by the plan (in partnership with the EHJV).
- Conserve habitat and wildlife within the Portage Island National Wildlife Area (Miramichi Bay estuary; in adjacent Acadian Peninsula HCS bioregion) according to the vision, goals and objectives of its management plan.
- Continue to work together through the coordination of volunteers and partners in Piping Plover monitoring, breeding habitat protection, and stewardship on beaches in SE New Brunswick, including joint monitoring collaborations, outreach, and volunteer celebration events. A Piping Plover recovery strategy has been developed, with a population objective of 105 pairs for NB (which includes both NB Acadian Peninsula and NB Northumberland Strait HCS bioregions).

- Undertake a multi-year Piping Plover banding project to quantify movement and survival, to better understand anthropogenic threats and other sources of mortality throughout the species' life cycle. Coordinate banded bird resighting efforts within the bioregion and more broadly throughout the species' range.
- Collaboration to implement species at risk recovery strategies and critical habitat designation in the bioregion.
- Implement the following Acts and regulations as required: the Migratory Bird Convention Act (MBCA); Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA); Species at Risk Act (SARA); Canadian Environmental Protection Act (CEPA); Canada Wildlife Act (CWA); Environmental Enforcement Act (EEA); Canadian Environmental Assessment Act (CEAA); Fisheries Act (water pollution); the Federal Policy on Wetland Conservation.
- Communication and engage with the public and conservation groups on financial programs for the protection of habitat.

<u>Kouchibouguac National Park</u>

- Maintain productivity for Piping Plover of 1.65 chicks per pair per year, calculated as a 5 year running average.
- Maintain current populations of Beach Pinweed at KNP through a combination of monitoring and reduction of human disturbance in habitat.
- Installation of two Wood Turtle crossings on Highway 117 within KNP to improve habitat connectivity and reduce mortality.
- Explore possibility of re-introduction of Gulf of St. Lawrence Aster to historical sites at KNP.

<u>Nature Conservancy of Canada</u>

- Acquisition of a minimum of 500 ha of high conservation value habitat as opportunities for land donation or purchase arise.
- Apply to the Province of New Brunswick to designate all NCC lands in the bioregion under the NB Protected Natural Areas Act, thus preventing sub-surface claims.
- Research in the following areas: ATV us in Escuminac; identification and prioritization of bog habitat for acquisition; aquatic connectivity on route 11 and 134 proposed upgrades; and, working forests and forest easements in the bioregion.

<u>Nature Trust of New Brunswick</u>

- Work with landowners to develop voluntary stewardship agreements on private land which will address specific threats to Species at Risk, rare species communities, and threatened ecosystems.
- Stewardship and monitoring of NTNB holdings in the region.
- Communication and public engagement on species at risk, threats, and conservation.

<u>New Brunswick Department of Energy and Resource Development</u>

- Protect and manage 5,160 hectares of Protected Natural Area containing representative forest and wetland ecosystems.

- Evaluate and potentially designate 4 intertidal areas for Protected Natural Area status (≈ 1,000 hectares).
- Implement sustainable forest management on the approximately 172,000 hectares of Crown Timber License lands within the bioregion and ensure activities on the remaining Crown lands are planned and undertaken in a manner consistent with the protection water quality, species at risk and other conservation priorities.
- Implement and enforce the New Brunswick Fish and Wildlife Act, Protected Natural Areas Act, Species at Risk Act, Clean Environment Act, Clean Water Act, Wetland Conservation Policy and Coastal Areas Protection Policy to conserve fish and wildlife populations, species at risk and the ecological, economic and social functions of these ecosystems on Crown and private lands.
- Continue to collaborate with and support non-government organization efforts on biodiversity, species at risk, habitat and ecosystem identification, conservation and stewardship through direct and in-kind support.

<u>New Brunswick Department of Environment and Local Government</u>

- Continue to enforce the "Rules of Engagement for the Short Term Measures", which provide protection under the NB Wetlands Conservation Policy for Provincially Significant Wetlands in the province.
- Continue to implement the Coastal Areas Protection Policy for activities occurring in coastal areas of New Brunswick.
- Continue to require and review EIAs for activities which fall under Schedule A of the Clean Water Act.
- In partnership with UNB, completion of the Wet Areas Mapping project which will provide improved knowledge of area of extent and types of watercourses in NB.
- Develop and implement a new Long Term Wetlands Strategy for NB.

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Shediac Bay Watershed Association – Remi Donnelle

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CONSERVATION CONTEXT

A. BIOREGION SCOPE

1. Location and Size

The New Brunswick Northumberland Strait bioregion is located within the Northern Appalachian – Acadian (NAA) Ecoregion (Figure 1), on the southeastern coast of New Brunswick, extending from Miramichi Bay south to Baie Verte. The bioregion encompasses 570,638 hectares (approximately 5,706 km^2) and is a low elevation landscape characterized by meandering rivers, peat bogs, barrier beaches, dunes and associated fringing salt marsh, and extensive river estuaries. The forests of the bioregion have a boreal-like aspect due to a long fire history and to the poorly drained acidic soils (Zelazny 2007). The eastern boundary lies along the warm waters of the Northumberland Strait, a tidal water body between Prince Edward Island and the coast of eastern New Brunswick and northern Nova Scotia. A high concentration of suspended red silt and clay in the turbulent waters led early French colonists to name the strait "la mer rouge" (red sea). The coastline is an area of low relief developed on flat-lying, friable, sandstone bedrock.

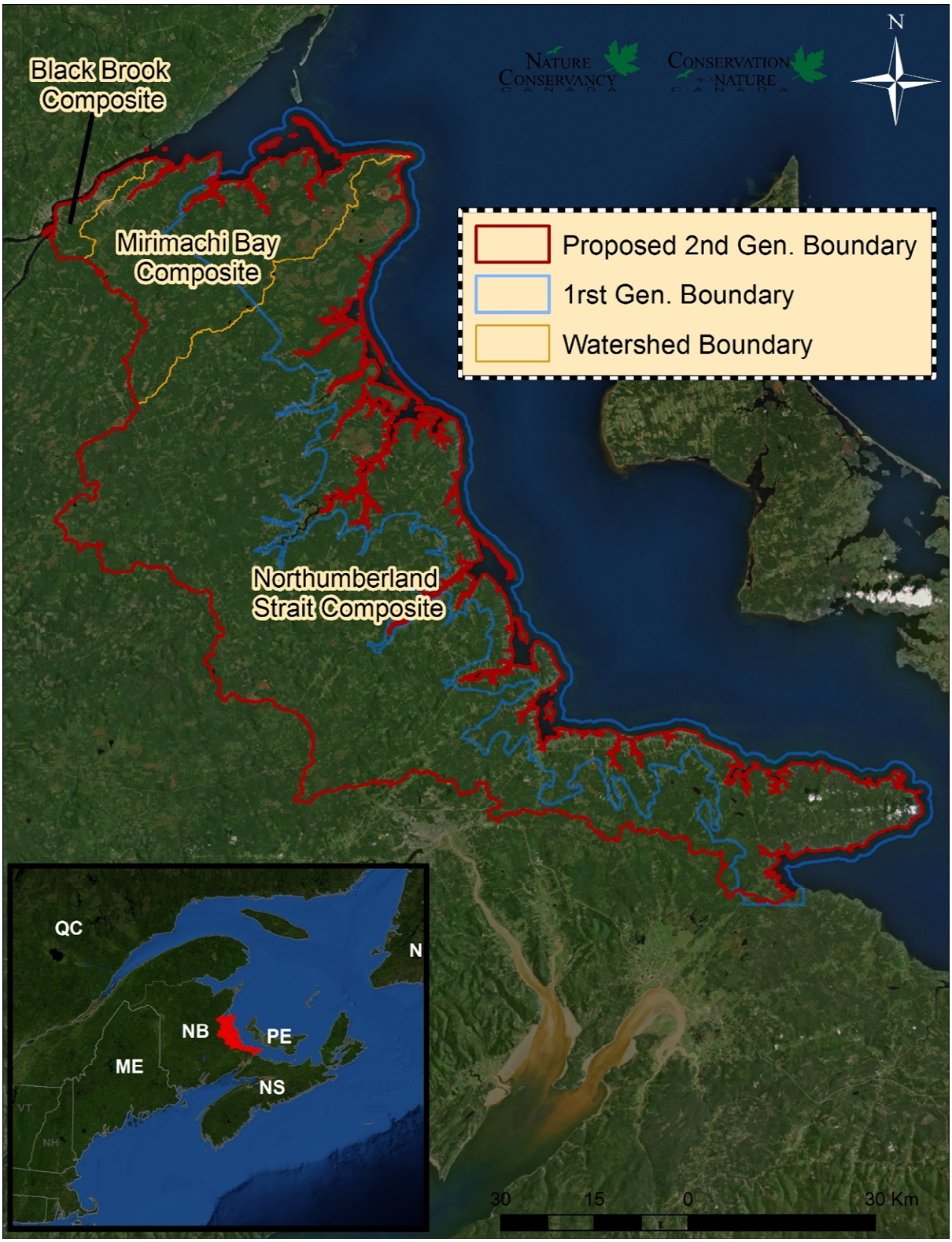

Figure 1. Location and boundary of the New Brunswick Northumberland Strait bioregion.

2. Boundary Justification

The boundary of the bioregion was selected using watershed boundaries and the provincially delineated ecodistricts (Figure 2). The north-south boundary is similar to the provincial Kouchibouguac Ecodistrict as defined by the Province of New Brunswick (Zelazny 2007). The inland or western boundary was based on the watersheds flowing into the Northumberland Strait. The bioregion is bounded by the adjacent Acadian Peninsula, Miramichi Watershed and Upper Bay of Fundy bioregions. Watersheds were chosen as the primary planning unit as threats and land use are relatively consistent within watersheds; agriculture and forestry impacts, in particular, are ideally measured within watersheds. The nature of the soil and topography makes southeastern New Brunswick particularly prone to increasing rates of long-term flooding and coastal erosion and sensitive to climate change impacts such as rising sea levels and larger storm surges (Environment Canada 2006).

3. Ecological Significance

The New Brunswick Northumberland Strait bioregion has high ecological significance primarily because of the coastal ecological system targets (beaches, dunes, salt marshes and coastal islands). These targets, and other ecological systems associated with lower elevations such as riparian/floodplains and freshwater wetlands, are in greater need of protection within the Northern Appalachian-Acadian Ecoregion, as there are few examples of them in formally designated Protected Natural Areas compared to other ecological system types (Anderson et al. 2006). Coastal habitats in this bioregion provide nationally significant bird habitat, recognized through the designation of three Important Bird Areas (IBA). Outside of the IBAs, coastal islands in this bioregion provide habitat for regionally important colonies of Common Tern (*Sterna hirundo*), Great Blue Heron (*Ardea herodias*) and Double-crested Cormorant (*Phalacrocorax auritus*). This coast is also significant in the migration of several species of shorebirds and waterfowl including Barrow's Goldeneye (*Bucephala islandica*), a federally listed Species at Risk (SAR). The sandy beaches are home to endemic plants and butterflies and provide critical breeding habitat for 25 percent of New Brunswick's population of the nationally endangered Piping Plover (*Charadrius melodus*). Riparian areas provide habitat for the nationally threatened Wood Turtle (*Glyptemys insculpta*) and several species at risk birds, such as the Bank Swallow (*Riparia riparia*).

The New Brunswick Northumberland Strait bioregion has one of the warmest and driest climates in the Northern Appalachian – Acadian Ecoregion, and one of the longest growing seasons in New Brunswick (Zelazny 2007). Despite the favourable climate poor soil drainage and marine exposure (winds and salt spray) restrict forest productivity in this bioregion compared to other regions of New Brunswick (Zelazny 2007). Expansive peatlands with patchy stunted forest cover composed of Black Spruce (*Picea mariana*), American Larch (*Larix laricina*) and ericaceous shrubs are common, especially in the northern part of the bioregion. More fine-textured soils found in the southern end of this bioregion are suitable for growing a mixture of crops and raising livestock.

The Northern Appalachian-Acadian Ecoregional Plan (or NAAP) identified a number of critical ecological systems for the New Brunswick Northumberland Strait bioregion including: a large matrix forest block; extensive barrier beaches, dunes and banks; critical salt marshes; and, many large peatlands (Anderson et al. 2006). Interaction between the barrier beaches and the tidal estuaries at the mouths of major rivers (e.g. Richibucto, Bouctouche, and Cocagne) has created a series of rich coastal marshes (Zelazny 2007). The NAAP also identified two species as primary targets, Piping Plover and Beach Pinweed

(*Lechea maritima*). These "primary species targets" are species that cannot be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention.

In addition to the primary species targets identified in the NAAP, there are many nationally listed species at risk found in this Natural Area such as Red Knot (*Calidris canutus*), Short-eared Owl (*Asio flammeus*), and Olive-sided Flycatcher (*Contopus cooperi*), among others. The provincially listed Southern Twayblade (*Listera australis*) is found in only half a dozen bogs in New Brunswick, some of which are located within this bioregion (ACCDC 2007). Coastal islands host a Red Oak (*Quercus rubra*) woodland community that has been ranked as vulnerable (S3) in New Brunswick.

B. ECOLOGICAL CONTEXT

1. Dominant Ecological Processes

Climate

Despite the maritime influences throughout the province, overall, New Brunswick has what is considered a continental climate. The Northumberland Strait bioregion has one of the warmest and driest climates of the province (Zelazny 2007) with annual daily temperature average of 4.9^0C and an average yearly precipitation of roughly 1100 mm (Government of Canada 2015). The relatively constant elevation across the bioregion results in a relatively consistent temperature, with temperature ranges only increasing with increasing elevation as you move inland (Zelazny 2007).

Geology

Overall, the bedrock in New Brunswick belongs to the Appalachian Mountain Range, with late Carboniferous sedimentary strata dominating the both the Northumberland and inland. The Carboniferous strata of the region is relatively flat and uniform, with the only topographical relief the result of river erosion of the bedrock over time. The geology of this bioregion is characterized by Pennsylvanian grey and red sandstone, mudstone, and conglomerate. Elevation is only 60 m near the coastline, rising to an elevation of 90 m inland at the western border of the bioregion. River estuaries and barrier beaches (such as those found at Kouchibouguac and Bouctouche) are important features of the bioregion (Zelazny 2007).

Forest

Topographical and geological features favour a high number of wetlands in the region. The bioregion is dominated by poorly drained soil types suited to predominantly conifer forest type as well as an abundance of forested wetlands, treed bogs, and cedar swamps (Zelazny 2007). Due to over 400 years of human influence on the landscape, the forest mosiac has shifted to a less diverse forest of younger age-classes and early successional species (Loo & Ives 2003).

In the absence of the major influence of human disturbance (e.g., forestry), the forests in the bioregion are almost entirely dependent on gap-replacing natural disturbance regimes, where canopy openings are created by tree mortality from old age, wind damage, fire, or slope failure. Small gap disturbance generally covering less than one percent of the area annually is the dominant force influencing species composition and age class distribution in the Acadian Forest (Mosseler et al. 2003). Forests along the coastline would typically be of shorter size due the constant exposure to wind, windblown sand, and salt spray, and are subject to disturbance cycles of shorter patterns (less than 100 years) such as blowdown, disease, insect, and occasionally fire. Short-lived species such as Balsam Fir would only experience this

type of disturbance once, while longer lived species such as Spruce and Hemlock would encounter multiple disturbance events during their lifetime (Neily et al. 2004).

Spruce Budworm outbreaks occur in New Brunswick every 30-40 years, and as a natural disturbance, it is an integral part of the forest ecosystem. Significant defoliation and mortality of spruce-fir forests is possible, and dependent upon the severity and longevity of the outbreak (Gray and MacKinnon 2006). Given the economic ramifications of timber loss, the province has spent considerable time and resources in an effort to research and combat this forest pest species. Other invasive pests have the potential to alter forest dynamics in the region; Brown Spruce Longhorn Beetle (*Tetropium fuscum*), an exotic species from Europe which attacks the phloem of healthy spruce trees and eventually causes death, was recently found in Kouchibouguac National Park (Canada Food Inspection Agency 2016).

Hydrology

Freshwater wetlands and riparian habitats are dynamic ecological systems that are constantly changing over space and time. The extent and type of wetlands and riparian systems that occur within any given watershed are a function of climate, geology and landscape condition (Naiman et al. 1992), all of which ultimately dictate the biota and ecological processes that will occur there. Within the NB Northumberland Strait bioregion, variations in these three factors across the landscape have led to a diversity of habitats. Lithological and hydrological regimes have resulted in distinct patterns of wetlands and riparian systems across the landscape. Within the bioregion, a relatively uniformly flat terrain and low elevation have led to extensive coastal wetland complexes. Large bogs and fens are common in this watershed, often interspersed amongst open aquatic beds and emergent wetlands, which are fed by ground water close to the soil surface. Tidal influences of the watersheds in the bioregion have a strong influence on the riparian environment (Zelazny 2007).

Coastal Systems

The coastal systems of the New Brunswick Northumberland bioregion are dynamic systems influenced by tides, wave action, salinity, sediment structure, currents, wind, temperature, ice cover and scouring, among others (DFO 2008a; DFO 2008b). The duration and frequency of tidal flooding in the coastal zone determines where species will occur (Olsen et al. 2005; Bertness 2007). Wave action is one of the most important processes influencing coastal development through erosion and sediment deposition, which varies depending on intensity and severity of the waves (Environment Canada 2006). The soft sandstone and mudstone of the region and dynamic coastal processes results in a continually eroding coastline, releasing vast quantities of clay, silt and sand into the water. Much of this sediment settles out to form mud flats and salt marshes, and contributes to sea-floor buildup (Buzeta et al. 2003). These mudflats, salt marshes and submarine deposits are transitory and owe their existence to subtle balances in the competing forces of the tides and currents that deposit sediments and those that erode them away. If either the rate of deposition or the rate of erosion changes over time, the mud layers will change, enlarging, shrinking or disappearing altogether (Daborn *in* Percy et al. 1997; Percy 1999). Long stretches of peat cliffs are not uncommon for the region, the result of millennia of coastal erosion processes and provide glimpses of post-glacial vegetation communities (Zelazny 2007).

Coastal marshes respond to gradual sea level rise by growing vertically and transgressing inland, provided there is a sufficient sediment supply and that human activity on the upland does not inhibit inland migration (Redfield 1972, Environment Canada 2006).

In addition to geological and biological processes, rising sea level and changing tidal amplitude, ice scour and storms also modify and shape the Northumberland coastline. Winter ice can be particularly damaging, where thick layers of ice can form on the salt marshes and tidal flats, and sediments may be deeply gouged or completely abraded away over large areas. However, winter ice also has the effect of dampening wave action, as well as wave impacts of storm surges. As a result, long-term climate change impacts on wave action through the loss of winter sea ice in the bioregion. Storm surges in excess of 100 cm occur roughly once a year in the bioregion, and those exceeding 130 cm roughly three times in a decade. Wind impact (those associated with higher wave action) appear to be associated with tropical or low-pressure systems tracking northeast (Environment Canada 2006).

2. Priority Species

Species are considered a priority species if the habitats within the bioregion are particularly relevant to them, or if the species are considered of conservation concern (Table 1). Currently, there are 36 species identified as at risk by COSEWIC. Of these, 24 are listed under the federal Species at Risk Act, and 31 are listed under the New Brunswick Species at Risk Act (Table 1). There are a total of 17 globally significant species (G1-G3G4) that are known to occur within the bioregion, 6 of which are COSEWIC-designated species at risk (Table 2).

Table 1. Species at Risk found within the New Brunswick Northumberland Strait bioregion (current as of March 2016).

Species Common Name	Scientific Name	COSEWIC[1]	SARA[2] SCH1	NB SARA[3]
Molluscs				
Brook Floater	*Alasmidonta varicosa*	Special Concern	Special Concern	Special Concern
Vascular Plants				
Butternut	*Juglans cinereal*	Endangered	Endangered	Endangered
Gulf of St. Lawrence Aster	*Symphyotrichum laurentianum*	Threatened	Threatened	Endangered
Beach Pinweed	*Lechea maritima*	Special Concern	Special Concern	Special Concern
Prototype Quillwort	*Isoetes prototypus*	Special Concern	Special Concern	Endangered
Parkers Pipewort	*Eriocaulon parkeri*	Not at risk		Endangered
Invertebrates				
Monarch	*Danaus plexippus*	Special Concern	Special Concern	Special Concern
Pygmy Snaketail	*Ophiogomphus howei*	Special Concern	Special Concern	Special Concern
Yellow-banded Bumble Bee	*Bombus terricola*	Special Concern	No status	
Rusty-patched Bumble Bee	*Bombus affinis*	Endangered	Endangered	
Gypsy Cuckoo Bumble Bee	*Bombus bohemicus*	Endangered	No status	
Fish				
American Eel	*Anguilla rostrate*	Threatened	No status	Threatened
Atlantic Salmon Gaspe-Southern Gulf of St. Lawrence population	*Salmo salar*	Special Concern	No status	Special Concern

Striped Bass Southern Gulf of St. Lawrence population	*Morone saxatilis*	Special Concern	No status	Special Concern
Turtles				
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatened	Threatened
Birds				
Piping Plover melodus subspecies	*Charadrius melodus melodus*	Endangered	Endangered	Endangered
Red Knot rufa subspecies	*Calidris canutus rufa*	Endangered	Endangered	Endangered
Bank Swallow	*Riparia riparia*	Threatened	No status	
Barn Swallow	*Hirundo rustica*	Threatened	No status	Threatened
Bobolink	*Dolichonyx oryzivorus*	Threatened	No status	Threatened
Canada Warbler	*Cardellina canadensis*	Threatened	Threatened	Threatened
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened	Threatened
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened
Eastern Meadowlark	*Sturnella magna*	Threatened	No status	Threatened
Eastern Whip-poor-will	*Antrostomus vociferus*	Threatened	Threatened	Threatened
Least Bittern	*Ixobrychus exilis*	Threatened	Threatened	Threatened
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	
Wood Thrush	*Hylocichla mustelina*	Threatened	No status	Threatened
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	Special Concern	Special Concern
Harlequin Duck (Eastern population)	*Histrionicus histrionicus*	Special Concern	Special Concern	Endangered
Barrow's Goldeneye Eastern population	*Bucephala islandica*	Special Concern	Special Concern	Special Concern
Eastern Wood-pewee	*Contopus virens*	Special Concern	Special Concern	Special Concern
Peregrine Falcon anatum/tundrius	*Falco peregrinus anatum/tundrius*	Special Concern	Special Concern	Endangered
Red-necked Phalarope	*Phalaropus lobatus*	Special Concern	No status	
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern	Special Concern
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	Special Concern
Bald Eagle	*Haliaeetus leucocephalus*	Not at Risk		Endangered
Mammals				
Little Brown Myotis	*Myotis lucifugus*	Endangered	Endangered	Endangered
Canada Lynx	*Lynx canadensis*	Not at Risk		Endangered

[1] The Committee on the Status of Endangered Wildlife in Canada is an independent committee of experts that assesses the national status of wildlife species in Canada based on the best available scientific, community, and Aboriginal traditional knowledge, and recommends a classification for their legal protection.

[2] The Species at Risk Act (2003) is the federal legislation that provides for the protection and recovery of wildlife species, subspecies, and distinct populations that are listed as extirpated, endangered, or threatened on Schedule 1 of the Act; once a species is listed, the provisions of the Act apply to protect and recover the species.

[3] The New Brunswick Species at Risk Act is the provincial Act and associated regulations which provides for the protection and recovery of species at risk that occur within the province of New Brunswick.

Table 2. Globally significant species (G1-G3G4) within the New Brunswick Northumberland Strait bioregion (current as of March 2016).

Common Name	Scientific Name	Type	Global Rank
Brook Floater	*Alasmidonta varicosa*	Mollusc	G3
Little Georgia	*Tetrodontium brownianum*	Moss	G3G4
A Moss	*Pohlia sphagnicola*	Moss	G3?
Friable Horsehair Lichen	*Bryoria friabilis*	Lichen	G3
Gulf of St. Lawrence Aster	*Symphyotrichum laurentianum*	Vascular plant	G2
Gaspé Arrowgrass	*Triglochin gaspensis*	Vascular plant	G3G4
Auricled Twayblade	*Listera auriculata*	Vascular plant	G3G4
Nootka Alkali Grass	*Puccinellia laurentiana*	Vascular plant	G3?Q
Connecticut Beggar-Ticks	*Bidens heterodoxa*	Vascular plant	G2Q
Pygmy Snaketail	*Ophiogomphus howei*	Insect	G3
Salt Marsh Copper	*Lycaena dospassosi*	Insect	G2G3
Short-tailed Swallowtail	*Papilio brevicauda*	Insect	G3G4
Short-tailed Swallowtail	*Papilio brevicauda bretonensis*	Insect	G3G4T2T3
Wood Turtle	*Glyptemys insculpta*	Turtle	G3
Piping plover melodus sp.	*Charadrius melodus melodus*	Shorebird	G3NR
Little Brown Myotis	*Myotis lucifugus*	Mammal	G3
Maritime Shrew	*Sorex maritimensis*	Mammal	G3

Appendix C and D each provide a list of significant species within the NB Northumberland Strait bioregion with their associated broad habitat associations. Appendix C provides the list of species used for the purposes of the assessments within this Habitat Conservation Strategy (HCS) and were developed by The Nature Conservancy of Canada-Atlantic Region under the *New Brunswick Northumberland Strait Natural Area Plan*. Parameters were as follows: Species within the NA (or within 1km of the NA boundary) were considered significant if ranked globally (G1-G3G4), nationally (N1-N3), provincially (S1-S2), were COSEWIC assessed or provincially listed as a species at risk. Significant species occurrence records were tabulated from the Atlantic Canada Conservation Data Centre species database (2013), the Canadian Wildlife Service shorebird and waterfowl survey datasets (Hicklin 1999, Bateman 2001, Chardine 2008, Morrison 2006, 2007) and the Bird Studies Canada Shorebird, Rare and Colonial Bird and Maritime Point Count datasets (MBBA 2008). Species listed as a Bird Conservation Region 14 priority (Environment Canada 2013) or a Northern Appalachian-Acadian Ecoregional Plan primary species (Anderson et al. 2006) were also included if occurrences were recorded in the datasets above, regardless of conservation rank.

Appendix D provides an updated species list for the bioregion in accordance with criteria used by other Habitat Conservation Strategies currently in development. These lists include all species designated federally as Endangered Threatened, or Special Concern by COSEWIC or under SARA schedule 1; species at risk identified by the province of New Brunswick as Endangered, Threatened, or Special Concern under the NB SARA; provincially rare- (S1 or S2) or globally- (G1-G3G4) rare or uncommon element occurrence records from the Atlantic Canada Conservation Data Centre (ACCDC) most recent dataset; and, all BCR 14 and MBU 11 priority bird species that occur within the bioregion. An additional list of all

S3 (rare) species element occurrences within the bioregion can be found in Appendix C. A complete glossary of definitions for Biodiversity and Conservation Ranks can be found in Appendix B.

Birds

The different forest communities, a result of multiple tree species, age classes, understory vegetation, and factors such as slope, soil types, drainage, and aspect, provides habitat for a wide range of bird species. Forty-one different bird species identified as rare, at risk, or a priority within the BCR 14 are thought to occur in the bioregion and require forested habitat for all or a portion of their life cycle. The brightly coloured Canada Warbler, recognized as an Endangered species at both the national and provincial level, breeds in wet mixedwood forests that have well-developed understories. The species has shown declines of 43% in the Maritimes for the period of 1997-2007, with habitat loss on the breeding grounds being a potential contributing factor in their declines (COSEWIC 2008a). Aerial insectivorous species, such as Common Nighthawk (*Chordeiles minor*), Eastern Whip-poor-will (*Caprimulgus vociferous*), and Olive-sided Flycatcher (*Contopus cooperi*) rely on forest communities for nesting and on adjacent natural/anthropogenic openings for foraging. Each of these species have been identified as at risk by COSEWIC and all have shown widespread declines over the years (COSEWIC 2007b, COSEWIC 2007c, COSEWIC 2009).

The Northumberland Strait bioregion is renowned for its extensive barriers beaches. A combination of low relief, coastal subsidence, and high sediment deposition has given rise to expansive bays and sandy beaches along much of the coastline (Zelazny 2007). At the mouths of rivers are tidal flats and estuaries which are important stopover areas for many shorebirds and waterfowl including species of plovers, sandpipers, and Lesser Yellowlegs (*Tringa flavipes*). Beaches and dunes provide key habitat for a variety of at risk species, such as the federally and provincially endangered Piping Plover. Piping plovers nest on gravel sand beaches in small depressions, feeding on invertebrates and crustaceans in the intertidal zone. Piping plovers in the Northumberland Strait prefer more mixed substrate, less beach wrack, and flatter areas in comparison to Piping Plovers nesting along the Atlantic Ocean (Boyne et. al. 2014). The beaches of the Northumberland coast hosts 25% of the New Brunswick population (Environment Canada 2012a). Large coastal storms create habitat for the species during the nonbreeding season, and has been correlated with an increase in young fledged in the bioregion (Bourque et al. 2015).

Fifty-eight bird species were identified as conservation priorities by Environment Canada within BCR 14, MBU 12, or both, and have known occurrences within the bioregion (Table 3).

Table 3. Priority bird species occurring within BCR 14 and MBU 12 and associated conservation priorities.

Priority Species	Group	Conservation Priority[1]	COSEWIC[2]	SARA[3]	NB SARA[4]	BCR 14	MBU 12
Piping Plover melodus subspecies	Shorebird	Recovery Objective	EN	EN	EN	Y	Y
Red Knot rufa subsp.	Shorebird	Assess/maintain	EN	EN	EN		Y
Tree Swallow	Landbird	Maintain current				Y	
Bobolink	Landbird	Increase 100%	TH		TH	Y	
Canada Warbler	Landbird	Increase 100%	TH	TH	TH	Y	
Chimney Swift	Landbird	Increase 100%	TH	TH	TH	Y	
Common Nighthawk	Landbird	Increase 100%	TH	TH	TH	Y	

Eastern Meadowlark	Landbird	Increase 50%	TH		TH	Y	
Eastern Whip-poor-will	Landbird	Assess/maintain	TH	TH	TH	Y	
American Bittern	Waterbird	Increase 100%				Y	
Least Bittern	Waterbird	Recovery objective	TH	TH	TH	Y	
Olive-sided Flycatcher	Landbird	Increase 100%	TH	TH		Y	
Wood Thrush		Increase 100%	TH		TH	Y	
Yellow Rail	Waterbird	Assess/maintain	SC	SC	SC	Y	Y
Sora	Waterbird	Assess/maintain				Y	
Virginia Rail	Waterbird	Assess/maintain				Y	
Peregrine Falcon anatum/tundrius	Landbird	Assess/maintain	SC	SC	EN	Y	
Rusty Blackbird	Landbird	Increase 100%	SC	SC	SC	Y	
Short-eared Owl	Landbird	Assess/maintain	SC	SC	SC	Y	
Northern Goshawk	Landbird	Increase 50%				Y	
Red-shouldered Hawk	Landbird	Assess/maintain				Y	
American Redstart	Landbird	Maintain current				Y	
American Three-toed Woodpecker	Landbird	Assess/maintain				Y	
Black-backed Woodpecker	Landbird	Increase 50%				Y	
Yellow-bellied Sapsucker	Landbird	Maintain current				Y	
Bay-breasted Warbler	Landbird	Maintain current				Y	
Blackburnian Warbler	Landbird	Maintain current				Y	
Black-throated Blue Warbler	Landbird	Maintain current				Y	
Black-throated Green Warbler	Landbird	Maintain current				Y	
Cape May Warbler	Landbird	Increase 100%				Y	
Magnolia Warbler	Landbird	Maintain current				Y	
Blue-headed Vireo	Landbird	Maintain current				Y	
Boreal Chickadee	Landbird	Increase 100%				Y	
Belted Kingfisher	Landbird	Assess/maintain				Y	
Black-billed Cuckoo	Landbird	Increase 100%				Y	
Eastern Kingbird	Landbird	Increase 50%				Y	
Evening Grosbeak	Landbird	Increase 100%				Y	
Nelson's Sparrow	Landbird	Assess/maintain				Y	
White-throated Sparrow	Landbird	Maintain current				Y	
Purple Finch	Landbird	Maintain current				Y	
Rose-breasted Grosbeak	Landbird	Maintain current				Y	
Ruffed Grouse	Landbird	Assess/maintain				Y	
Veery	Landbird	Increase 100%				Y	

White-breasted Nuthatch	Landbird	Maintain current				Y	
American Woodcock	Landbird	Increase 50%				Y	
American Golden-Plover	Shorebird	Assess/maintain				Y	
Black-bellied plover	Shorebird	Assess/maintain					Y
Dunlin	Shorebird	Assess/maintain					Y
Hudsonian Godwit	Shorebird	Assess/maintain					Y
Lesser Yellowlegs	Shorebird	Assess/maintain				Y	Y
Sanderling	Shorebird	Assess/maintain					Y
Least Sandpiper	Shorebird	Assess/maintain					Y
Semipalmated Sandpiper	Shorebird	Assess/maintain					Y
Solitary Sandpiper	Shorebird	Assess/maintain				Y	Y
Spotted Sandpiper	Shorebird	Increase 50%				Y	
Whimbrel	Shorebird	Assess/maintain				Y	Y
Willet	Shorebird	Increase 50%					Y
Wilson's Snipe	Shorebird	Increase 100%				Y	
Black Tern	Waterbird	Assess/maintain				Y	
Common Tern	Waterbird	Assess/maintain				Y	Y
Common Loon	Waterbird	Maintain current (BCR 14) Assess/maintain (MBU 12)				Y	Y
Red-throated Loon	Waterbird	Assess/maintain					Y
Horned Grebe	Waterbird	Assess/maintain					Y
Red-necked Grebe	Waterbird	Assess/maintain					Y
Pied-billed Grebe	Waterbird	Assess/maintain				Y	
Green Heron	Waterbird	Assess/maintain				Y	
American Black Duck	Waterfowl	Maintain current				Y	Y
Canada Goose (North Atlantic)	Waterfowl	Maintain current				Y	Y
Canada Goose (Temperate)*	Waterfowl	Decrease				Y	Y
Barrow's Goldeneye Eastern population	Waterfowl	Assess/maintain	SC	SC	SC	Y	Y
Common Goldeneye	Waterfowl	Increase 50% (BCR 14) Assess/maintain (MBU 12)				Y	Y
Harlequin Duck (Eastern population)	Waterfowl	Recovery objective	SC	SC	EN	Y	Y
Green-winged Teal	Waterfowl	Increase 50%				Y	Y
Mallard	Waterfowl	Increase 100%				Y	
Ring-necked Duck	Waterfowl	Increase 50%				Y	
Wood Duck	Waterfowl	Increase 50%				Y	
Long-tailed Duck	Waterfowl	Assess/maintain					Y

Common Eider	Waterfowl	Increase 50%					Y
Black Scoter	Waterfowl	Assess/maintain					Y
Surf Scoter	Waterfowl	Assess/maintain					Y

[1]Population objectives apply to all units were the species is a priority (BCR 14, MBU 12), unless indicated.

[2]Species assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered (EN), Threatened (TH), or Special Concern (SC).

[3]Species listed on Schedule 1 of Canada's Species at Risk Act (SARA) as Endangered (EN), Threatened (TH), or Special Concern (SC).

[4]Species listed on the New Brunswick Species at Risk Act (NB SARA) as Endangered (EN), Threatened (TH), or Special Concern (SC).

*Should not be used as a basis for conservation planning.

Insects

Insects of priority concern occupy a wide range of habitats within the bioregion. Dragonfly species such as the Pygmy Snaketail (*Ophiogomphus howei*) require aquatic habitat (both rivers and riparian areas) as well as forested habitat to complete all or a portion of their life cycle. Pygmy Snaketails require large, fast-flowing rivers with sandy bottoms for egg deposition and larval development, and adults are thought to spend the majority of their time in the canopy of adjacent forests (COSEWIC 2008b). The importance of dragonflies cannot be understated; they are recognized throughout the world as indicators of water quality, ecosystem health, and predictors of climate change impacts due to their sensitivity to anthropogenic disturbances, temperature fluctuations, and pollution (Homung and Rice 2003, Bush et al. 2008, Acquah-Lampey et al. 2013, Kutcher and Bried 2014).

The Salt Marsh Copper (*Lycaena dospassosi*) is one of only five species of butterflies endemic to Canada with a range that includes the Northumberland Strait bioregion. Their habitat is restricted to the drier portions of salt marshes where the host plant Egede's Silverweed (*Argentina egedii*) is found, with Sea-Lavender (*Limonium nashii*), as the primary nectar source (Maritime Butterfly Atlas 2011).

Most recently, attention has been drawn to the plight of bumble bee species and their dramatic declines in recent years. Three species have been identified as at risk by COSEWIC and potentially occur (or did occur) in the bioregion: Yellow-banded Bumble Bee (*Bombus terricola*) (COSEWIC 2015), Rusty-patched Bumble Bee (*Bombus affinis)* (COSEWIC 2010a), and Gypsy Cuckoo Bumble Bee (*Bombus bohemicus)* (COSEWIC 2014). One species, the Yellow-banded Bumble Bee has been confirmed as occurring within the bioregion (D. Doucet, pers. comm.). It is unclear if the other two species are present in the bioregion; however, given that insect species have not been well studied historically, and bumble bees for this bioregion in particular, they should be considered as priority species requiring further study.

Mammals

Three of seven bat species in New Brunswick have recently been assessed by COSEWIC as Endangered: the Tricolored Bat (*Perimyotis subflavus*), Little Brown Myotis (*Myotis lucifugus*) and the Northern Myotis (*Myotis septentrionalis*) (COSEWIC 2013), one of which, the Little Brown Myotis, is found in the bioregion. Catastrophic declines of Little Brown Myotis in recent years has reduced the population to only 1% of what was previously known to occur to occur in the province. This decline is attributed to White-Nose Syndrome (WNS), caused by the fungal pathogen *Pseudogymnoascus destructans*. First discovered in New York in 2006, *P. destructans* is thought to have originated in Europe, and thrives in the environmental conditions suitable in caves for hibernating bats. The fungus, named for the white powder on exposed skin of muzzles and wings, causes bats to wake from torpor during the hibernation

period, using essential fat stores needed for survival (Cryan et al. 2010, Blehert 2012). As of 2012, White-Nose Syndrome has been found in 19 U.S. states and 4 Canadian provinces, and resulted in the death of over 5 million bats (Blehert 2012).

To date, most known hibernacula in NB are found in the New Brunswick Inner Bay of Fundy bioregion, and none are known to exist within the NB Northumberland Strait bioregion. However, the forested landscape of the region provides ample breeding and migratory habitat for bat species. Bats (especially the migratory species) are more likely to be impacted by wind farms than birds and where such features exist, this needs to be carefully considered in analysing present and emerging threats and establishing conservation and recovery actions (Kuns et al. 2007, Baerwald and Barclay 2009).

Canada Lynx (*Lynx canadensis*) is considered rare in New Brunswick and listed as an Endangered Species under the NB SARA. The species requires mature coniferous and mature mixedwood forests. Although forest practices help create habitat for Snowshoe Hare, the Lynx's primary prey, increasing pressure from forest harvesting practices will result in less habitat for this species on the landscape (MacAlpine and Heward 1993, Poole 2003).

Plants

There are a number of plant species which provide important structural components of different habitats in the bioregion. Marram grass, with their extensive network of underground rhizomes, stabilize sand dunes and prevent coastal erosion, allowing other species to colonize the area (DFO 2008c). Likewise, eelgrass is found within estuaries, and the extensive eelgrass beds throughout bays in the bioregion support substrate deposition, prevent erosion, and provide habitat for aquatic species (NOAA Fisheries Office of Habitat Conservation 2012).

Red Oak (*Quercus rubra*) dominate the coastal forests on islands, typically associated with a nearby salt marsh and coastal dune on mesic upland soils (Basquill 2008). These Red Oak coastal forests have been evaluated by Atlantic Canada Conservation Data Centre (ACCDC) as S3 (vulnerable to extirpation or extinction) based on the Nature Serve criteria. As defined by Sean Basquill's (2008) report, three coastal Red Oak community types for this bioregion have been identified based on their species associations. The first Red Oak forest community (NB forest community code -A271) is associated with White Pine (*Pinus strobus*) and Bracken Fern (*Pteridium aquilinum*) and is found on Bay du Vin Island. The second association (NB forest community code -A272) is Red Oak with Sugar Maple (*Acer saccharum*) and Intermediate Woodfern (*Dryopteris intermedia*) and can be found on the other coastal islands. Finally, the third Red Oak community type (NB forest community code - A313) is ranked as S2 and is associated with Purple Chokeberry (*Photinia floribunda*), American Beachgrass (*Ammophila breviligulata*), and Seaside Goldenrod (*Solidago sempervirens*) (Basquill 2008).

Aquatic and Riparian Species

Riparian ecosystems within the bioregion support a high diversity of species and habitat types, ranging from brackish and freshwater aquatic habitats, to shrub wetlands and seepage areas, forested floodplains, upland forest communities and grasslands/agro-ecosystems. The major river systems along the Northumberland Strait bioregion and their tributaries are particularly diverse due to the mixing of fresh and saltwater at the river mouths and the strong tidal influence. A number of rare and at-risk species depend on aquatic habitats to complete their lifecycle, such as anadromous fish – those that spawn in freshwater but migrate to the ocean to feed and mature (e.g., southern Gulf of St. Lawrence

Striped Bass, Atlantic Salmon), catadromous fish – those that spawn in saltwater but can migrate to freshwater (e.g., American Eel) and freshwater mussels such as the Brook Floater.

Although there has been a resurgence in the population of Southern Gulf of St. Lawrence Striped Bass, populations of Atlantic Salmon have decreased substantially since the early 20th century, the reasons for which are not well understood but is believed to be linked to low marine survival (COSEWIC 2010b). As a result of declining numbers, a catch and release only fishery for salmon was introduced in 2015 (DFO 2016). Southern Gulf of St. Lawrence Striped Bass, as indicated, have seen a rebound in population numbers in recent years such that a recreational retention fishery has been opened; however, as there is still only one known spawning ground for the species on the Northwest Miramichi River (DFO 2015a), any activity which could detrimentally affect this area would impact the long-term sustainability of the population (COSEWIC 2012b).

The Wood Turtle, a semi-aquatic species and North American endemic, also depend on riparian habitats. Stream, lakes and ponds are used for mating and hibernation, while upland sites (within 300 m of a watercourse) are used for foraging and nesting. Riparian shrub wetlands and forested riparian areas are considered the preferred terrestrial habitat for this species, although they are known to use a range of upland sites, including agricultural lands and roadside ditches (COSEWIC 2007a).

3. Protected and Conservation Lands

The International Union for the Conservation of Nature (IUCN) defines protected areas as "*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.*" (IUCN Definition 2008 in IUCN 2013). A number of federal, provincial, and private initiatives has resulted in a network or conservation and protected areas within the bioregion totalling 30,947 ha and 5.42 % of the bioregion's landscape (Table 1).

Federally protected lands in the bioregion are administered by Environment Canada either through the Parks Canada agency or the Canadian Wildlife Service. The total area of federal protected land is 25,133 ha and includes one National park (Kouchibouguac) and one National Wildlife Area (NWA) (Cape Jourmain). According to the *Kouchibouguac National Park of Canada Management Plan* (2010), the park was formed in 1979 to protect and conserve a national significant area representative of the Maritime Plain Natural Region, characterized by a low elevation landscape of sand dunes and barrier beaches. The park is home to a number of species at risk and is "*essential to the conservation of regional biodiversity*" (Parks Canada 2010).

Provincial government conservation areas in the region include two provincial parks (Murray Beach and Parlee Beach) and seven PNAs. All New Brunswick provincial PNAs within the bioregion are Class II, which allow for low impact recreational activities and traditional food gathering. No industrial or commercial activities are permitted in the PNAs, and education and scientific work requires a permit (Government of New Brunswick 2003).

Private conservation initiatives in the bioregion include land holdings of Ducks Unlimited Canada and the Nature Conservancy of Canada. The Nature Conservancy of Canada has 6 land holdings totalling 483 hectares (Table 4).

Table 4. Conservation and Protected Areas within the New Brunswick Northumberland Strait bioregion (as of February 2016).

Landownership	Organization	Site Name	Hectares (ha)	Percentage (%) of Bioregion
Federal	Environment Canada, Canadian Wildlife Service	Cape Jourmain NWA	592	4.38
	Department of Canadian Heritage, Parks Canada	Kouchibouguac National Park	24,541	
Private	Ducks Unlimited	Various	91	0.02
	Nature Conservancy of Canada	Baie Verte	91	0.08
		Barachois	17	
		Cape Jourmain	13	
		Escuminac	257	
		Ephraim Island	54	
		Richibucto Dunes	52	
Provincial	New Brunswick Department of Tourism, Heritage, and Parks	Murray Beach Provincial Park	27	0.04
		Parlee Beach Provincial Park	63	
	New Brunswick Department of Energy and Resource Development	Bay Du Vin Island (Class II)	224	0.90
		Black River (Class II)	3,997	
		Blind Brook (Class II)	216	
		Goodfellow Brook (Class II)	112	
		Hells Gate Hardwoods (Class II)	211	
		McLean Settlement (Class II)	5	
		Richibuctou River (Class II)	395	
	Totals		30,947	5.42

Important Bird Areas (IBAs) are areas identified as significant for rare and at risk birds. IBAs are developed using standardized, quantitative criteria, and are a useful tool to aid in identifying conservation priorities in a region. The IBA program is an international initiative administered by BirdLife International (Bird Studies Canada 2016).

Three IBAs are located within the New Brunswick Northumberland Strait bioregion, with Kouchibouguac National Park Sand Islands by far the largest of the three. All three were identified as IBAs primarily for their role in providing habitat for the Piping Plover, a globally rare and federally and provincially endangered species (Table 5).

Table 5. List of Important Bird Areas (IBAs) located all or partially within the bioregion (as of February 2016).

IBA Name	Location (lat/long)	Elevation (m)	Size (km^2)

Buctouche Bar	46.481° N 64.668° W	0 – 5	73
Escuminac Beaches	47.077° N 64.878° W	0 -5	34
Kouchibouguac NP Sand Islands	46.825° N 64.934° W	0 -10	340

The sand spits and barrier islands of Kouchibouguac National Park are especially important as breeding sites for Common Terns and Piping Plovers. On average over 12 pairs have been present each breeding season. As a result, the Kouchibouguac IBA supports as much as 6% of Atlantic Canada Piping Plover population and about 1% of the Atlantic coastal Piping Plover population.

As with many other Piping Plover beaches in the Maritimes, one of the most significant conservation issues is recreational beach use. Recreational use of ATVs on the Escuminac beaches is consesidered heavy and is possibly the worst in southeastern New Brunswick (Bird Studies Canada 2016).

Although this Habitat Conservation Strategy identifies only those protected habitat and conservation areas which are legally protected under federal or provincial legislation, it should be noted that there are a number of areas set aside for conservation on private lands which are not legally protected. These include areas such as La Dune de Bouctouche, a 12 km sand dune with infrastructure (centre and boardwalk) owned by J.D. Irving, Ltd., and the Community Forest International, which promotes conservation through an education/demonstration woodlot near Sackville, N.B. The number of private conservation initiatives in the bioregion is unknown but could be substantive.

4. Social and Economic Considerations

First Nations people occupied New Brunswick for thousands of years prior to the arrival of European settlers in the 1600s. New Brunswick First Nation communities historically belonged to either the Maliseet or Mi'kmaq, with the Mi'kmaq First Nation territory found in the north and east of the province. Prior to European settlement, the Mi'kmaq roamed their entire territory, using the area for hunting, fishing, and farming; today, the Mi'kmaq First Nation is restricted to 9 communities along the eastern coastline of New Brunswick, only 1 of which are located within the bioregion. The first overwintering European settlement in North America was in 1604 when Samuel de Champlain and the Pierre du Gast settled on an island they named Isle St. Croix, near what is now St. Andrews, New Brunswick. The continuing arrival of French and English settlers over the next 200 years resulted in displacement of the original Aboriginal peoples from their traditional territories and a dramatic change in the landscape as forests were cleared and dykes built to create farmland (Fort Folly First Nation New Brunswick 2016).

The bioregion includes portions of three New Brunswick counties (Northumberland, Kent, and Westmorland). Many towns and villages are located along the coastline, including Shediac, Bouctouche, and Richibucto, among others. The largest community in the bioregion is the city of Miramichi, with a population of over 28,000, making it the 5th largest city in the province (Statistics Canada 2016a).

During the 19th and 20th centuries, the economy of the region was driven mainly by forestry, agriculture, shipbuilding, and shellfish and fish harvesting. The towns of Shediac, Bouctouche, Cocagne, and Richibucto were well established by 1860 with 31 sawmills, shipbuilding factories, and an active

agricultural industry. Mining once played a significant role here, partly because of coal mines, but primarily because of a major sandstone quarry near Shediac. Lumbering was a major industry in the bioregion from the 1800s on as the numerous river systems provided easy access and transport of logs in comparison with other regions of the province (Zelazny 2007).

The economy has recently changed from a primarily resource-driven economy to a services and tourism economy for the region. The region has had significant and recent upheaval in economic drivers, highlighted by the closure of 4 mills in the Miramichi region between 2003-2008, resulting in job losses exceeding 1,000 positions, not including indirect losses (Smith and Parkins 2011). However, resource extraction is still an economic contributor in the region, and includes inshore and offshore fisheries, aquaculture, and peat production. Peat production is an industry that contributes over 114 million annually to the New Brunswick economy and is concentrated in two main areas of the province, one of which (east of Miramichi in the Point-Sapin region) occurs in the bioregion.

The kilometers of coastal beach and warm waters make this area of the province an important tourist destination. The Northumberland Strait is the tidal water body which separates New Brunswick and Prince Edward Island. The shallow depths of the strait yield the warmest summer water temperatures in Canada (20^0C or higher) and have resulted in a subsequent concentration of tourist activities along the coast, as well as a productive lobster fishery and aquaculture (oyster) industry. Beaches in the Province are increasingly being promoted as tourist destination sites on both local and provincial levels to attract visitors and enhance the economy. As 90% of New Brunswick's inhabitants live within 100 kilometres of the coast, the importance of the coastal environment for the New Brunswick economy, as well as for cultural and recreational activities is significant (Bérubé and Thibault 1998).

Popular destinations include Kouchibouguac National Park, la Dune de Bouctouche, and Cape Jourmain. Two provincial parks, Parlee Beach and Murray Beach, are important tourist destinations for the province. The Confederation Bridge, completed in 1997, provided a fixed-link between New Brunswick and Prince Edward Island and likely increased tourism to the region.

II. PRIORITY HABITAT, THREATS, AND ASSESSMENT

A. PRIORITY HABITATS

The central component of the Habitat Conservation Strategy are the priority habitat types which contain all priority species identified within the bioregion. Priority habitats are the native biological entities (i.e., ecological systems, communities and/or species[1]) that the HCS aims to conserve. These priority habitat

[1] Ecological systems: Assemblages of ecological communities that occur together on the landscape and share common ecological processes (e.g., flooding), environmental features (e.g., soils and geology) or environmental gradients (e.g., temperature).
Communities: Groupings of co-occurring species, including natural vegetation associations and alliances.
• Major groupings of targeted species that share common natural processes or have similar conservation requirements (e.g., forest-interior birds, freshwater mussels)
• Globally significant examples of species aggregations (e.g., migratory shorebird stopover area)
Species: Types of species targets may include:
• Globally imperilled and endangered native species (e.g., G1 to G3G4)

types contain all species of conservation significance (all provincially and federally listed species at risk, species identified by COSEWIC, and any species with a general status ranking of S1, S2, and S3 with a G1-G3 rank). This includes all terrestrial species as well as aquatic species such as the Brook Floater *Alasmidonta varicose*, but excludes pelagic aquatic species, as conservation efforts for these species would likely require significant planning and consultation with multiple government agencies across different provincial jurisdictions.

Initial consultations by the NCC as part of a New Brunswick Northumberland Strait Natural Area Conservation Plan (the precursor to this HCS), discussions with experts in numerous disciplines relevant to the strategy, and workshops with conservation partners identified the following list of eight priority habitats within the bioregion:

9. Beaches, Dunes, and Cliffs
10. Freshwater Wetlands
11. Riparian
12. Acadian Forest Mosaic
13. Grasslands and Agro-ecosystems
14. Salt Marsh
15. Tidal Flats/Estuaries
16. Coastal Islands

Priority habitats are described individually in the following section. Each priority habitat has been evaluated according to their size, condition, and landscape context in order to assess each ecosystem's ability to maintain regional biodiversity. High quality habitat should be of sufficient size and condition that it provides for a species needs; ample resources which support reproduction and survivability (Anderson et al. 2006). The context within which the landscape falls is also critical important, as it dictates the persistence of the habitat into the future as well as the threats which constrain or hinder ecosystem function (Anderson et al. 2006). The ranking criteria have been adapted from the *Nature Conservancy of Canada's Northern Appalachian / Acadian Ecoregion Conservation Assessment*, originally developed with the goal of identifying areas of the landscape where "...when conserved, will maintain all biodiversity across the ecoregion." (Anderson et al. 2006). The goal with respect to the HCS is to use the size, condition, and landscape context to provide an overall assessment of each priority habitat identified in the bioregion (Table 6).

Table 6. Description of assessment ranks for ecological integrity of priority habitat within the New Brunswick Northumberland Strait bioregion.

Rank	Description
Very Good	**Ecological Integrity is Optimal**: The structure, species composition, and key ecological processes and functions of the habitat conservation priority are intact and unimpaired by anthropogenic stresses. Ecosystems are functioning at a level comparable with the natural or historic range of variation for that ecosystem, and its capacity for self-renewal is maintained. The habitat conservation priority requires little or no management.

• Species of concern due to vulnerability, declining trends, disjunct distributions or endemism
• Focal species, including keystone species, wide-ranging regional species and umbrella species

Good	**Ecological Integrity is Good**: The structure, species composition, and key ecological processes and functions of the habitat conservation priority are somewhat impaired by anthropogenic stresses. Ecosystems are functioning within a range of acceptable variation compared with the natural or historic range of variation for that ecosystem and may require some management.
Fair	**Ecological Integrity is Degraded**: The structure, species composition, and key ecological processes and functions of the habitat conservation priority are impaired by anthropogenic stresses. Ecosystems are functioning below the range of acceptable variation compared with the natural or historic range of variation for that ecosystem, and require management, without which the habitat conservation priority will be vulnerable to serious degradation.
Poor	**Imminent Loss of Ecological Integrity**: The structure, species composition, and key ecological processes and functions of the habitat conservation priority are seriously degraded by anthropogenic stresses. Ecosystems are functioning well below the range of acceptable variation compared with the natural or historic range of variation for that ecosystem and require significant management and/or restoration. Allowing the habitat conservation priority to remain in this condition for an extended period will make successful restoration highly improbable.
Unknown	**Research Need**: The habitat conservation priority is known to occur, but information on this assessment criterion is currently unknown.
N/A	**Not Applicable**: This criterion is not significant for assessing the ecological integrity of the habitat conservation priority.

Priority Habitat: Beaches, Dunes, and Cliffs

Anderson et al. (2006) defines beaches as thick accumulations of unconsolidated waterborne, well-sorted sand and pebbles deposited on a shore, or in active transit along it. Dunes are defined as transient mounds of loose, windblown sand, sometimes stabilized with vegetation. Coastal banks are eroding, vertical shoreline composed of unconsolidated substrates, such as sand or other fine sediment (Davidson-Arnott & Ollerhead 2011).

The Northumberland Strait coastline is renowned for its extensive barriers beaches. A combination of low relief, coastal subsidence and high sediment deposition has given rise to expansive bays and sandy beaches along much of the coastline. The greatest examples of barrier beaches are found within Kouchibouguac National Park and along the Bouctouche Dunes (Zelazny 2007).

Beaches, dunes and coastal banks are ecologically significant ecosystems in the bioregion as they support a high number of rare and at risk species, including Piping Plover (*Charadrius melodus melodus*), Red Knot (*Calidris canutus rufa*) and Bank Swallow (*Riparia riparia).* Beaches are particularly important for roosting shorebirds during high tide, and although a number of beach- and dune-obligate plant species that occur within the bioregion are wide-ranging, they are restricted to this specific habitat type (Anderson et al. 2006).

Although not explicitly identified in the New Brunswick Provincial Resource Inventory, coastal banks (i.e. vertical shoreline) are critical to maintaining beach and dune ecosystems. Shoreline ecosystems undergo erosion during wave action, and to a lesser extent tidal action, wind, storm, ice, rain and surface runoff (Davidson-Arnott & Ollerhead 2011). If sediment supply is restricted (i.e. not available

due to shoreline hardening), beach and dunes are more susceptible to shoreline recession, and may degrade or disappear from a particular location.

Beaches and dunes were spatially delineated from the New Brunswick Provincial Resource Inventory (WC = BE and DU). Critical occurrences were identified as follows: Beach/Dune size > 8.1 ha; Landscape Context Index[1] (LCI) <= 30 (Anderson et al. 2006). Coastal banks are not identified in the New Brunswick Provincial Resource Inventory, as they are vertical structures and difficult to interpret from aerial photography.

Habitat type: Marine Intertidal – Rocky Shoreline; Marine Intertidal – Sandy Shoreline and/or Beaches, Sand Bars, Spits, Etc.; Marine Intertidal – Shingle and/or Pebble Shoreline and/or Beaches; Marine Coastal/Surpatidal – Seas Cliffs and Rocky Offshore Islands; Marine Coastal/Supratidal – Coastal Sand Dunes.

Size Assessment (Beaches, Dunes, and Cliffs): Good

Total amount of this priority habitat within the bioregion is 1,319 ha, representing only 0.2 % of the total area. This priority habitat is slightly underrepresented, as cliffs are not identified within the New Brunswick provincial resource inventory as they are vertical structures, and hence, difficult to delineate. The overall habitat is fairly contiguous for the entire length of the coastline.

Condition Assessment (Beaches, Dunes, and Cliffs): Poor

The highest levels of human impact within the bioregion are concentrated along the coastline. South of Kouchibouguac National Park, 36 % of the shoreline has been lost to development. Threats to habitat and species such as development, recreational activities, pollution, and shoreline hardening have the potential to increase with increased human activity and use of the area. Pollution along the coastline has been a major issue in recent years, with closures of popular tourist beaches for periods of time due to human health concerns (Parlee Beach Water Quality. [Accessed January 26 2017] Retrieved from: http://www2.gnb.ca/content/gnb/en/corporate/promo/ParleeBeach.html). Shoreline hardening is thought to be a major issue for coastal habitats in the bioregion; a survey of just the Aboiteau, Shediac, and Cocagne region indicated almost 11 % of the total shoreline for the bioregion was subject to some form of shoreline hardening. The coastlines of New Brunswick have also shown high sensitivity to sea level rise and impacts (direct and indirect) from storms (Diagle 2011).

Little information on invasive species exists for this habitat type. European Common Reed (*Phragmites australis* ssp. *australis*) is present locally but not considered invasive (S. Blaney pers. comm.). However, the species has shown to be a concern for other jurisdictions, where it outcompetes native species for water and nutrients, and releases toxins into the soil to kill surrounding plants (Swearingen and Saltonstall 2010).

Landscape Context (Beaches, Dunes, and Cliffs): Fair

[1] This measure refers to the relative amount of development, agriculture, quarries, roads or other fragmenting features within a 1 km radius of a specific ecosystem occurrence. It provides an estimate of the isolation of the occurrence as well estimates of future encroachment on the occurrence. Lower LCI values indicate the habitat occurrence is surrounded by primarily natural land cover.

The entirety of this priority habitat stretches the length of the Northumberland coastline of New Brunswick. At certain locations the area is heavily fragmented and disconnected from terrestrial habitats due to commercial, residential, or tourism development.

Overall Assessment (Beaches, Dunes, and Cliffs): Fair

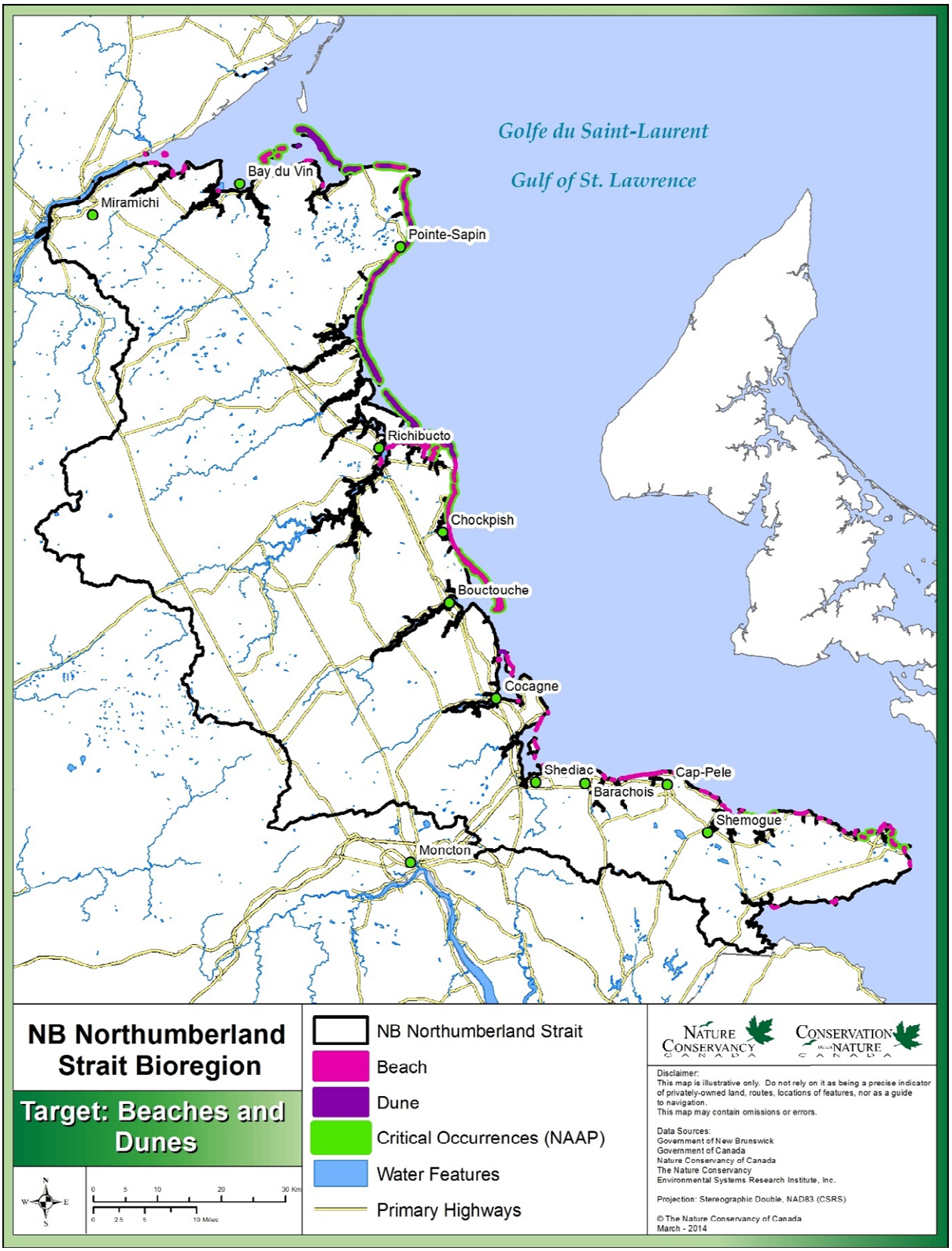

Figure 2. Beaches, Dunes, and Cliffs priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Freshwater Wetlands

Freshwater wetlands refer to areas where the water table saturates the soil surface either errantly or periodically. The extent and type of freshwater wetlands that occur in a given watershed are functions of climate, land surface configuration, type of bedrock and soil (mineral or organic), degree of inundation and nutrient status of the water supply (Davis and Browne 1996). Within the bioregion this includes bogs, fens, marshes, shrub swales, treed swamps, and seasonal vernal pools.

Freshwater wetland systems of this bioregion provide habitat for many federally and provincially listed species. The majority of provincially significant species (S1-S2) depend on wetlands for at least a portion of their life cycle, and almost half of all COSEWIC-assessed species within the bioregion are wetland-dependant, such as the Common Nighthawk (*Chordeiles minor*), Wood Turtle (*Glyptemys insculpta*) and Southern Twayblade (*Listera australis*). Wetlands also provide a number of ecosystem services in addition to wildlife habitat, such as flood control, water filtration, and carbon sequestration (Woodward & Wui 2001).

Due to their significant coverage of the area and vulnerability to commercial harvest, bogs are highlighted within this priority habitat. Coastal raised bogs are an important component of the landscape of New Brunswick, having rare and unique species and communities (Zelazny 2007). Approximately half of all freshwater wetlands in this bioregion are classified as bogs or peatlands, a number of which are commercially mined for peat. Many are considered “raised bogs” which are associated with an abundance of various lichens and rare species including a small flowering plant called Southern Twayblade. Unlike raised bogs found elsewhere in New Brunswick, bogs found in this region have large surface pools (Zelazny 2007). Bogs in this region have been estimated to be about 5,000 years old (Parks Canada 2008). The bog ecosystems of Kouchibouquac National Park actually extend well beyond the park for a total of 46,189 acres (18,700 ha). Sixty-three ecologically connected bogs, both inside and out of the park, have been identified and all are important in maintaining the ecological integrity of the park. Bogs adjacent to the park have been judged non-commercial because of their isolation and small size.

With the exception of vernal pools, freshwater wetlands were spatially delineated from the New Brunswick Provincial Resource Inventory (WC = AB, BO, FE, FM, FW and SB). Critical occurrences were identified as: size > 20 ha (wetland complex) and LCI < 20 (Anderson et al. 2006).

Size Assessment (Freshwater Wetlands): Very Good

Total amount of freshwater wetlands in the bioregion is 57.8 ha, or 10.13 % of the landscape. Of this, the largest freshwater wetland type represented within the bioregion are bogs, at 47 % of the total amount of freshwater wetlands (Table 6). Vernal pools are not currently represented in the provincial inventory.

Table 7. Amount of freshwater wetlands within the New Brunswick Northumberland Strait Bioregion by type.

Wetland Type	Area (ha)	Percentage of Bioregion
Aquatic Bed	171	0.03
Bog	27,168	4.8
Fen	10,815	1.9
Freshwater Marsh	2,152	0.4

Forested Wetland	856	0.1
Shrub	16,610	2.9

Condition Assessment (Freshwater Wetlands): Good

Provincial regulations under the New Brunswick Clean Water Act and the Wetlands Protection Policy require permits for any activities which occur within 30 m of a provincially-designated wetland. The goal of the wetland buffer is to provide protection for water quality and aquatic habitat. Some forestry activities are allowed within the watercourse buffer depending upon the type of wetland and provided certain conditions are met (for example, a minimum setback distance from the watercourse where no activities are permitted). For those wetlands greater than 1 ha, or with a natural watercourse greater than 0.5 m wide, harvesting is not allowed within the buffer zone. Any wetland designated as a Provincially Significant Wetland receives full protection under the legislations (NB DNR 2014). Currently, however, most forested wetlands in New Brunswick are not designated and therefore not provided this level of protection. As many as 300 wetland permits are issued by the New Brunswick Department of Environment in New Brunswick each year, with an additional 35-40 permits for work in coastal wetlands (P. McLaughlin, pers. comm.).

Commercial peat activities are important economically within the bioregion; as a result, bogs, which represent 47 % of the total amount of freshwater wetlands in the bioregion, are under significant developmental pressure. Approximately 70% of peatland occurs on public lands and the province of New Brunswick regulates the exploitation on peatlands through the *Quarriable Substances Act* (Poulin et al. 2004; NB DNR 2012). Water drainage, impact to flora and fauna, and restoration of peat mined areas to pre-mined conditions are all concerns with respect to commercial mining of bogs in the bioregion.

Habitat type: Wetlands (inland); Wetlands – Shrub Dominated Wetlands; Wetlands – Bogs, Marshes, Swamps, Fens, Peatlands; Wetlands – Permanent Freshwater Marshes/Pools [under 8 ha]; Wetlands – Seasonal/Intermittent Freshwater Marshes/Pools [under 8 ha].

Landscape Context (Freshwater Wetlands): Good

The Eastern Lowlands ecoregion of New Brunswick contains the highest percentage of wetlands for any ecoregion in the province (Zelazny 2007). The Northumberland Strait bioregion has one of the highest concentrations of peatlands of any bioregion in the province. Peatlands are primarily located in the northeast region near Baie-Sainte-Anne and comprise roughly 6.8 % of the total area; of this amount close to half (16,986 ha) is regulated for commercial use.

Overall Assessment (Freshwater Wetlands): Good

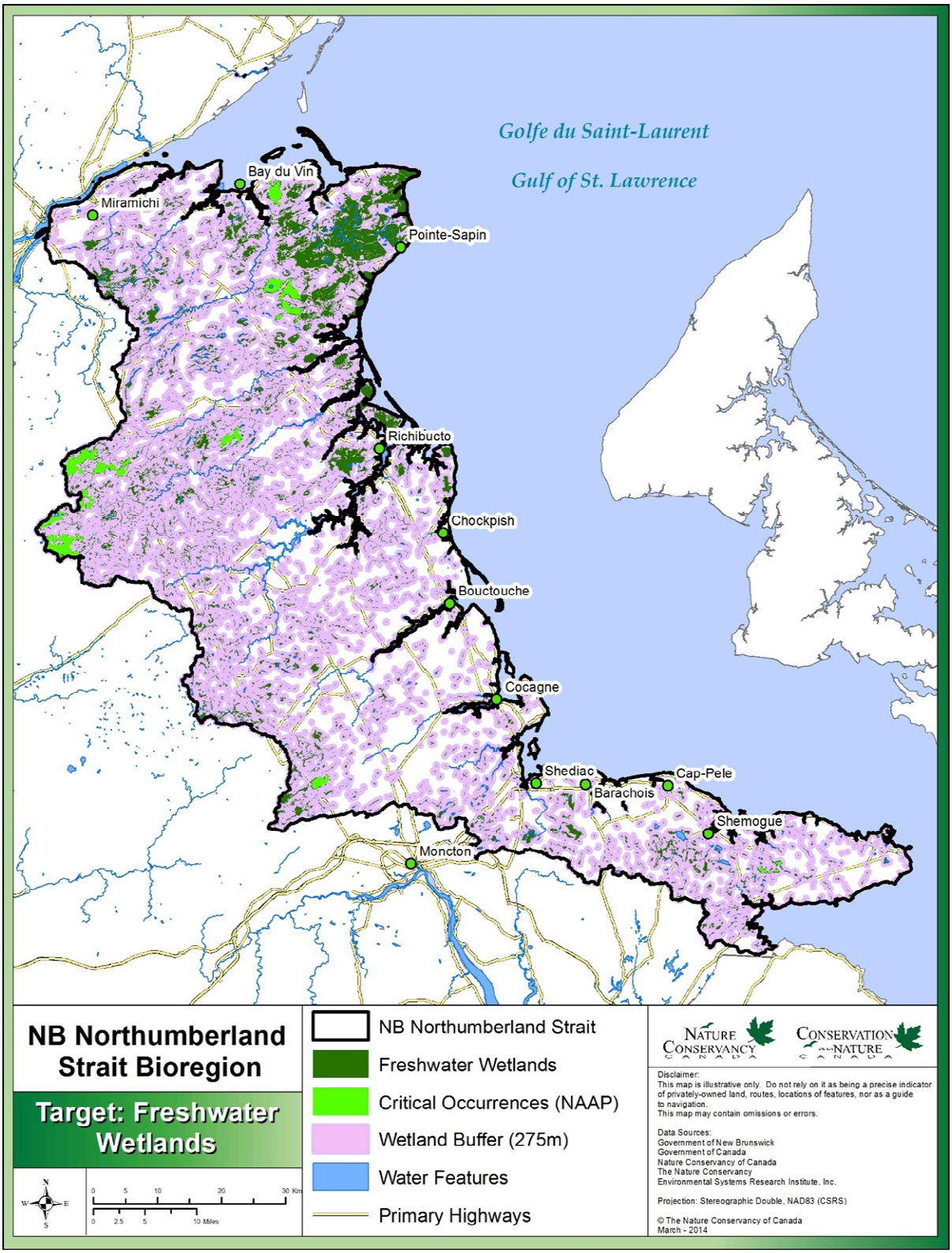

Figure 3. Freshwater Wetlands priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Riparian

Riparian and aquatic systems within the bioregion are defined as the full suite of lentic and lotic systems, as well as the adjacent upland that directly impacts those systems. These systems may contain a variety of communities, such as floodplain forests, herbaceous and woody alluvial wetlands, sandbars and oligotrophic – eutrophic freshwater communities. The terrain along the Northumberland Strait is divided by sprawling shallow river valleys where the banks seldom reach 25 m above the watercourse. Typically in this bioregion, rivers are slow moving, with shallow channels and a gentle slope. The Cocagne River, for example, has an average water depth of 4 m to 7 m, an average slope of 0.5 % and average rate of water flow of 4.6 m^3/s (reaching 49 m^3/s during large rain events) (Leblanc-Poirier et al. 2014).

Riparian and aquatic systems are recognized as the most biodiverse, complex, and dynamic non-marine ecosystems on the planet. This is due to the large variety of habitats that may occur within them, as well as the diversity of biological, geological, and hydrological processes (Naiman, Decamps & Pollock 1993). Narrow bands of unique floodplain forest exist along the major rivers containing trees rarely found elsewhere in the province such as the nationally and provincially Endangered Butternut (*Juglans cinerea*). Along the river's edge, diverse communities develop and include rare species such as Shining Ladies'-tresses (*Spiranthes lucida)* and Indian Wild Rice (*Zizania aquatica* var. *aquatica*). Wood Turtle (*Glyptemys insculpta*), a species assessed as threatened by COSEWIC, inhabits riparian systems in small numbers in most of the river systems. The rivers flowing to the Northumberland Strait are relatively unobstructed and have good water quality, which supports anadromous fish populations including the Atlantic Salmon (Southern Gulf of St. Lawrence population) as well as the catadromous American Eel (*Anguilla rostrata*).

Aquatic features were spatially delineated from the New Brunswick Provincial Hydrography stream network. Riparian zones were identified by buffering all streams and rivers by 275 m from the line feature (Environment Canada, Ontario Department of Natural Resources, and Ontario Ministry of Environment 1998).

Habitat type: Riparian Areas; Rivers, Streams, Creeks; Freshwater Lakes; Wetlands - Permanent Rivers, Streams, Creeks [includes waterfalls]; Wetlands - Seasonal/Intermittent/irregular Rivers, Streams, Creeks; Wetlands - Permanent Freshwater Lakes [over 8 ha]; Wetlands – Seasonal / Intermittent Freshwater Lakes [over 8 ha].

Size Assessment (Riparian): Very Good

As a result of the extensive network of watercourses within the Bioregion, almost half of the total area is considered in the riparian habitat type (248,552 ha, which represents 43.5% of the total area).

Condition Assessment (Riparian): Good

Over 86.8% of riparian habitat within the bioregion is considered to be in a natural state. The area of riparian habitat that is in a natural state (i.e., no agriculture, paved or developed surfaces, settlements, powerline right-of-ways, or forest plantations) is 215,662.5 ha, with a remaining 32,889.2 ha in a non-natural state.

The close proximity to water as well as soil characteristics means there is significant value associated with riparian areas and their development potential in multiple economic sectors. As a result, terrestrial

riparian areas are under threat from agriculture and residential development, recreation, and forestry practices, as well as the associated pollution impacts from forestry and agriculture effluents (Environment Canada 2013). The extensive road network in the Bioregion lends itself to numerous watercourse crossings; 2,099 culverts were mapped within the Bioregion, a potential threat to both habitat and species. Improperly designed crossings have the potential to affect the biological, chemical, and physical processes of a watercourse, and in turn, impact the ecological integrity of associated riparian areas (Bunn and Arthington 2002; Wells 1999).

Landscape Context (Riparian): Good

Major river systems in the bioregion where the largest amount of riparian habitat can be located include the Miramichi, Richibouctо, Cocagne, Bouctouche, and Shediac rivers. River valleys are considered to be quite low in elevation in this area of the province, rarely rising to 25 m above the river system (Zelazny 2007). As is typical with most areas of the province, development has historically been concentrated along river systems and the mouths of such systems. Pollution, fragmentation (through road building and other means), and habitat degradation are all potential impacts of this development on the priority habitat. Major settlements in the bioregion associated with these areas include the city of Miramichi, Bouctouche, and Shediac.

Overall Assessment (Riparian): Good

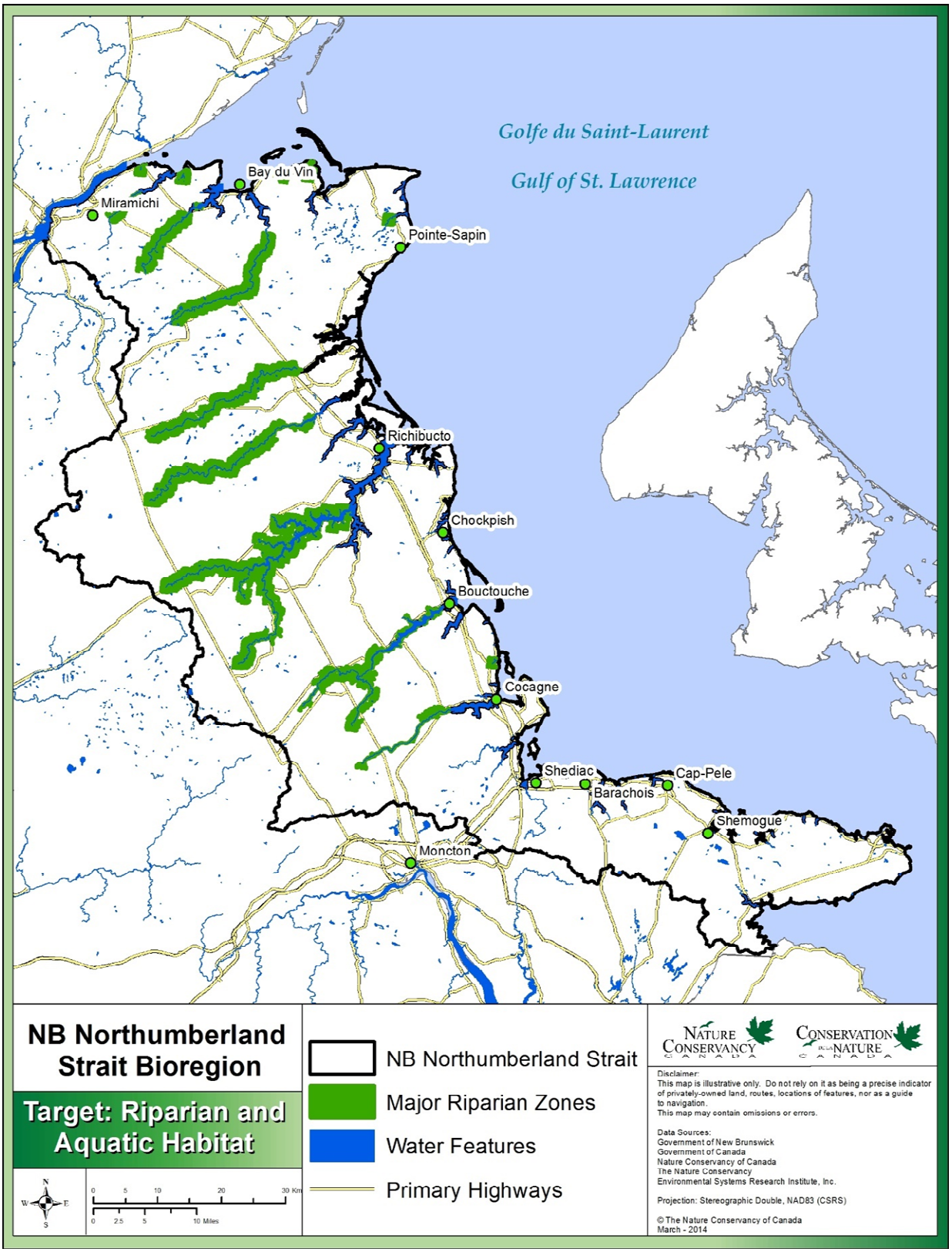

Figure 4. Riparian priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Acadian Forest Mosiac

The Acadian Forest is a transitional zone between southern temperate forest species and northern boreal forest species. Within the scope of the bioregion, climax forest communities would mostly be comprised of temperate, long-lived, shade-tolerant tree species that exhibit old-growth characteristics. Due to human influence across the region, forests have shifted to a less diverse forest of younger age-classes and early successional species (Loo and Ives 2003).

The World Wildlife Fund identified the Acadian Forest as "critical/endangered", with logging, agriculture, and development being the major sources of forest loss across the ecoregion. Across eastern North America, only approximately five percent of the original Acadian Forest remains in pre-settlement condition (Davis *et al.* 2013). Historically, this region was largely characterized by 26 tree species, dominated by shade tolerant conifers in late successional development stages (Crossland 2006). One species, Bur Oak (*Quercus macrocarpa*), has been extirpated from the region. Common species included Spruce (*Picea* spp.), Eastern Hemlock (*Tsuga canadensis*), White Pine (*Pinus strobus*), Yellow Birch (*Betula alleghaniensis),* Eastern White Cedar (*Thuja occidentalis*), maple (*Acer* spp.), and Balsam Fir (*Abies balsamea*). Changes in forest composition has occurred over the last few centuries with European settlement of the region. For example, large old-growth Eastern Hemlock stands are no longer common on the landscape, and American Beech (*Fagus grandifolia*) has suffered a drop from 5-7 % to only 1% of the total forest composition for the bioregion (Crossland 2006). Once the dominant forest type in the Bioregion, large and intact patches of long-lived forest communities are becoming increasingly rare due to forest harvesting practices that both directly and indirectly favor boreal species, a phenomenon termed borealization (Simpson 2008). Specifically, forest communities comprised of shade-tolerant conifers, hardwoods, and pines that are in a mature or overmature age-class (L1DS = M or O) are highly underrepresented across the landscape. These old forest communities provide habitat for a variety of rare species such as the Canada Warbler (*Cardellina canadensis*) and Wood Thrush (*Hylocichla mustelina*).

Critical occurrences identified within the Bioregion were limited to three nested targets within forests, identified as: Size = Summits > 12 ha, Steep Slopes > 10 ha, Sheltered Coves > 10 ha; LCI < 20 (Anderson et al. 2006).

Size Assessment (Acadian Forest Mosiac): Very Good

Total amount of forested land in the Bioregion is 383,648 ha, or 67.1 % of the Bioregion's total landbase (excluding coastal islands). Of this amount, less than half 172,500 ha or 30.2 %) is crown land forest under the direction of the province.

Condition Assessment (Acadian Forest Mosiac): Good

The Acadian Forest Mosiac has undergone significant change since European settlement in the early 1600s. Across eastern North America, approximately five percent of the original Acadian Forest remains in pre-settlement condition (Davis et al. 2014). Most recently, the 2014 forestry plan produced by the province of New Brunswick doubled the number of PNAs throughout the province, but overall, shrank the amount of forest in the conservation designation from 28 % to 23 %. Timber harvesting, with varying restrictions, is allowed in certain types of forested areas set aside for conservation such as Deer Wintering Areas (DWAs) and Old Forest Communities (OFC) (NB DNR 2014).

Landscape Context (Acadian Forest Mosiac): Fair

The forests in the bioregion are heavily fragmented, the result of natural features such as the relatively large number of wetlands in the ecoregion (Zelazny 2007), as well as the extensive road network (highways and forest roads).

Crown timber land (the amount of forest under direct jurisdiction of the province) accounts for 30.2 % (172,500 ha) of the New Brunswick Northumberland Strait bioregion. Of this amount, 9.4 % is set aside for "conservation features": i.e., areas identified as important for different conservation values and either given full protection under legislation (e.g. PNAs) or under sustainable forest management (e.g. Deer Wintering Areas) (Table 8).

Table 8. New Brunswick provincial crown land conservation features in the bioregion.

Provincial Crown Land Conservation Feature	Area (ha)	% of Crown Timber License Lands	% of Total HCS Landbase
Deer Wintering Area	2,810	1.6%	na
Old Forest Community	4,649	2.7%	na
Old-Forest Wildlife Habitat	4,709	2.7%	na
Protected Natural Area	5,161	3.0%	na
Site-Specific Wildlife Habitat	3,604	2.1%	na
Other Conservation Property	173	0.1%	na
Total (accounting for overlapping features)	16,180	9.4%	na
Total Crown Timber License	**172,500**		**30.2%**

Overall Assessment (Acadian Forest Mosiac): Fair

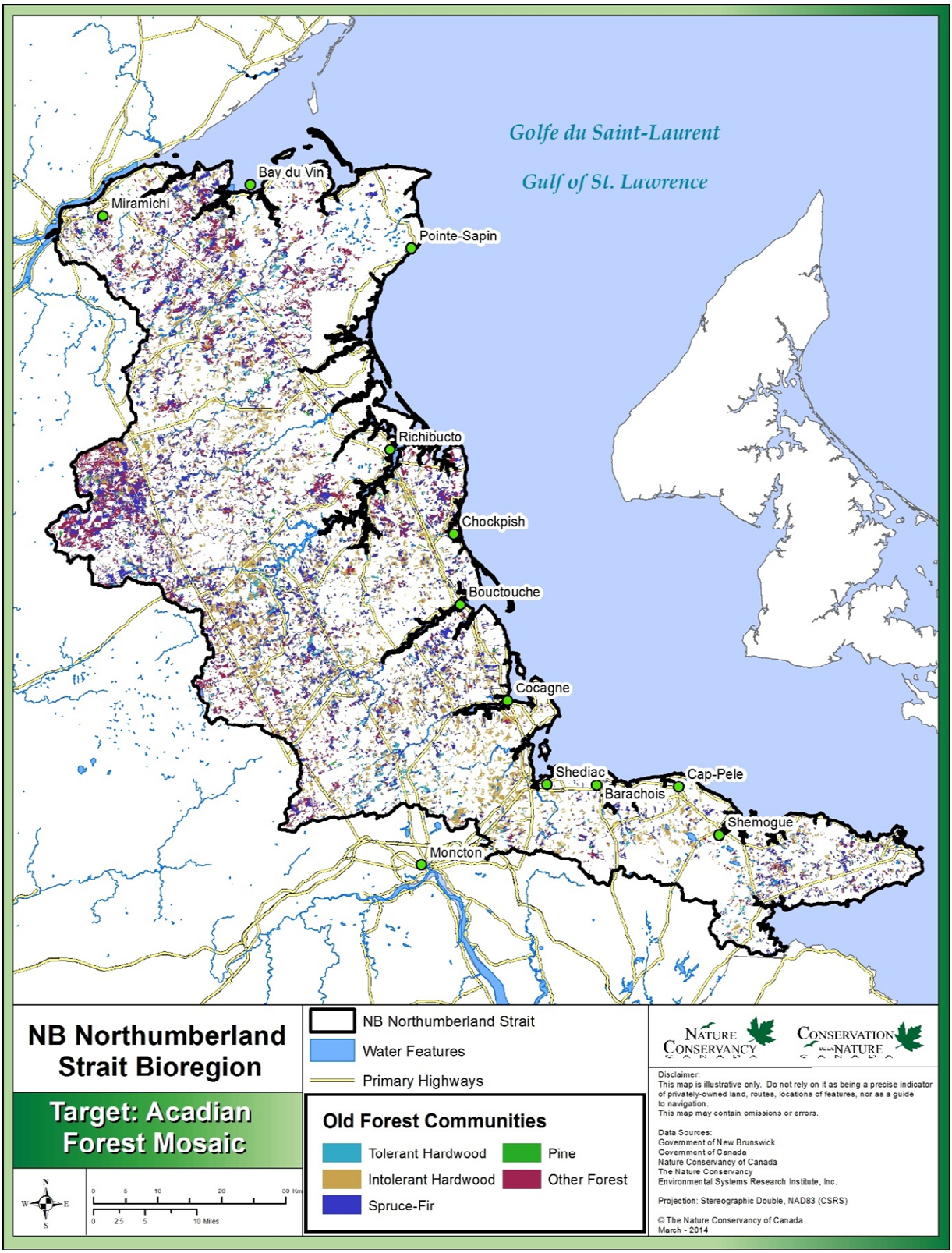

Figure 5. Acadian Forest Mosiac priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Grasslands and Agro-ecosystems

Grasslands and agro-ecosystems are primarily man-made and/or managed ecosystems within the bioregion; prior to European settlement open field systems were largely restricted to sedge meadows, bogs, as well as salt and freshwater marshes. Clearing of forested areas and the use of dykes to restrict water flow on wetlands resulted in the conversion of these different habitats to those primarily for agricultural use. Now, a number of species at risk and BCR 14 identified priority species rely on grassland habitat for nesting and breeding. Many of these species are suffering major continent-wide declines in population numbers, such as the Rusty Blackbird (*Euphagus carolinus*), Savannah Sparrow (*Passerculus sandwichensis*), and Common Nighthawk (*Chordeiles minor*) (Environment Canada 2013). Grassland habitat provides additional foraging and nesting opportunities for non-grassland dependent species such as the Wood Turtle (*Glyptemys insculpta*) and many species of waterfowl.

Given the complex and dynamic nature of this predominantly man-made (anthropogenic) habitat, it was determined that any spatial delineation, or the identification of critical occurrences, would not be required for this HCS.

Size Assessment (Grasslands and Agro-ecosystems): Good

Amount of agriculture land within the bioregion is 36, 207 ha, or 6.3 % of the total landbase. However, the annual amount is in a continual state of flux due to the conversion of lands to non-agriculture use, and vice-versa, more than any of the other priority habitats. The overall trend of decreasing amount of agriculture land across New Brunswick over the past 70 years will likely continue, and result in continued loss of this type of priority habitat on the landscape as the agriculture land reverts back to its original condition or towards some other use (such as residential development).

Condition Assessment (Grasslands and Agro-ecosystems): Fair

As this is primarily a managed habitat in comparison to the other priority habitats identified in the HCS, there are multiple actions which could impact the condition of the habitat. Direct mortality from pesticide use, timing of hay harvest which could affect nesting and breeding seasons, contamination of food sources, and the loss of prey sources are all possible threats to species which rely on this habitat (Environment Canada 2013).

Landscape Context (Grasslands and Agro-ecosystems): Fair

Information on historical agricultural use specific to the bioregion is not available. Zelazny (2007) indicated that agriculture was a significant contribution to the local economy with roughly 9% of the landbase in agriculture holdings. Historically in the province there has been a progression over the past 70 years from many small farms to fewer large farms overall; in 2011, the number of farms decreased 5.9 % from the number of farms censused 5 years prior (Statistics Canada 2016b). Total amount of farmland has also significantly decreased over this time (Table 7).

Table 9. Number of farms and total area of farmland in New Brunswick, 1951-2011.

Year	Number of Farms	Total Amount of Farmland (acres)
2011	2,611	364,217*
2001	3,034	388,053**
1986	3,554	408,893**

1971	5,485	541,874***
1951	26,431	1,404,259***

* Source: Stats Canada 2016b
** Source: Stats Canada 2008
***Source: Stats Canada 1999

Overall Assessment (Grasslands and Agro-ecosystems): Good

Priority Habitat: Salt Marsh

Salt marshes are flat, poorly drained areas subject to periodic inundation by salt water and are covered with a thick mat of salt tolerant plants (Anderson et al. 2006). These ecosystems are often part of larger coastal complexes of beaches, dunes, estuaries and tidal flats. Within Maritime Canada, salt marshes are dominated by *Spartina* spp. grasses and can be further classified by temporal inundation patterns (high or low marsh) and salinity (saline or brackish marsh). Due to low elevation and coastal land subsidence in the bioregion, extensive estuaries and associated salt marshes can be found along several rivers, such as the Richibucto and Kougibouguac (Zelazny 2007).

Salt marshes in this bioregion provide habitat for a number of rare species including the Annual Saltmarsh Aster (*Symphyotrichum subulatum*), Beach Pinweed (*Lechea maritima var. subcylindrica*) and Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*). This habitat is also provides important foraging grounds for over 20 species of shorebird, waterfowl and colonial nesting bird species. Salt marshes are known to be critical breeding grounds for a variety of marine species (Beck et al. 2001), sequester abundant carbon (Gordon et al. 1985), and serve the ecological role of filtering contaminants, nutrients and suspended sediments from the water column (Chmura et al. 2001; Hung & Chmura 2006).

Salt marshes were spatially delineated from the New Brunswick Provincial Resource Inventory (WC = CM). Critical occurrences of salt marsh were identified as follows: > 24 ha or part of a coastal complex > 40 ha; LCI < 30 (Anderson et al. 2006). To protect the ecological integrity of salt marsh and identify adjacent habitat critical for species that use salt marsh, a spatial buffer of 275 m was applied to all occurrences within the Bioregion (Environment Canada, Ontario Department of Natural Resources, and Ontario Ministry of Environment 1998).

Habitat type: Marine Intertidal – Salt Marshes (Emergent Grasses).

Size Assessment (Salt Marsh): Fair

The amount of salt marsh within the bioregion is 3,721 ha, representing 0.7 % of the total landbase. Average size of salt marshes in the bioregion is 10 ha. Historically, it is thought that up to 65 % of New Brunswick's salt marsh habitat has been lost over the past 300 years (National Wetlands Working Group 1988).

Condition Assessment (Salt Marsh): Fair

One of the biggest impacts to salt marsh habitat in the bioregion is the restriction of tidal influences. Poorly constructed or small culverts, bridges, and/or roadways restrict water flow. The use of dykes and aboiteaux by European settlers allowed for the conversion of salt marsh habitat to agriculture use by

restricting tidal water flow. This change in water regime alters soil characteristics and vegetation, which in turn, alters the salt marsh habitat (Roman et al. 1984). Currently, salt marshes also experience what is called “coastal squeeze”, where salt marshes surrounded by hard structures (such as housing, roads, and dams) are unable to adapt to human and natural disturbances through inland migration (Gedan et al. 2009).

Landscape Context (Salt Marsh): Good

The Northumberland Strait bioregion has the largest percentage of wetlands (salt and freshwater) of any region in province. Due to low elevation and coastal land subsidence within the bioregion, extensive estuaries and associated salt marshes can be found along several rivers, such as the Richibucto and Kougibouguac (Zelazny 2007).

Overall Assessment (Salt Marsh): Good

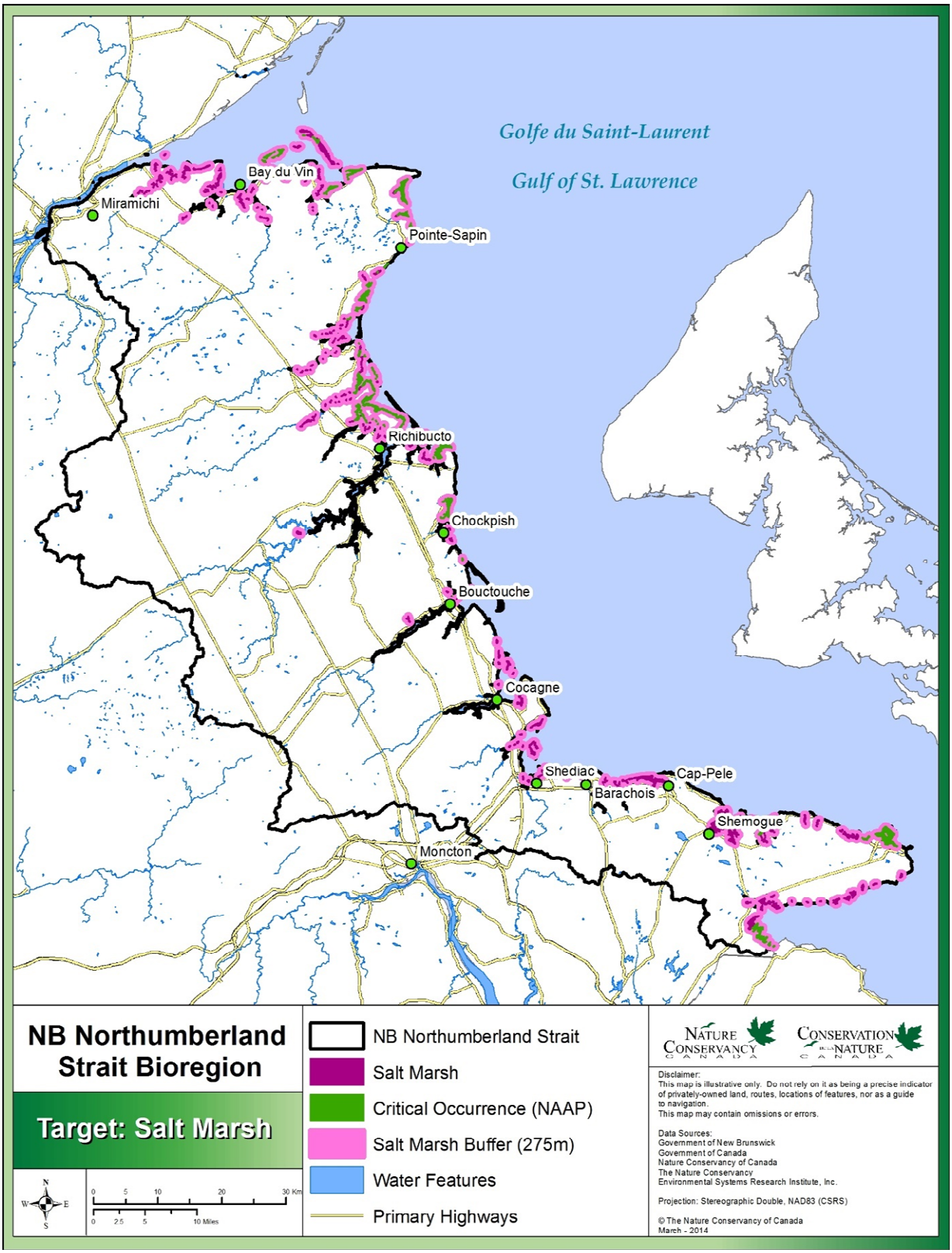

Figure 6. Salt Marsh priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Tidal Flats/Estuaries

Anderson et al. (2006) defines tidal flats as extensive, horizontal tracts of unconsolidated clays, silts, sands and organic material that are alternately covered and uncovered by the tide. Although tidal flats are sparsely vegetated, during low tide many species of waterfowl and shorebird congregate to stage and feed within the nutrient-rich sediments. Tidal flats also provide habitat for a variety of invertebrate species including polychaete worms, molluscs and immense concentrations of unicellular organisms such as diatoms and dinoflagellates, which form the basis of the food web in this habitat (DFO 2008b). Estuaries, and seagrass (or Eelgrass) ecosystems in particular, are extremely productive ecosystems and store more carbon than tropical forests per square km (McIver 2015). Eelgrass is a highly productive perennial aquatic plant found on coarse sand to mud bottoms in low intertidal and sub tidal environments. Eelgrass has been identified as an ecologically significant species because it creates habitat used preferentially by other species, provides protection for associated communities, and has substantial influence over the ecology of the habitat (DFO 2008b).

Currently, only tidal flats are spatially identified in this bioregion; adding estuaries would represent the subtidal and pelagic regions more comprehensively and increase the amount of priority habitat which can be spatially identified. River estuaries are a dominant feature of the landscape, and those associated with the Richibucto, Cocagne and Bouctouche rivers are quite expansive, partly due to the amount of coastal land subsidence that has occurred (Zelazny 2007). This data gap will likely be assessed in subsequent iterations of this HCS.

Tidal Flats were spatially delineated from the New Brunswick Provincial Resource Inventory (WC = TF). Critical occurrences were identified as: Tidal Flat size > 40 ha; LCI < 30 (Anderson et al. 2006).

Habitat type: Marine Intertidal – Mud Flats and Salt Flats.

Size Assessment (Tidal Flats/Estuaries): Fair

Total amounts of tidal flats within the bioregion is 331 ha representing 0.1 % of the landscape. As indicated previously, the extent of the estuaries within the bioregion has not been calculated but would obviously result in a significant increase in the total amount of this habitat type within the bioregion.

Condition Assessment (Tidal Flats/Estuaries): Good

Human impacts extend inland from coastal regions, following the larger river systems such as the Miramichi, Richibucto, Cocagne, and Buctouche Rivers. Although development would primarily be restricted to the upland areas, indirect impacts associated with human influence such as recreational activities and pollution, have the potential to impact the tidal flats and estuaries.

Landscape Context (Tidal Flats/Estuaries): Good

Estuaries are a dominant feature on the landscape, penetrating up to 30 km inland from the Northumberland Strait on major river systems such as the Richibucto, Cocagne, and Buctouche (Zelazny 2007).

Overall Assessment (Tidal Flats/Estuaries): Good

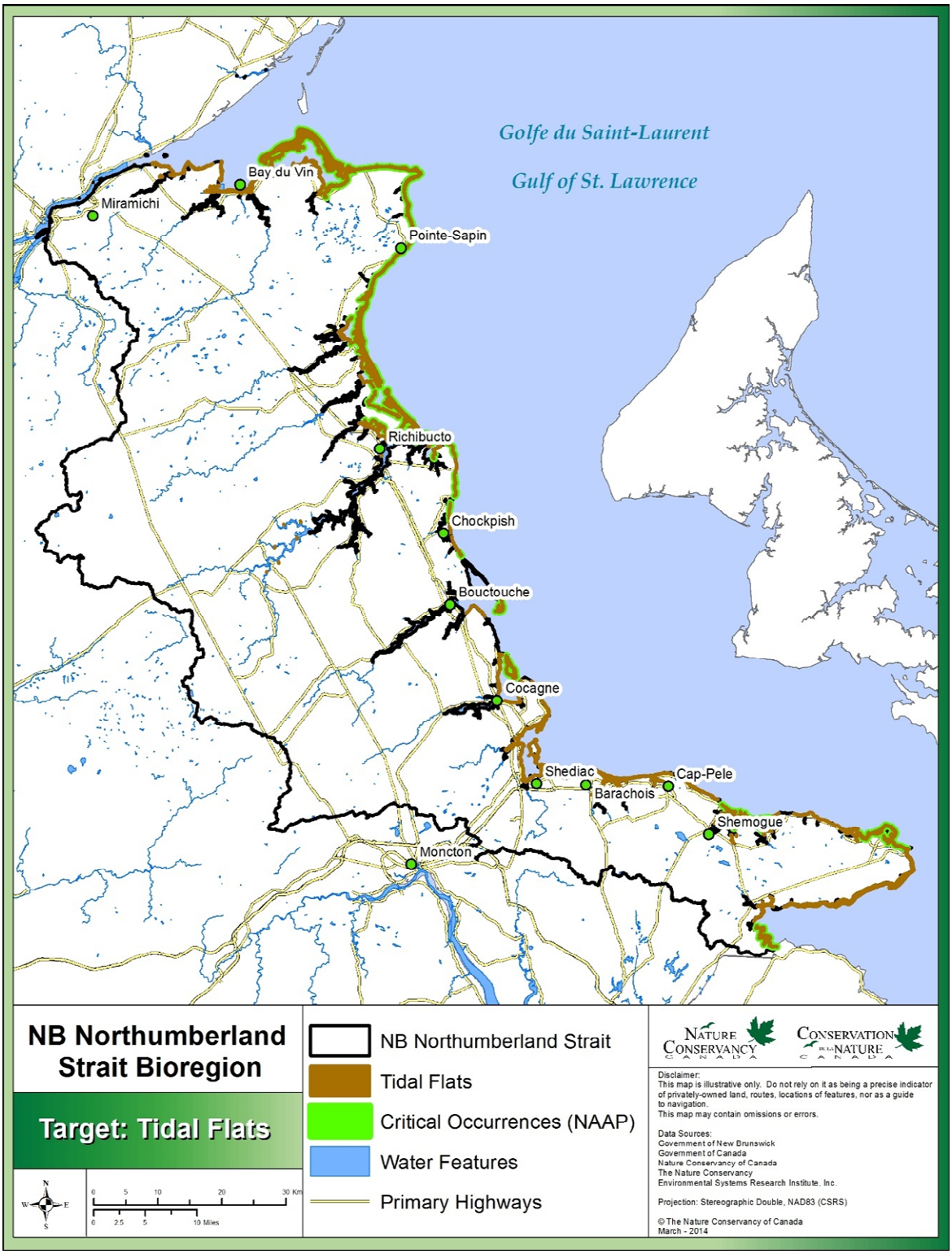

Figure 7. Tidal Flats/Estuaries priority habitat within the New Brunswick Northumberland Strait bioregion.

Priority Habitat: Coastal Islands

Within this bioregion there are several coastal islands identified by the New Brunswick Provincial hydrography inventory including larger islands such as Bay du Vin Island, Indian Island, Egg, Fox, Huckleberry, Cocagne Island, and Shediac Island. Extensive sandy islands or bars found in the bioregion, such as those found in Kouchibouguac, are captured under the Beaches, Dunes, and Cliffs priority habitat type. Because of their isolated nature, islands can be more valuable to wildlife than other similar type habitat located on the mainland (S. Makepeace, pers. comm.). As they tend to be relatively free of mammalian predators, coastal islands provide excellent habitat for the many nesting and migrating seabirds, waders and songbird species that use them (NB Eastern Habitat Joint Venture 2007). Many bird species also depend on coastal islands as stopover sites before or after completing long oceanic migrations (Gellin and Morris 2001, Suomala et al. 2012). Coastal islands in the bioregion are recognized for supporting large numbers of waterfowl and regionally important colonies of Great Blue Heron, Black-crowned Night Herons and Double-crested Cormorant (*Phalacrocorax auritus*). Twelve colonial-nesting bird species have been identified in the bioregion, including rare and endangered species such as the Red Knot (*Calidris canutus rufa*), Arctic Tern (*Sterna paradisaea*) and the Black-legged Kittiwake (*Rissa tridactyla*).

As mentioned in Section 1. B., Red Oak coastal forests and associated community types dominate the coastal island forests, and are typically associated with a nearby salt marsh and coastal dune on mesic upland soils. These are considered unusual community types associated with warmer coastal areas of the Maritimes (Basquill 2008).

Within the Bioregion there were seven coastal islands identified by the New Brunswick Provincial hydrography inventory: Bay du Vin, Indian, Egg, Fox, Huckleberry, Cocagne, and Shediac Island. The typical “sand islands” found in the Bioregion (e.g. Kouchibouguac) are included in the Beaches/Dunes priority habitat type.

Habitat type: Marine Coastal/Surpatidal – Seas Cliffs and Rocky Offshore Islands.

Size Assessment (Coastal Islands): Good

There are a total of 207 coastal islands within the Bioregion. Minimum island size is 0.02 ha and maximum island size is 394.2 ha (Fox Island), with an average size of 8.22 ha.

Coastal islands within the bioregion hold significant importance for birds as nesting, breeding, and migratory stopover sites, as well as having unique forest community types; these features exist regardless of size of the island.

Condition Assessment (Coastal Islands): Very Good

Coastal islands in the bioregion are primarily undeveloped and covered by natural vegetation. However, undeveloped does not translate to undisturbed; extensive trail systems exist on both Cocagne and Shediac Island which are frequently visited by snowmobilers and snowshoers in the winter, and accessed via boat and kayak in the summer months.

Landscape Context (Coastal Islands): Very Good

Size, location, topography, and degree of isolation means that disturbance for coastal islands varies in both type and intensity. Proximity to population centres would likely result in an increase in potential

boat traffic. Active commercial aquatic licenses exist in close proximity to Bay du Vin, Cocagne, and Shediac Islands. Winter ice fishing shacks are also common along the bays of the Northumberland coastline.

Overall Assessment (Coastal Islands): Very Good

Table 10. Summary of priority habitat assessments for the New Brunswick Northumberland Strait Bioregion.

Priority habitat	Assessment			Summary
	Size	Condition	Landscape	
Beaches, Dunes, and Cliffs	Good	Poor	Fair	Fair
Freshwater Wetlands	Very Good	Good	Good	Good
Riparian	Very Good	Good	Good	Good
Acadian Forest Mosiac	Very Good	Good	Fair	Good
Grasslands	Good	Fair	Fair	Good
Salt Marsh	Fair	Fair	Good	Good
Tidal Flats/Estuaries	Fair	Good	Good	Good
Coastal Islands	Good	Very Good	Very Good	Very Good

B. THREATS

Threats are the proximate activities or processes that have caused, are causing or may cause the destruction, degradation and/or impairment of one or more of the identified biodiversity habitats. Threats impact the habitat's viability and/or key ecological attributes. Threats to the priority habitats were identified using relevant literature, reviewing the draft New Brunswick Northumberland Strait Natural Area Conservation Plan produced by NCC, as well as meetings and discussions with relevant organizations, government agencies, and experts. MIRADI, a program developed by the Conservation Measures Partnership and Sitka (https://www.miradi.org/), ranked threats based on scope, severity, magnitude, and irreversibility. These threats were then categorized to relevant IUCN criteria based upon the IUCN Threats Classification v. 3.1 (Appendix F). Some threats, such as road networks and culverts which cause fragmentation to both terrestrial and aquatic resources are interconnected and may be briefly discussed under multiple threat headings.

Table 11 provides a summary of the threats identified for the New Brunswick Northumberland Strait bioregion. The overall threat status for the NB Northumberland Strait bioregion is **Medium**. The geographic extent of each identified threat is indicated, where known, in Figures 10-13.

Table 11. Summary of threats to the priority habitats within the New Brunswick Northumberland Strait bioregion.

Threats		Priority Habitats								Summary
		Beaches, Dunes, and Cliffs	Freshwater Wetlands	Riparian	Acadian Forest Mosiac	Grasslands	Salt Marsh	Tidal Flats/Estuaries	Coastal Islands	
1. Residential and Commercial Development	1.1 Housing and Urban Areas	M	M	M	M		M	M	M	M
	1.3 Tourism and Recreation Areas	H	L	M				M	H	M
2. Agriculture and Aquaculture	2.1 Annual and Perennial Non-Timber Crop		L	L	L					L
	2.2. Wood and Pulp Plantations			L	L					L
	2.3 Livestock Farming and Ranching			L	L					L
	2.4 Marine and Freshwater Aquaculture			L			L	L		L
4. Transportation and Service Corridors	4.1 Roads and Railroads		M	M	M					M
5. Biological Resource Use	5.1.3 Persecution/Control (e.g. beaver trapping at KNP)		L	L						L
	5.2 Gathering Terrestrial Plants (e.g. peat)		H							M
	5.3 Logging and Wood Harvesting (incompatible forestry practices)		M	M	H					M
	5.4 Fishing and Harvesting Aquatic Resources (salmon, striped bass, eel fishing)	L		L			L	L	L	L
6. Human Intrusions and Disturbance	6.1 Recreational Activities	L						L	L	L
7. Natural System Modifications	7.2 Dams and Water Management/Use		L	M			L			L
	7.3 Other Ecosystem Modifications (e.g. rip rap use)	M	M					M		M
8. Invasive & Other Problematic Species, Genes & Diseases	8.1 Invasive Non-Native/Alien Species/Diseases	L	L	L	L	L		L		L

9. Pollution	9.1 Domestic and Urban Waste Water		L	M			L	L		
	9.3 Agricultural and Forestry Effluents (e.g. nutrient runoff)		M	M	M	M				M
	9.4 Garbage and Solid Waste (e.g. garbage which could entangle wildlife on coastal areas)	L						L	L	L
11. Climate Change & Severe Weather	11.1 Habitat Shifting & Alteration	M					M	M	M	M
	11.3 Temperature Extremes	M	M	M	M	M	M	M	M	M
	11.4 Storms and Flooding	H						H	H	H
Summary		L	M	M	M	M	L	M	M	

***Very High** The threat is likely to destroy or eliminate the habitat conservation priority **High** The threat is likely to seriously degrade the habitat conservation priority **Medium** The threat is likely to moderately degrade the habitat conservation priority **Low** The threat is likely to only slightly impair the habitat conservation priority **Unknown** The threat's impact on the habitat conservation priority is unknown

Figure 8. Ranked IUCN sub-categories of threats to priority bird species within BCR 14 based on number of priority bird species affected and magnitude of threats (calculated using an inverse of the 3:5:7 rule; Salaksky 2003). Modified from Environment Canada.

Figure 9. Ranked IUCN sub-categories of threats to priority bird species within MBU 11 based on number of priority bird species affected and magnitude of threats (calculated using an inverse of the 3:5:7 rule; Salaksky 2003). Modified from Environment Canada.

1.1 Housing, Cottage and Rural Development (Threat Status: **Medium**)

The demand for development along shorelines (coastal and riverfront) in New Brunswick is increasing. Wetland and shoreline areas and Acadian forest are threatened by habitat conversion and development across the region (Environment Canada 2013). New Brunswick currently has legislation regulating development within 30 metres of a watercourse (NB DELG 2012) however, individual landowners are often unaware of, or ignore, this regulation. Infractions are often missed as the department responsible for enforcement relies on public reporting as their main source of regulation (G. Godin, Department of Environment and Local Government, pers. comm.). Detrimental activities associated with residential or cottage development in the shoreline and riparian zone include clearing of natural vegetation, often to the waters edge to facilitate access and provide water views, and shoreline armouring. Both of these activities are permitted under certain restrictions on developed private land along watercourses (NB DELG 2012).

The results from the "The Human Footprint" index, created by the Wildlife Conservation Society, were used to assess the current threat level of development on biodiversity targets (Woolmer et al. 2008). The Human Footprint (HF) of the Northern Appalachian/Acadian ecoregion measures the extent and relative intensity of human influence on terrestrial ecosystems at a resolution of 90 m using best available data sets on human settlement (population density, dwelling density, urban areas), access (roads, rail lines), landscape transformation (landuse/landcover, dams, mines, watersheds), and electrical power infrastructure (utility corridors) (Woolmer et al. 2008). The assessment indicated much of the land south of Kouchibouguac National Park is heavily impacted by development and infrastructure (Woolmer et al. 2008). The majority of the bioregion north of Kouchibouguac National Park remains relatively wild, owing to greater Crown ownership and lack of access to the coastline and the extensive freshwater wetlands in this region. Within the bioregion, 2.47% of the land cover has been permanently converted from natural cover while 36% of shoreline has been lost to development (within 275m of the coastline).

1.3 Tourism and Recreation Areas (Threat Status:)

Recreation and tourism areas located within the bioregion are primarily associated with coastal areas. Major tourism locations are the two provincial parks, Murray Beach Provincial Park and Parlee Beach Provincial Park, and one national park, Kouchibouguac National Park. In addition, there are a number of privately owned recreational areas which encourage public access and use, such as La Dune de Bouctouche and Cape Jourmain. All of these areas provide beach and/or shoreline access, which results in increased environmental risks such as pollution, trampling of plants, soil compaction, introduction of invasive species, and dune destabilization. Tourism and recreation are not limited to impacts to coastal habitats as their areas can extend inland; for example Kouchibouguac provides year-round recreational opportunities for the public through their extensive trail network.

Tourism is an important component of the provincial economy, contributing 605 million dollars to the provincial Gross Domestic Product (GDP) in 2015 (NB THC 2016a). Provincial park usage overall in New Brunswick showed an increasing trend from 2015 to 2016, and the hotel occupancy rates for the Acadian Coastal Drive (which includes the Northumberland Coastline) showed increases over the same time period (NB THC 2016b). New campgrounds are currently under development in the area near Parlee Beach. The continued push by government to increase revenue through tourism will place increased pressure on existing tourist areas as well as the surrounding habitat.

2.1 Annual and Perennial Non-Timber Crop (Threat Status:) **and 2.3 Livestock Farming and Ranching** (Threat Status:)

The number of farms in the province went from 26,431 in 1951 to 2,776 in 2010 (Walls 2011). However, this has not resulted in a straightforward reduction in the total hectares of farmed land, as farming transitioned over this time from traditional smaller family farms to larger-scale factory-type operations (DAAF 2016). This change over time from many, smaller farms to fewer, large farms would likely decrease the overall (bioregion-wide) influence but increase it a local level. Threats from incompatible farm practices that occur in the bioregion include habitat loss and increase fragmentation in freshwater wetlands, riparian/aquatic ecosystems and Acadian forest habitats. The alteration of these habitats can also lead to increase flooding and edge sensitivity (Baynen & Hobson 2000) as well as a loss of ecosystem services (Zedler 2003). Removal of natural vegetation creates erosion and sedimentation and can increase water temperatures due to a lack of cover (Carpenter et al. 1998, Henley et al. 2000, Allan

2004). Timing of hay harvesting can be detrimental to species in the bioregion such as Bobolink which face the threat of mortality associated with farm machinery (McCracken 2013).

Livestock farming and ranching also occur within the bioregion; 11,258 ha, representing 2 % of the land base, has been identified as fallow pasture land. Although environmental impacts have been reduced over the past 50 years with improved techniques, increasing efficiency and resulting in more product to market using smaller farms and fewer animals, impacts to water quality and land use are still present (Capper 2011, Capper et al. 2014). Livestock waste can enter adjacent watercourses, and erosion of streambanks can result in land-based nutrient loss while increasing siltation in watercourses (Skinner et al. 1997).

2.2. Wood and Pulp Plantations (Threat Status: **Low**)

According to the provincial forest inventory, over 17,988 ha of forest plantations are present in the bioregion, representing 3% of the natural area and 4% of the forested land base. Betts et al. (2005) suggested that plantations within New Brunswick have lower biodiversity value compared to natural forest due to a lack of forest structure (species composition, snags, coarse woody debris, multiple canopy layers, etc.) and the application of intensive management regimes (herbicide and pesticide application, short harvest rotation, etc.). Forest plantations act as fragmenting features across the forested landscape for many species (Christian et al. 1998) and habitats, including riparian/aquatic ecosystems and Acadian forest, and are associated with other fragmenting features such as roads and cut blocks. Specifically, conifer plantations in New Brunswick are known to have lower breeding success of forest birds (Villard 2014), as well as decreases in the abundance and diversity of amphibians (Waldick et al. 1999), bryophytes (Ross-Davis & Frego 2002) and vascular plants (Ramovs & Roberts 2005) in comparison to natural forest communities. Despite all of these impacts and the long term nature of this threat, the threat status of wood and pulp plantations is considered low given the relatively small land area converted to plantations across the bioregion.

2.4 Marine Aquaculture (Threat Status: **Low**)

Shellfish, and in particular, oyster aquaculture is considered a threat to the coastal resources and habitats along the Northumberland Strait. One of the major concerns is the increased disturbances related to aquaculture activities (such as getting to and from site, garbage, etc.). This threat is of increased concern to shorebirds such as Piping Plovers and Spotted Sandpipers which use shoreline habitat (Environment Canada 2012b). There is also a risk of attracting predators (e.g. gulls) to Piping Plover nest sites and other nesting birds, potentially impacting population dynamics. In addition, little research has been done to date answering questions of carrying capacity and occupation of waterfowl feeding areas in proximity to aquaculture sites (Sabine 2002).

In 2014, there were 134 oyster operations using 831 ha of surface area within 11 Bays, Coves and Rivers within the bioregion (Y. Chaisson, Province of New Brunswick, pers. comm.). The mostly intensely farmed bays by surface area are Richibouctou River, Bouctouche Harbour, and Cocagne Harbour. Oyster operation types are a mixture of bottom culture (37%) and suspended culture (63%). Effects on eelgrass have been found to occur within 25 m of suspended oyster operations, bringing the effect area much higher than the direct area measure of 524 ha (Skinner et al. 2013). There is a shift in the industry towards suspended culture operations as the method has been found to reduce mortality from benthic

predators. In addition, warmer surface temperatures provide access to better food sources which in turn, enhances growth and shortens production cycle by approximately two years (Comeau 2013).

A bay scale model using current levels of aquaculture suggested that there is not a significant influence of oyster farms on phytoplankton resources, however, there is the potential that other parts of the upper bay may be negatively impacted (Comeau 2013). When considering the threat on the light availability, nutrient stress, and organic loading of eelgrass, it has been found that there is a consistent decline in biomass up to 79 % when comparing suspended culture lease sites to control sites correlated with stocking density and age of the lease (Skinner et al. 2013). Reduction in eelgrass photochemistry and primary production were observed at suspended culture sites by 37.9%, the combination of which suggests that light limitation was caused by shading of aquaculture equipment (Skinner et al. 2013). A subsequent study also found that suspended oyster operations caused a reduction in eelgrass structure, distribution and photosynthesis within 67 days with no substantial recovery after 253 days (Skinner et al. 2014). This negative effect, however, was only found with the treatment that used a conventional floating plastic mesh bags as oppose to a system that used floating pontoon rack system supported by a rebar frame (Skinner et al. 2014), indicating that the type of aquaculture farm system used impacts eelgrass growth and production. The Skinner et al. (2014) study found that nutrient loading under suspended oyster operations appeared to have no noticeable impact on eelgrass growth or productivity.

4.1 Roads and Railroads (Threat Status: **Medium**)

Road construction can result in habitat fragmentation, which has both direct and indirect negative impacts on many wildlife species (Beazley et al. 2004). Forest roads fragment and expose what were once isolated forest tracts to harvesting, off-road vehicle use, and can increase the spread of some invasive species (Trombulak and Frissell 2000). Remote roads are also used for illegal dumping, particularly in the northeast portion of the bioregion (M. Godin, Department of Environment, pers. comm). Road networks can cause localized changes in wetland and watercourse hydrology and increase erosion and sedimentation to downstream water bodies, effecting both wetlands and Acadian forest habitats (Forman & Alexander 1998).

Within the bioregion there are 2,099 stream and road crossings, which represents roughly the number of potential culverts in the bioregion. Culverts can lead to an increase of stream vulnerability to sedimentation and erosion; this impact to water quality is detrimental to fish populations as many headwaters streams are critical spawning habitat (Curry 2000). In addition, monitoring and enforcement of regulations relating to stream and road crossings may not occur because they are not well defined or mapped.

A number of wildlife species in New Brunswick depend on large tracts of interior forest, some of which decline rapidly when these tracts are fragmented (Villard 2014). The total effect of a road on surrounding habitat stretches out far beyond the road's edge; the surrounding habitat can be damaged through increased public access, which typically includes sediment travel (through surface drainage and through air) as well as road salt, increased access for off-road vehicles, increased number of smaller roads and trails, and the potential for introduction of invasive species (Betts & Forbes 2005).

Greater Fundy Ecosystem guidelines suggest a maximum road density of 0.6 km/km^2 to promote the maintenance of biodiversity (Betts and Forbes 2005). There are a total of 7,351 km of roads in the New Brunswick Northumberland Strait bioregion, equating to a road density of 1.28 km/km^2. The total

combined road effect area encompasses 28% of the bioregion, well above the stated Greater Fundy Ecosystem Guidelines (Betts & Forbes 2005).

5.2 Gathering Terrestrial Plants (Threat Status: **Medium**)

New Brunswick is the leading peat producer in Canada, with the majority of extraction operations occurring in the northeastern section of the province (NB DNR 2012). Peat mining is a significant threat in the bioregion, particularly north of Kouchibouguac National Park. Within the bioregion, over 6% (34,298 ha) of the area is peatland, of which nearly half of which (16,986 ha) is licensed for harvest. In addition, there is currently approximately 14% (4,800 ha) of peatlands that are protected within the bioregion.

Approximately 70% of peatland occurs on provincial Crown land and the province of New Brunswick regulates the industry through the Quarriable Substances Act (Poulin et al. 2004, NB ERD 2017). Following harvest, industry is required to restore most of the former peat producing areas to wetland/peatland habitat (J. Thibault, NB ERD, pers. comm.). Although restoration is designed to replace the original natural function, current restoration has occurred over a relatively short timeframe, where it is not possible to re-create the ecological values that evolved over thousands of years (Gorham and Rochefort 2003).

The principal concerns with peat mining are: the impact of drainage water on receiving water bodies and tidal flats; the impact of habitat change on flora and fauna; and, the issue of post-harvesting restoration or reclamation. Activities such as harvesting and ditching around the bogs alter the integrity of the remaining bog by depleting the water supply. Harvested sites rarely return to functional ecosystems after abandonment because drainage and peat extraction lower the water table and expose relatively decomposed peat, which is hydrologically unsuitable for sphagnum moss reestablishment (Seters and Price 2001). Peat mining, in addition to destroying the habitat, can reduce the water quality and have a negative impact on wetland species (Environment Canada 2012b). When peatlands are drained for development, the drainage waters change the quality of streams flowing out of bogs, increasing nitrogen flow in the watershed (McIver 2015), thus affecting fish and invertebrates downstream (Sabine 2002).

5.3 Logging and Wood Harvesting (Incompatible Forestry Practices): (Threat Status: **Medium**)

The World Wildlife Fund has classified the Acadian Forest as critical/endangered, with logging identified as the primary cause of forest habitat loss (Davis et al. 2013, Environment Canada 2013). Forest management practices have influenced the composition and structure of forests in New Brunswick, resulting in a landscape dominated by young, highly fragmented forest communities (Anderson et al. 2011). The primary harvesting technique used in New Brunswick is clearcutting, which does not mimic the gap-replacement disturbance dynamics for most climax tolerant softwood and hardwood communities that naturally occur in the region. According to the provincial forest inventory, which does not include industrial freehold, between 2000 and 2006 almost 79,900 ha of forested areas or 14% of the bioregion has been clearcut harvested and 184 ha (> 1%) has been selection and shelterwood cut harvested. Additionally, a legally-binding forest strategy for Crown land was recently released (GNB 2014) that will result in a decrease in conservation forest, a further reduction of old-forest communities, a 25% increase in clearcut size, increased cutting within riparian buffers, and the complete loss of protection for Acadian Forest community types (McAlpine et al. 2014).

Although forestry impacts on aquatic systems have been improved in the last decades, there are still significant potential impacts on riparian and aquatic systems. There are regulations limiting forestry activities within 30 m of a wetland or stream and within 100 m of a major rivers, however, depending on the designation, size, or type of watercourse or wetland, either partial or full harvesting can occur within the buffer (NB DNR 2014). Even with 30 m buffer strip regulations in riparian areas, clearcutting adjacent to this regulated area can alter groundwater regimes and the 30% harvest allowed within 30 m buffers may be correlated with elevated stream temperatures (Curry 2000). However, the recommended buffer in the bioregion under this plan is 275 m, so the majority of this buffer has no specific regulations (Environment Canada 1998).

6.1 Recreational Activities (Threat Status:)

Many beaches are used heavily for recreation throughout the bioregion. The use of motorboats increases potential for human activity on previously inaccessible beaches and coastal areas. The threats associated with traditional recreational beach uses (e.g. sunning, swimming, clambakes) include: creating trails through dune vegetation; increased garbage that can be ingested by species or attract predators; and, general disturbance at foraging, nesting and roosting sites (Environment Canada 2012b). Tourism development is rapidly increasing in this region, leading to increased beach use (Sabine 2002).

The use of all-terrain vehicles (ATVs; including four wheelers and 4x4 trucks) in wetlands and beaches is illegal under the Vehicle Trespass Act of New Brunswick; however, it occurs nonetheless and enforcement is difficult and rarely occurs. Disturbances through illegal use of ATVs on beaches, tidal flats, and salt marshes are a major concern because it can severely damage wetland and coastal habitats as well as the species they support (Rock, pers. comm.). ATV traffic in bogs destroys the vegetation by cutting ruts and causing long-lasting scars on the surface through extensive braided trail networks. Vehicles on dunes destroy Marram Grass, which in turn increases erosion of coastal habitats. Direct damage from vehicles is minor compared to storm related erosion; however, the deterioration of the vegetation weakens the integrity of the beaches, dunes and banks, and renders them more prone to erosion events such as blowouts and hence contributing to loss of habitat (D. Berube pers. comm.). ATVs also have the potential to disturb nesting Piping Plovers, which may lead to nest abandonment, possible crushing of nests and birds, and lower productivity. Of the total ATV and truck tracks counted on 13 beaches in the bioregion in 2014, the highest total number (33 %) came from the Escuminac area (M. Denise, South East New Brunswick Piping Plover coordinator, pers. comm.). Some of the increased vehicle traffic on beaches at Escuminac may be related to the collection of the red seaweed Irish Moss, which is sold for fertilizer and other products.

7.2. Dams and Water Management/Use (Threat Status: **Low**)

Aquatic barriers refer specifically to dams and improperly designed road-stream crossings (i.e. culverts). Six dams have been identified within the bioregion and 2,099 potential culverts representing a potential threat to riparian/aquatic systems and species. These barriers (full or partial) limit the access of fish species to spawning and nursing grounds and can create major changes in physical, chemical and biological characteristics of the watercourse (Bunn and Arthington 2002, Wells 1999), ultimately impacting riparian wetland and forest habitat. Road networks interrupt natural ecological processes, such as groundwater flow and long-term gene dispersal of wide-ranging aquatic species (Lindenmayer and Franklin 2002). Improperly designed and/or installed road-stream crossings are another significant source of aquatic fragmentation, which may have a cumulative impact greater than that of large dams

(Jospe 2013). Culverts in particular are often barriers to fish passage (and other aquatic organisms) due to factors such as increased water velocity, low water depth and "hanging culverts" or large outflow drops (Tillinger and Stein 1996). The high number of potential culverts occurring within the bioregion are due to the extensive forest road network (based on intersection of roads with streams), although there has been no consistent survey for their potential as aquatic barriers, particularly on small private lands.

7.3 Other Ecosystem Barriers (e.g Coastline Hardening) (Threat Status: **Medium**)

Hardening of the coastline refers to installation of rip-rap, seawalls, breakwaters and retaining walls to protect coastal development. The reasons behind coastal hardening are primarily economic: the protection of cottages and houses from erosion and storm surge loss. However, coastline hardening can decrease beach and dune area and lower sediment supply, which further effects sediment replenishment on affected beaches (Environment Canada 2006). In addition, these structures can impact the marine environment through temperature and flow changes, resulting in changes in the species diversity and abundance (Jordan et al. 2009, Morley et al. 2012). Changes in shoreline distribution of wrack and other debris could also impact the invertebrate community and species of shorebirds which rely on this food source. (Duggan and Hubbard 2006). The placement of these structures can also prevent the natural development of other coastal environments such as tidal flats and salt marshes. In combination with other factors such as climate change, structures could prevent the natural migration of habitat necessary for breeding Piping Plovers (Seavey et al 2011). The communities of Aboiteau, Shediac and Cocagne in particular have experienced high levels of coastline hardening; in 2001, Environment Canada (2006) measured 8,324 m in Aboiteau, 9,408 m in Shediac and 13,287 m in Cocagne of hardened coastline, representing roughly 11 % of the shoreline within the bioregion.

8.1 Invasive Non-Native/Alien Species/Diseases (Threat Status: **Low**)

A number of terrestrial and aquatic invasive species have been identified as threats within the bioregion. However, outside of forest pests which impact commercially important tree species, little is known about their spatial extent or cumulative impact on native biodiversity. The biggest overall threat to biodiversity from a terrestrial invasive in the bioregion is the shrub Glossy Buckthorn (*Frangula alnus*), which invades riparian zones and associated embankments, where it forms dense patches that crowd out native species (NBISC 2012). The perennial Common Valerian (*Valeriana officinalis*) is widespread in disturbed areas of the bioregion and can move into natural areas and displace an abundance of native species (NBISC 2012).

Estuarine invasives have been better assessed, especially those that have economic impacts on the aquaculture; particularly tunicates. The most likely estuarine invasives to impact overall biodiversity are Green Crab (*Carcinus maenas*) and Oyster Thief (*Codium fragile spp. fragile*) (a species of seaweed). Green Crab can typically be found in vegetation or shallow water with a mud, sand or pebble bottom and disrupts ecosystems through uprooting of eelgrass, destroying shellfish beds, and impacting native species and diversity. Oyster Thief inhabits subtidal area and attaches to rocks, pilings, and aquatic species of molluscs and crustaceans as well as eelgrass. Its impacts include disrupting mollusc feeding on those it is attached to, uprooting of eelgrass, and displacement of native species (DFO 2015b).

DFO (2015) maintains monitoring programs in the bioregion for Green Crab and Oyster Thief, along with other invasive aquatic species. In Bouctouche in 2013 and 2014, the Maximum Catch per Unit of Effort (CPUE) of Green Crab in Bouctouche was approximately 10 with preliminary DFO data showing a reduction in CPUE by 2 for the 2015 season. Seasonal variations can be associated with these numbers and the data has not been completely complied yet. The cause of the apparent decline in 2015 is unknown; however, the last two harsh winters may have affected the growing populations of green crab negatively (E. Watson, invasive species technician, pers. comm.). DFO (2015) do not have active monitoring of Oyster Thief in the bioregion but a map of the locations of this species has been developed through the past several years by R. Bernier of the Gulf Region of DFO.

9.1 Domestic and Urban Waste Water (Threat Status: **Low**)

The impact of household sewage is related to bacteria entering the environment from inadequate or faulty sewage treatment systems. Residents are often unaware of the issue or lack the financial resources to address this matter effectively (R. Donnelle, Shediac Bay Watershed Association, pers. comm.). Faecal contamination of water sources is tested using two main bacterial indicators: Coliform and Esherichia coli (also known as E. coli). Coliform is an indicator bacteria found in the environment (e.g. soils) as well as in the intestines of humans and other animals but which does not cause gastrointestinal illness. However, E. coli bacteria can cause severe gastrointestinal illness. The bacteria is indicative of direct fecal matter entering the system since it is only found in the intestines of humans and animals.

The Groupe de Development Durable de la Pays de Cocagne, has been monitoring water quality for a number of years and have noted high E. coli and Coliform counts in samples from multiple areas of the Cocagne River watershed. It is thought that the source is coming from municipal lagoons, faulty septic systems, or agricultural run-off (Leblanc-Poirier et al. 2014). The Shediac Bay and Bouctouche Watersheds periodically find elevated counts of E. coli and coliform in the spring, in association with large amounts of rain water or snow melt (R. Donnelle, Shediac Bay Watershed Association, pers. comm.). The Shediac Sewage Commission is in the process of upgrading their municipal treatment plant to enable them to better separate storm water from septic systems since the current system cannot handle the overflow; too much rain overflows at the lift stations (pumps next to the Bay prior to reaching the lagoons) and sends overflow directly into the nearby bay.

Closed septic systems built for new homes in rural areas are thought to be in better shape as strict guidelines must be followed for design and installation. Government of New Brunswick Public Health Inspectors inspect new installations and ensure they are in accordance with the On-site Sewage Disposal System Regulation and New Brunswick Technical Guidelines for On-site Sewage Disposal Systems (GNB 2015). However, older homes and cottages, such as in the Caissie Cape area (an area that has a large concentration of cottages with small lots which are not adequate for a full septic field) is known to have ongoing water quality issues. It is thought that raw sewage is pumped directly into the ground by landowners, which then leaches into the water (R. Donnelle, Shediac Bay Watershed Association, pers. comm.).

Pollution is currently a concern at tourism areas along the Northumberland coastline. Parlee Beach Provincial Park and Murray Beach Province Park have both had fluctuating bacterial counts 100 times higher than acceptable levels dating back to 2011. It is unknown what exactly is causing the high E. coli and fecal streptococci counts, but wastewater sewage is thought to be a possibility (CBC News 2016).

9.3 Agriculture and Forestry Effluents (Nutrients, Pesticides, and Herbicides) (Threat Status: **Medium**)

Agriculture land comprises roughly 4% of the bioregion, and percent of area of forestry operations (including harvested areas and plantations) is 17%, not including industrial freehold areas. Agricultural and forestry effluents include the direct and indirect effects of nutrient loading and the release of sediments and pesticides into the environment. These practices generally occur in close proximity to waterways. The impacts of agriculture along rivers include nutrient run-off, sedimentation and eutrophication to the receiving waters (Chow et al. 2011). Working forests are heavily managed and may be subject to range of chemicals, such as herbicides, insecticides, fungicides and fertilizers, which leach into waterways. Studies have shown that exposure to glyphosate, the most common pesticide treatment in New Brunswick, is lethal to a number of amphibian species during their larval stage (Relyea 2005). Herbicide application is widespread to favor conifer species in regenerating cuts; as a result, much of the forest has transitioned to a composition of boreal and pioneer species (Simpson 2008). Loss of habitat from herbicides is a significant threat to songbird species and the reduction in prey from pesticides is also linked to declines in many insectivorous bird species (Environment Canada 2013).

A Dalhousie student's Master's thesis using a nitrogen loading model to estimate magnitude and sources of nitrogen loading within bays in the Northumberland Strait revealed that atmospheric deposition to watershed and bay surfaces is the primary source of nitrogen loading (between 72-94%) in six of the seven bays along the Northumberland Strait coast. The exception was Kouchibouguac, which had a higher eelgrass average canopy height greater than 20 cm, an anomaly thought to have occurred because of a high tannin content from high dissolved organic carbon content in the column which reduces light penetration (McIver, 2015). The Kouchibouguac watershed is surrounded by a National park system where riparian areas as well as wetlands, natural peatland and saltmarsh systems are preserved and are functioning to more efficiently transport carbon to the ocean (McIver, 2015).

McIver (2015) suggested that within the natural area, the bays that are at most risk of becoming eutrophic are Cocagne, Bouctouche and Richibucto with the latter bay being most at risk. The Richiboucto Bay is at moderate to high risk of eutrophication because it has the longest flushing time, has several point sources of Nitrogen release including a seafood processing plant and municipal wastewater treatment effluent plant. All three bays of concern within the natural area are at increased risk of eutrophication because of recent changes made to the forestry act in New Brunswick reducing the amount of protected crown land (McIver, 2015). Reducing forest cover along riparian and wetland areas reduces nitrogen sequestration potential to the water surface area. Since the majority of deposited nitrogen comes from atmospheric or air transport, the amount of forest cover in riparian areas as well as maintenance of wetlands including peatlands is essential to providing watersheds with an increased resilience from additional anthropogenic sources of stress such as climate change, sea level rise, herbicide, pesticide and aquaculture expansion (McIver, 2015).

11.1 Habitat Shifting and Alteration (Threat Status: **Medium**), **11.3 Temperature Extremes** (Threat Status:) and **11.4 Storms and Flooding** (Threat Status:)

Given how closely all three threats under Section 11. *Climate Change and Severe Weather* are linked, they are assessed together here. The degree to which the coastline of the bioregion experiences physical changes such as flooding, erosion, beach migration, coastal dune destabilization, and ecosystem functionality can be attributed to climate change and associated accelerated sea-level rise. Climate change will impact, and in fact is already starting to impact, coastal habitat in the region in multiple

ways. Sea level rise also increases erosion of coastal islands, beaches, dunes, banks, and riparian ecosystems (Shaw et al. 1998). Rates of sea-level increase will result in further inland migration of salt marshes and tidal flats, provided there is undeveloped land behind these systems to allow for migration (Najjar et al. 2000, Environment Canada 2006). Sea-level rise will also increase salinity, temperature, clarity, and oxygenation of estuarine ecosystems, as these areas are further influenced by encroaching ocean waters (Najjar et al. 2000, Scavia et al. 2002).

One of the major consequences of climate change in New Brunswick is the acceleration of coastal erosion rates, particularly during storm events. (Bérubé 2008). Storm surges, such as the ones experienced in along the Northumberland coastline in December 2010, are increasing in frequency in the region and had major impacts to the shoreline (D. Bérubé, pers. comm.). The severity of erosion resulting from these storms has dramatically increased (Environment Canada 2006).

Environment Canada (2006) completed a study projecting relative sea-level rise along the coast of the New Brunswick Northumberland Strait (Environment Canada 2006) over a 10 year period (2000-2100), with projections ranged from 50 to 59 cm, ± 35 cm. The highest sea level rise projections are on the south east coast of the bioregion, which is also where development pressure is highest for the bioregion. The magnitude of projected sea-level rise is expected to alter almost all priority habitats in the bioregion, including salt marshes, tidal flats, coastal island, beaches, dunes and riparian ecosystems (Robinson 2010).

Increased rate of sea level rise and erosion affect the breeding habitat of Piping Plovers both negatively and positively (Environment Canada 2006). Piping Plovers frequently occupy new sites in response to creation of habitat due to winter storms, ice scour and tidal surges among other causes; however, increased storm severity can flood nesting sites (Environment Canada 2006; J. Rock, pers. comm. 2011).

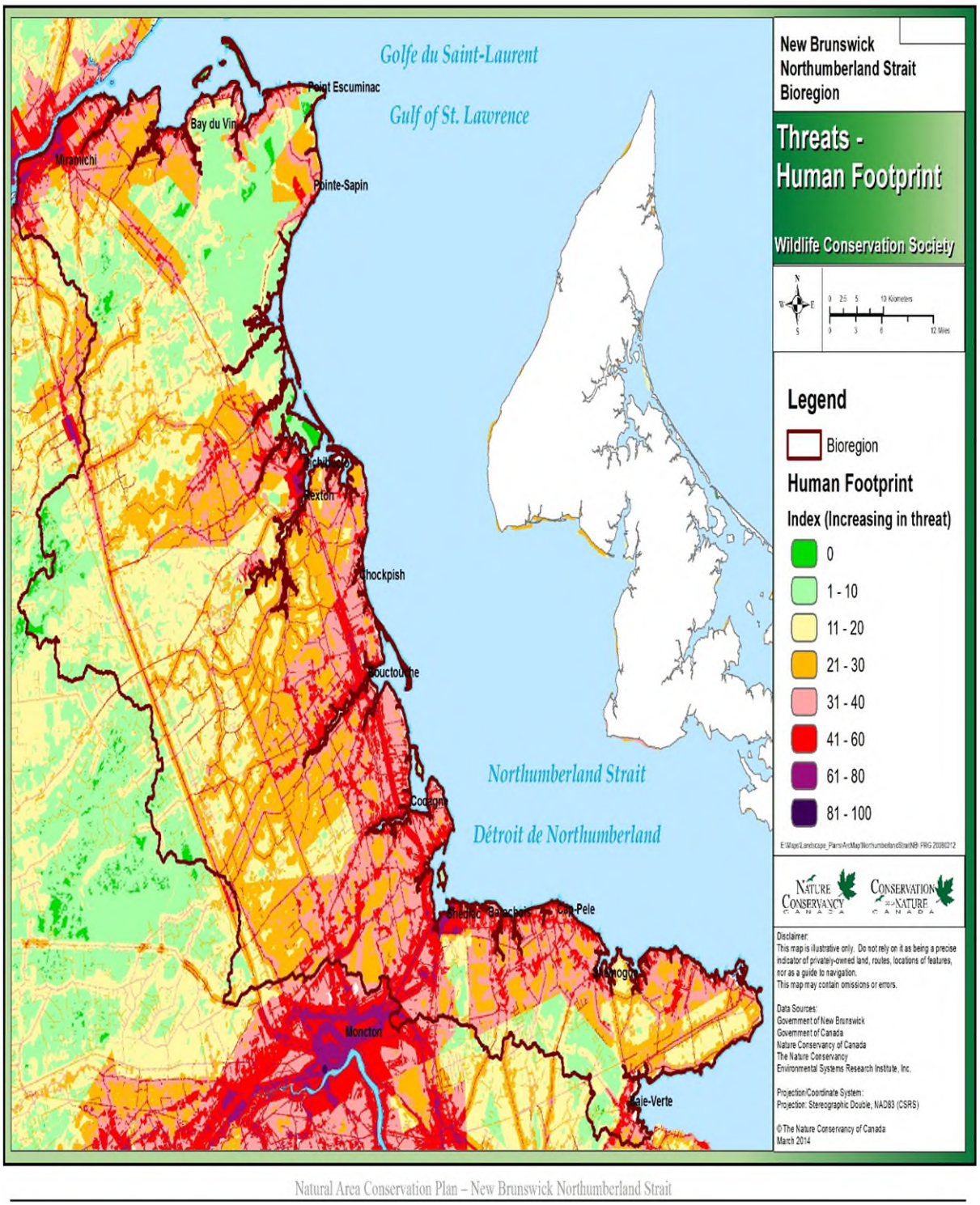

Figure 10. Human footprint within the New Brunswick Northumberland Strait bioregion (1.1 Housing, Cottage, and Rural Development).

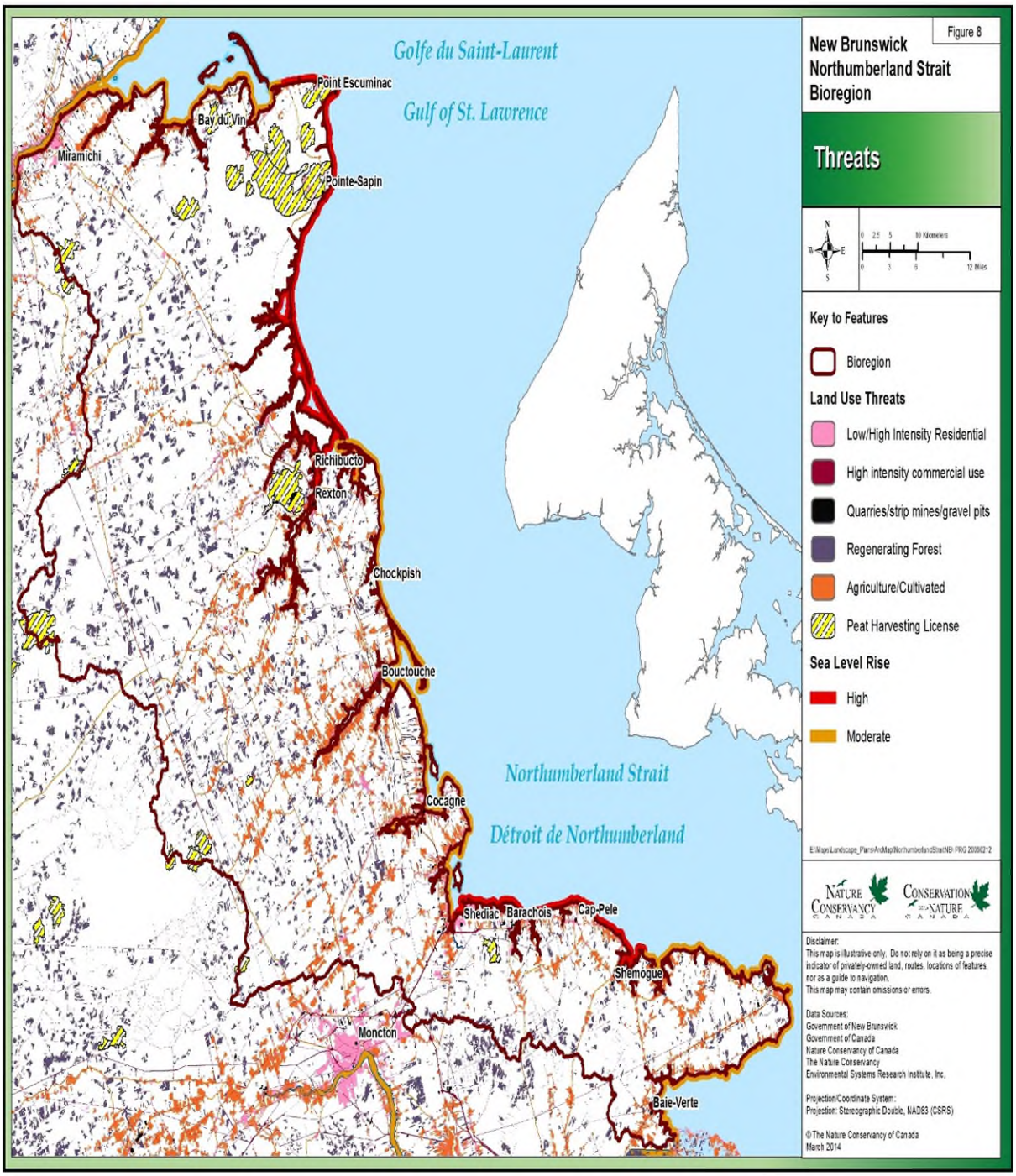

Figure 11. Anthropogenic land use within the New Brunswick Northumberland Strait bioregion and projected sea level rise (1. Residential and Commercial Development, 2.1 Annual and Perennial Non-Timber Crop, 2.2 Wood and Pulp Plantations, 2.3 Livestock Farming and Ranching, and 11.1 Habitat Shifting and Alteration).

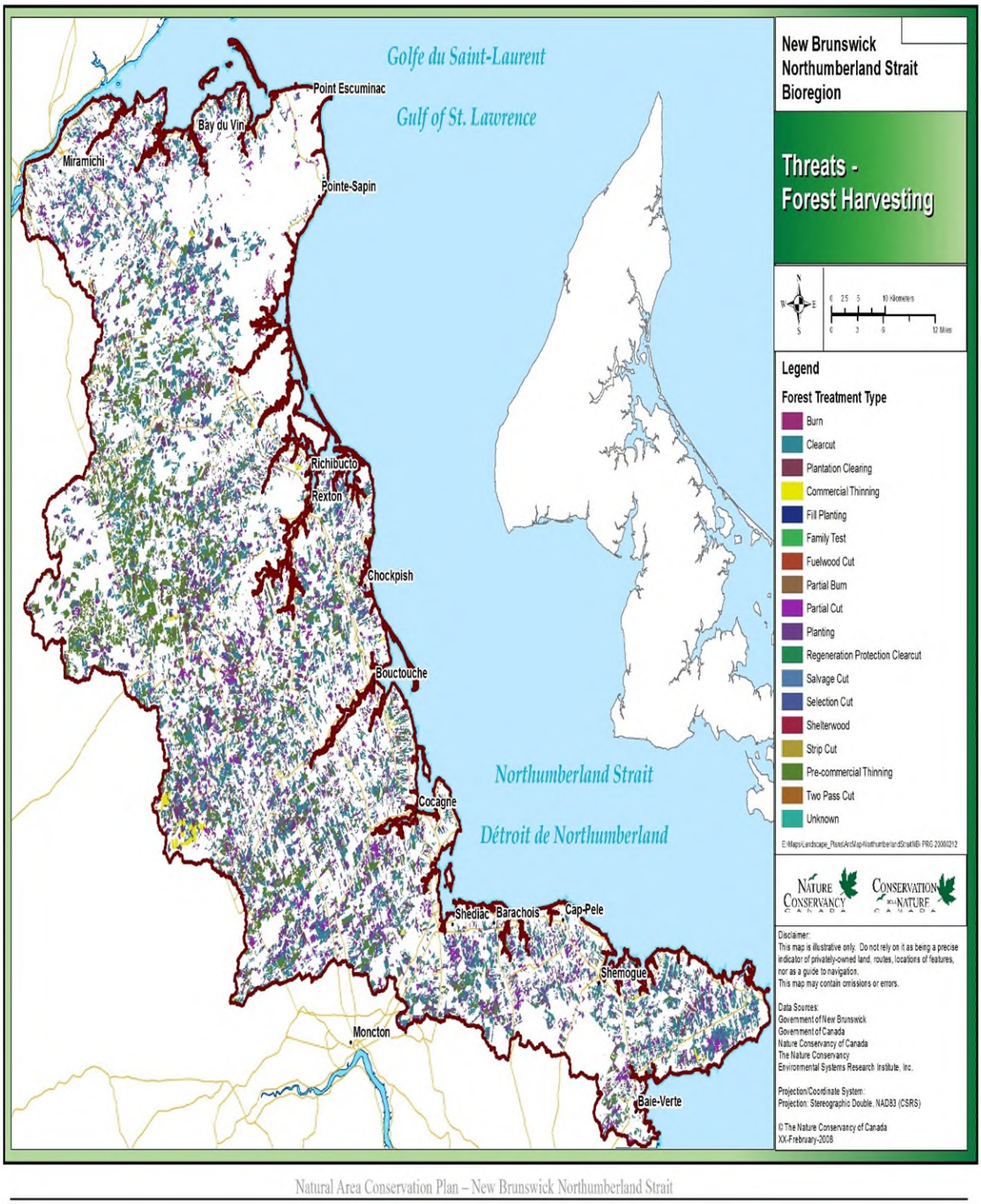

Figure 12. Forest harvesting and silviculture within the NB Northumberland Strait bioregion (2.2. Wood and Pulp Plantations and 5.3 Logging and Wood Harvesting (Incompatible Forestry Practices).

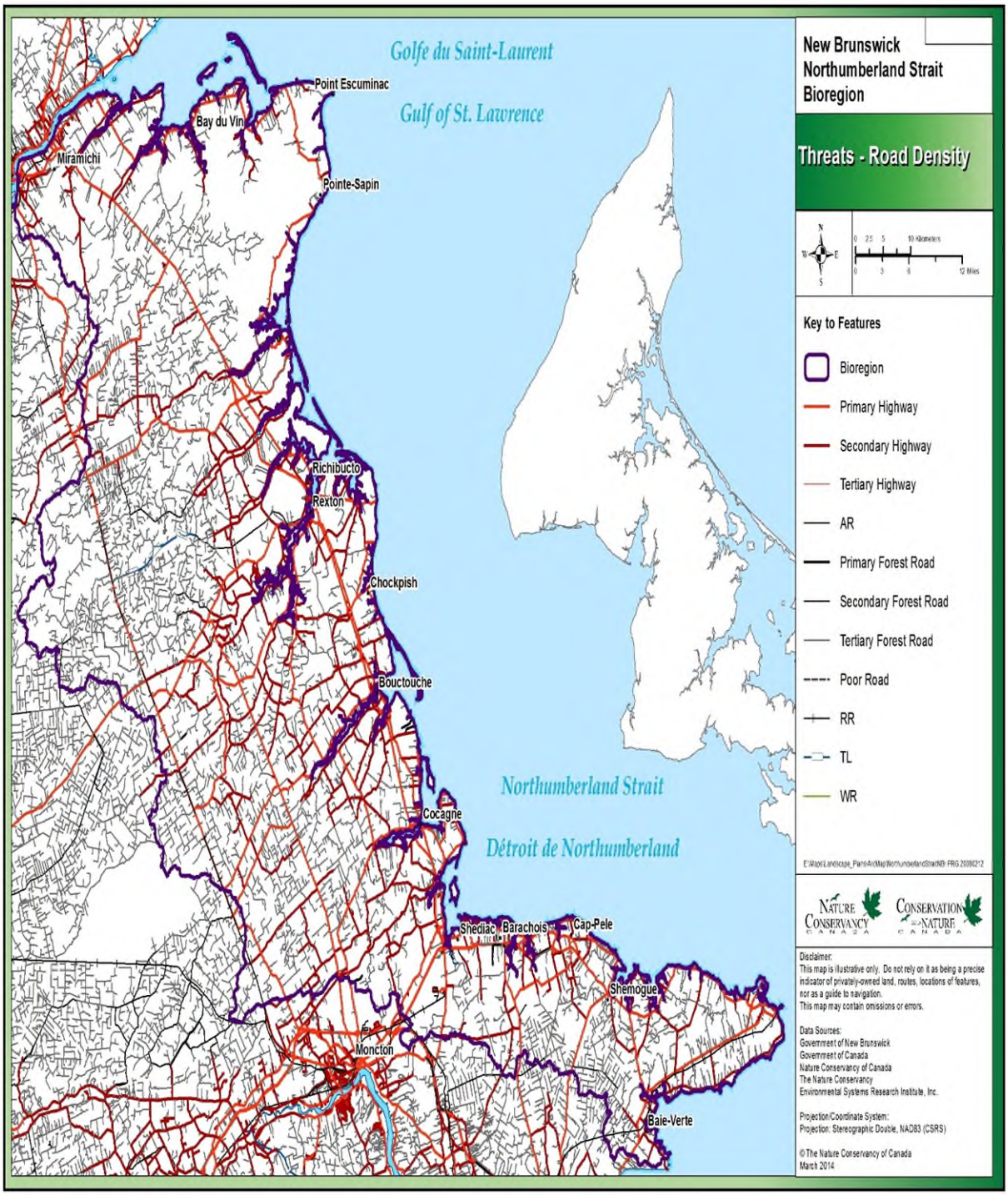

Figure 13. Road network within the NB Northumberland Coastline Bioregion (4.1 Roads and Railroads).

C. SPATIAL PRIORITIZATION

As part of this Habitat Conservation Strategy, methodologies were developed using priority habitats and species of conservation concern to identify areas within the NB Northumberland Strait bioregion that have high conservation value. The goal was to achieve the best possible impact of collective conservation actions in those areas that are the most critical for the priority habitats and species. Maps were produced in the analysis which should be used together as decision-support tools: the Conservation Value Index (CVI) and the Species Composite maps. Depending upon need, a conservation group or agency working in the bioregion may find one or all maps useful as part of their decision-making process. No single map is intended to answer all questions regarding conservation needs and these maps are not designed as stand-alone products; the narrative of this report as well as the threat maps are important elements to be examined. For various reasons, including introduced bias, the CVI map and various species composite maps can present contrasting perspectives on spatial priorities. This is expected and also reflects the reality that different approaches to conservation may be required for the conservation of different species and the habitats that host them (i.e. land acquisition versus stewardship).

1. Habitat Spatial Prioritization

Habitat classification and data pre-processing

Prior to assigning conservation priority scores to habitat patches, spatial data for each priority habitat type was "pre-processed" in order to identify and isolate those habitat patches with the highest potential to have conservation value. For rare habitat types (e.g., coastal islands) all habitats found to be present were considered to have potential, thus no occurrences of these habitats were eliminated from the analysis. More widespread and complex habitats (e.g., forest or non-forested areas) also include patches of land unsuitable for conservation action, such as clear cuts or plantation forest blocks, very young forest, or urban and industrial land. Prior to habitat scoring, these patches of land were eliminated from the analysis by methods developed by the conservation partners. For a detailed description of the datasets, habitat classification methods employed, and calculations used please refer to Appendix E.

Habitat patch weighting

The process for assigning priority ranks to habitats within the New Brunswick Northumberland Strait bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. The priority ranks assigned to private land parcels in the bioregion were the result of combining three equally weighted metrics to represent the ecological significance of habitat, landscape context, and species. First, a three-tiered equation was applied based on the size, representivity, and uniqueness of habitat occurrences in the bioregion. Second, each parcel was assigned a score indicating its level of landscape intactness (or natural cover). Thirdly, each parcel received a score based on the number of unique significant species observed on the parcel. Each of these three metrics contributed to 1/3 to the overall initial prioritization rank (Priority 1, 2, 3 or No Priority).

Several other factors were considered post-hoc to boost the prioritization of relevant parcels. Properties that were adjacent (within 30m) to existing protected areas were upgraded one priority rank (e.g. Priority 2 became a Priority 1). Parcels containing all or a portion of NAAP (Northern Appalachian-

Acadian Ecoregional Plan) critical habitat occurrences were upgraded one priority rank. Parcels that contained a species at risk (Federal or Provincial) or globally significant (G1-G3) occurrence after 1995, and with a precision value of less than 2.7 (886 m literal range) were upgraded one priority rank. Parcels containing all or a portion of a significant community were upgraded one priority rank. Parcels within the Chignecto Isthmus wildlife corridor and with a value of Priority 3 or No Priority were upgraded one priority rank.

2. Species Spatial Prioritization

Species occurrence data

Spatial data for priority species were gathered from various sources. For some species, multiple sources of spatial data exist, so the most complete or appropriate dataset was chosen. A single layer of information was derived for each species based on the most appropriate data available and used to generate a spatial representation of relative occurrence across the province. A detailed description of the methodology and the data used to create the individual species layers can be found in Appendix E. The reader is cautioned that species occurrence data are for the most part temporally and/or spatially incomplete; as such, maps that rely on species occurrence data may reflect bias due to uneven intensity of survey or research effort and should be interpreted as presenting relative available evidence of occurrence rather than true relative abundance. Such effort bias expectedly is pronounced in maps of species for which detections are rare (e.g., difficult to detect species, rare species) or that require an intensive survey approach. In order to improve future iterations of species maps, any organization, agency, or individual with any additional rare and priority species occurrence data are encouraged to contribute their records to the Atlantic Canada Conservation Data Centre.

Species composite

Individual species datasets for the full suite of priority species were combined in this analysis to produce an overall biodiversity composite with all species receiving equal weighting (Figure 19). However, given important expected differences among the broad range of priority species included in this Habitat Conservation Strategy with respect to taxonomic groups, conservation status, habitat dependency, and survey bias, a series of species composites were developed for a number of sub-suites of the priority species. Sub-suites of priority species include taxonomic affiliation (i.e., birds, plants, mammals), COSEWIC status (species at risk), habitat dependency (habitat-limited species include those species that are considered to be long-term obligate species of a particular habitat type that have predictable, repetitive use of a relatively limited area over time), and, in the case of birds, survey type (i.e., breeding evidence data, point count data). Lists of the priority species, including their conservation status, habitat associations, and occurrence data sources are provided in Appendices C and D.

Consideration of the various species composites provides the reader with a better sense of the species and data sources driving certain map outputs, and better enables the reader to consult the underlying data that are most appropriate to their question of interest and hopefully make more accurate conservation decisions. It was felt that this approach and the materials produced would better reflect the ecological complexity of the bioregion and would provide more complete decision support for the broad range of users expected to make use of this Habitat Conservation Strategy.

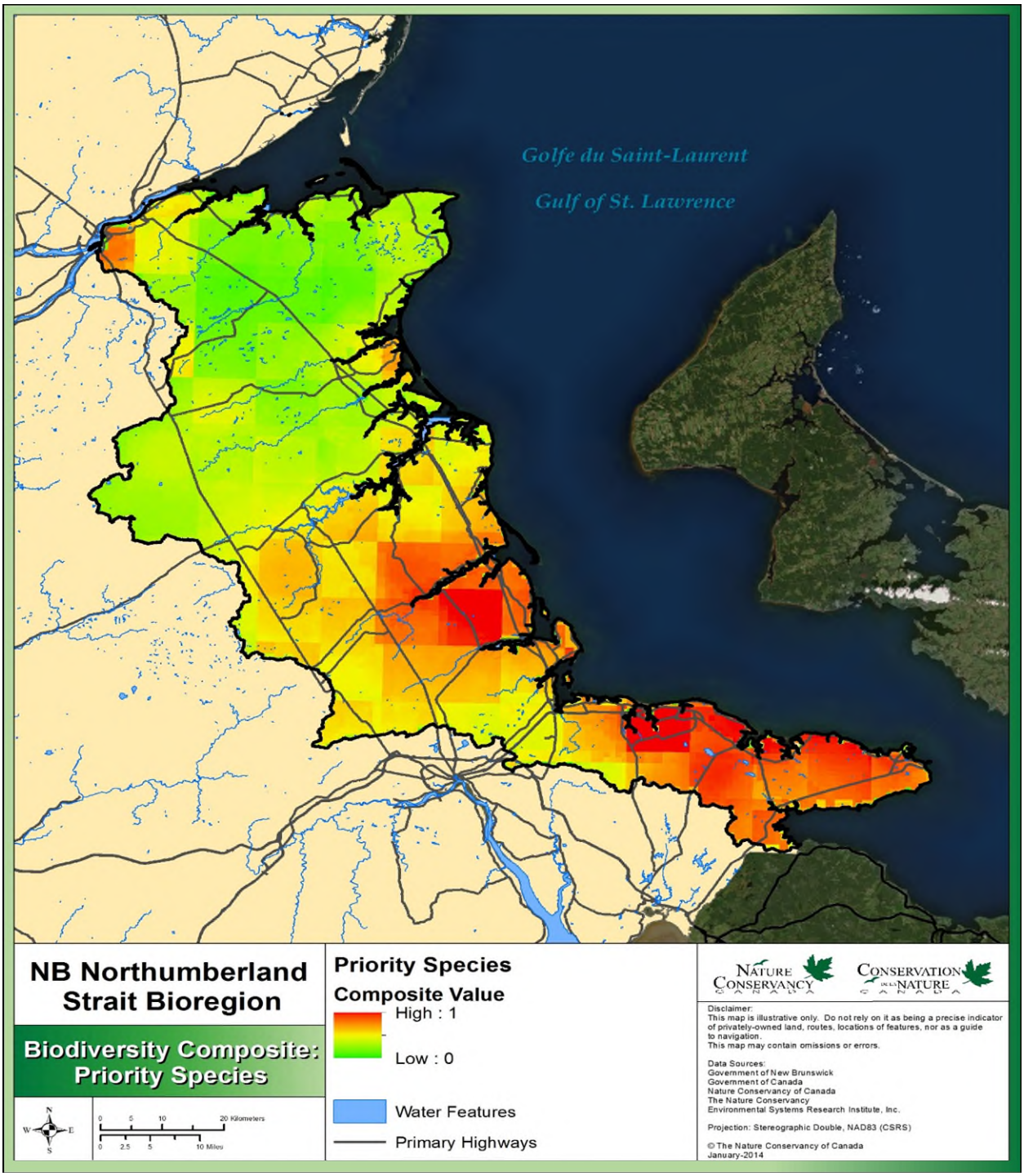

Figure 14. Species composite of all priority species within the New Brunswick Northumberland Strait bioregion.

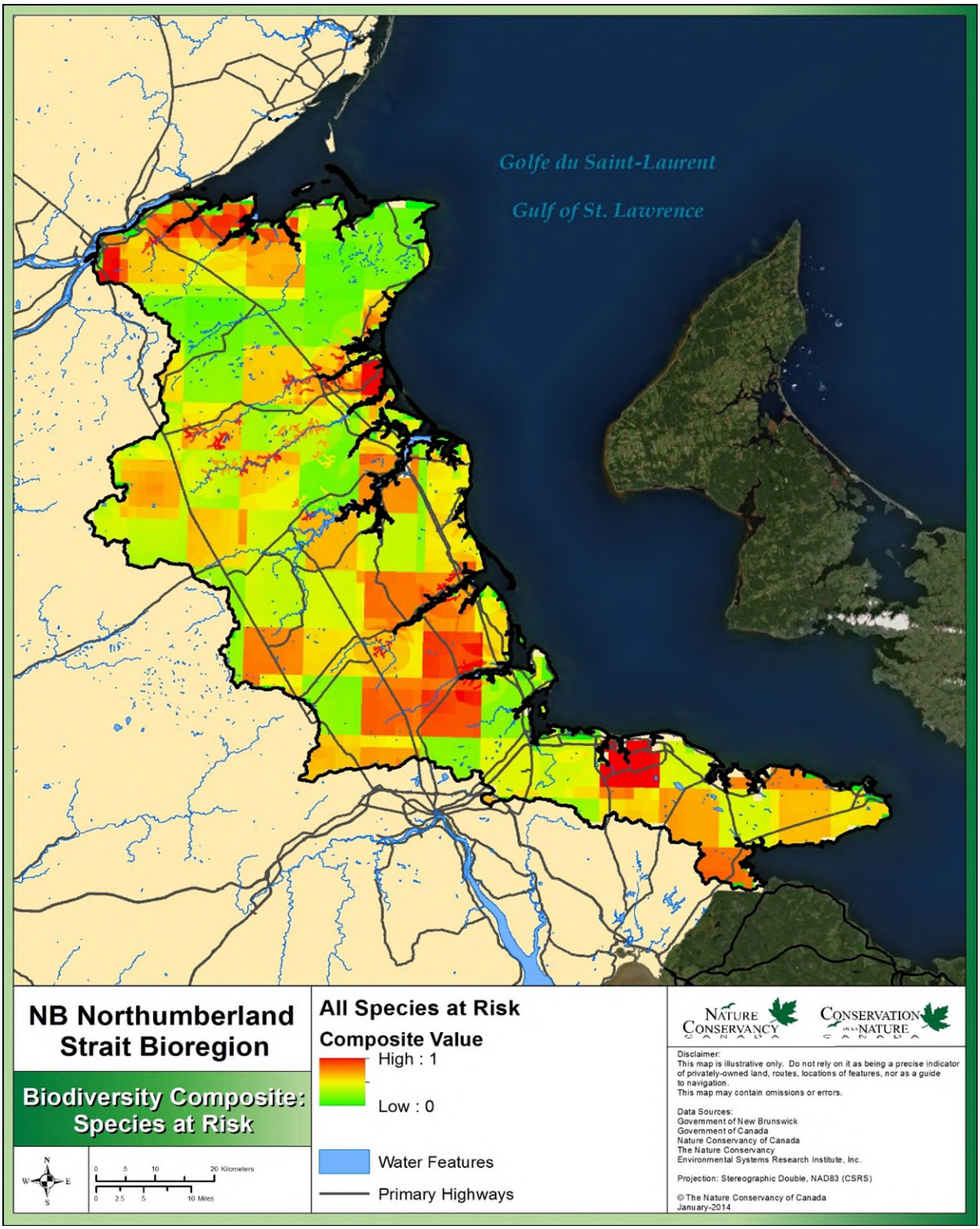

Figure 15. Species composite of all rare and at-risk species (assessed by COSEWIC and NB SARA listed) within the New Brunswick Northumberland Strait bioregion.

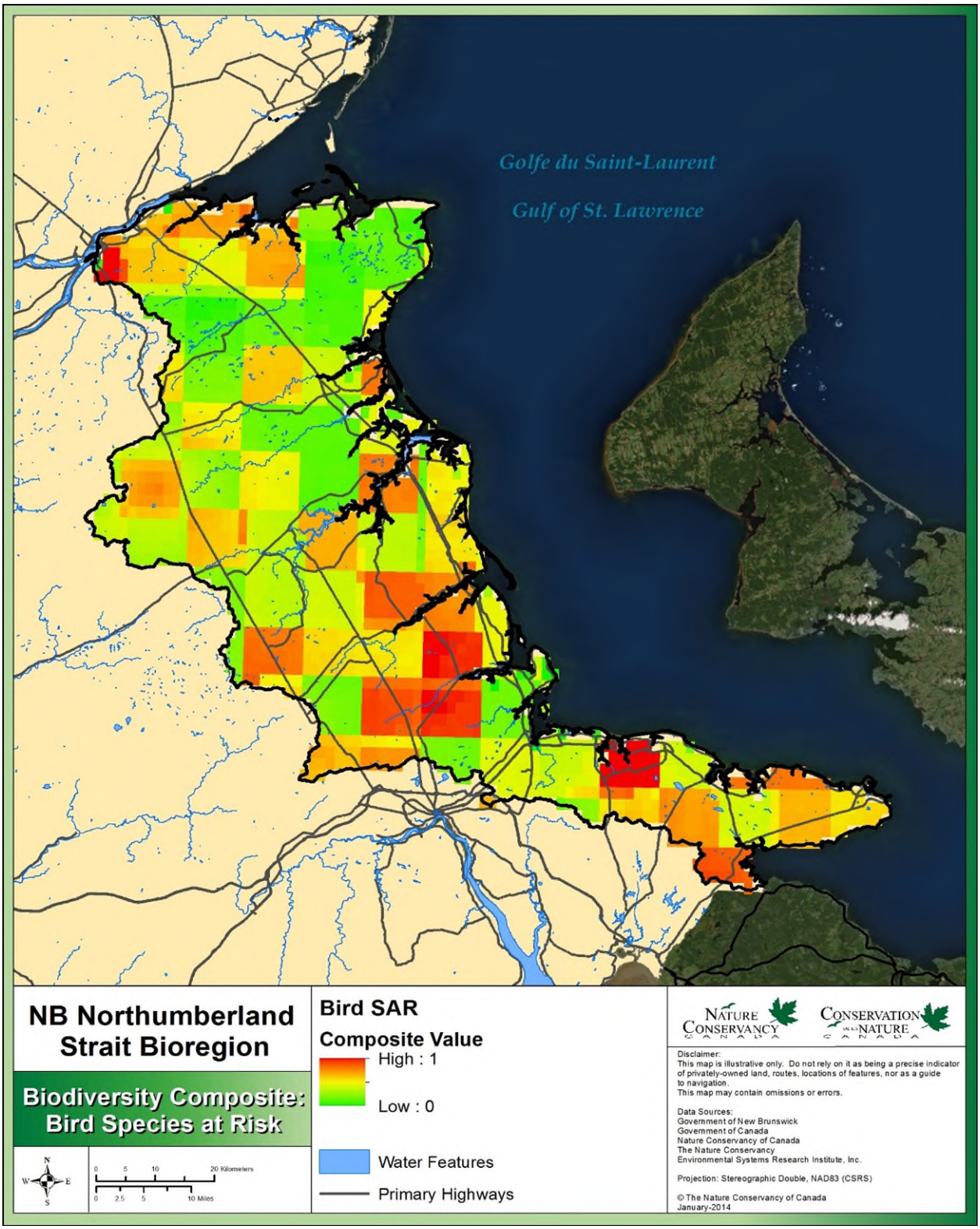

Figure 16. Species composite of rare and at-risk birds (assessed by COSEWIC and NB SARA listed) within the New Brunswick Northumberland Strait bioregion.

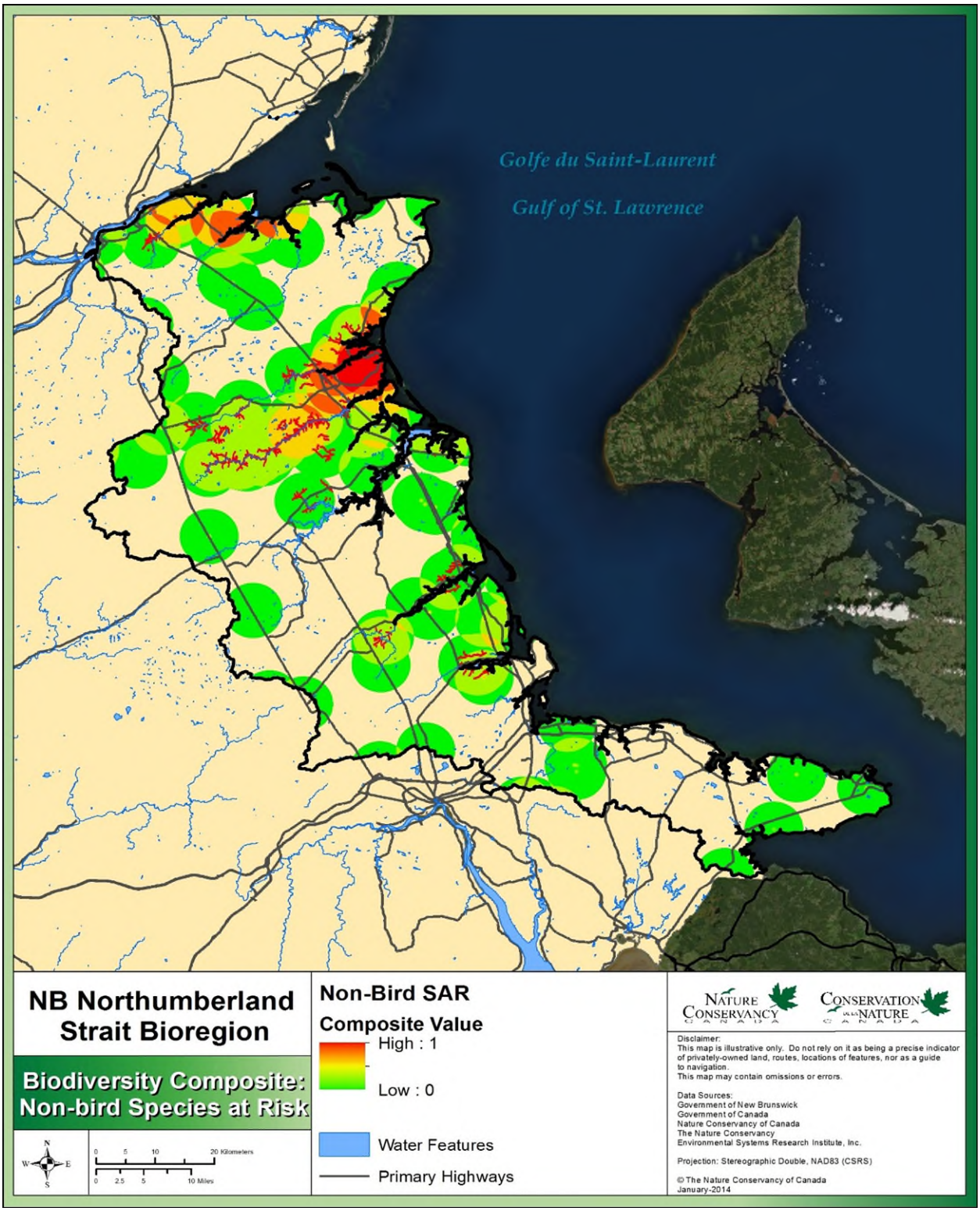

Figure 17. Species composite of all non-bird species (assessed by COSEWIC and NB SARA listed) within the New Brunswick Northumberland Strait bioregion.

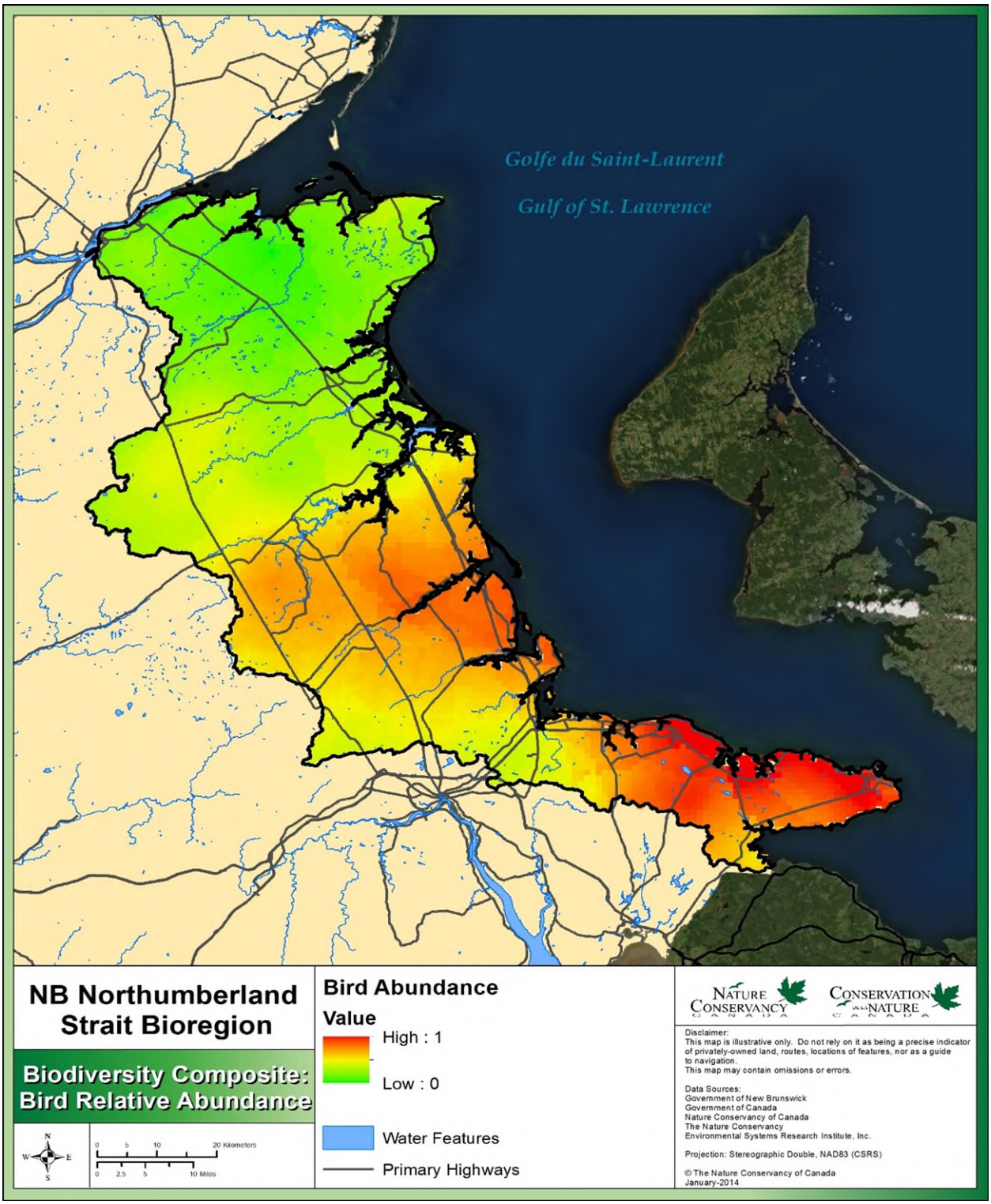

Figure 18. Species composite of relative abundance of priority bird species within the New Brunswick Northumberland Strait bioregion.

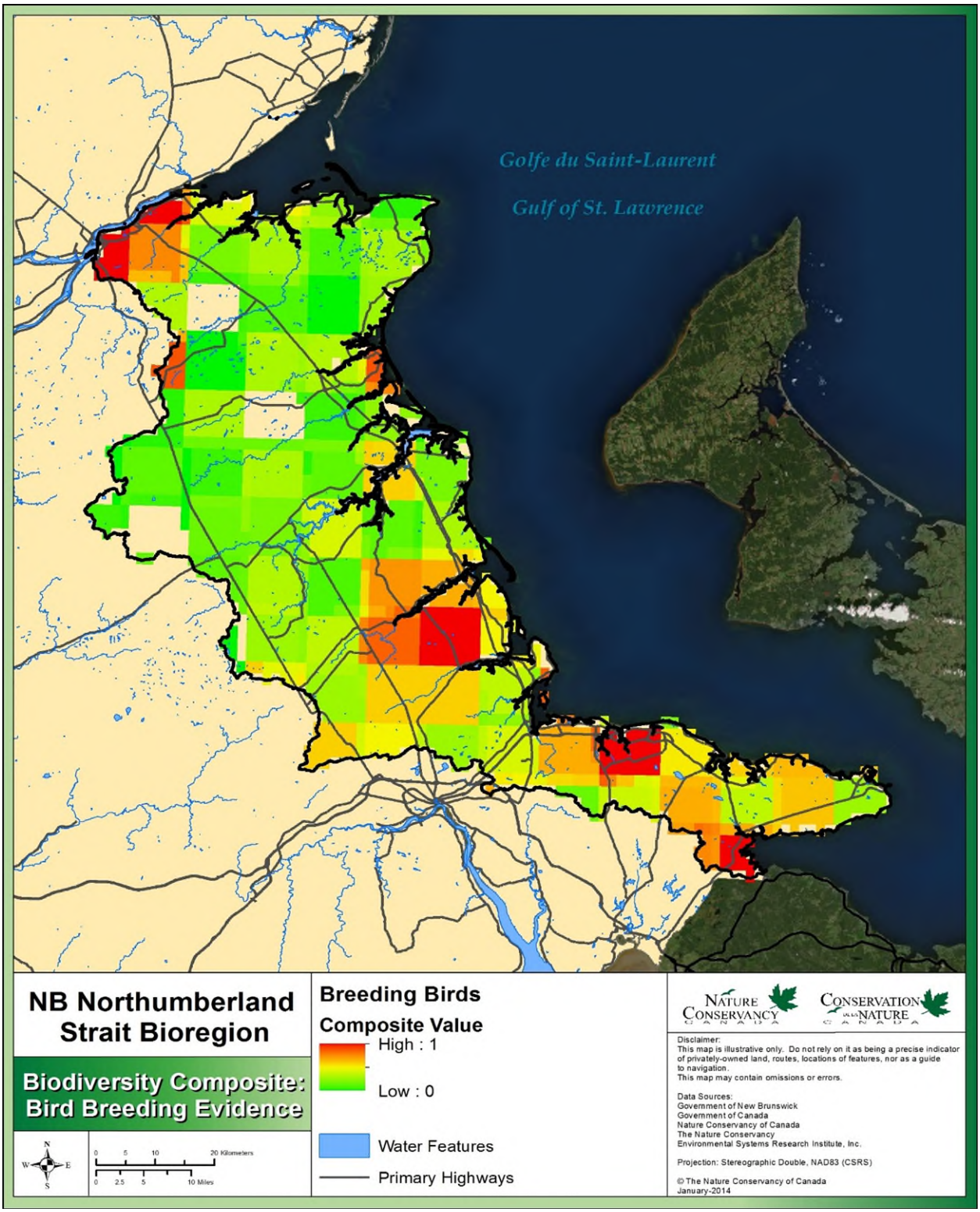

Figure 19. Species composite of breeding evidence of priority bird species within the New Brunswick Northumberland Strait bioregion.

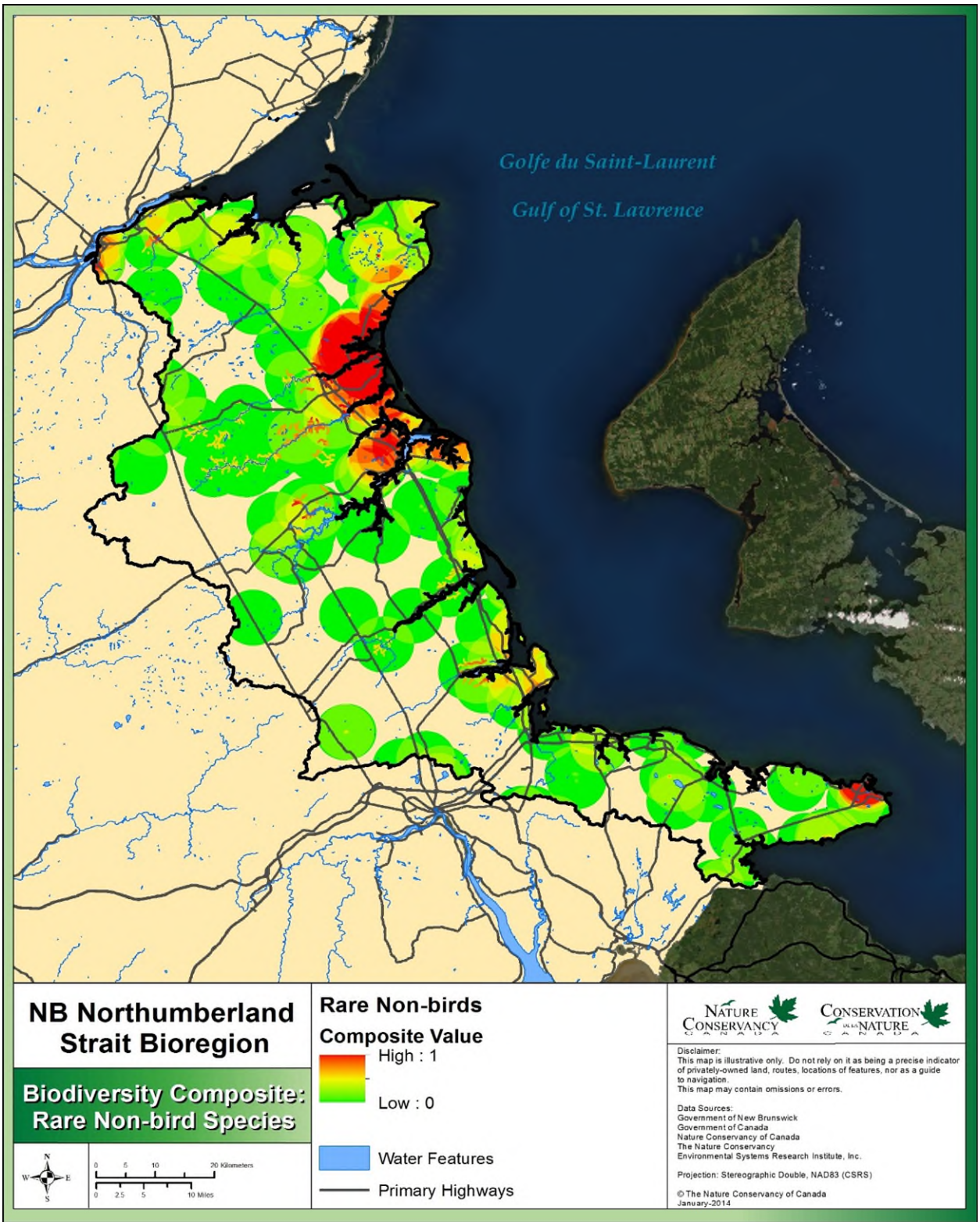

Figure 20. Species composite of rare non-bird species within the New Brunswick Northumberland Strait bioregion.

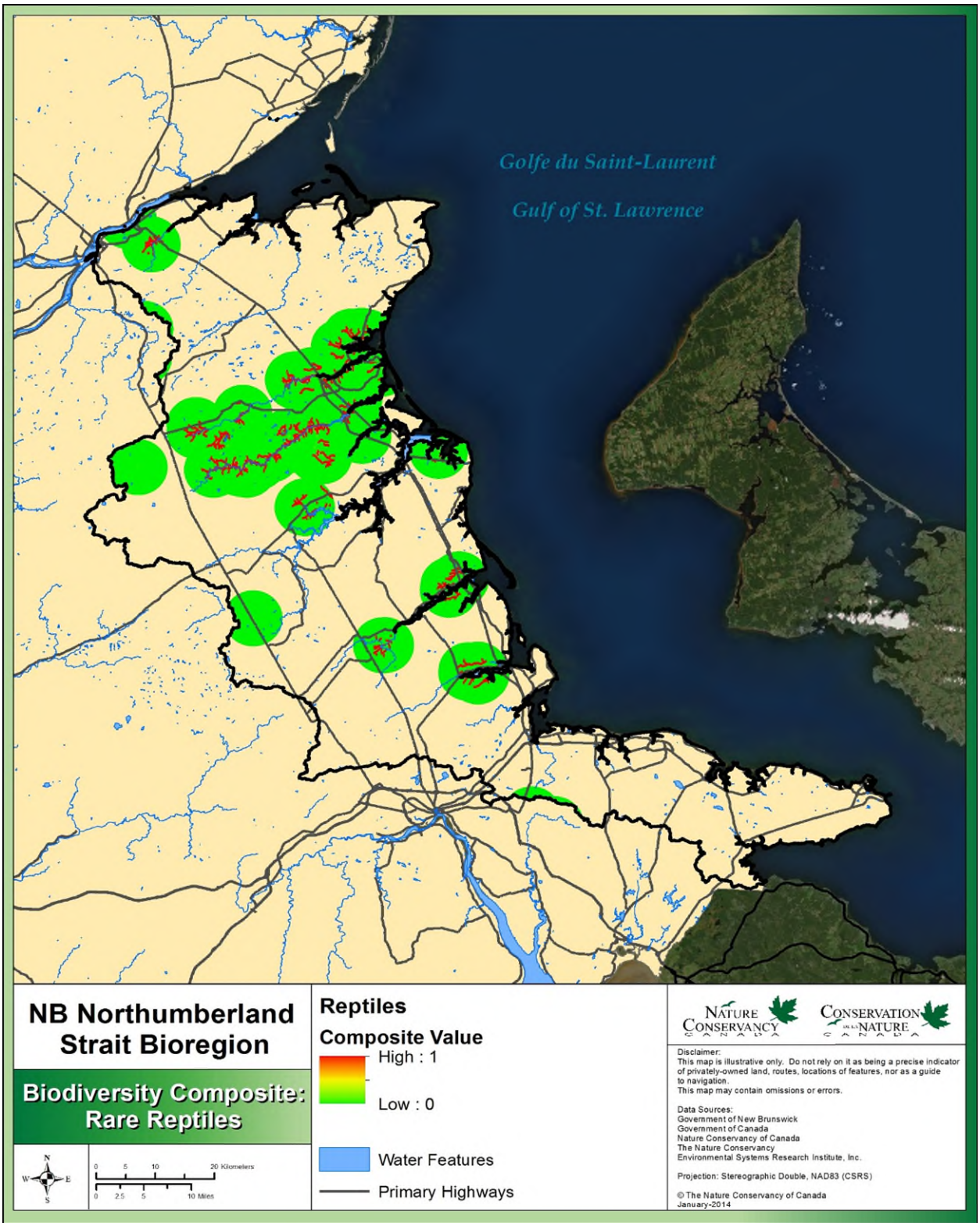

Figure 21. Species composite of rare reptiles within the New Brunswick Northumberland Strait bioregion.

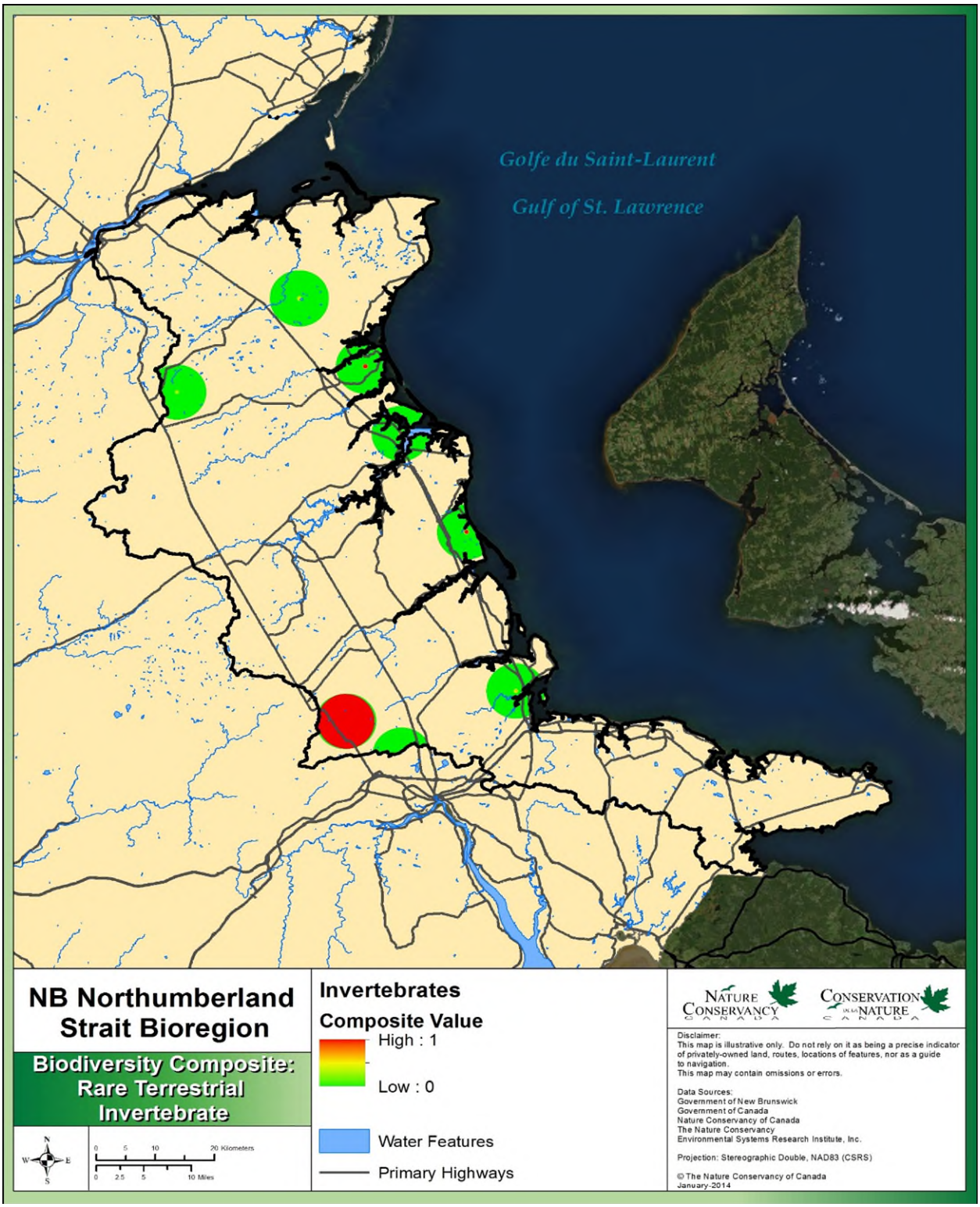

Figure 22. Species composite of rare terrestrial invertebrates within the New Brunswick Northumberland Strait bioregion.

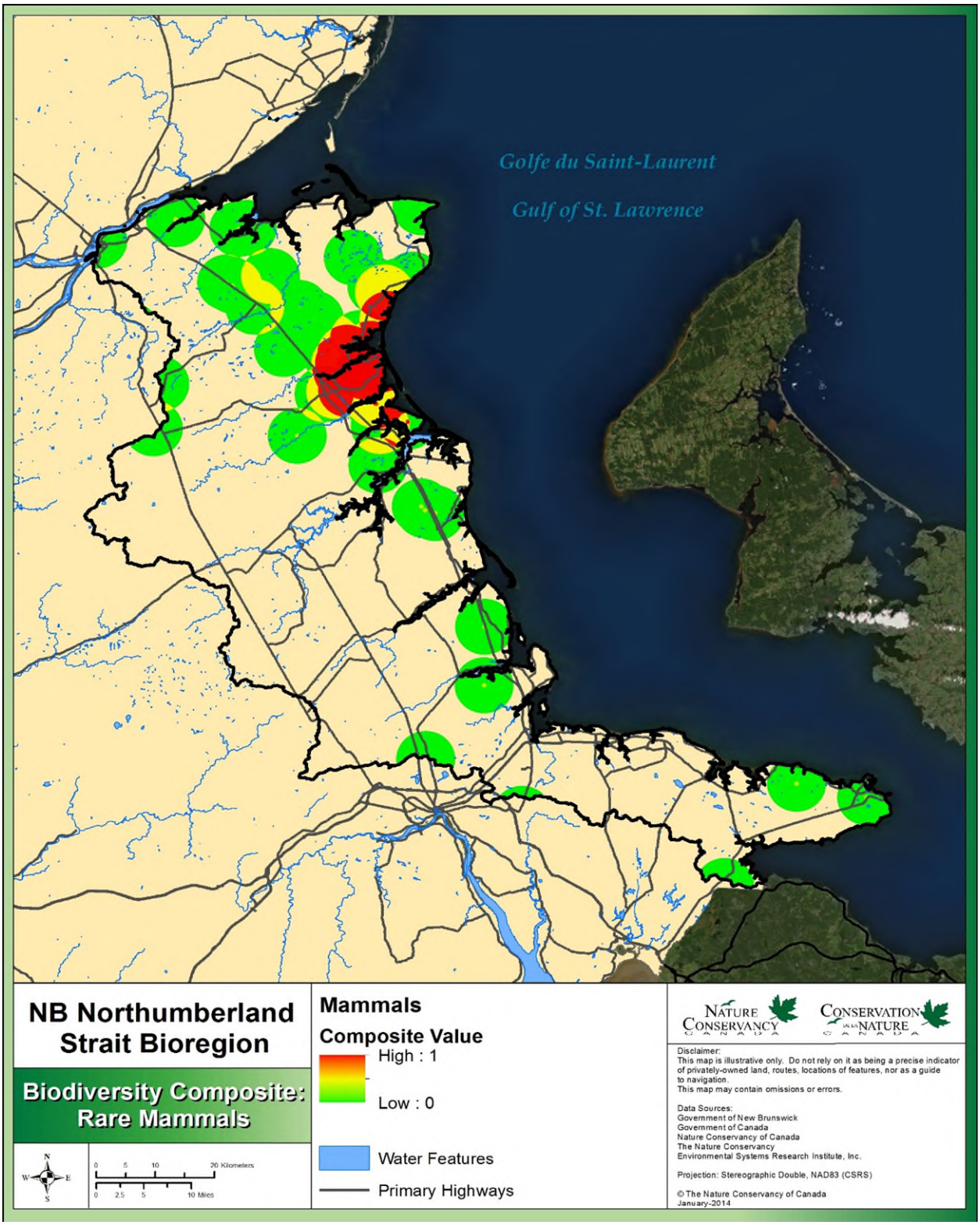

Figure 23. Species composite of rare mammals within the New Brunswick Northumberland Strait bioregion.

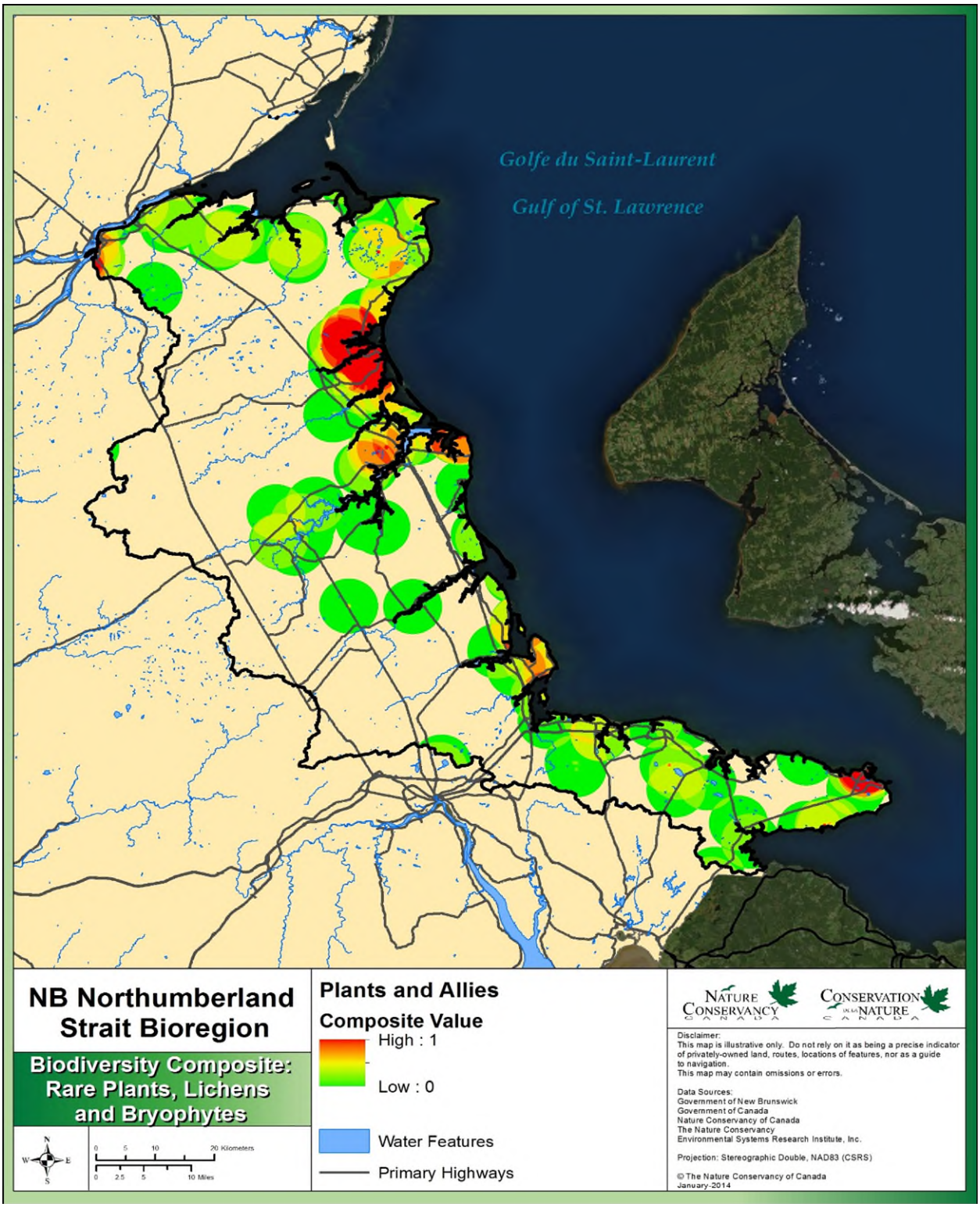

Figure 24. Species composite of rare plants (vascular and non-vascular), lichens, and fungi within the New Brunswick Northumberland Strait bioregion.

3. Conservation Value Index

The scores generated through development of the priority habitat composite and the priority species composite (using the full list of priority species) were combined to yield a conservation value index for the NB Northumberland Strait Bioregion, presented in Figure 31. Table 12 provides a summary of the results of the conservation value index analysis.

The results of the final prioritization appear to be consistent with firsthand knowledge of conditions across the NB Northumberland Strait bioregion; however, the results of this analysis should be used in combination with field visits and local knowledge. Any discernable patterns in how/where prioritization occurs should be regarded as relative and would be most appropriately used to compare the conservation priority for habitats of the same type to one another, but not the absolute ecological value or quality of a habitat. Rankings should be considered in relation to each other; for example, low conservation value rank does not indicate that an area is of little conservation value, only that it is of lesser conservation value than Very High or High-ranked areas.

Table 12. Priority Rank summary for all lands across the bioregion.

Priority Ranking	# of Land Units (legal parcels)	% of Properties	Hectares	% of Bioregion
P1	1,523	2	161,942	28
P2	4,064	6	167,827	29
P3	9,512	14	119,752	21
No Priority	52,251	78	129,580	22
Total	**67,350**	**100%**	**579,101**	**100%**

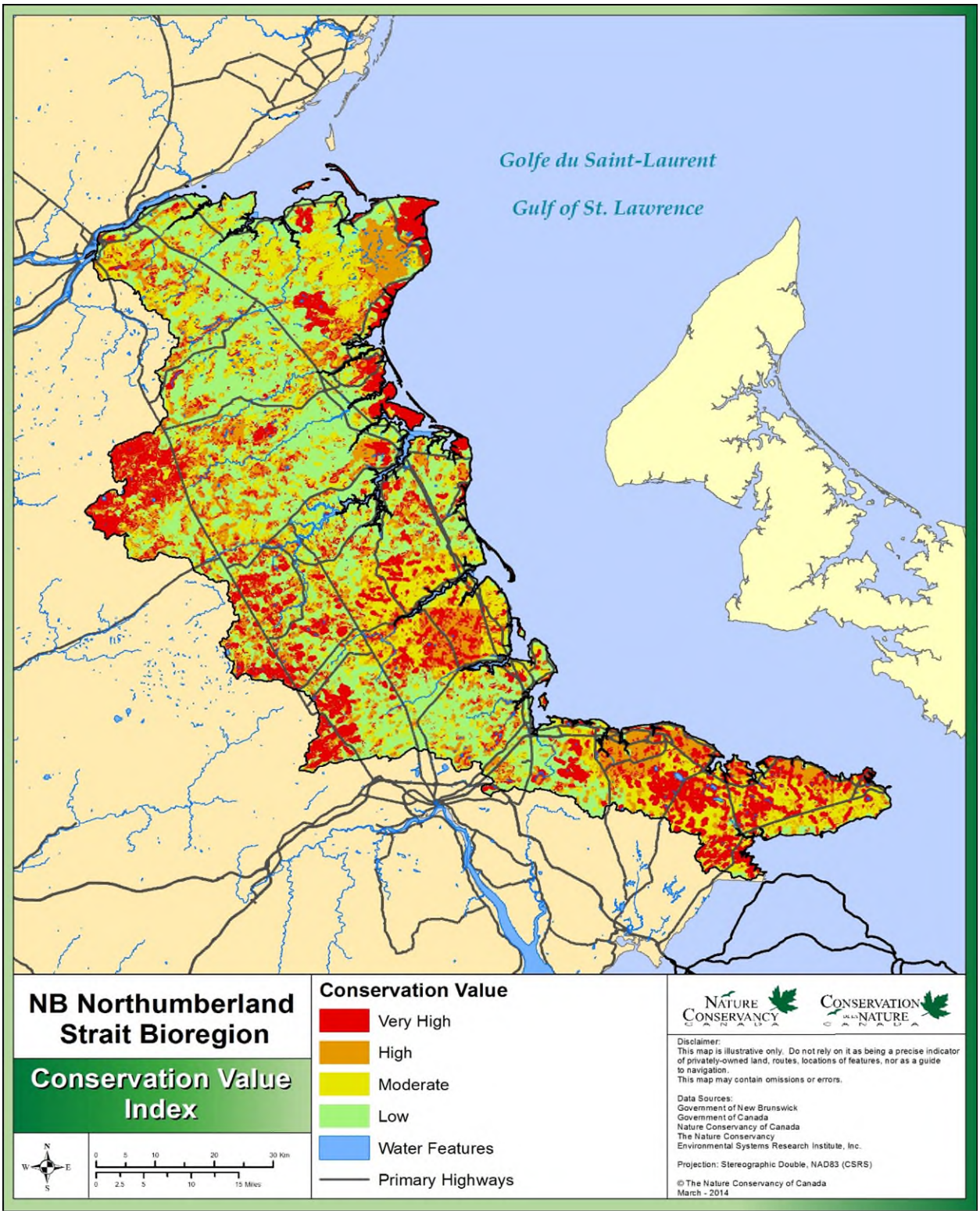

Figure 25. Conservation Value Index (CVI) for the New Brunswick Northumberland Strait bioregion (excluding Grasslands and Agro-ecosystems habitat type).

III. CONSERVATION ACTIONS

The basis of this HCS was the New Brunswick Northumberland Strait Natural Area Plan (NAP), a document developed and spearheaded by the Nature Conservancy of Canada, in partnership with federal and provincial government departments, agencies, and NGOs. The purpose of this HCS is to identify the species and ecosystems of conservation priority for the New Brunswick Northumberland Strait bioregion to achieve their conservation and stewardship. The document is designed to provide an ecosystem-based support system to decision making processes of these partners in conservation efforts throughout the region.

A. Vision

The New Brunswick Northumberland Strait bioregion is an ecologically-diverse and species-rich landscape of high conservation value. The diverse habitat types and number of species of conservation concern found here are the result of region's unique topography, geography, and Maritime climatic influences. Rich and productive coastal regions (including tidal flats, estuaries, coastal islands, and beaches and dunes) provide important breeding and staging habitat for many migratory species of birds, such as the Piping Plover. In addition, the Eastern Lowlands Ecoregion (which is contained within the bioregion) boasts the largest percentage of freshwater wetlands for any ecoregion in the province (Zelazny 2007). Research, conservation land securement, and continued sustainable management will lead to a better understanding of the environment and species of the New Brunswick Northumberland Strait bioregion and to improved ecosystem health.

B. Goals

The conservation goals that have been identified to guide the development of this HCS are:

8. Identify areas of importance for conservation priority habitats and species.
9. Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
10. Maintain healthy, intact, and fully-functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
11. Protect and support the management of habitat corridors between existing protected areas and other conservation lands through land securement, partnerships, and community outreach.
12. Support the recovery of species at risk through the conservation actions of partner organizations, supported and enhanced by federal and provincial knowledge and guidance on species at risk.
13. Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
14. Support the advancement of community support and understanding of biodiversity values and inform local stewardship initiatives.

C. Conservation Partners

The Atlantic Canada Conservation Data Centre (AC CDC)

The ACCDC was established in 1997 with the mission to "*assemble and provide objective and understandable data and expertise about species and ecological communities of conservation concern, including those at risk, and to undertake field biological inventories in support of decision-making, research, and education in Atlantic Canada"*. The ACCDC hosts the most comprehensive and current

database on the distribution of biological diversity in Atlantic Canada which includes more than 1,030,000 geo-located records of species occurrences, over 186,000 of which represent species of conservation concern. Apart from conducting their own research, the organization provides ecological consulting services including wildlife and vegetation surveys and GIS mapping.

Environment and Climate Change Canada- Canadian Wildlife Service (CWS)

The Canadian Wildlife Service's (CWS) mandate is primarily focused on migratory birds, species at risk, and their associated habitats. Important Acts that govern CWS's work include the Migratory Bird Convention Act, Species at Risk Act, and Canada Wildlife Act. Through the Canada Wildlife Act, CWS identifies, designates, and protects important habitats such as National Wildlife Areas and IBAs. CWS works closely with partners to develop recovery strategies and management plans for nationally recognized species at risk and the identification of critical habitat. CWS supports the EHJV, and provides science guidance to conservation partners on conservation actions and priorities for migratory birds, species at risk, and their habitats, including involvement in the development, refinement, and implementation of HCSs, and the NB Bird Conservation Region 14 Strategy. CWS shares its migratory bird survey data and expertise to inform biodiversity and habitat conservation initiatives that contribute to meeting not only the CWS mandate, but also the broader mandates and objectives of its conservation partners.

CWS supports activities throughout the bioregion that benefit species at risk through its two main funding programs, the Habitat Stewardship Program (HSP) and the Aboriginal Fund for Species at Risk (AFSAR). Additional funding resources include the HSP and AFSAR Prevention Stream (for species other than species at risk) and the National Conservation Plan – National Wetland Conservation Fund, the Gulf of Maine Initiative, and the Ecological Gifts Program. Environment and Climate Change Canada also funds the EcoAction Community Funding Program, the Atlantic Ecosystem Initiatives, and Environmental Damages Fund.

CWS is supportive of the Habitat Conservation Strategy approach as it represents how species and habitat data can be compiled and assessed in ways that benefit a broader suite of conservation-oriented user-groups.

Nature Conservancy of Canada (NCC)

The Nature Conservancy of Canada (NCC) has been involved in protection of wild spaces in Canada since the 1960s. The vision statement of the NCC is to "*protect areas of natural diversity for their intrinsic value and for the benefit of our children and those after them*." NCC uses the best available conservation science to prioritize work, develop conservation actions, and assess threats to biodiversity. The organization has well-established partnerships with government, researchers, and environmental organizations which have been used effectively to achieve conservation goals.

Nature Trust of New Brunswick (NTNB)

Established in 1987, the Nature Trust of New Brunswick (NTNB) is a charitable land conservation organization responsible for the protection and conservation of over 2400 ha of land within New Brunswick. The mission of the NTNB is to conserve lands of ecological or other non-monetary value within the province; stewardship through partnerships; and, educating the public in conservation, stewardship, and appreciation of nature.

Currently the NTNB has only one nature preserve located within the NB Northumberland Strait bioregion. The organization is always looking at opportunities to expand their network of conservation lands within the province, especially in areas where they are typically underrepresented.

Province of New Brunswick - Department of Energy and Resource Development (NB ERD) (formerly Department of Natural Resources (DNR)) and Department of Environment and Local Government (NB DELG)

Two provincial departments play crucial roles in the protection of conservation lands within the bioregion: the Department of Energy and Renewable Resources (NB ERD), and the Department of Environment and Local Government (NB DELG). NB ERD is responsible for activities relating to conservation of species and areas within the province, including species at risk recovery and protected natural areas (PNAs). The province enforces regulations and acts such as the *New Brunswick Species at Risk Act*, the *Protected Natural Areas Act*, and the *New Brunswick Fish and Wildlife Act*.

NB DELG maintains responsibility for management and protection of watercourses and waterways in the province, including coastal zones. *The Watercourse and Wetland Alteration Regulation – Clean Water Act* requires that any work within 30m of a designation wetland in the province requires a permit. Between 200-300 wetland permits are issued each year by the department, with 35-40 of these permits for work within coastal wetlands (P. McLaughlin, pers. comm.). Guidance for appropriate activities along coastal zones is provided through the *Coastal Areas Protection Policy for New Brunswick* (2002).

Both departments partner with numerous NGOs and federal and municipal agencies in conservation initiatives, and provide support (monetarily or logistically) through funding programs such as the New Brunswick Wildlife Trust Fund (NBWTF) and the Environmental Trust Fund (ETF).

Parks Canada - Kouchibouguac National Park (KNP)

Kouchibouguac National Park (KNP) was established in 1969 and is one of only two national parks in New Brunswick. The Park was established to protect representative examples of the Maritime Plain Natural region and the Atlantic- Gulf of St. Lawrence Marine region. As with many national parks, it is multi-use, with camping (and associated facilities), roads, docks, and hiking trails throughout the park. However, maintenance and restoration of ecological integrity is the primary focus of national parks.

The mandate of Canada's national parks is "*On behalf of the people of Canada, we protect and present nationally significant examples of Canada's natural and cultural heritage and foster public understanding, appreciation and enjoyment in ways that ensure their ecological and commemorative integrity for present and future generations*." KNP protects a number of priority habitats identified in the HCS including salt marsh, estuaries, coastal islands, peat bogs, and Acadian forests. The 15-year *Kouchibouguac National Park Management Plan* identified several key strategies and actions to support species at risk recovery (including Piping Plover, Gulf of St. Lawrence Aster, and Beach Pinweed), sea-level rise monitoring, invasive species occurrences, Acadian Forest restoration, enhanced education and awareness, and inclusion of Aboriginal Traditional Knowledge. In addition, a recent draft *Multi-species Action Plan for Kouchibouguac National Park of Canada and associated National Historic Sites* (Parks Canada Agency 2016) provides guidance on the protection and recovery for species at risk found in KNP. This includes contributions to the Atlantic Canada initiative to have, at a minimum, 255 Piping Plover chicks per year (5 year average of 1.65 chicks/pair/yr); surveys of historical sites of Gulf St. Lawrence

Aster within the park and potential for restoration and/or reintroduction; and, the maintaining the existing Beach Pinweed population of which 60% of the global population occurs in KNP.

D. Conservation partner actions

Conservation actions projected to happen over the next 5-10 years or those which are currently underway by conservation partners, along with the priority habitats and threats these actions address, are described in Table 12. Conservation actions were identified through discussions with partner organizations and the review of relevant provincial and federal Acts, Regulations, policies, and strategies, (such as the *New Brunswick Species at Risk Act* and the *New Brunswick Clean Water Act*), and management planning documents (such as the *Kouchibouguac National Park Management Plan*). The IUCN Conservation Actions Classification v. 2.0 was used as the standard to categorize conservation actions (Appendix H).

Table 13. Conservation actions of partner organizations over the next 5-10 years and the priority habitats and threats these actions address.

Conservation Actions[2] Description of related action (specific and measurable if possible)	**Collaborators**	**Importance[3] /Conservation Goals**	**Date for Completion**	**Priority Habitats[4]**	**Primary Related Threat(s)**
1. Land/Water Protection					
1.1 Site/Area Protection Contribute to Marine Protected Area Network planning within the Gulf marine bioregion, and to the identification and description of Ecologically and Biologically Significant Areas and other habitat classification schemes toward the goal of protecting 10% of coastal and offshore marine areas by 2020.	DFO, ECCC, PC	Necessary	2020	Beaches and Dunes, Salt Marshes, Tidal Flats	1.3 Tourism and Recreation Areas 2.4 Marine and Freshwater Aquaculture 5.4 Fishing and Harvesting Aquatic Resources 7.3 Other Ecosystem Modifications 8.1 Invasive Non-Native/Alien Species/Diseases 9. Pollution

[2] *Categories based on IUCN – CMP Unified Classification of Conservation Actions Needed (Version 2.0). Actions are meant to be specific and measureable if possible, and are not listed in order of importance.*

[3] *CRITICAL: Conservation actions that, without implementation, would clearly result in the reduction of viability of a biodiversity target or the increase in magnitude of a critical threat within the next 5-10 years. Also includes research information that is needed before key decisions can be made on the management of biodiversity targets. NECESSARY: Conservation actions that are needed to maintain or enhance the viability of biodiversity targets or reduce critical threats. Also includes research that will assist in decisions on management of biodiversity targets. BENEFICIAL: Conservation actions that will assist in maintaining or enhancing viability of biodiversity targets and reducing threats.*

[4] *Priority Habitats: Beaches, Dunes, and Cliffs; Freshwater Wetlands; Riparian; Acadian Forest Matrix; Grasslands; Salt Marshes; Tidal Flats/Estuaries; Coastal Islands.*

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
					11. Climate Change & Severe Weather
1.1 Site/Area Protection Acquisition of a minimum of 500 ha of high conservation value habitat as opportunities for land donation or purchase arise.	NCC	Critical	2024	All	1.1 Residential and Commercial Development
1.1 Site/Area Protection Evaluate and potentially designate 4 intertidal areas for Protected Natural Area status (≈ 1,000 hectares).	NB ERR	Beneficial	2022	Tidal Flats/Estuaries	
1.1 Site/Area Protection The Nature Trust of New Brunswick will pursue permanent protection of high conservation-value habitat within the Northumberland Strait as opportunities for land donation or purchase arise.	NTNB	Critical	2022	All	
1.1 Site/Area Protection Meet with provincial staff and politicians to propose designation of bog habitat on Crown land surrounding NCC's land at Point Escuminac, under the Protected Natural Area Act.	NCC, NB ERD	Critical	2017	Freshwater Wetlands	5.2 Gathering terrestrial plants (peat).
1.1 Site/Area Protection NCC to apply to the Province of New Brunswick to designate all NCC lands in the bioregion under the NB Protected Natural Areas Act, thus preventing sub-surface claims.	NCC,	Necessary	2024	All	
1.2 Resource and Habitat Protection Work with landowners to develop voluntary stewardship agreements on private land which will address specific threats to Species at Risk, rare species communities, and threatened ecosystems.	NTNB	Beneficial	2022	All	
2. Land/Water Management					
2.1 Site/Area Management Inform and implement the North American Waterfowl Management Plan (NAWMP)	ECCC, EHJV, USFWS, USGS	Necessary	Ongoing	Salt Marshes, Tidal Flats, Freshwater Wetlands,	

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
and conduct waterfowl surveys as required by the plan (in partnership with the EHJV).				Grasslands, Hydro-riparian Systems	
2.1 Site/Area Management Conserve habitat and wildlife within the Portage Island National Wildlife Area (Miramichi Bay estuary; in adjacent Acadian Peninsula HCS bioregion) according to the vision, goals and objectives of its management plan.	ECCC, MREAC, ACCDC	Necessary	Ongoing	Beaches and Dunes, Salt Marshes, Tidal Flats, Acadian Forest, Freshwater Wetlands, Hydro-riparian Systems	1.1 Residential and Commercial Development 2.4 Marine and Freshwater Aquaculture 5. Biological Resource Use 6. Human Intrusions and Disturbance 7. Natural System Modifications 11. Climate Change & Severe Weather
2.1 Site/Area Management Protect and manage 5,160 hectares of Protected Natural Area containing representative forest and wetland ecosystems.	NB ERD	Beneficial	Ongoing	Freshwater Wetlands, Acadian Forest	
2.1 Site/Area Management Implement sustainable forest management on the approximately 172,000 hectares of Crown Timber License lands within the bioregion to conserve, including DWAs, site-specific habitat, wetland and watercourse features, and spatially mapped forest community types and old forest wildlife habitat.	NB ERD	Beneficial	Ongoing	Freshwater Wetlands, Riparian, Acadian Forest	
2.1 Site/Area Management Completion of Wet Areas Mapping project which will provide improved knowledge of area of extent and types of watercourses in NB.	NB DELG, UNB	Necessary	2023	Freshwater Wetlands	
1.2 Resource and Habitat Protection Identify bogs wholly owned by private landowners to target for land securement.	NCC	Critical	2017	Freshwater Wetlands	
1.2 Resource and Habitat Protection	NCC	Necessary	2024	Freshwater Wetlands	

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
Map bogs on public land which are not licenced, prioritize for rare plant surveys, and complete field surveys.					
1.2 Resource and Habitat Protection Evaluate planned route 11 and route 134 upgrades to determine opportunities to improve aquatic connectivity.	NCC	Beneficial		Riparian and Aquatic Ecosystems	
1.2 Resource and Habitat Protection Facilitate social science research in communities such as Escuminac where ATV use is negatively affecting the health and viability of targets and/or species at risk.	NCC	Necessary	2019	Beaches and Dunes	6.1 Recreational Activities
1.2 Resource and Habitat Protection Species of conservation concern and priority habitats monitored by staff and volunteers on NTNB land holdings.	NTNB	Necessary	Ongoing		
3.0 Species Management					
3.2 Species Recovery Continue to work together through the coordination of volunteers and partners in Piping Plover monitoring, breeding habitat protection, and stewardship on beaches in SE New Brunswick, including joint monitoring collaborations, outreach, and volunteer celebration events. A Piping Plover recovery strategy has been developed, with a population objective of 105 pairs for NB (which includes both NB Acadian Peninsula and NB Northumberland Strait HCS bioregions).	BSC, ECCC	Beneficial		Beaches and Dunes	1.3 Tourism and Recreation Areas 6.1 Recreational Activities
3.2 Species Recovery Engage and consult with all partners in the development of SAR recovery documents, and support the activities described within recovery documents for the schedule of studies for SAR and the	PC, ECCC, GNB, Academic Institutions, NatureNB, NCC, ACCDC, NTNB, MREAC	Necessary	Ongoing	All	All

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
identification of their critical habitat within the bioregion.					
3.2 Species Recovery Undertake a multi-year Piping Plover banding project to quantify movement and survival, to better understand anthropogenic threats and other sources of mortality throughout the species' life cycle. Coordinate banded bird resighting efforts within the bioregion and more broadly throughout the species' range.	ECCC, PC, BSC, (also University of Havana Cuba, Virginia Tech)	Beneficial		Beaches and Dunes	1.3 Tourism and Recreation Areas 6.1 Recreational Activities
3.2 Species Recovery Maintain productivity for Piping Plover of 1.65 chicks per pair per year, calculated as a 5 year running average.	KNP	Critical	Ongoing	Beaches and Dunes	6.1 Recreational Activities
3.2 Species Recovery Maintain current populations of Beach Pinweed at KNP through a combination of monitoring and reduction of human disturbance in habitat.	KNP	Critical	Ongoing	Beaches and Dunes	6.1 Recreational Activities
3.2 Species Recovery Installation of two Wood Turtle crossings on Highway 117 within KNP to improve habitat connectivity and reduce mortality.	KNP	Critical	2016		4.1 Roads and Railroads
3.3 Species Re-introduction Explore possibility of re-introduction of Gulf of St. Lawrence Aster to historical sites at KNP.	KNP	Necessary	2021	Beaches and Dunes, Salt Marsh	6.1 Recreational Activities
4. Education & Awareness					
4.2 Training Develop educational tools and support products for woodlot owners to promote sustainable forest management on private woodlots	NCC	Necessary	2016	Acadian Forest	
4.2 Training Train voluntary preserve stewards to monitor Nature Trust properties annually for impacts from use and respond to any potential threats to biodiversity targets.	NTNB	Necessary	Ongoing	All	6.1 Recreational Activities

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
4.3 Awareness and Communications Update ECCC website regarding NCP Connecting Canadians to Nature, SAR, ECCC protected areas. Partner in biodivcanada.ca website, and adhere to biodiversity goals and targets for 2020 within the Canadian Biodiversity Strategy.	ECCC	Beneficial	Ongoing		
4.3 Awareness and Communications Promote ecosystem based adaptation through positive media stories on ENGO / Planning Commission partnership.	NCC	Necessary	2019	All	
4.3 Awareness and Communications Implement the NTNB communications strategy to raise awareness of the need for land conservation and by promoting the province's natural heritage through maintaining public access to Nature Trust preserves.	NTNB	Beneficial	Ongoing	All	
4.3 Awareness and Communications NTNB to share information and increase awareness about threats to species at risk and provide stewardship tips for private landowners throughout the bioregion via preserve steward training workshops.	NTNB	Beneficial	Ongoing	All	
4.3 Awareness and Communications Promote ecosystem based adaptation through positive media stories on ENGO / Planning Commission partnership.	NCC	Necessary	2019	All	
4.3 Awareness and Communications Identify large forested properties with mature / old forest habitat and meet with landowners to share information / tools.	NCC	Necessary	2023	Acadian Forest	

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
4.3 Awareness and Communications Strengthen partnership with Atlantic Conservation Data Centre (ACCDC) through annual submission of monitoring findings on conservation lands.	ECC, NCC, NTNB, NB ERD, NB DELG, others	Beneficial	Ongoing		
5. Law & Policy					
5.1.2 Legislation (National level) Implement the Migratory Bird Convention Act (MBCA), Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA), Species at Risk Act (SARA), Canadian Environmental Protection Act (CEPA), Canada Wildlife Act (CWA), Environmental Enforcement Act (EEA), Canadian Environmental Assessment Act (CEAA), Fisheries Act (water pollution)..	ECCC, DFO	Necessary	Ongoing	All	All
5.1.3 Legislation (Provincial level) Implement and enforce the New Brunswick Fish and Wildlife Act, Protected Natural Areas Act, Species at Risk Act, Clean Environment Act, Clean Water Act, Wetland Conservation Policy and Coastal Areas Protection Policy to conserve fish and wildlife populations, species at risk and the ecological, economic and social functions of these ecosystems on Crown and private lands.	NB ERD	Necessary	Ongoing	All	All
5.1.3. Sub-national Level Develop a working paper on the potential for working forest and forest easement projects in New Brunswick.	NCC	Beneficial	2018	Acadian Forest	
5.2 Policies and Regulations Implement the Federal Policy on Wetland Conservation.	ECCC	Necessary	Ongoing	Freshwater Wetlands, Riparian, Tidal Flats/Estuaries, Salt Marsh	7. Natural System Modifications

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
5.2 Policies and Regulations Develop and implement a new Long Term Wetlands Strategy for NB.	NB DELG	Crucial	2022	Freshwater Wetlands, Salt Marsh	
5.2 Policies and Regulations Participate in the Southeast NB Regional Planning Commission's ecosystem based adaptation project.	NCC, SENB RPC, Nature NB, Local watershed groups	Beneficial	2018	All	
5.2 Policies and Regulations Support progressive planning and ecosystem based adaptation to decision makers by meeting with local and regional politicians.	NCC, NB provincial departments	Beneficial	2019	All	
5.4 Compliance and Enforcement Assume environmental assessment responsibilities (inform and/or coordinate) as required.	ECCC, GNB, CEEA	Necessary	Ongoing	All	All
5.4 Compliance and Enforcement Undertake wildlife and environmental enforcement activities (ECCC Wildlife Enforcement, Environmental Enforcement); address illegal hunting and disturbance, illegal activities, and habitat destruction.	ECCC, GNB	Necessary	Ongoing	All	All
5.4 Compliance and Enforcement Continue to enforce the "Rules of Engagement for the Short Term Measures", which provide protection under the NB Wetlands Conservation Policy for Provincially Significant Wetlands in the province.	NB DELG	Crucial	Ongoing	Salt Marsh	
5.4 Compliance and Enforcement Continue to implement the Coastal Areas Protection Policy for activities occurring in coastal areas of New Brunswick.	NB DELG	Crucial	Ongoing	Beaches, Dunes and Cliffs, Salt Marsh	
5.4 Compliance and Enforcement Continue to require and review EIAs for activities which fall under Schedule A of the Clean Water Act.	NB DELG	Beneficial	Ongoing	Beaches, Dunes, and Cliffs, Freshwater Wetlands,	

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
				Riparian, Salt Marsh	
6. Livelihood, Economic & Other Incentives					
6.4 Conservation Payments Implement and encourage the use of ECCC Ecological Gifts (Ecogifts) program.	ECCC, NCC, NSNT	Necessary	Ongoing	All	1. Residential and Commercial Development
7. External Capacity Building					
7.1 Institutional and Civil Society Development Provide ECCC-CWS support and input into the development of Habitat Conservation Strategies.	EHJV, ECCC, NCC, NTNB, DUC, GNB, BSC, ACCDC, watershed groups, municipalities	Beneficial	Ongoing	All	All
7.2 Alliance and Partnership Development Support the EHJV and provide science guidance to conservation partners on actions and priorities for migratory birds and SAR including development, refinement, and implementation of this HCS and of the NB Bird Conservation Region 14 Strategy.	EHJV, BSC, ECCC, NCC, DUC, GNB, WHC	Necessary	Ongoing	All	All
7.2 Alliance and Partnership Development Provide ECCC-CWS input into: Staying Connected Initiative, Western Hemispheric Shorebird Reserve Network, Important Bird Areas. Coordinate work of Atlantic Canada Shorebird Survey volunteers at 10 survey sites in the bioregion.	ECCC, NCC, DUC, Province of NB, BSC, ACCDC, International ENGOs, other government agencies, watershed groups, municipalities,	Beneficial	Ongoing	All	All
7.2 Alliance and Partnership Development Develop capacity of NCC staff and partners in ecosystem based adaptation practice and tools (e.g. INVEST software, review examples in other jurisdictions).	NCC	Beneficial	2018	All	
7.2 Alliance and Partnership Development NCC regional staff will assist Other Qualifying	NCC, other NGOs	Necessary	2024	All	

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
Organizations (OQO) in identifying eligible projects for funding in the NA and will provide input to application process.					
7.2 Alliance and Partnership Development Work with Community Forests International and support their efforts in working forest easements and Acadian forest restoration.	NCC, CFI	Beneficial	2024	Acadian Forest	
7.2 Alliance and Partnership Development KNP to provide expertise and logistical support to First Nations, NGOs and other partners to support recovery of Piping Plover in areas adjacent to the park	KNP, NGOs, First Nations	Necessary	Ongoing	Beaches and Dunes	
7.2 Alliance and Partnership Development NCC to develop partnership with local Bartibog watershed group to discuss upgrades to route 134 bridge/causeway.	NCC, local watershed groups	Beneficial	2016	Riparian and Aquatic Ecosystems	
7.2 Alliance and Partnership Development Partner with industrial forestry company to develop plan to maintain connectivity across their lands on the Chignecto Isthmus.	NCC	Beneficial	2018	All	
7.2 Alliance and Partnership Development Build and advance conservation partnerships and project/program collaboration with conservation and local community groups	NTNB, others	Beneficial	Ongoing	All	
7.3 Conservation Finance Communicate, inform, and increase awareness related to funding opportunities for ENGOs, communities, indigenous organizations and academia related to conservation. For example: Community Action Programs for the Environment, including work on habitat and ecological system conservation/stewardship through direct and in-kind	ECCC, US Federal and State partners	Necessary	Ongoing	All	All

Conservation Actions[2] Description of related action (specific and measurable if possible)	Collaborators	Importance[3] /Conservation Goals	Date for Completion	Priority Habitats[4]	Primary Related Threat(s)
support (EcoAction Community Funding Program, Environmental Damages Fund (EDF), National Conservation Plan (NCP) – National Wetland Conservation Fund (NWCF), Gulf of Maine Initiative (GMI), Atlantic Ecosystem Initiatives (AEI), Habitat Stewardship Program (HSP), Aboriginal Fund for Species at Risk (AFSAR), North American Wetland Conservation Act (NAWCA)/Eastern Habitat Joint Venture (EHJV), North Atlantic Landscape Conservation Cooperative (NALCC)).					
7.3 Conservation Finance Offer support to ENGOs, communities, aboriginal organizations, and academia via employment programs, including the Science Horizons Youth Internship Program, and the International Environmental Youth Corps program delivered by Environmental Careers Organization Canada and Colleges and Institute Canada.	ECCC	Beneficial	Ongoing	All	All
7.3 Conservation Finance Implement and encourage the use of ECCC Ecological Gifts (Ecogifts) program.	ECCC, NCC, NSNT	Necessary	Ongoing	All	1. Residential and Commercial Development
7.3 Conservation Finance Continue to collaborate with and support non-government organization efforts on biodiversity, species at risk, habitat and ecosystem identification, conservation and stewardship through direct and in-kind support (Examples: New Brunswick Wildlife Trust Fund, Environmental Trust Fund).	NB ERD	Beneficial	Ongoing	All	All
7.3 Conservation Finance Fundraising to support work on mature / old forest habitats	NCC, CFI	Beneficial	2024	Acadian Forest	

E. Knowledge Gaps

The following knowledge gaps and opportunities for improvement were identified through the course of developing this HCS:

- Identified during the March 2017 stakeholder workshop was the need for improved communication and collaboration amongst conservation partners.
- An assessment of road crossings and culverts within the bioregion would help identify barriers and threats to aquatic habitat connectivity. Mapping of this information would be an important tool which conservation groups could use in prioritization of activities to remove threats and improve habitat.
- With the exception of forest pest species or aquatic species, there is little information on distribution and abundance of terrestrial or aquatic invasive species. This information is critical to be able to better develop management tools for protection and enhancement of habitat.
- The wet areas mapping tool currently under development by the University of New Brunswick and the Department of Environment and Local Government will provide refined details on aquatic habitats throughout the bioregion, allowing for improved priority habitat identification and more targeted conservation actions.
- Currently available geomorphological data is not well-implemented into long-term planning and tools for adaptation of coastal communities to combat sea-level rise and climate change impacts.
- Increased knowledge of local sediment stocks within coastal communities. Current sediment stocks are considered in crisis, given that post-glacial sediment stocks are historically low and new inputs are limited by shoreline hardening (D. Berube, pers. comm.). The availability of new sediment is critical to maintain coastal habitats in dynamic equilibrium with climate change and sea-level rise. Use of the sediment cell concept (the region of deposition, erosion, and transportation of sediment along a coastline) should be encouraged to manage coastal areas in the future and encouraging coastal communities to work to preserve sediment stocks for future coastal habitats.

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APPENDIXES

Appendix A. Glossary

Acronyms	Title
ACCDC	Atlantic Canada Coastal Data Centre
BCR	Bird Conservation Region
BSC	Bird Studies Canada
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DUC	Ducks Unlimited Canada
EC	Environment Canada
ECCC	Environment and Climate Change Canada
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
MBBA	Maritime Breeding Bird Atlas
MBCA	Migratory Bird Convention Act
MBU	Marine Biogeographical Unit
NAP	Natural Area Plan
NAAP	Northern Appalachian-Acadian Ecoregional Plan
NAWCA	North American Waterfowl Conservation Act
NAWMP	North American Waterfowl Management Plan
NB DNR	New Brunswick Department of Natural Resources
NB ERD	New Brunswick Department of Energy and Resource Development
NB DELG	New Brunswick Department of Environment and Local Government
NB SARA	New Brunswick Species at Risk Act
NCC	Nature Conservancy of Canada
NTNB	Nature Trust of New Brunswick
Pers. comm.	Personal Communication
PNA	Protected Natural Area
SAR	Species at Risk
SARA	Canada's Species at Risk Act
WNS	White Nose Syndrome

Appendix B. Glossary of Biodiversity and Species Ranking.

Species at Risk (SAR): those species that have been designated as Endangered, Threatened or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), or listed through provincial endangered species legislation.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): a national committee of experts that assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. COSEWIC assigns the following status to species:

Status	Definition
Extinct (EXT)	A wildlife species that no longer exists.
Extirpated (EXP)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere in the wild.
Endangered (EN)	A wildlife species facing imminent extirpation in Canada, or extinction.
Threatened (TH)	A wildlife species likely to become endangered if limiting factors are not reversed. A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)	A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)	A wildlife species that has been evaluated and found to be not at risk given the current circumstances.
Data Deficient (DD)	A species for which there is insufficient information to resolve a species' eligibility for assessment or to permit an assessment of the species' risk of extinction.

Species at Risk Act (SARA): Enacted in 2002, the purposes of this Act are to prevent wildlife species in Canada from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened. The legislation sets out requirements for recovery strategies, management plans, the designation of critical habitat to guide and protect species and their habitats, as well as penalties should any section of the act be violated. The Act applies to all species occurring on federal lands, as well as migratory species identified under the *Migratory Bird Convention Act*.

New Brunswick Species at Risk Act (NB SARA): The NB SARA replaced the *New Brunswick Species at Risk Act* in 2013, and provided increased guidance and direction to the recovery and management of species at risk in New Brunswick. A provincial species at risk committee evaluates and recommends species for listing. Species are assessed to determine feasibility of recovery using factors such as biological, technical, economic, and social factors. Set out in the legislation are requirements and timelines for the development and publishing of such items as recovery strategies, action plans, protection assessments,

and the designation of survival and recovery habitat. The NB SARA uses COSEWIC terminology and definitions for species at risk rankings.

Rarity Ranks

Global Rank (G-RANK): the overall status of a species or ecological community is regarded as its "global" status; this range-wide assessment of condition is referred to as its global conservation status rank. Global conservation status assessments are generally carried out by NatureServe scientists with input from relevant natural heritage member programs (e.g., CDCs and NHICs) and experts on particular taxonomic groups, and are based on a combination of quantitative and qualitative information.

Global Conservation Status Ranks

Status	Definition
GX	**Presumed Extinct (species)—**Not located despite intensive searches and virtually no likelihood of rediscovery. Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
GH	**Possibly Extinct (species)—**Missing; known from only historical occurrences but still some hope of rediscovery. Presumed Eliminated (historic ecological communities)—Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut Forest.
G1	**Critically Imperilled—**At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	**Imperilled—**At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	**Vulnerable—**At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4	**Apparently Secure—**Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure—**Common; widespread and abundant.
G#G#	**Range Rank—**A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. A G2G3 rank would indicate that there is a roughly equal chance of G2 or G3 and other ranks are much less likely. Ranges cannot skip more than one rank.
GU	**Unrankable—**Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and a question mark qualifier may be added (e.g., G2?) to express minor uncertainty, or a range rank (e.g., G2G3) may be used to delineate the limits (range) of uncertainty.
GNR	**Unranked—**Global rank not yet assessed.
GNA	**Not Applicable—**A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Sub-national (Provincial) Rank (S-RANK): sub-national conservation status assessments are generally carried out by Canadian Data Centre (CDC) scientists with input from federal and provincial experts on particular taxonomic groups, and are based on a combination of quantitative and qualitative information. Provincial ranks are used by CDCs and Nature Serve programs to set conservation priorities

for rare species and vegetation communities and are not legal designations. Comparison of global and provincial ranks gives an indication of the status and rarity of an element in that province in relation to its overall conservation status, therefore providing insight into the urgency of conservation action for it in the province.

Sub-national Conservation Status Ranks

Status	Definition
SX	**Presumed Extirpated**—Species or community is believed to be extirpated from the province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	**Possibly Extirpated (Historical)**—Species or community occurred historically in the province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become SH without such a 2040 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
S1	**Critically Imperilled**—Critically imperilled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the province.
S2	**Imperilled**—Imperilled in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
S3	**Vulnerable**—Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	**Secure**—Common, widespread, and abundant in the province.
SNR	**Unranked**—Province conservation status not yet assessed.
SU	**Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	**Not Applicable**—A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#S# S#B S#N	**Range Rank**—A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4). Breeding (Migratory species) Non-breeding (Migratory species)

Appendix C. Species Ranking.

Common Name	Scientific Name	COSEWIC	Provincial Status	SARA Schedule 1	G Rank	S Rank	BCR 14	MBU 12
Molluscs								
Brook Floater	*Alasmidonta varicosa*	Special Concern	Special Concern	Special Concern	G3	S1S2		
Triangle Floater	*Alasmidonta undulata*				G4	S2		
Fungi or Lichens								
Crumpled Bat's Wing Lichen	*Collema leptaleum*				GNR	S1S2		
Corrugated Shingles Lichen	*Fuscopannaria ahlneri*				G4G5	S1		
a lichen	*Dendriscocaulon umhausense*				GNR	S2S3		
Friable Horsehair Lichen	*Bryoria friabilis*				G3	SNR		
Eastern Candlewax Lichen	*Ahtiana aurescens*				G3G5	S3		
Non-vascular Plants								
Small Notchwort	*Lophozia ascendens*				G4	S1S3		
Bog-Moss Flapwort	*Odontoschisma sphagni*				G3G5	S1S3		
a Moss	*Anacamptodon splachnoides*				G3G5	S1S2		
Pale Bryum Moss	*Bryum pallescens*				G5	S1S2		
Bonjean's Broom Moss	*Dicranum bonjeanii*				G4G5	S1		
a Moss	*Leucodon brachypus*				G5	SH		
Long-necked Nodding Moss	*Pohlia elongata*				G4G5	S2		
Cottony Nodding Moss	*Pohlia proligera*				G4G5	S2		
a moss	*Pohlia sphagnicola*				G5	S2		
Flexuous Peatmoss	*Sphagnum flexuosum*				G4?	SH		
Yellow Collar Moss	*Splachnum luteum*				G4	S1S3		
Little Georgia	*Tetrodontium brownianum*				G3G4	S1S2		
Geniculate Four-tooth Moss	*Tetraphis geniculata*				G3G5	S3		
a Moss	*Zygodon viridissimus*				G5	S2		

a Moss	*Zygodon viridissimus var. viridissimus*				G5T4T5	S1		
Showy Bristle Moss	*Orthotrichum speciosum*				G5	S2		
Mountain Hair Moss	*Pogonatum dentatum*				G4G5	S2		
One-sided Groove Moss	*Aulacomnium heterostichum*				G3G5	S3		
a Moss	*Schistidium maritimum*				G3?	S2		
Adnate Hairy-gray Moss	*Homomallium adnatum*				G5	S1		
Smaller Fern Moss	*Rauiella scita*				G3G5	S3		
Vascular Plants								
Butternut	*Juglans cinerea*	Endangered	Endangered	Endangered	G4	S1		
New York Aster	*Symphyotrichum novi-belgii var. crenifolium*				G5TNR	S2?		
Annual Saltmarsh Aster	*Symphyotrichum subulatum (non-Bathurst pop)*				G5T5	S1		
Stiff Aster	*Ionactis linariifolius*				G5	S2		
Gulf of St. Lawrence Aster	*Symphyotrichum laurentianum*	Threatened	Endangered	Threatened	G2	S1		
Bathurst Aster - Bathurst pop.	*Symphyotrichum subulatum (Bathurst pop)*				G5T1	S2		
Estuary Beggarticks	*Bidens hyperborea var. hyperborea*				G4T2T4	S3		
Fleshy Stitchwort	*Stellaria crassifolia*				G5	S1		
Beach Pinweed	*Lechea maritima*	Special Concern		Special Concern	G5T2	S2		
Seaside Spurge	*Chamaesyce polygonifolia*				G5?	S1		
Red-disked Yellow Pond-lily	*Nuphar lutea ssp. rubrodisca*				G5T3T5	S2		
Purple-veined Willowherb	*Epilobium coloratum*				G5	S2?		
Water Blinks	*Montia fontana*				G5	SH		
Pennsylvania Blackberry	*Rubus pensilvanicus*				G5	S2?		
Arching Dewberry	*Rubus recurvicaulis*				G4?	S2?		
Labrador Bedstraw	*Galium labradoricum*				G5	S2S3		
Long-lobed Arrowhead	*Sagittaria calycina var. spongiosa*				G5T4	S2		
Eastern Skunk Cabbage	*Symplocarpus foetidus*				G5	S2		
Narrow-leaved Beaked Sedge	*Carex rostrate*				G5	S1S2		

Limestone Meadow Sedge	*Carex granularis*				G5	S2		
Lesser Brown Sedge	*Carex adusta*				G5	S2S3		
Yellow-Fruited Sedge	*Carex annectens*				G5	S1		
White-tinged Sedge	*Carex albicans var. emmonsii*				G5T5	S2		
Sparse-Flowered Sedge	*Carex tenuiflora*				G5	S2		
Pubescent Sedge	*Carex hirtifolia*				G5	S2		
Slender Cottongrass	*Eriophorum gracile*				G5	S2		
Gaspé Arrowgrass	*Triglochin gaspensis*				G3G4	S3		
Greene's Rush	*Juncus greenei*				G5	S1		
Moor Rush	*Juncus stygius ssp. Americanus*				G5T5	S1		
Vasey Rush	*Juncus vaseyi*				G5?	S2		
Auricled Twayblade	*Listera auriculata*				G3G4	S2S3		
Southern Twayblade	*Neottia bifolia*		Endangered		G4	S2		
Canada Rice Grass	*Piptatherum canadense*				G5	S2		
Slender Rice Grass	*Piptatherum pungens*				G5	S2		
Nootka Alkali Grass	*Puccinellia laurentiana*				G3?Q	S2		
Creeping Alkali Grass	*Puccinellia phryganodes*				G5	S2		
Slim-stemmed Reed Grass	*Calamagrostis stricta ssp. inexpansa*				G5T5	S1		
Virginia Chain Fern	*Woodwardia virginica*				G5	S2		
Fragrant Wood Fern	*Dryopteris fragrans var. remotiuscula*				G5T3T5	S3		
Bog Fern	*Thelypteris simulata*				G4G5	S1S2		
Long-leaved Starwort	*Stellaria longifolia*				G5	S2		
Red Pigweed	*Chenopodium rubrum*				G5	S2		
Carey's Smartweed	*Polygonum careyi*				G4	S2		
Narrow-Leaved Gentian	*Gentiana linearis*				G4G5	S2		
Thread-leaved Pondweed	*Stuckenia filiformis ssp. alpina*				G5T5	S2		
Rough Hawthorn	*Crataegus scabrida*				G5?	S2		
Blunt-leaved Bedstraw	*Galium obtusum*				G5	S2?		

Spotted Coralroot	*Corallorhiza maculata var. occidentalis*				G5T3T5	S2S3		
Branched Bartonia	*Bartonia paniculata ssp. iodandra*				G5T3T5	S2S3		
Seabeach Dock	*Rumex pallidus*				G4	S2S3		
American Waterwort	*Elatine americana*				G4	S2S3		
Shining Ladies'-Tresses	*Spiranthes lucida*				G5	S2		
Michaux's Dwarf Birch	*Betula michauxii*				G4G5	S1		
Poison Ivy	*Toxicodendron radicans*				G5	S2?		
Connecticut Beggar-Ticks	*Bidens heterodoxa*				G2Q	S1?		
Common Hop	*Humulus lupulus var. lupuloides*				G5T5	S1S2		
Buttonbush Dodder	*Cuscuta cephalanthi*				G5	S1?		
Blood Milkwort	*Polygala sanguinea*				G5	S2		
Indian Wild Rice	*Zizania aquatica var. aquatica*				G5T5	S2		
Prickly Hornwort	*Ceratophyllum echinatum*				G4?	S2S3		
Red Bulrush	*Blysmus rufus*				G5	S2		
Peach-leaved Dock	*Rumex maritimus var. persicarioides*				G5T3?Q	S2S3		
Nodding Ladies'-Tresses	*Spiranthes cernua*				G5	S2		
Insects								
Yellow-banded Bumble Bee	*Bombus terricola*	Special Concern			G2G4			
Rusty-patched Bumble Bee	*Bombus affinis*	Endangered		Endangered	G1			
Gypsy Cuckoo Bumble Bee	*Bombus bohemicus*	Endangered			G4	SH		
Monarch	*Danaus plexippus*	Special Concern	Special Concern	Special Concern	G4	S3		
Pygmy Snaketail	*Ophiogomphus howei*	Special Concern	Special Concern	Special Concern	G3	S1		
Salt Marsh Copper	*Lycaena dospassosi*				G2G3	S3		
Henry's Elfin	*Callophrys henrici*				G5	S2S3		
Grey Hairstreak	*Strymon melinus*				G5	S2		
Crowberry Blue	*Plebejus idas empetri*				G5	S2		
Subarctic Bluet	*Coenagrion interrogatum*				G5T3T4	S3		
Short-tailed Swallowtail	*Papilio brevicauda*				G3G4	S3		
Short-tailed Swallowtail	*Papilio brevicauda bretonensis*				G3G4T2T3	S3		

Transverse Lady Beetle	*Coccinella transversoguttata richardsoni*				GNRTNR	S1S2		
Quebec Emerald	*Somatochlora brevicincta*				G4	S2		
Clamp-Tipped Emerald	*Somatochlora tenebrosa*				G5	S2		
Canada Whiteface	*Leucorrhinia patricia*				G4	S1		
White Corporal	*Ladona exusta*				G4	S2		
Fishes								
American Eel	*Anguilla rostrata*	Threatened	Threatened	No status	G4	S5		
Atlantic Salmon Gaspe-Southern Gulf of St. Lawrence population	*Salmo salar*	Special Concern	Special Concern	No status	G5	S2		
Striped Bass Southern Gulf of St. Lawrence population	*Morone saxatilis*	Special Concern	Special Concern	No status	G5TNR	SNR		
Reptiles								
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatened	Threatened	G3	S3		
Birds								
Piping Plover melodus subspecies	*Charadrius melodus melodus*	Endangered	Endangered	Endangered	G3TNR	S2B	Y	Y
Red Knot rufa subspecies	*Calidris canutus rufa*	Endangered	Endangered	Endangered	G4T2	S3M		Y
Bank Swallow	*Riparia riparia*	Threatened		No status	G5	S3B		
Barn Swallow	*Hirundo rustica*	Threatened	Threatened	No status	G5	S3B		
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*				G5	S1S2B		
Tree Swallow	*Tachycineta bicolor*				G5		Y	
Bobolink	*Dolichonyx oryzivorus*	Threatened	Threatened	No status	G5	S3S4B	Y	
Canada Warbler	*Cardellina canadensis*	Threatened	Threatened	Threatened	G5	S3S4B	Y	
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened	Threatened	G5	S2S3B	Y	
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened	G5	S3B	Y	
Eastern Meadowlark	*Sturnella magna*	Threatened	Threatened	No status	G5	S1S2B	Y	
Eastern Whip-poor-will	*Antrostomus vociferus*	Threatened	Threatened	Threatened	G5	S2B	Y	
American Bittern	*Botaurus lentiginosus*				G4	S4B	Y	
Least Bittern	*Ixobrychus exilis*	Threatened	Threatened	Threatened	G5	S1S2B	Y	
Olive-sided Flycatcher	*Contopus cooperi*	Threatened		Threatened	G4	S3S4B	Y	
Willow Flycatcher	*Empidonax traillii*				G5	S1S2B		
Purple Martin	*Progne subis*				G5	S1S2B		
Wood Thrush	*Hylocichla mustelina*	Threatened	Threatened	No status	G5	S1S2B	Y	

Yellow Rail	*Coturnicops noveboracensis*				G5	S2B		
Sora	*Porzana carolina*	Special Concern	Special Concern	Special Concern	G4	S1?B	Y	Y
Virginia Rail	*Rallus limicola*				G5	S4B	Y	
Eastern Wood-pewee	*Contopus virens*				G5	S3B	Y	
Peregrine Falcon anatum/tundrius	*Falco peregrinus anatum/tundrius*	Special Concern	Special Concern	Special Concern	G5	S4B		
Red-necked Phalarope	*Phalaropus lobatus*	Special Concern	Endangered	Special Concern	G4T4	S1B	Y	
Wilson's Phalarope	*Phalaropus tricolor*	Special Concern		No status	G4G4	S3M		
Rusty Blackbird	*Euphagus carolinus*				G5	S1B		
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	Special Concern	G4	S3B	Y	
Long-eared Owl	*Asio otus*	Special Concern	Special Concern	Special Concern	G5	S3B	Y	
Boreal Owl	*Aegolius funereus*				G5	S2S3		
Bald Eagle	*Haliaeetus leucocephalus*				G5	S1S2B		
Northern Goshawk	*Accipiter gentilis*	Not at Risk	Endangered		G5	S3B		
Red-shouldered Hawk	*Buteo lineatus*				G5	S4	Y	
Cooper's Hawk	*Accipiter cooperii*				G5	S2B	Y	
Gyrfalcon	*Falco rusticolus*				G5	S1S2B		
American Redstart	*Setophaga ruticilla*				G5	S1N		
American Three-toed Woodpecker	*Picoides dorsalis*				G5	S3?	Y	
Black-backed Woodpecker	*Picoides arcticus*				G5	S4	Y	G5
Yellow-bellied Sapsucker	*Sphyrapicus varius*				G5	S5B	Y	G5
Bay-breasted Warbler	*Setophaga castanea*				G5	S4B	Y	
Blackburnian Warbler	*Setophaga fusca*				G5	S5B	Y	
Black-throated Blue Warbler	*Setophaga caerulescens*				G5	S5B	Y	
Black-throated Green Warbler	*Setophaga virens*				G5	S5B	Y	
Cape May Warbler	*Setophaga tigrina*				G5	S4B	Y	
Magnolia Warbler	*Setophaga magnolia*				G5	S5B	Y	
Blue-headed Vireo	*Vireo solitarius*				G5	S5B	Y	
Boreal Chickadee	*Poecile hudsonicus*				G5	S4	Y	
Belted Kingfisher	*Megaceryle alcyon*				G5	S5B	Y	
Black-billed Cuckoo	*Coccyzus erythropthalmus*				G5	S4B	Y	

House Wren	*Troglodytes aedon*				G5	S1B		
Marsh Wren	*Cistothorus palustris*				G5	S2B		
Eastern Kingbird	*Tyrannus tyrannus*				G5	S3S4B	Y	
Evening Grosbeak	*Coccothraustes vespertinus*				G5	S3S4B,S4S5N	Y	
Nelson's Sparrow	*Ammodramus nelson*				G5	S4B	Y	
Vesper Sparrow	*Pooecetes gramineus*				G5	S2B		
White-throated Sparrow	*Zonotrichia albicollis*				G5	S5B	Y	
Purple Finch	*Haemorhous purpureus*				G5	S4S5B	Y	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*				G5	S4B	Y	
Pine Grosbeak	*Pinicola enucleator*				G5	S2S3B,S4S5N		
Ruffed Grouse	*Bonasa umbellus*				G5		Y	
Veery	*Catharus fuscescens*				G5	S4B	Y	
White-breasted Nuthatch	*Sitta carolinensis*				G5	S5	Y	
American Woodcock	*Scolopax minor*				G5	S5B	Y	
American Golden-Plover	*Pluvialis dominica*				G5	S3M	Y	
Black-bellied Plover	*Pluvialis squatarola*				G5	S4M		Y
Dunlin	*Calidris alpina*				G5	S4M		Y
Hudsonian Godwit	*Limosa haemastica*				G4	S4M		Y
Killdeer	*Charadrius vociferus*				G5	S3B		
Horned Lark	*Eremophila alpestris*				G5	S2B		
Eastern Meadowlark	*Sturnella magna*				G5	S1S2B		
Lesser Yellowlegs	*Tringa flavipes*				G5	S5M	Y	Y
Sanderling	*Calidris alba*				G5	S4M,S1N		Y
Least Sandpiper	*Calidris minutilla*				G5	S4M		Y
Semipalmated Sandpiper	*Calidris pusilla*				G5	S4M		Y
Solitary Sandpiper	*Tringa solitaria*				G5	S2B,S5M	Y	Y
Spotted Sandpiper	*Actitis macularius*				G5	S4B	Y	
Upland Sandpiper	*Bartramia longicauda*				G5	S1B		
Whimbrel	*Numenius phaeopus*				G5	S4M	Y	Y
Willet	*Tringa semipalmata*				G5	S2S3B		Y
Wilson's Snipe	*Gallinago delicata*				G5	S4B	Y	
Black-headed Gull	*Chroicocephalus ridibundus*				G5	S2M,S1N		

Laughing Gull	*Leucophaeus atricilla*				G5	S1B		
Black-legged Kittiwake	*Rissa tridactyla*				G5	S1B,S4N		
Northern Gannet	*Morus bassanus*				G5	SHB,S5M,S5N		
Arctic Tern	*Sterna paradisaea*				G5	S1B		
Black Tern	*Chlidonias niger*				G4	S2B	Y	
Common Tern	*Sterna hirundo*				G5	S3B	Y	Y
Common Loon	*Gavia immer*				G5	S4B,S5M,S4N	Y	Y
Red-throated Loon	*Gavia stellata*				G5	S4M,S4N		Y
Green Heron	*Butorides virescens*				G5	S1S2B	Y	
Black-crowned Night-heron	*Nycticorax nycticorax*				G5	S1S2B		
Horned Grebe	*Podiceps auritus*				G5	S4M,S4N		Y
Pied-billed Grebe	*Podilymbus podiceps*				G5	S4B	Y	
Red-necked Grebe	*Podiceps grisegena*				G5	S3M,S2N		Y
American Black Duck	*Anas rubripes*				G5	S5B,S4N	Y	Y
Black Scoter	*Melanitta americana*				G5	S3M,S2S3N	Y	
Surf Scoter	*Melanitta perspicillata*				G5	S4M,S4N		Y
Canada Goose	*Branta canadensis*				G5	S4B,S4M	Y	Y
Common Eider	*Somateria mollissima*				G5	S4		Y
King Eider	*Somateria spectabilis*				G5	S2N		
Barrow's Goldeneye Eastern population	*Bucephala islandica*	Special Concern	Special Concern	Special Concern	G5	S2N	Y	Y
Common Goldeneye	*Bucephala clangula*				G5	S4B,S5M,S4N	Y	Y
Harelquin Duck (Eastern population)	*Histrionicus histrionicus*	Special Concern	Endangered	Special Concern	G4T4	S1B,S1N	Y	Y
Green-winged Teal	*Anas carolinensis*				G5	S4S5B	Y	Y
Long-tailed Duck	*Clangula hyemalis*				G5	S4N		Y
Mallard	*Anas platyrhynchos*				G5	S5B,S4N	Y	
Ring-necked Duck	*Aythya collaris*				G5	S5B	Y	
Wood Duck	*Aix sponsa*				G5	S4B	Y	
Ruddy Duck	*Oxyura jamaicensis*				G5	S1B,S4N		
Northern Shoveler	*Anas clypeata*				G5	S2B		
Gadwall	*Anas strepera*				G5	S2B		

Brant	*Branta bernicla*				G5	S2S3M,S2S3N		G5
American Coot	*Fulica americana*				G5	S2B		
Greater Scaup	*Aythya marila*				G5	S1B,S2N		
Mammals								
Little Brown Myotis	*Myotis lucifugus*	Endangered	Endangered	Endangered	G3	S1		
Hoary Bat	*Lasiurus cinereus*				G5	S2?		
Canada Lynx	*Lynx canadensis*	Not at Risk	Endangered		G5	S1		
Cougar-Eastern population	*Puma concolor pop. 1*	Data Deficient			G5THQ	SU,SH		
Maritime Shrew	*Sorex maritimensis*				G3	S3		

Appendix D. NCC Natural Area Plan species list for the Northumberland Strait bioregion.

Species common name	Species scientific name	Species type	COSEWIC status	Provincial status	G-rank	N-rank	S-rank	Other status	Associated targets							Other notes
									Estuaries (Tidal Flats)	Acadian Forest	Freshwater Wetlands	Salt Marsh	Beaches/ Dune	Coastal Island	Aquatic/ Riparian	
America Green-winged Teal	*Anas crecca*	Bird			G5		S4S5B			x	x				x	Open waters & Grasslands
American Black Duck	*Anas rubripes*	Bird			G5		S5B,S4N	BCR 14 NB		x	x				x	Open waters & Grasslands
American Golden-Plover	*Pluvialis dominica*	Bird			G5		S3M	BCR 14 NB	x				x			Coastal areas & grasslands. Beaches
Arctic Tern	*Sterna paradisaea*	Bird			G5		S1B	BCR 14 NB						x		open tundra, boreal forest, or on rocky islands and beaches

Baird's Sandpiper	*Calidris bairdii*	Bird			G5		SNAM		x		x					dry coastal & alpine tundra, mudflats, estuaries, grassy marshes, and dry grassy areas near lakes and ponds
Bald Eagle	*Haliaeetus leucocephalus*	Bird	NAR	Endangered	G5		S3B	BCR 14 NB		x	x				x	Mature Forest near water
Bank Swallow	*Riparia riparia*	Bird	T	Reg.Endangered	G5		S3B	BCR 14 NB		x					x	Banks & cliffs, with sandy soil
Barn Swallow	*Hirundo rustica*	Bird	TH		G5		S3B	BCR 14 NB		x					x	
Barred Owl	*Strix varia*	Bird			G5		S5			x						mature forests with deciduous & evergreens, often near water.
Barrow's Goldeneye - Eastern pop.	*Bucephala islandica (Eastern pop.)*	Bird	SC		G5		S2N	BCR 14 NB			x				x	
Bicknell's Thrush	*Catharus bicknelli*	Bird	TH		G4		S2S3B	BCR 14 NB		x						High elevation dense conifers
Black Scoter	*Melanitta nigra*	Bird			G5		S3M,S2S3N	BCR 14 NB								
Black-backed Woodpecker	*Picoides arcticus*	Bird			G5		S4	BCR 14 NB		x	x					
Black-bellied Plover	*Pluvialis squatarola*	Bird			G5		S4M	BCR 14 NB	x			x	x			Coastal areas & grasslands

Black-headed Gull	*Chroicocephalus ridibundus*	Bird			G5		S2M,S1N		x		x			x		Breeds along lakes, rivers, bogs, moors, grasslands, swamps, and coastal marshes. In winter, found primarily along seacoasts, estuaries, and bays.
Black-legged Kittiwake	*Rissa tridactyla*	Bird			G5		S1B,S4N	BCR 14 NB						x		
Blackpoll Warbler	*Setophaga striata*	Bird			G5		S4B			x						Breeds in boreal coniferous forest (primarily spruce) and woodland, mixed coniferous-deciduous second growth, tall shrubs, and alder thickets; in migration and winter found in a variety of forest, woodland, scrub and brushy habitats.
Bobolink	*Dolichonyx oryzivorus*	Bird	TH		G5		S3S4B	BCR 14 NB			x					Grasslands & herbaceous
Boreal Owl	*Aegolius funereus*	Bird	NAR		G5		S1S2B			x	x					Dense coniferous or mixedwood forst and alder thickets
Brant	*Branta bernicla*	Bird			G5		S2S3M, S2S3N				x					Marsh
Brown Thrasher	*Toxostoma rufum*	Bird			G5		S2B			x						Thickets in deciduous clearings
Buff-breasted Sandpiper	*Tryngites subruficollis*	Bird	SC		G4		SNA		x		x		x		x	Grasslands. Coastal areas & wetlands. Beaches

Bufflehead	*Bucephala albeola*	Bird			G5		S3N			x				x		Coasts & large bodies of water, shallow saltwater bays. Northern forest lakes where conifers mix with poplars or aspens.
Canada Goose	*Branta canadensis*	Bird			G5		SNAB,S4M	BCR 14 NB		x	x				x	BCR 14 priority species - management concern. Open water & herbaceous
Canada Warbler	*Wilsonia canadensis*	Bird	TH		G5		S3S4B	BCR 14 NB		x	x					Moist forest/wetland with dense understory
Cape May Warbler	*Setophaga tigrina*	Bird			G5		S4B	BCR 14 NB		x						old spruce-fir forest
Caspian Tern	*Hydroprogne caspia*	Bird			G5		SNA									
Chimney Swift	*Chaetura pelagica*	Bird	T		G5		S2S3B	BCR 14 NB		x	x					Mature & poplar
Cliff Swallow	*Petrochelidon pyrrhonota*	Bird			G5		S3S4b									vertical cliff faces. They have adopted many bridges, overpasses, and culverts as their colonial nesting sites. They feed in areas near and over water, frequently mixing with other species of swallows.
Common Eider	*Somateria mollissima*	Bird			G5		S4	BCR 14 NB				x				Beaches, rocky shores. Coastal areas
Common Goldeneye	*Bucephala clangula*	Bird			G5		S4B,S5M,S4N	BCR 14 NB			x				x	Mature forest near water

Common Loon	*Gavia immer*	Bird	NAR		G5		S4B,S5M,S4N	BCR 14 NB							x	Large water bodies with sheltered coves
Common Merganser	*Mergus merganser*	Bird			G5		S5B,S4N			x	x	x				Freshwater rivers and lakes. Sometimes use saltwater estuaries in winter, nesting in tree cavities in northern forests near rivers and lakes.
Common Nighthawk	*Chordeiles minor*	Bird	TH		G5		S3B			x	x		x			Mature open forest, bogs, beaches & herbaceous
Common Tern	*Sterna hirundo*	Bird	NAR		G5		S3B	BCR 14 NB				x	x	x		Prefers islands in large water bodies. Nests on beaches
Double-crested Cormorant	*Phalacrocorax auritus*	Bird			G5		S5B							X		Large freshwater lakes.
Dunlin	*Calidris alpina*	Bird			G5		S4M	BCR 14 NB	x	x	x		x		x	Beach, mudflats & shorelines
Eastern Bluebird	*Sialia sialis*	Bird			G5		S4B									Eastern Bluebirds live in meadows and openings surrounded by trees. With the proliferation of nest boxes and bluebird trails, bluebirds are now a common sight along roads, field edges, golf courses, and other open areas.
Eastern Meadowlark	*Sturnella magna*	Bird	TH		G5		S1S2B	BCR 14 NB								Grasslands & wet fields

Eastern Wood-Pewee	*Contopus virens*	Bird	SC		G5		S4B	BCR 14 NB		x						Old tolerant hardwood
European Golden-Plover	*Pluvialis apricaria*	Bird			G4?							x				Mudflats & grasslands
Gadwall	*Anas strepera*	Bird			G5		S2B			x	x					Open waters & grasslands
Great Black-backed Gull	*Larus marinus*	Bird			G5		S5B,S5N							x	x	
Great Blue Heron	*Ardea herodias*	Bird			G5		S4B				x	x				Grasslands,saltwater and freshwater habitats, from open coasts, marshes, sloughs, riverbanks, and lakes
Great Crested Flycatcher	*Myiarchus crinitus*	Bird			G5		S3B			x						woodlots and open woodland, particularly among deciduous trees
Greater Scaup	*Aythya marila*	Bird			G5		S1B,S2N								x	Found on lakes, ponds, and bays. Mostly marine in winter.
Greater Yellowlegs	*Tringa melanoleuca*	Bird			G5		S5M				x	x			x	Shorebird. Wet bogs with small wooded islands, and forests (usually coniferous). Winters in wide variety of shallow fresh and saltwater habitats.
Herring Gull	*Larus argentatus*	Bird			G5		S5B,S5N		x			x		x	x	

Horned Lark	*Eremophila alpestris*	Bird			G5		S2B									Grasslands, terrestrial & marine
House Finch	*Haemorhous mexicanus*	Bird			G5		SNA									Urban areas. Grasslands
House Wren	*Troglodytes aedon*	Bird			G5		S1B			x	x					Dense thickets in forests. Grasslands
Hudsonian Godwit	*Limosa haemastica*	Bird			G4		S4M	BCR 14 NB	x		x	x	x		x	Coastal areas, wetlands & grassland
Indigo Bunting	*Passerina cyanea*	Bird			G5		S3B									Open woodland
Killdeer	*Charadrius vociferus*	Bird			G5		S3B	BCR 14 NB			x		x			Beach, marsh & grasslands
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Bird			G5		S2B	BCR 14 NB						x		
Purple Sandpiper	*Calidris maritima*	Bird			G5		S4M, S3M, S3N	BCR 14 NB	x							Beach, rocky shores & coastal areas
Least Sandpiper	*Calidris minutilla*	Bird			G5		S4M	BCR 14 NB	x	x	x				x	Beach, rocky shores. Wetlands & coastal areas. Bog, fen & emergent WL
Lesser Yellowlegs	*Tringa flavipes*	Bird			G5		S5M	BCR 14 NB	x	x	x	x			x	Coastal areas & wetlands. Beach, bog,emergent WL & forested WL.
Long-eared Owl	*Asio otus*	Bird			G5		S2S3									Require a combination of grassland or other open

																country for foraging, and dense tall shrubs or trees (pine stands) for nesting and roosting.
Long-tailed Duck	*Clangula hyemalis*	Bird			G5		S4N	BCR 14 NB							x	Large water bodies
Mallard	*Anas platyrhynchos*	Bird			G5		S5B,S4N	BCR 14 NB		x	x				x	Open water & grasslands
Marbled Godwit	*Limosa fedoa*	Bird			G5		SNA							x		Large shorebird
Northern Cardinal	*Cardinalis cardinalis*	Bird			G5		S4B			x						Open woodland, dense shrubby areas such as forest edges, overgrown fields, hedgerows, backyards, marshy thickets, regrowing forest, and ornamental landscaping
Northern Mockingbird	*Mimus polyglottos*	Bird			G5		S3B									Songbird. Parks, forest edges, and open land at low elevations.
Northern Pintail	*Anas acuta*	Bird			G5		S3B				x				x	Duck. Lakes & ponds
Northern Saw-whet Owl	*Aegolius acadicus*	Bird			G5		S4B, S4N			x						
Northern Shoveler	*Anas clypeata*	Bird			G5		S2B		x	x	x				x	Open waters & grasslands

Olive-sided Flycatcher	*Contopus cooperi*	Bird	TH		G4		S3S4B	BCR 14 NB		x	x					Open areas in old spurce-fir (2nd growth-mature)
Osprey	*Pandion haliaetus*	Bird			G5		S4S5B					x				Saltmarshes, rivers, ponds, estuaries
Pectoral Sandpiper	*Calidris melanotos*	Bird			G5		S4M		x							Shorebird
Peregrine Falcon - anatum/tundrius	*Falco peregrinus pop. 1*	Bird	SC		G4T4		S1B	BCR 14 NB		x						Beaches for foraing. Beach & cliff area
Pied-billed Grebe	*Podilynbus podiceps*	Bird			G5		S4B	BCR 14 NB			x	x				Emergent vegetations with open water
Pine Grosbeak	*Pinicola enucleator*	Bird			G5		S2S3B, S4S5N									Winter Finch. Boreal forest
Pine Warbler	*Setophaga pinus*	Bird			G5		S4B			x						Pine forests or in deciduous woods with pine mixed in
Piping Plover melodus ssp	*Charadrius melodus melodus*	Bird	EN		G3TNR		S2B	BCR 14 NB	x				x			Beaches (sand or cobble)
Purple Martin	*Progne subis*	Bird		Endangered	G5		S1S2B		x	x	x	x			x	Open areas near water
Red Crossbill	*Loxia curvirostra*	Bird			G5		S3			x						
Red Knot rufa ssp	*Calidris canutus rufa*	Bird	E		G4T2		S3M	BCR 14 NB	x			x	x	x		intertidal, marine habitats, especially near coastal inlets, estuaries, and bays.

Red Phalarope	*Phalaropus fulicaria*	Bird			G5		S3M	BCR 14 NB							Primarily pelagic
Red-breasted Merganser	*Mergus serrator*	Bird			G5		S3B,S4 S5N					x			Large lakes, rivers and the ocean. It prefers salt water more than the other two species of merganser.
Red-necked Phalarope	*Phalaropus lobatus*	Bird			G4G5		S3M	BCR 14 NB				x	x		Primarily pelagic
Red-shouldered Hawk	*Buteo lineatus*	Bird	NAR		G5		S2B	BCR 14 NB		x	x				Deciduous forest & swamp
Ring-billed Gull	*Larus delawarensis*	Bird			G5		S3B		x		x	x	x		Estuaries, beaches, mudflats, and coastal waters. Seen inland than most other gull species, at reservoirs, lakes, ponds, streams, landfills, parking lots.
Ring-necked Duck	*Aythya collaris*	Bird			G5		S5B	BCR 14 NB			x				Open water with vegetation
Ring-necked Pheasant	*Phasianus colchicus*	Bird			G5		SNA								Agricultural areas intermixed with areas of taller vegetation. Rural roadsides, in overgrown or recently harvested fields, and in brushy areas and hedgerows.
Rusty Blackbird	*Euphagus carolinus*	Bird	SC		G4		S3B	BCR 14 NB		x	x				Moist & swampy forest, bogs

Sanderling	*Calidris alba*	Bird			G5		S4M,S1N	BCR 14 NB	x				x		x	Beach, mudflats & shorelines
Scarlet Tanager	*Piranga olivacea*	Bird			G5		S3S4B									Deciduous & mixed deciduous-evergreen forests in eastern North America. Sensitive to habitat fragmentation, they like large, undisturbed tracts of forest.
Semipalmated Plover	*Charadrius semipalmatus*	Bird			G5		SNRB,S5M		x				x			Shorebird
Semipalmated Sandpiper	*Calidris pusilla*	Bird			G5		S4M	BCR 14 NB	x	x	x				x	Beach & rocky shores. Wetlands & coastal areas
Short-billed Dowitcher	*Limnodromus griseus*	Bird			G5		S4M		x		x	x	x			Coastal mud flats & brackish lagoons, saltwater tidal flats, beaches, and salt marshes. Found in freshwater mud flats and flooded agricultural fields.
Solitary Sandpiper	*Tringa solitaria*	Bird			G5		S2B,S5M	BCR 14 NB	x	x	x	x			x	Forested wetlands & coastal area
Sora	*Porzana carolina*	Bird			G5		S4B	BCR 14 NB		x	x					
Spotted Sandpiper	*Actitis macularius*	Bird			G5		S4B	BCR 14 NB		x			x		x	Beaches & grasslands near shorelines

Surf Scoter	*Melanitta perspicillata*	Bird			G5		S4M,S4N	BCR 14 NB	x		x				x	Coastal areas & wetlands
Upland Sandpiper	*Bartramia longicauda*	Bird			G5		S1B				x	x				Dry patches in wet meadows, peat & grasslands. Bog & emergent WL
Vesper Sparrow	*Pooecetes gramineus*	Bird			G5		S2B									Grasslands, terrestrial
Virginia Rail	*Rallus limicola*	Bird			G5		S3B	BCR 14 NB		x	x					Shallow water with emergent vegetation. Aquatic & emergent WL & vernal pools
Warbling Vireo	*Vireo gilvus*	Bird			G5		S4B			x						Mature deciduous woodlands especially along streams, ponds, marshes, and lakes.
Whimbrel	*Numenius phaeopus*	Bird			G5		S4M	BCR 14 NB	x		x		x		x	Primarily coastal but breeds in hervaceous-shrub areas. Rocky shore,bog, emergent WL, shrub WL, floodplain, Grasslands
Whip-Poor-Will	*Caprimulgus vociferus*	Bird	T		G5		S2B									Mudflats & sandbars. Near water, but unlike many other shorebirds, they are also common in dry areas.
White-rumped Sandpiper	*Calidris fuscicollis*	Bird			G5		S4M		x			x				Marshes, mudflats, sandy beaches, flooded fields, and shores of ponds and lakes.

White-winged Scoter	*Melanitta fusca*	Bird			G5		S4M,S3S4N		x		x			x		Breeds on large freshwater or brackish lakes & ponds. Winters in coastal estuaries, bays, and open coastline with shallow water over shellfish beds.
Willet	*Tringa semipalmata*	Bird			G5		S2S3B	BCR 14 NB	x	x	x	x	x		x	Coastal areas & wetlands.Rocky shore, aquactic bed,emergent WL, flooplain, vernal pools & grasslands
Willow Flycatcher	*Empidonax traillii*	Bird			G5		S1S2B			x	x				x	Deciduous wetlands & forest. Grasslands
Wilson's Phalarope	*Phalaropus tricolor*	Bird			G5		S1B		x		x	x	x			Wetlands & coastal areas. Grasslands
Wilson's Snipe	*Gallinago delicata*	Bird			G5		S4B	BCR 14 NB		x	x				x	Wetlands & wet grasslands
Wood Thrush	*Hylocichla mustelina*	Bird	T		G5		S1S2B	BCR 14 NB		x						Mature forest with dense understory
American Eel	*Anguilla rostrata*	Fish	T		G4		S5								x	Anadromous
Atlantic Salmon	*Salmo salar*	Fish	SC		G5		S2				x				x	Anadromous
Striped Bass	*Morone saxatilis*	Fish	E,E,SC		G5		S2		x		x				x	Anadromous

Little Brown Myotis	*Myotis lucifugus*	Mammal	E		G3		S1			x	x				x	Wide range of habitats. Plus caves & Grasslands
Canadian Lynx	*Lynx canadensis*	Mammal	NAR	Reg.Endangered	G5		S1			x	x					Prefers old coniferous forest.Mixed woods & vernal pools
Cougar - Eastern pop.	*Puma concolor pop. 1*	Mammal	DD	Endangered	G5THQ		SU,SH			x						Mountainous forest
Wood Turtle	*Glyptemys insculpta*	Turtle	T		G3		S3			x	x				x	Grasslands. Permanent streams but will roam to a variety of terrestrial habitats
Canada Whiteface	*Leucorrhinia patricia*	Invertebrate		0	G4		S1			x	x				x	bog ponds & fens with low emergent vegetation, especially floating moss
Clamp-Tipped Emerald	*Somatochlora tenebrosa*	Invertebrate			G5		S2				x					
Grey Hairstreak	*Strymon melinus*	Invertebrate			G5		S2									Open, nonforested sites; common in disturbed, weedy areas.
Hairy-necked Tiger Beetle	*Cicindela hirticollis*	Invertebrate			G5		S2S3				x				x	

Henry's Elfin	*Callophrys henrici*	Invertebrate			G5		S2			x	x				x	Forests, shrub bogs, streamsides
Monarch	*Danaus plexippus*	Invertebrate	SC		G5		S3B				x					Milkweed dependant
Quebec Emerald	*Somatochlora brevicincta*	Invertebrate			G4		S2				x					Bogs, marshes & swamp
Subarctic Bluet	*Coenagrion interrogatum*	Invertebrate			G5		S2								x	Running water or wave washed shores
White Corporal	*Ladona exusta*	Invertebrate			G4		S2									Sandy lakes & ponds. Acid bogs with abudant vegetation. Nutrient poor glacial lakes & ponds
Brook Floater	*Alasmidonta varicosa*	Invertebrate	SC		G3		S1S2								x	
Triangle Floater	*Alasmidonta undulata*	Invertebrate			G4		S2								x	Small streams with gravel & sand
a lichen	*Dendriscocaulon umhausense*	Fungus or Lichen			GNR		S2S3									This species grows among mosses in moist situations.
a Moss	*Anacamptodon*	Vascular plant			G3G5		S1S2									

	splachnoides															
a Moss	*Campylostelium saxicola*	Vascular plant			G3G5		S1									
a Moss	*Drummondia prorepens*	Vascular plant			G5		S1									
a moss	*Pohlia sphagnicola*	Vascular plant			G3?		S2									
a Moss	*Seligeria brevifolia*	Vascular plant			G2G3		S1									
a Moss	*Zygodon viridissimus var. viridissimus*	Vascular plant			G5T4T5		S1									
a Peatmoss	*Sphagnum angermanicum*	Vascular plant			G4		S1S2									
a Peatmoss	*Sphagnum subfulvum*	Vascular plant			GNR		S1									
American Waterwort	*Elatine americana*	Vascular plant			G4		S2S3					x			x	Brackish or salt marshes and flats, lacustrine (in lakes or ponds), riverine (in rivers or streams), shores of rivers or lakes

Annual Saltmarsh Aster	*Symphyotrichum subulatum*	Vascular plant			G5		S2					x				Brackish or salt marshes and flats, marshes, shores of rivers or lakes
Annual Saltmarsh Aster	*Symphyotrichum subulatum*	Vascular plant			G5T5		S1									
Arching Dewberry	*Rubus recurvicaulis*	Vascular plant			G4?		S2?			x						Sandy soils
Auricled Twayblade	*Listera auriculata*	Vascular plant			G3G4		S2S3				x				x	Alder thickets on rocky stream edge and cedar swamps
Annual Saltmarsh Aster (var 2)	*Symphyotrichum subulatum var. 2*	Vascular plant	SC	Endangered	G5T1		S2					x				Grows in areas where salt water is present; found in salt marshes or in saline sands and gravel that occur at or just below sea level.
Beach Pinweed	*Lechea maritima var. subcylindrica*	Vascular plant	SC		G5T2		S2						x			Anthropogenic (man-made or disturbed habitats), coastal beaches (sea beaches), dunes, grassland, meadows and fields, sandplains and barrens
Blood Milkwort	*Polygala sanguinea*	Vascular plant			G5		S2				x		x			Anthropogenic (man-made or disturbed habitats), meadows and fields. Dunes & grasslands
Blunt-leaved Bedstraw	*Galium obtusum*	Vascular plant			G5		S2?			x	x					Floodplain (river or stream floodplains), forests,

																swamps, forests and wet forests.
Bog-Moss Flapwort	*Odontoschisma sphagni*	Vascular plant			G3G5		S1S3									No habitat
Bonjean's Broom Moss	*Dicranum bonjeanii*	Vascular plant			G4G5		S1									No habitat
Branched Bartonia	*Bartonia paniculata ssp. iodandra*	Vascular plant			G5T3T5		S2S3									No habitat
Butternut	*Juglans cinerea*	Vascular plant	E		G4		S1								x	
Buttonbush Dodder	*Cuscuta cephalanthi*	Vascular plant			G5		S1?									Parasite plant. Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes, swamps
Canada Rice Grass	*Piptatherum canadense*	Vascular plant			G5		S2			x						Coniferous, deciduous, mixed forest. Sandy barrens and rocky clearings
Carey's Smartweed	*Polygonum careyi*	Vascular plant			G4		S2				x					Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes
Common Hop	*Humulus lupulus var. lupuloides*	Vascular plant			G5T5		S1S2				x					Anthropogenic (man-made or disturbed habitats), floodplain (river or stream

																floodplains), forests, shrublands or thickets
Connecticut Beggar-Ticks	*Bidens heterodoxa*	Vascular plant			G2Q		S1?				X	X	X			Fresh, brackish, or saline marshes. Typically on upper salt marshes in densely vegetated depressions with an organic substrate. Less frequent on beaches.
Corrugated Shingles Lichen	*Fuscopannaria ahlneri*	Vascular plant			G4G5		S1			x						Dense, humid areas needed for growth.
Cottony Nodding Moss	*Pohlia proligera*	Vascular plant			G4G5		S2			x	x					Beech & spruce forests, pine platations, wetland vegetation meadows, peat bogs and some dry pastures.
Creeping Alkali Grass	*Puccinellia phryganodes*	Vascular plant			G5		S2				x	x				Coastal brackish, freshwater marshes & freshwater sledge meadows.
Crumpled Bat's Wing Lichen	*Collema leptaleum*	Vascular plant			GNR		S1S2			x						Boreal forest, hardwood alluvial floodplain & peatland near sea level.
Dwarf Flapwort	*Jungermannia pumila*	Vascular plant			G5		S2S4			x	x					Substrata, rotting logs, calcareous locations near flowing water.
Eastern Cudweed	*Pseudognaphalium obtusifolium*	Vascular plant			G5		S1			x						Anthropogenic (man-made or disturbed habitats), meadows and fields, shores of rivers or lakes

Eastern Skunk Cabbage	*Symplocarpus foetidus*	Vascular plant			G5		S2				x				x	Floodplain (river or stream floodplains), shores of rivers or lakes, swamps, wetland margins (edges of wetlands)
Felted Leafy Moss	*Rhizomnium pseudopunctatum*	Vascular plant			G5		S1			x						Non-marine. (Nonvascular)
Fleshy Stitchwort	*Stellaria crassifolia*	Vascular plant			G5		S1									Marsh, meadows, riverbank & streams. Perennial, non-marine
Flexuous Peatmoss	*Sphagnum flexuosum*	Vascular plant			G5		S2			x						Non-marine. (Nonvascular)
Forked Panic Grass	*Dichanthelium dichotomum var. dichotomum*	Vascular plant			G5T5		S1				x		x			Dunes, floodplain, grassland,Lakes & meadows. Perennial & non-marine
Frankton's Saltbush	*Atriplex franktonii*	Vascular plant			G2G4		S2					x				Salt marsh and beach
Greene's Rush	*Juncus greenei*	Vascular plant			G5		S1			x	x					Wet meadows
Gulf of St Lawrence Aster	*Symphyotrichum laurentianum*	Vascular plant	T	Endangered	G2		S1					x	x			Grows in (often damp to wet) brackish to saline sand or mud around pools in dune slacks, on sand flats behind dunes, in drier sites in saline marshes, on the littoral fringe, or on sandy

																beaches in protected coves. Sites may have sparse or dense salt marsh vegetation and are generally in full sunlight.
Indian Wild Rice	*Zizania aquatica var. aquatica*	Vascular plant			G5T5		S2				x				x	
Labrador Bedstraw	*Galium labradoricum*	Vascular plant			G5		S2S3				x					Fens (calcium-rich wetlands), marshes, swamps
Lesser Brown Sedge	*Carex adusta*	Vascular plant			G5		S2S3			x	x					Dry, acidic, sandy soils of open woods and clearings, moist shores; 0–400m. Non-marine
Limestone Meadow Sedge	*Carex granularis var. Haleana*	Vascular plant			G5		S2									Habitats ;woodlands, swamps, riverbottom prairies, moist dolomite prairies, weedy meadows, fens and seeps, moist depressions in limestone cliffs, and abandoned fields. This species occurs in both disturbed areas and higher quality habitats.Full sun to full shade, usually on calcareous soils. It occupies habitats from wet meadows and swales to low, wet woods, often along creeks. It is often a successional

																species of small gaps, river floodshores, or even gravel pits and mine tailings.
Little Georgia	*Tetrodontium brownianum*	Vascular plant			G3G4		S1S2							x		Coastal. Non-marine. (Nonvascular)
Long-leaved Starwort	*Stellaria longifolia*	Vascular plant			G5		S2			x	x					Wet meadows and woodlands, marshes, muskegs, grassy roadsides, usually in circumneutral to calcareous sites; 0-2800m. Forests & forest margins
Long-lobed Arrowhead	*Sagittaria calycina var. spongiosa*	Vascular plant			G5T4		S2									Obilgate wetland
Long-necked Nodding Moss	*Pohlia elongata*	Vascular plant			G4G5		S2			x						Non-marine. (Nonvascular)
Michaux's Dwarf Birch	*Betula michauxii*	Vascular plant			G4G5		S1				x					Sphagnum bogs, around pools, and wet peaty meadows; 0--700m.
Moor Rush	*Juncus stygius ssp.*	Vascular plant			G5T5		S1				x					Boggy open ground

	americanus															
Narrow-leaved Beaked Sedge	*Carex rostrata*	Vascular plant			G5		S1S2				x				x	Boggy shores and meadows
Narrow-Leaved Gentian	*Gentiana linearis*	Vascular plant			G4G5		S2				x					Facultative & obilgate wetland, forb/herb, non-marine
New York Aster	*Symphyotrichum novi-belgii var. crenifolium*	Vascular plant			G5TNR		S2?				x				x	Thickets and gravelly shores
Nootka Alkali Grass	*Puccinellia laurentiana*	Vascular plant			G3?Q		S2							x		Facultative & obilgate wetland, perennial, non-marine, coast
Pale Bryum Moss	*Bryum pallescens*	Vascular plant			G5		S1S2									No information found
Peach-leaved Dock	*Rumex persicarioides*	Vascular plant			G5T3?Q		S2S3				x	x				Anthropogenic (man-made or disturbed habitats), brackish or salt marshes and flats, coastal beaches (sea beaches), meadows and fields, wetlands
Pennsylvania Blackberry	*Rubus pensilvanicus*	Vascular plant			G5		S2?			x						Clearings and roadsides

Poison Ivy	*Toxicodendron radicans*	Vascular plant			G5		S2?			x					x	
Prickly Hornwort	*Ceratophyllum echinatum*	Vascular plant			G4?		S2S3				x				x	Stillwaters
Pubescent Sedge	*Carex hirtifolia*	Vascular plant			G5		S2			x					x	Dry rich woods and rocky floodplains
Willow-herb	*Epilobium coloratum*	Vascular plant			G5		S2?			x	x					Habitates include poorly drained areas of black soil prairies, moist woodlands, woodland borders, and various kinds of wetlands, including marshes, bogs, fens, seeps, and edges of ponds, rivers, or drainage ditches. The Willow Herbs are pioneer species that thrive on some kind of disturbance, such as fire.
Red Bulrush	*Blysmus rufus*	Vascular plant			G5		S2				x	x				Coast, freshwater,salt marsh, peatland. Perennial, non-marine & obilgate wetlands
Red Pigweed or Red goosefoot	*Chenopodium rubrum*	Vascular plant			G5		S2					x	x			A real "weed" capable of growing almost everywher. Dunes & saline/brackish
Red-disked Yellow Pond-lily	*Nuphar lutea ssp. rubrodisca*	Vascular plant			G5T3T5		S2				x				x	Lakes, ponds sluggish streams and backwaters

Rough Hawthorn	*Crataegus scabrida*	Vascular plant			G5?		S2			x					x	
Seabeach Dock	*Rumex pallidus*	Vascular plant			G4		S2S3					x	x	x		Coast, dune, marsh, sand, sea beach, non-marine. Factulative Wetland
Seaside Spurge or Seaside Sandmat	*Chamaesyce polygonifolia*	Vascular plant			G5?		S1									Sandy beach, coast, dune, lake, ocean & wetlands. Factultive Upland
Shining Ladies'-Tresses	*Spiranthes lucida*	Vascular plant			G5		S2				x				x	
Slender Cottongrass	*Eriophorum gracile*	Vascular plant			G5		S2				x					Bogs, fens (calcium-rich wetlands), meadows and fields
Slender Rice Grass	*Piptatherum pungens*	Vascular plant			G5		S2			x						rocky or sandy, open woods and clearings
Small Notchwort	*Lophozia ascendens*	Vascular plant			G4		S1S3									Non-marine. (Nonvascular)
Southern Twayblade	*Listera australis*	Vascular plant		Endangered	G4		S2			x	x					
Sparse-Flowered Sedge	*Carex tenuiflora*	Vascular plant			G5		S2				x					Lime rich fens and boggy meadows
Spotted Coralroot	*Corallorhiza maculata var.*	Vascular plant			G5T3T5		S2S3			x						Part shade, shade; moist upland forest, swamps

	occidentalis															
Stiff Aster	*Ionactis linariifolius*	Vascular plant			G5		S2						x			Habitats include stabilized sand dunes, open rocky woodlands, rocky wooded slopes, and sandstone glades. This wildflower is found in high quality natural habitats with sparse ground cover. It benefits from occasional wildfires in wooded areas, as this reduces the encroachment of woody vegetation.
Thread-leaved False Pondweed	*Stuckenia filiformis ssp. alpina*	Vascular plant			G5T5		S2								x	Lacustrine (in lakes or ponds), riverine (in rivers or streams)
Vasey Rush	*Juncus vaseyi*	Vascular plant			G5?		S2								x	Wet sandy shores and dune hollows
Virginia Chain Fern	*Woodwardia virginica*	Vascular plant			G5		S2				x					Upland, non-aquatic. Anthropogenic (man-made or disturbed habitats), bogs, marshes, swamps, wetland margins (edges of wetlands)
White-tinged Sedge	*Carex albicans var. emmonsii*	Vascular plant			G5T5		S2			x						Not assessed,Cedar slopes and clearings
Yellow Bartonia	*Bartonia virginica*	Vascular plant			G5		S1				x					Meadows and fields, swamps, wetland margins

																(edges of wetlands). Terrestrial & wetlands
Yellow-Fruited Sedge	*Carex annectens*	Vascular plant			G5		S1									Anthropogenic (man-made or disturbed habitats), meadows and fields. Terrestrial

Appendix E. Species-habitat associations for species list in accordance with other Habitat Conservation Strategies.

Species Common Name	Species Scientific Name	Beaches, Dunes, and Cliffs	Freshwater Wetlands						Riparian			Acadian Forest Mosaic					Grasslands	Salt Marsh	Tidal Flats/Estuaries	Coastal Islands	References	Habitat Notes
			Aquatic Bed	Bog	Fen	Emergent Wetland	Shrub Wetland	Forested Wetland	Aquatic	Banks	Floodplain	Coniferous	Deciduous	Mixedwood	Cedar Swamps	Vernal Pools						
Molluscs																						
Brook Floater	*Alasmidonta varicose*								X												1	Variable sizes from streams to rivers; moderate to high currents; intermediate depth.
Triangle Floater	*Alasmidonta undulata*								X												2	Small streams with gravel and sand.
Fungi or Lichen																						
Crumpled Bat's Wing Lichen	*Collema leptaleum*											x	x								3	Found on White Spruce in humid conifer-dominant forests.
Corrugated Shingles Lichen	*Fuscopannaria ahlneri*											x	x	x							4	Found on twigs, branches, rocks.
a lichen	*Dendriscocaulon umhausense*		x	x	x		x	x													4	Grows among mosses.
Friable Horsehair Lichen	*Bryoria friabilis*									X		x	x	x							2	Grows on conifers and hardwoods, riparian areas.
Eastern Candlewax Lichen	*Ahtiana aurescens*							x				x									5	Grows on twigs and branches of conifers, cedar swamps.
Non-vascular Plants																						

Small Notchwort	*Lophozia ascendens*											x									6	Decaying wood in wet coniferous forests.
Bog-Moss Flapwort	*Odontoschisma sphagni*			x	x																7	Bogs, peat.
a Moss	*Anacamptodon splachnoides*											x		x	x						8	Closed crown canopies or open mixedwood.
Pale Bryum Moss	*Bryum pallescens*								x	x					x						7	Rivers and streams; substrate rock outcrops and soil over rock outcrops
Bonjean's Broom Moss	*Dicranum bonjeanii*				x										x						8	Eutrophic fens.
a Moss	*Leucodon brachypus*												x		x						8	Trees, stumps in hardwood forests.
Long-necked Nodding Moss	*Pohlia elongata*	x							x	x											8	Stream banks and coastal cliffs.
Cottony Nodding Moss	*Pohlia proligera*									x											8	Open sites along rivers and trails.
a moss	*Pohlia sphagnicola*			x	x										x						2	Sphagnum hummocks on bogs and fens.
Flexuous Peatmoss	*Sphagnum flexuosum*			x	x																8	small poor fens, lake margin peatlands & boggy coniferous woods; substrate humus & peat
Yellow Collar Moss	*Splachnum luteum*											x	x	x							8	Associated with feces of moose.
Little Georgia	*Tetrodontium brownianum*									x											7	Shaded moist areas and rocky outcrops along river brooks.
Geniculate Four-tooth Moss	*Tetraphis geniculata*											x	x	x							8	Moist forests, on well decayed wood, stumps, and rocks.
a Moss	*Zygodon viridissimus*											x			x						7	Moist coniferous woods, cedar swamps, and rock bluffs; substrate trunks of cedar trees and on rock
a Moss	*Zygodon viridissimus var. viridissimus*											x			x						8	Moist coniferous woods and cedar swamps.
Showy Bristle Moss	*Orthotrichum speciosum*												x	x							8	Tolerant hardwood and mixedwood stands.
Mountain Hair Moss	*Pogonatum dentatum*									x											8	Open ravine habitats'; dry habitats of silt, sand, and gravel.
One-sided Groove Moss	*Aulacomnium heterostichum*									x											9	Dry rocky outcrops along banks of brooks.

a Moss	*Schistidium maritimum*	x																		x	8	Coastal cliffs within the spray zone.
Adnate Hairy-gray Moss	*Homomallium adnatum*								x	x		x	x	x							8	Brooks and in forest stands; substrate boulders and rock exposures
Smaller Fern Moss	*Rauiella scita*												x	x							8	Intermediate to mature rich tolerant hardwood forests.
Vascular Plants																						
Butternut	*Juglans cinerea*										x		x								10	Rich, moist, well-drained soils.
New York Aster	*Symphyotrichum novi-belgii var. crenifolium*									x											11	In gravel near shore.
Annual Saltmarsh Aster	*Symphyotrichum subulatum (non-Bathurst pop)*																	x	x		11	Salt marsh, estuaries.
Stiff Aster	*Ionactis linariifolius*									x		x	x	x			x				12	Shorelines, woodlands.
Gulf of St. Lawrence Aster	*Symphyotrichum laurentianum*	x																x			13	Areas near salt marshes sheltered by dunes.
Bathurst Aster - Bathurst pop.	*Symphyotrichum subulatum (Bathurst pop)*																	x	x		11	Salt marsh, estuaries.
Estuary Beggarticks	*Bidens hyperborea var. hyperborea*																	x	x		8	Marshes, estuaries.
Fleshy Stitchwort	*Stellaria crassifolia*			x	x		x	x													14	Poorly drained areas.
Beach Pinweed	*Lechea maritima*	x																			15	Stabilized sand dunes.
Seaside Spurge	*Chamaesyce polygonifolia*	x																			16	Sandy dunes and beaches.
Red-disked Yellow Pond-lily	*Nuphar lutea ssp. rubrodisca*					x	x														17	Shallow water.
Purple-veined Willowherb	*Epilobium coloratum*			x	x	x	x	x		x											12	Swamps, shorelines.
Water Blinks	*Montia fontana*			x	x	x	x	x				x	x	x							12	Wide ranging; forests, rivers, marshes.
Pennsylvania Blackberry	*Rubus pensilvanicus*			x	x	x	x	x				x	x	x							12	Forest edges, meadows, swamps.

Arching Dewberry	*Rubus recurvicaulis*			x	x	x	x	x				x	x	x							12	Woodlands, meadows, swamps.
Labrador Bedstraw	*Galium labradoricum*			x								x	x	x							18	Bogs and woods.
Long-lobed Arrowhead	*Sagittaria calycina var. spongiosa*																	x	x		18	Tidal marshes and streams.
Eastern Skunk Cabbage	*Symplocarpus foetidus*					x	x	x		x	x										12	Shorelines, edges of wetlands.
Narrow-leaved Beaked Sedge	*Carex rostrate*			x	x					x											8	Fens, bogs, and shorelines.
Limestone Meadow Sedge	*Carex granularis*				x		x	x		x											8	Fens, swamps, and shorelines.
Lesser Brown Sedge	*Carex adusta*											x	x	x							8	Dry, sandy soils of open woods and clearings.
Yellow-Fruited Sedge	*Carex annectens*			x	x						x						x				8	Open habitats, wet meadows.
White-tinged Sedge	*Carex albicans var. emmonsii*												x								8	Rich hardwood sites.
Sparse-Flowered Sedge	*Carex tenuiflora*			x				x			x										8	Sphagnum bogs, wet woodlands.
Pubescent Sedge	*Carex hirtifolia*										x										8	Lowland forests.
Slender Cottongrass	*Eriophorum gracile*			x																	8	Peat environment.
Gaspé Arrowgrass	*Triglochin gaspensis*																	x	x		8	Tidal marshes, usually submerged at some point during the day.
Greene's Rush	*Juncus greenei*	x										x									8	Sandy areas such as dunes and pine stands.
Moor Rush	*Juncus stygius ssp. Americanus*				x																18	Fens.
Vasey Rush	*Juncus vaseyi*			x			x	x						x							19	Peat, wet meadows, mixed conifer-hardwood forests.
Auricled Twayblade	*Listera auriculata*			x	x		x	x		x					x						2	Bogs, fens, forested wetlands.
Southern Twayblade	*Neottia bifolia*			x																	20	Semi-open areas of bogs.

Canada Rice Grass	*Piptatherum canadense*									x		x	x	x			x				12	Cliffs, forests, meadows.
Slender Rice Grass	*Piptatherum pungens*									x		x	x	x			x				12	Wide range of habitats.
Nootka Alkali Grass	*Puccinellia laurentiana*																	x	x		17	Wet saline environments.
Creeping Alkali Grass	*Puccinellia phryganodes*																	x	x		14	Wet saline environments.
Slim-stemmed Reed Grass	*Calamagrostis stricta ssp. inexpansa*									x		x									18	Damp woods and shaded cliffs.
Virginia Chain Fern	*Woodwardia virginica*			x	x	x	x	x													12	Swamps and wetland edges.
Fragrant Wood Fern	*Dryopteris fragrans var. remotiuscula*									x											8	Cliffs.
Bog Fern	*Thelypteris simulata*			x	x		x	x													8	Shaded swamp and bog, associated with sphagnum.
Long-leaved Starwort	*Stellaria longifolia*			x	x	x	x	x			x					x					8	Wet areas.
Red Pigweed	*Chenopodium rubrum*																	x	x		12	Brackish and salt marsh areas.
Carey's Smartweed	*Polygonum careyi*			x	x	x	x	x													8	Swamps and bogs.
Narrow-Leaved Gentian	*Gentiana linearis*									x	x	x	x	x							18	Moist woods and riparian areas.
Thread-leaved Pondweed	*Stuckenia filiformis ssp. alpina*																	x	x		8	Brackish water.
Rough Hawthorn	*Crataegus scabrida*											x	x	x			x				8	Forests, forest edge, meadows.
Blunt-leaved Bedstraw	*Galium obtusum*			x	x	x	x	x													12	Wetlands.
Spotted Coralroot	*Corallorhiza maculata var. occidentalis*											x		x							8	Coniferous and mixedwoods.
Branched Bartonia	*Bartonia paniculata ssp. iodandra*			x	x																21	Sphagnum bog and fen.

Seabeach Dock	*Rumex pallidus*	x																x		x	8	Costal marshes and beaches.
American Waterwort	*Elatine americana*						x	x		x						x					2	Shallow water and shoreline edge.
Shining Ladies'-Tresses	*Spiranthes lucida*				x					x											8	Rocky or sandy banks, fens.
Michaux's Dwarf Birch	*Betula michauxii*			x	x																22	Bogs, fens, edges of pools of water.
Poison Ivy	*Toxicodendron radicans*											x	x	x							12	Forests and anthropogenic areas.
Connecticut Beggar-Ticks	*Bidens heterodoxa*					x	x	x		x									x		8	Lakes, marshes, estuarine areas.
Common Hop	*Humulus lupulus var. lupuloides*									x		x	x	x							8	Woods and river banks.
Buttonbush Dodder	*Cuscuta cephalanthi*					x	x	x		x							x				12	Man-made areas, meadows, shores of rivers and lakes, swamps.
Blood Milkwort	*Polygala sanguinea*																x				12	Man-made areas and meadows.
Indian Wild Rice	*Zizania aquatica var. aquatica*			x	x	x	x		x									x			12	Fresh and salt wetlands.
Prickly Hornwort	*Ceratophyllum echinatum*					x	x		x												8	Lakes, ponds, freshwater marshes.
Red Bulrush	*Blysmus rufus*																		x		2	Tidal flats.
Peach-leaved Dock	*Rumex maritimus var. persicarioides*																	x	x	x	8	Coastal and saline habitats.
Nodding Ladies'-Tresses	*Spiranthes cernua*	x		x	x	x	x	x		x	x	x	x	x		x					8	Wide variety of habitats.
Invertebrates																						
Yellow-banded Bumble Bee	*Bombus terricola*			x	x	x	x	x			x	x	x	x	x	x	x				23	Wide variety of habitats.
Rusty-patched Bumble Bee	*Bombus affinis*			x	x	x	x	x			x	x	x	x	x	x	x				24	Wide variety of habitats.
Gypsy Cuckoo Bumble Bee	*Bombus bohemicus*											x	x	x			x				25	Open woodlands, meadows, and urban areas.
Monarch	*Danaus plexippus*					x	x				x						x				26	Anywhere milkweed can grow.
Pygmy Snaketail	*Ophiogomphus howei*								x	x		x	x	x							27	Large, swift flowing rivers with fine substrate for larvae and exuviae. Adults use forested habitat.

Salt Marsh Copper	*Lycaena dospassosi*																	x			2	Salt marshes with larval plants and sea lavendar.
Henry's Elfin	*Callophrys henrici*			x			x				x	x	x	x							2	Forests, shrub bogs, stream sides.
Grey Hairstreak	*Strymon melinus*			x	x	x		x			x					x					2	Vast array of open habitats, wet areas.
Crowberry Blue	*Plebejus idas empetri*			x	x																2,28	Maritime bog.
Subarctic Bluet	*Coenagrion interrogatum*			x	x	x	x				x					x					29	Variety of wetlands.
Short-tailed Swallowtail	*Papilio brevicauda*	x																		x	30	Coastal areas.
Short-tailed Swallowtail	*Papilio brevicauda bretonensis*	x																		x	30	Anywhere milkweed can grow.
Transverse Lady Beetle	*Coccinella transversoguttata richardsoni*																x				31	Open fields.
Quebec Emerald	*Somatochlora brevicincta*			x																	32	Pools in sphagnum bogs.
Clamp-Tipped Emerald	*Somatochlora tenebrosa*			x				x	x												33	Prefers shady forest waters.
Canada Whiteface	*Leucorrhinia patricia*			x	x			x		x											34	Wetlands with low emergent vegetation, riparian forested areas.
White Corporal	*Ladona exusta*			x		x			x	x											35	Freshwater and riparian areas.
Fishes																						
American Eel	*Anguilla rostrata*								x										x		36	
Atlantic Salmon Gaspe-Southern Gulf of St. Lawrence population	*Salmo salar*								x												37	
Striped Bass Southern Gulf of St. Lawrence population	*Morone saxatilis*								x									x			38	
Turtles																						
Wood Turtle	*Glyptemys insculpta*	x							x	x	x										39	Prefers clear streams with a moderate current and sandy or

																						gravel bottom. Uses beaches or anthropogenic areas (such as gravel pits) for nesting).
Birds																						
Piping Plover melodus subspecies	*Charadrius melodus melodus*	x																	x		40	Beaches and dunes for breeding habitat.
Red Knot rufa subspecies	*Calidris canutus rufa*	x																	x	x	41	Coastal areas with intertidal flats during migration.
Bank Swallow	*Riparia riparia*									x						x					42	Banks with sandy substrate to burrow for nests. Large wetlands during migration and post-breeding. Feeding areas are open areas such as wetlands, grasslands.
Barn Swallow	*Hirundo rustica*					x					x					x	x				43	Primarily nest in caves, holes in cliffs. Nest in artificial structures such as bridges, buildings. Forage in open areas.
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*									x	x										44	Open areas, banks.
Tree Swallow	*Tachycineta bicolor*					x		x			x					x					45	Nests in tree cavities near water.
Bobolink	*Dolichonyx oryzivorus*					x											x				46	Nests in forage crops and grassland habitats.
Canada Warbler	*Cardellina canadensis*							x				x	x	x	x						47	Moist forests with a dense understory.
Chimney Swift	*Chaetura pelagica*							x				x	x	x		x					48	Historically, natural nest sites are old hollow trees in mature forests; artificial ones are chimneys. Forage over areas of open water.
Common Nighthawk	*Chordeiles minor*	x		x		x						x		x		x	x				49	Mature open forest, bogs, beaches, and herbaceous areas.
Eastern Meadowlark	*Sturnella magna*																x				50	Grasslands, open fields.
Eastern Whip-poor-will	*Antrostomus vociferus*												x	x		x					51	Mixedwood habitat, avoids closed canopy forests.
American Bittern	*Botaurus lentiginosus*			x	x	x	x											x			52	Wetlands.
Least Bittern	*Ixobrychus exilis*					x												x			53	Emergent wetlands.

Olive-sided Flycatcher	*Contopus cooperi*			x								x		x		x					54	Open areas in old growth spruce-fir.
Willow Flycatcher	*Empidonax traillii*						x	x	x			x		x		x	x				2	Deciduous wetlands and forests.
Purple Martin	*Progne subis*					x					x	x	x	x			x	x	x		2	Open areas near water.
Wood Thrush	*Hylocichla mustelina*												x	x		x					55	Mature forests with dense understory.
Yellow Rail	*Coturnicops noveboracensis*					x					x						x	x			56	Marshy areas and grassland/agro-ecosystems.
Sora	*Porzana carolina*					x															57	Shallow water emergent wetlands.
Virginia Rail	*Rallus limicola*		x			x										x					52	Shallow water with emergent vegetation.
Eastern Wood-pewee	*Contopus virens*												x	x		x					58	Old tolerant hardwood.
Peregrine Falcon anatum/tundrius	*Falco peregrinus anatum/tundrius*	x																			59	Beaches for foraging habitat. Will nest on top of buildings.
Red-necked Phalarope	*Phalaropus lobatus*	x																x			60	Primarily pelagic.
Wilson's Phalarope	*Phalaropus tricolor*	x				x											x	x	x		2	Primarily pelagic.
Rusty Blackbird	*Euphagus carolinus*			x				x			x	x		x							61	Moist forests, forested wetlands, bogs.
Short-eared Owl	*Asio flammeus*			x		x	x					x					x	x			62	Herbaceous and shrub cover.
Long-eared Owl	*Asio otus*											x	x	x							2	Dense wooded areas.
Boreal Owl	*Aegolius funereus*						x					x		x							2	Dense coniferous or mixedwood forests and alder thickets.
Bald Eagle	*Haliaeetus leucocephalus*							x			x	x	x	x							52	Mature forests with large, tall trees for nests and near water.
Northern Goshawk	*Accipiter gentilis*												x			x					52	Old hardwood forest.
Red-shouldered Hawk	*Buteo lineatus*							x					x	x		x					52	Deciduous forest and swamp.
Cooper's Hawk	*Accipiter cooperii*											x	x	x		x					2,63	Mature forest, mostly deciduous.
Gyrfalcon	*Falco rusticolus*																	x	x	x	2	Coastal areas.

American Redstart	*Setophaga ruticilla*							x				x	x	x							52	Forests with dense understory near water.
American Three-toed Woodpecker	*Picoides dorsalis*							x				x		x							52	Mature, moist or swampy Black Spruce forest.
Black-backed Woodpecker	*Picoides arcticus*							x				x									52	Old growth spruce-fir forests.
Yellow-bellied Sapsucker	*Sphyrapicus varius*												x	x		x					52	Old tolerant hardwood.
Bay-breasted Warbler	*Setophaga castanea*										x	x		x							52	Old growth spruce-fir forests.
Blackburnian Warbler	*Setophaga fusca*											x	x	x	x						52	Old mixedwood forests.
Black-throated Blue Warbler	*Setophaga caerulescens*												x	x							52	Old growth tolerant hardwoods.
Black-throated Green Warbler	*Setophaga virens*						x					x		x	x						52	Mature forest and shrubland.
Cape May Warbler	*Setophaga tigrina*											x									52	Old spruce-fir forest.
Magnolia Warbler	*Setophaga magnolia*			x								x									52	Dense conifers and peat bogs.
Blue-headed Vireo	*Vireo solitarius*											x		x							52	Old growth spruce-fir forests.
Boreal Chickadee	*Poecile hudsonicus*											x									52	Old spruce-fir forest.
Belted Kingfisher	*Megaceryle alcyon*							x		x	x					x					2.52,63	Water bodies with banks.
Black-billed Cuckoo	*Coccyzus erythropthalmus*												x	x							52	2nd growth forest with shrub layer.
House Wren	*Troglodytes aedon*						x	x		x		x	x	x			x				2	Forested wetlands, riparian areas, forested areas.
Marsh Wren	*Cistothorus palustris*					x										x		x			2,63	Fresh and brackish marsh.
Eastern Kingbird	*Tyrannus tyrannus*					x	x	x			x	x	x	x		x	x				2,52,63	Forest edges with shrub cover near water.
Evening Grosbeak	*Coccothraustes vespertinus*											x		x							52	Old spruce-fir forest.
Nelson's Sparrow	*Ammodramus nelsoni*																x	x			52	Grasslands/agro-ecosystems and salt marsh.

Vesper Sparrow	*Pooecetes gramineus*																x				2	Grasslands and clearings.
White-throated Sparrow	*Zonotrichia albicollis*			x	x	x	x	x			x	x	x	x	x	x	x				2,52,63	Forest with shrubby areas.
Purple Finch	*Haemorhous purpureus*												x	x							52	Moist deciduous and mixedwood forests.
Ruffed Grouse	*Bonasa umbellus*												x	x		x					52, 63	Mature forest with coarse woody debris.
Veery	*Catharus fuscescens*						x						x	x		x					52, 63	Moist, 2nd growth forest with dense understory.
White-breasted Nuthatch	*Sitta carolinensis*											x	x	x							2	Forested habitat.
American Woodcock	*Scolopax minor*												x				x				2	Edge habitat species.
American Golden-Plover	*Pluvialis dominica*	x															x		x		52	Coastal areas and grasslands/agro-ecosystems.
Black-bellied Plover	*Pluvialis squatarola*	x															x	x	x		52	Coastal areas and grassland/agro-ecosystems.
Dunlin	*Calidris alpina*	x		x	x	x					x					x			x		2	Beach, mudflats, and shorelines.
Hudsonian Godwit	*Limosa haemastica*	x		x	x	x					x						x	x	x		2	Coastal areas, wetlands, and grassland/agro-ecosystems.
Killdeer	*Charadrius vociferus*	x				x											x				52	Beaches, marsh, and grassland/agro-ecosystems, anthropogenic areas (gravel pits, roads).
Horned Lark	*Eremophila alpestris*																x				2	Grasslands.
Eastern Meadowlark	*Sturnella magna*					x	x	x									x				2	Grasslands, sometimes wetlands.
Lesser Yellowlegs	*Tringa flavipes*	x		x		x		x			x					x		x	x		2,52	Wetlands and coastal areas.
Sanderling	*Calidris alba*	x									x								x		2	Beach, mudflats, and shorelines.
Least Sandpiper	*Calidris minutilla*	x		x	x	x					x					x			x		2	Wetlands and coastal areas.
Semipalmated Sandpiper	*Calidris pusilla*	x				x					x					x			x		2	Wetlands and coastal areas.
Solitary Sandpiper	*Tringa solitaria*			x	x	x		x			x	x	x	x		x		x	x		2,52	Forested wetlands and coastal areas.

Spotted Sandpiper	*Actitis macularius*	x									x					x	x				52, 63	Beaches and riparian/grasslands/agro-ecosystems near shorelines.
Upland Sandpiper	*Bartramia longicauda*			x		x											x				2	Dry patches in wet meadows, peat- and grasslands/agro-ecosystems
Whimbrel	*Numenius phaeopus*	x		x		x	x				x						x		x		2	Primarily coastal but breeds in shrub/herbaceous areas.
Willet	*Tringa semipalmata*	x	x			x					x					x	x	x	x		2	Coastal areas and wetlands.
Wilson's Snipe	*Gallinago delicata*		x	x	x	x	x	x	x							x	x				2,52	Wetlands and wet grasslands/agro-ecosystems.
Black-headed Gull	*Chroicocephalus ridibundus*								x									x	x	x	2	Lakes, rivers, coastal areas.
Laughing Gull	*Leucophaeus atricilla*								x									x	x	x	2	Coastal areas and large inland waterbodies.
Black-legged Kittiwake	*Rissa tridactyla*																			x	2	Breeds on coastal islands.
Northern Gannet	*Morus bassanus*																			x	2	Breeds on coastal islands.
Arctic Tern	*Sterna paradisaea*																			x	2	Breeds on coastal islands.
Black Tern	*Chlidonias niger*		x			x			x								x		x		2,52	Wetlands, coastal areas, and grasslands/agro-ecosystems.
Common Tern	*Sterna hirundo*	x																x		x	2,52	Prefers islands on large water bodies. Nests on beaches.
Common Loon	*Gavia immer*								x												2,52	Large water bodies with sheltered coves.
Red-throated Loon	*Gavia stellata*								x										x		2	Large lakes and coastal areas.
Green Heron	*Butorides virescens*					x					x	x				x					2,52	Marsh and shorelines.
Black-crowned Night-heron	*Nycticorax nycticorax*	x	x			x	x	x			x							x	x		2	Wetlands and coastal areas.
Horned Grebe	*Podiceps auritus*					x			x												2	Marshes, ponds, lakes.
Pied-billed Grebe	*Podilymbus podiceps*		x			x												x			52	Emergent vegetation with open water.
American Black Duck	*Anas rubripes*		x			x	x		x							x	x				52, 63	Open water and grasslands/agro-ecosystems.
Black Scoter	*Melanitta americana*		x			x			x		x								x		2	Open water, mostly coastal.
Surf Scoter	*Melanitta perspicillata*		x	x	x	x			x		x								x		2	Coastal areas and wetlands.

Canada Goose	*Branta canadensis*		x			x			x							x	x				52, 63	Open water and herbaceous areas.
Common Eider	*Somateria mollissima*	x																x			2	Coastal areas.
King Eider	*Somateria spectabilis*	x																x			2	Coastal areas.
Barrow's Goldeneye Eastern population	*Bucephala islandica*								x	x									x		64	Rivers, lakes, shoreline habitat for nesting.
Common Goldeneye	*Bucephala clangula*								x	x									x		2	Ponds, lakes, and bays.
Harelquin Duck (Eastern population)	*Histrionicus histrionicus*								x										x		2	Rivers and coastline.
Green-winged Teal	*Anas carolinensis*		x			x	x		x							x	x				52, 63	Open water and grasslands/agro-ecosystems.
Long-tailed Duck	*Clangula hyemalis*								x												2	Large water bodies.
Mallard	*Anas platyrhynchos*		x			x	x		x							x	x				52, 63	Open water and grasslands/agro-ecosystems.
Ring-necked Duck	*Aythya collaris*		x			x															52	Open water with vegetation.
Wood Duck	*Aix sponsa*					x	x	x													2	Forested and herbaceous wetlands.
Ruddy Duck	*Oxyura jamaicensis*					x			x									x	x		2	Marshes, lakes, coastal areas.
Northern Shoveler	*Anas clypeata*		x			x	x		x							x	x		x		2,63	Open water and grassland/agro-ecosystems.
Gadwall	*Anas strepera*		x			x	x									x	x				2,63	Open water and grassland/agro-ecosystems.
Brant	*Branta bernicla*																	x	x		2	Estuarine areas.
American Coot	*Fulica americana*		x	x	x	x		x	x							x	x				2,63	Wetlands and coastal areas.
Greater Scaup	*Aythya marila*			x		x			x		x							x	x		2	Open water for breeding habitat, estuarine habitats during migration/winter.
Mammals																						
Little Brown Myotis	*Myotis lucifugus*			x	x	x		x			x		x	x		x	x				2,63	Wide range of habitats.
Hoary Bat	*Lasiurus cinereus*											x	x	x							2	Primarily decidous and coniferous forests.

Canada Lynx	*Lynx canadensis*							x				x		x		x					2,63	Prefers old coniferous forests.
Cougar-Eastern population	*Puma concolor pop. 1*										x	x	x	x							2	Mountainous forests.
Maritime Shrew	*Sorex maritimensis*			x	x	x		x			x		x	x		x	x				65, 66	Wetland habitats.

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Appendix F. IUCN threat classifications scheme version 3.1, including definitions and expositions.

IUCN - CMP Unified Classification of Direct Threats					Direct threats are the proximate human activities or processes that have impacted, are impacting, or may impact the status of the taxon being assessed (e.g., unsustainable fishing or logging). Direct threats are synonymous with sources of stress and proximate Version: 3.2 pressures. Threats can be past (historical, unlikely to return or historical, likely to return), ongoing, and/or likely to occur in the future.
Level of Classification			**Definition**		* See Additional Notes on usage at the end *
1	**2**	**3**	**Examples**		**Exposition**
1. Residential and Commercial Development			Threats from human settlements or other non-agricultural land uses. Development with a substantial footprint.		These are threats tied to a defined and relatively compact area, which distinguishes them from those in 4. Transportation & Service Corridors which have a long narrow footprint, and 6. Human Intrusions & Disturbance which do not have an explicit footprint. This category obviously dovetails somewhat arbitrarily with 1.2 Commercial and Industrial Areas. As a general rule, however, if people live in the development, it should fall into this category.
	1.**1 Housing and Urban Areas**		Human cities, towns, and settlements including non-housing development typically integrated with housing.		This category obviously dovetails somewhat arbitrarily with 1.2 Commercial and Industrial Areas. As a general rule, however, if people live in the development, it should fall into this category.
		List type of development		urban areas, suburbs, villages, ranchettes, vacation homes, shopping areas, offices, schools, hospitals, birds flying into windows, land reclamation or expanding human habitation that causes habitat	

			degradation in riverine, estuary and coastal areas, etc.	
	1.2 Commercial & Industrial Areas Factories and other commercial centres		Factories and other commercial centres	Shipyards and airports fall into this category, whereas shipping lanes and flight paths fall under 4. Transportation & Service Corridors. Dams are NOT included here, rather they are in 7.2 Dams & Water Management/Use.
		List type of development	military bases, factories, stand-alone shopping centres, office.	
	1.3 Tourism and Recreation Areas			
		List type of development	parks, power plants, train yards, ship yards, airports, landfills, etc.	There is a fine line between housing and vacation housing/resorts. Be careful not to confuse this category, which focuses on the habitat effects of recreation areas, with those in 6.1 Recreational Activities, which focuses on the disturbance effects posed by recreation. List the type of development ski areas, golf courses, resorts, cricket fields, county parks, afghan goat polo fields, campgrounds, coastal and estuarine tourist resorts, etc.
2. Agriculture and Aquaculture			Threats from farming and ranching as a result of direct conversion expansion and intensification, including silviculture, mariculture and aquaculture (includes the impact of any fencing around farmed areas).	Threats resulting from the use of agrochemicals, rather than the direct conversion expansion and intensification, of land to agricultural use, should be included under 9.3 Agricultural & Forestry Effluents. Likewise in cases where conversion to agriculture causes increased run-off and hence sedimentation of rivers and lakes, that is also best treated under 9.3 Agricultural & Forestry Effluents.
	2.1 Annual and Perennial Non-Timber Crop		Crops planted for food, fodder, fibre, fuel, or other uses.	
		2.1.1 Shifting Agriculture		Select the appropriate scale of the farming activity and list the specific crop(s) e.g., wheat farms, sugar cane plantations, rice paddies, hillside rice production, household swidden plots, banana or pineapple plantations, mango or apple orchards, olive or date
		2.1.2 Small-holder Farming		
		2.1.3 Agro-industry Farming		
		2.1.4 Scale Unknown/Unrecorded		

				groves, vineyards, oil palm plantations, tea or coffee plantations, mixed agroforestry systems, coca plantations, etc.
	2.2 Wood and Pulp Plantations		Stands of trees planted for timber or fibre outside of natural forests, often with non-native species.	If it is one or a couple timber species that are planted on a rotation cycle, it often with non-native species belongs here. If it is multiple species or enrichment plantings in a quasi-natural system, it belongs in 5.3 Logging & Wood Harvesting.
		2.2.1 Small-holder Plantations		Select the appropriate scale for the plantation and list the specific trees eg. Teak or eucalyptus plantations, loblolly pine silviculture, Christmas tree farms, etc.
		2.2.2 Agro-industry Plantations		
		2.2.3 Scale Unknown/Unrecorded		
	2.3 Livestock Farming and Ranching		Domestic terrestrial animals raised in one location on farmed or non-local resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching).	In farming, animals are kept in captivity; in ranching they are allowed to roam in wild habitats. If a few animals are mixed in a subsistence cropping system, it belongs in 2.1 Annual & Perennial Non-Timber Crops. Forage of wild resources (ranching)for stall-fed animals falls under 5.2 Gathering Terrestrial Plants. Domesticated livestock that has gone feral should be treated under 8.1 Invasive Non- native/Alien Species, but other wild-roaming livestock may also require closer consideration to determine if they are best placed here or also under 8.1.
		2.3.1 Nomadic Grazing	Pastoralists who are normally only present for part of the year, usually after good rains have improved the grazing.	Select the appropriate scale of the farming activity and list the specific animals and/or system e.g., cattle feed lots, chicken farms, dairy farms, cattle ranching, goat, camel, or yak herding, etc.
		2.3.2 Small-Holder Grazing, Ranching, or Farming		
		2.3.3 Agro-Industry Grazing, Ranching, or Farming		
		2.3.4 Scale Unknown/Unrecorded		
	2.4 Marine and Freshwater Aquaculture		Aquatic animals raised in one location on farmed or non-local resources; also hatchery fish allowed to roam in the wild.	Farmed animals are kept in captivity; hatchery fish are put into wild habitats and resources are the aquatic equivalent of terrestrial ranching.

		2.4.1 Subsistence/Artisanal Aquaculture		Select the appropriate scale of aquaculture and list the specific species and/or Aquaculture 2.4.2 Industrial Aquaculture 2.4.3 Scale Unknown/Unrecorded system e.g., shrimp or fin fish aquaculture (especially those that cause destruction of mangrove habitats), fish ponds on farms, hatchery salmon, seeded shellfish beds, artificial algal beds, etc.
		2.4.2 Industrial Aquaculture		
		2.4.3 Scale Unknown/Unrecorded		
3. Energy Production and Mining			Threats from production of non-biological resources.	Various forms of water use (for example, dams for hydro power) could also be put in this class, but these threats seemed more related to other threats that involve alterations to hydrologic regimes. As a result, they should go in 7.2 Dams & Water Management/Use.
	3.1 Oil and Gas Drilling		Exploring for, developing, and producing petroleum and other liquid hydrocarbons	
		List the specific resource(s) and production method.	Oil wells, deep sea natural gas drilling, hydraulic fracking, etc.	Oil and gas pipelines go into 4.2 Utility & Service Lines. Oil spills that occur at the drill site should be placed here; those that come from oil tankers or pipelines should go in 4. Transportation & Service Corridors or in 9.2 Industrial & Military Effluents, depending on your perspective.
	3.2 Mining and Quarrying		Exploring for, developing, and producing minerals and rocks.	It is a judgement call whether deforestation caused by strip mining should be in this category or in 5.3 Logging & Wood Harvesting - it depends on whether the primary motivation for the deforestation is access to the trees or to the minerals. Sediment or toxic chemical runoff from mining should be placed in 9.2 Industrial & Military Effluents if it is the major threat from a mining operation.
		List the specific resource(s) and production method.	Coal strip mines, alluvial gold panning, gold mines, rock quarries, production method sand/salt mines, coral mining, deep sea nodules, guano harvesting, dredging outside of shipping lanes, etc.	

	3.3 Renewable Energy	Exploring, developing, and producing renewable energy.	Hydropower should be put in 7.2 Dams & Water Management/Use.
	List the specific resource(s) and production method.	Geothermal power production, solar farms, wind farms (including birds flying into windmills), tidal farms, etc.	
4. Transportation and Service Corridors			This class includes transportation corridors outside of human settlements and industrial developments. These corridors create specific stresses to biodiversity including especially fragmentation of habitats and lead to other threats including farms, invasive species, and poachers
	4.1 Roads and Railroads	Surface transport on roadways and dedicated tracks.	Off-road vehicles are treated in the appropriate category in 6. Human Intrusions & Disturbance. If there are small roads associated with a major utility line, they belong in 4.2. Utility & Service Lines.
	List the specific type of road.	Highways, secondary roads, primitive roads, logging roads, bridges & causeways, road kill, fencing associated with roads, freight/passenger/mining railroads, etc.	
	4.2 Utility and Service Lines	Transport of energy & resources.	Cell phone and other communication towers connected by small access roads belong here. If there are small utility lines using a road right of way, they belong in 4.1 Roads & Railroads. Oil spills from pipelines should go in 9.2 Industrial & Military Effluents.
	List the specific type of utility line	Electrical & phone wires, aqueducts, oil & gas pipelines.	
	4.3 Shipping Lanes	Transport on and in freshwater and ocean waterways.	This category includes dredging and other activities that maintain shipping lanes. Anchor damage from dive boats belongs in 6.1 Recreational Activities. Oil spills from ships should go in 9.2 Industrial & Military Effluents.

		List the specific type of shipping lane.	Dredging, canals, shipping lanes, ships running into whales, wakes from cargo ships, etc.	
	4.4 Flight Paths		Air and space transport.	Airports fall into 1.2 Commercial & Industrial Areas.
		List the specific resource(s) and production method.	Flight paths, jets impacting birds, etc.	
5. Biological Resource Use			Threats from consumptive use of "wild" biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species.	Consumptive use means that the resource is removed from the system or destroyed - multiple people cannot use the same resource, as they could under 6. Human Intrusions & Disturbance. Threats in the class can affect both target species (harvest of desired trees or fish species) as well as "collateral damage" to non-target species (trees damaged by felling or fisheries bycatch) and habitats (coral reefs destroyed by trawling). Persecution/control involves harming or killing species because they are considered undesirable. For some of the use threats there is an additional question on whether or not International trade is a significant driver of decline (5.1.1, 5.2.1, 5.3.1, 5.3.2, 5.4.1, 5.4.2).
	5.1 Hunting and Collecting Terrestrial Animals		Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch.	This category focuses on animals that primarily live in a terrestrial environment. There are obviously some species that live on the terrestrial/aquatic boundary. Hunting otters, beavers, amphibians, polar bears, penguins, waterfowl, and sea birds should (somewhat arbitrarily) go here. Hunting seals, whales and other marine mammals, and freshwater and marine turtles go in 5.4 Fishing & Harvesting Aquatic Resources. Yes, most people "gather" honey, eggs, or insects or other slow moving targets, rather than "hunt" them. But for consistency it was decided to keep all animal products as being hunted. This option does not distinguish between small and large scale (unlike others below) as generally most hunting and collecting of animals is

			small scale, but arguably some hunting in the past was very large "industrial" scale.
	5.1.1 Intentional Use (species being assessed is the target)	Bushmeat hunting, trophy hunting, beaver trapping, butterfly collecting, honey or bird nest hunting, etc.	
	5.1.2 Unintentional Effects (species being assessed is not the target)	Pest control often impacts non-targeted species, hunter's dogs may chase after and kill other non-target species during a hunt, loss of a species' prey base due to over-harvesting by humans of their prey, etc.	For species unintentionally impacted the stress is usually coded as mortality, however, in the case of species' losing their prey base the stress would be coded as 2.3.8 Indirect Species Effects - Other.
	5.1.3 Persecution/Control	Wolf control, pest control, persecution of snakes because of superstition, etc.	
	5.1.4 Motivation Unknown/Unrecorded		It is not known if the hunting or collection is intentional, unintentional or if it is persecution/control.
5.2 Gathering Terrestrial Plants		Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research, or cultural purposes, or for control reasons.	This category focuses on plants, mushrooms, and other non-animal terrestrial species except trees which are treated in 5.3 Logging & Wood Harvesting.
	5.2.1 Intentional Use (species being assessed is the target)	Wild mushroom collection, forage for stall fed animals, orchid collection, rattan harvesting, etc.	
	5.2.2 Unintentional Effects (species being stressed is not the target)	Other plants accidentally removed/killed as a result of methods/approach used to harvest a target species, etc.	
	5.2.3 Persecution/Control control of host plants to combat timber diseases, etc.		
	5.2.4 Motivation Unknown/Unrecorded		It is not known if the use is intentional, unintentional or if it is persecution/control.
5.3 Logging and Wood Harvesting		Harvesting trees and other woody vegetation for timber, fibre, or fuel.	Felling trees to clear agricultural land goes in the appropriate category in 2. Agriculture & Aquaculture. If it is a few timber species that are planted on a rotation cycle, it belongs in 2.2 Wood & Pulp

			Plantations. If it is multiple species or enrichment plantings in a quasi-natural system, it belongs here.
	5.3.1 Intentional Use: subsistence/small scale (species being assessed is the target) [harvest]		Select the appropriate scale and list the specific product(s) harvested and the method used e.g., clear cutting of hardwoods, selective commercial logging of ironwood, pulp or woodchip operations, fuel wood collection, mangrove charcoal production, etc. If the intention of the harvest is not known, then 5.3.5 should be used.
	5.3.2 Intentional Use: large scale (species being assessed is the target) [harvest]		
	5.3.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest]		
	5.3.4 Unintentional effects: large scale (species being assessed is not the target) [harvest]		
	5.3.5 Motivation Unknown/Unrecorded		
5.4 Fishing and Harvesting Aquatic Resources		Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch.	This category focuses on all kinds of species that are primarily found in an aquatic Resources environment. There are obviously some species that live on the terrestrial/aquatic boundary. Hunting otters, beavers, amphibians, polar bears, penguins, waterfowl, and sea birds should (somewhat arbitrarily) go in 5.1 Hunting & Collecting Terrestrial Animals. Hunting seals, whales and other marine mammals, and freshwater and marine turtles go here. It is important to consider the distinction between intentional and an unintentional fisheries - the former specifically targets a species or adjusts its fishing tactics to catch a particular species, whereas the unintentional option covers all other fisheries including bycatch and discards.
	5.4.1 Intentional Use: subsistence/small scale (species being assessed is the target) [harvest]	Seaweed collection, shellfish collection, collection for aquarium trade, fish traps, artisinal trawling, handline fishing, spear	

			fishing, turtle egg collection, whaling, seal hunting, blast fishing for grouper, etc.	
		5.4.2 Intentional Use: large scale (species being assessed is the target) [harvest]	Commercial trawling, commercial long-line fisheries, whaling, seal hunting, turtle egg collection, live coral collection, seaweed collection, etc.	
		5.4.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest]	Blast fishing, cyanide fishing, artisanal trawling, seaweed collection, shark nets trapping non-target species, loss of a species' prey base due to over-harvesting by humans of their prey, etc.	Note that the stresses can be both ecosystem degradation and species mortality. In the case of species' losing their prey base the stress would be coded as 2.3.8 Indirect Species Effects - Other.
		5.4.4 Unintentional effects: large scale (species being assessed is not the target) [harvest]	Blast fishing, cyanide fishing, commercial trawling, commercial long-line fisheries, seaweed collection, shark nets trapping non-target species, loss of a species' prey base due to over- harvesting by humans of their prey, etc.	Note that the stresses can be both ecosystem degradation and species mortality. In the case of species' losing their prey base the stress would be coded as 2.3.8 Indirect Species Effects - Other.
		5.4.5 Persecution/Control	Beach protection with shark nets, sharks and seals killed because they eat commercial fish species, etc.	
		5.4.6 Motivation Unknown/Unrecorded		It is not known if the harvest is intentional, unintentional or if it is persecution/control.
6. Human Intrusions and Disturbance			Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources.	Non-consumptive use means that the resource is not removed - multiple people can use the same resource (for example, birdwatching). These threats typically do not permanently destroy habitat except perhaps in extremely severe manifestations.
	6.1 Recreational Activities		People spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons	his category does not include work involving consumptive use of biodiversity - for example disturbance impacts from loggers or hunters would be in the appropriate category in 5. Biological Resource Use. Vehicles and boats in established transport corridors go in 4. Transportation & Service Corridors. The development of permanent recreational or tourist

			facilities (such as hotels and resorts) should be included under section 1.3 Tourism & Recreation Areas rather than here.
	List the specific activity	off-road vehicles, motorboats, motorcycles, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, cross-country skiers, hangliders, birdwatchers, scuba divers, pets brought into recreation areas, temporary campsites, caving, rock-climbing, etc.	
6.2 War, Civil Unrest & Military		Actions by formal or paramilitary forces without a permanent footprint.	his category focuses on military activities that have a large impact on natural habitats, but are not permanently restricted to a single area. Permanent military bases should go under 1.2 Commercial & Industrial Areas. Other military activities might best be assigned to other categories. For example, hunting of specific animals by soldiers living off the land fits under 5.1 Hunting & Collecting Terrestrial Animals.
	List the specific activity	Armed conflict, mine fields, tanks & other military vehicles, training exercises & ranges, defoliation, munitions testing, etc.	
6.3 Work and Other Activities		People spending time in or traveling in natural environments for reasons other than recreation or military activities.	
	List the specific activity	Law enforcement, drug smugglers, illegal immigrants, species research, vandalism, etc.	
7. Natural System Modifications		Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare.	This category deals primarily with changes to natural processes such as fire, hydrology, and sedimentation, rather than land use. Thus it does not include threats relating to agriculture (which should be under 2. Agriculture & Aquaculture), or infrastructure (1. Residential & Commercial Development and 4. Transportation & Service Corridors).

	7.1 Fire and Fire Suppression		Suppression or increase in fire frequency and/or intensity outside of its natural range of variation.	This category focuses on the human activities that lead to either not enough fire or too much fire in the ecosystem in question. If fire escapes from established agricultural lands, it belongs here, if fire is used to clear new agricultural lands, it belongs in the appropriate category in 2. Agriculture & Aquaculture. It also includes damaging "natural" fires in systems that have lost their natural resilience.
		7.1.1 Increase in Fire Frequency/Intensity	List the specific source of fire e.g., inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting, etc.	
		7.1.2 Suppression in Fire Frequency/Intensity	List the specific source of lack of fire e.g., fire suppression to protect homes, inappropriate fire management, etc.	
		7.1.3 Trend Unknown/Unrecorded		
	7.2 Dams and Water Management/Use		Changing water flow patterns from their natural range of variation.	This category focuses on the human activities that lead to either not enough water either deliberately or as a result of other activities or too much water in the ecosystem in question. Note that homogenizing flows to a constant level may be outside the "natural range of variation." Dredging belongs in 4.3 Shipping Lanes.
		7.2.1 Abstraction of Surface Water (domestic use)		List the specific source of the alteration e.g., change in salt regime, wetland filling for mosquito control, levees and dikes, surface water diversion, channelization, ditching, artificial lakes, etc.
		7.2.2 Abstraction of Surface Water (commercial use)		
		7.2.3 Abstraction of Surface Water (agricultural use)		
		7.2.4 Abstraction of Surface Water (unknown use)		
		7.2.5 Abstraction of Ground Water (domestic use)		List the specific source of the alteration e.g., groundwater pumping, etc.

		7.2.6 Abstraction of Ground Water (commercial use)		
		7.2.7 Abstraction of Ground Water (agricultural use)		
		7.2.8 Abstraction of Ground Water (unknown use)		
		7.2.9 Small Dams		List the specific source of the alteration e.g., dam construction, release of too little or cold water from dam operations, sediment control, etc. If dams are coded the following stresses may be appropriate: 1.1, 1.2, 1.3, 2.2 [to be completed].
		7.2.10 Large Dams		
		7.2.11 Dams (size unknown)		
	7.3 Other Ecosystem Modifications		Other actions that convert or degrade habitat in service of “managing” natural systems to improve human welfare.	This option includes both too much management (over-management) or too little (abondonement). The latter is particularly relevant when former agricultural lands are abandoned.
		List the specific source of the alteration	Land reclamation projects, abandonment of managed lands, rip- rap along shoreline, mowing grass, tree thinning in parks, beach construction, removal of snags from streams, etc.	
8. Invasive & Other Problematic Species, Genes & Diseases			Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance,	After much deliberation it was decided to restrict the use of "invasive species" to refer to non-native species to keep things simple for policy makers. The term "problematic native species" is used instead to refer to native species that have become superabundant or otherwise cause problems. If possible, also record the source of the invasive species and/or conditions that exacerbate their effect. This is the class of threats that covers diseases. Where the Kingdom for a fungal disease is unknown, it should be coded under 8.1.1, 8.2.1 or 8.3.1 and the disease name should be noted in the text field.
	8.1 Invasive Non-Native/Alien Species/Diseases		Harmful plants, animals, pathogens and other microbes not originally found within the	We are defining non-native/alien/exotic species and diseases as those brought in either intentionally or

			ecosystem(s) in question and directly or indirectly.	accidentally by humans in the last 10,000 years. Note that introduced and spread into it by human activities for diseases, it is the infective agent which is considered to be the threat, with the disease being its manifestation in individuals. Domesticated livestock that has gone feral should be coded here, but there is a grey area concerning 'farmed' livestock which are allowed to roam wild; if these are rounded up periodically they could be considered "farmed" and coded under 2.3 Livestock Farming & Ranching, but if there is little to no management they might be better placed here.
		8.1.1 Unspecified Species Only		Only to be used if it is known that there is a threat from an invasive, but the species involved have not been named or only named at a very general level - e.g. invasive plants, invasive animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the Threats narrative.
		8.1.2 Named Species	List the specific plant, animal, or microbe e.g., feral domesticated cattle, household pets, zebra mussels, Dutch elm disease or chestnut blight, Miconia tree, introduction of species for biocontrol, chytrid fungus affecting amphibians, etc.	A list of named taxa (e.g., species or a group of species like rats if it is unclear which species in particular is involved) is available to select from in the SIS database via the "Quick Add" function (this list has been compiled in collaboration with the IUCN SSC Invasive Species Specialist Group and links to the information held in the Global Invasive Species Database). In addition, any taxon already in the taxonomic hierarchy in the SIS database (at whatever taxonomic-level) can be added as a named invasive via the "Quick Add" function. Note, if the named disease is caused by viruses or prions, option 8.5 should be used instead and there is a separate list of those "organisms".

	8.2 Problematic Native Species/Diseases	Harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become “out-of-balance” or “released” directly or indirectly due to human activities.	t is a bit of a judgement call as to when a species becomes "problematic" (also referred to as species being "outside its natural range of variation"). Note that for diseases, it is the infective agent which is considered to be the threat, with the disease being its manifestation in individuals.
	8.2.1 Unspecified Species		Only to be used if it is known that there is a threat from a native taxon but the species involved have not been named or only named at a very general level - e.g. plants, animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the Threats narrative.
	8.2.2 Named Species	List the specific plant, animal, or microbe e.g., over-abundant native deer, over-abundant algae due to loss of native grazing fish, native plants that hybridize with other plants, plague affecting rodents, etc.	A list of named taxa (e.g., species or a group of species like rats if it is unclear which species in particular is involved) is available to select from via the taxonomic hierarchy in the SIS database using the Quick Add function. Additions to the hierachy will be required for taxa which are not yet in the system.
	8.3 Introduced Genetic Material	Human altered or transported organisms or genes.	Hatchery fish are not necessarily invasive species, but they can upset the gene pool of native fish.
	List the specific material or organism	pesticide resistant crops, hatchery salmon, restoration projects using non-local seed stock, genetically modified insects for biocontrol, genetically modified trees, genetically modified salmon, etc. Harmful plants, animals, or pathogens and other microbes of unknown origin.	
	8.4 Problematic Species/Diseases of Unknown Origin	Harmful plants, animals, or pathogens and other microbes or unknown origin. It is not known if they were deliberately or accidentally introduced (see 8.2) or if they were originally found within the ecosystem(s) in question (see 8.3).	Efforts should be made to determine if the options under 8.2 or 8.3 could be used, but if the origin of the problematic taxon concerned is really unknown, then this option should be used. Note that for diseases it is

			the infective agent which is considered to be the threat, with the disease being its manifestation in individuals.
	8.4.1 Unspecified Species		Only to be used if it is known that there is a threat from a taxon of unknown origin and the taxon involved has not been named or only named at a very general level - e.g. plants, animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the Threats narrative.
	8.4.2 Names Species	List the specific plant, animal, or microbe.	The named taxon can be selected from the taxonomic hierarchy in the SIS database via the "Quick Add" function. Additions to the hierachy will be required for taxa which are not yet in the system.
8.5 Viral/Prion-induced Diseases		Viruses are small infectious agents that replicate only inside the living cells of an organism. Although viruses occur universally, each cellular species has its own specific range that often infect only that species. Most viruses co-exist harmlessly in their host and cause no signs or impact on the species concerned. Note that it is the infective agent which is considered to be the threat, with the disease being its manifestation in individuals. symptoms of disease. However, a number are important pathogens which can result in diseases which significantly reduce reproduction or increase mortality. Prions are infectious agents composed of protein in a misfolded form. They do not contain nucleic acids. All known prion diseases affect the structure of the brain and other neural tissue, they are mainly found in mammals, are	The intention here is not to record all know viruses or prions recorded for the species being assessed, but only those that are thought to be having a negative impact on the species concerned. Note that it is the ineffective agent which is considered to be the threat, with the disease being its manifestation in individuals.

		currently untreatable and are universally fatal.	
	8.5.1 Unspecified "Species" (Disease)		Only to be used if it is known that there is a threat from what is probably a virus or a prion but the organism involved have not been named or is only named at a very general level - e.g. avian virus. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the Threats narrative.
	8.5.1 Named "Species" (Disease)	List the specific virus (e.g., Foot and Mouth Disease Virus, West Nile Virus, Rabies Virus, Newcastle Disease Virus, etc.) or prion (e.g., scrapie, Bovine spongiform encephalopathy (BSE) or mad cow disease, etc.).	A list of the most commonly encountered viruses and prions that cause diseases in plants and animals is maintained in the SIS database separate from the taxonomic hierarchy. These are available for selection from a drop-down list. The list will be added to as new problematic viruses and prions are identified.
	8.6 Diseases of Unknown Cause	Occasionally plants and animals are impacted by diseases of unknown origin and often it may take many years to identify the pathogen responsible. For example, it is not known what causes white-band disease (WBD) in Acroporid corals, but the disease is having a huge impact in some parts of the world.	This option will be used in cases where a disease has been described, but the pathogen responsible is not yet known. Once the pathogen is identified the records will need to be recoded accordingly.
9. Pollution		Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources.	This class deals with exotic or excess materials introduced to the environment. There is obviously a fine distinction when the pollution comes from another threat - for example, should an oil spill from a pipeline be classified as 4.2 Utility & Service Lines or 9.2 Industrial & Military Effluents? You will have to

			exercise some judgement here as to which represents the direct threat in your situation. In some cases, the source of the pollution may be either unknown or from a historical source (e.g., heavy metals buried in sediments). In these cases, you may have to make an educated guess as to which category to assign the pollutant.
	9.1 Domestic & Urban Waste Water	Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments.	This category does not include major industrial discharge, which falls under 9.2 Industrial & Military Effluents. It does include chemicals and next generation pollutants (caffeine or pharmaceuticals) in household waste streams. Technically, sewage from a pipe is "point-source" whereas a leaking septic system is "nonpoint- source." This category does not include agricultural runoff, which falls under 9.3 Agricultural & Forestry Effluents.
	9.1.1 Sewage	List the source, and if possible, the specific pollutants of concern e.g., discharge from municipal waste treatment plants, leaking septic systems, untreated sewage, outhouses, etc.	
	9.1.2 Run-off	List the source, and if possible, the specific pollutants of concern e.g., oil or sediment from roads, fertilizers and pesticides from lawns and golf-courses, road salt, etc.	
	9.1.3 Type Unknown/Unrecorded		
	9.2 Industrial & Military Effluents	Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments.	The source of the pollution is often far from the system – an extreme example arethe heavy metals that migrating eels bring to the Sargasso Sea. Often, the pollutants only become a problem when they bioconcentrate through the food chain. Oil spills from pipelines should generally go here.

		9.2.1 Oil Spills	List the source e.g., leakage from fuel tanks, oil spills from pipelines, PCBs in river sediments, etc.	
		9.2.2 Seepage from Mining	List the specific pollutants if possible e.g., mine tailings, arsenic from gold mining, etc.	
		9.2.3 Type Unknown/Unrecorded		There are other known examples of industrial pollution, which are not specifically captured under the classification scheme. These should be coded here for now, and the type/cause of the pollution noted in the text box. Examples include: toxic chemicals from factories, illegal dumping of chemicals, other industrial effluent, ship waste discharge, etc.
	9.3 Agricultural & Forestry Effluents		Water-borne pollutants from agricultural, silivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied.	Wind erosion of agricultural sediments or smoke from forest fires goes in 9.5 Air-Borne Pollutants.
		9.3.1 Nutrient Loads	List the source and specific pollutant of concern: e.g., nutrient loading from fertilizer run-off, manure from feedlots, nutrients from aquaculture, etc.	
		9.3.2 Soil Erosion, Sedimentation	List the source and specific pollutant of concern: e.g., soil erosion from overgrazing, increased run-off and hence sedimentation due to conversion of forests to agricultural lands, etc.	
		9.3.3 Herbicides and Pesticides	List the source and specific pollutant of concern: e.g., herbicide run-off from orchards, etc.	
		9.3.4 Type Unknown/Unrecorded		
	9.4 Garbage & Solid Waste		Rubbish and other solid materials including those that entangle wildlife.	This category generally is for solid waste outside of designated landfills - landfills themselves should go in 1.2 Commercial & Industrial Areas. Likewise, toxins leaching from solid waste - for example, mercury

				leaking out of a landfill into groundwater - should go in 9.2 Industrial & Military Effluents.
		List the type, source, and if possible, the specific pollutants of concern.	Municipal waste, litter from cars, flotsam & jetsam from recreational boats, waste that entangles wildlife, construction debris, etc.	
	9.5 Air-Borne Pollutants		Atmospheric pollutants from point and nonpoint sources.	It may be difficult to determine the sources of many atmospheric pollutants – and thus hard to take action to counter them.
		9.5.1 Acid rain	List the source, and if possible, the specific pollutants of concern e.g., acid rain, excess nitrogen deposition, radioactive fallout, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves, etc.	
		9.5.2 Smog	List the source, and if possible, the specific pollutants of concern e.g., smog from vehicle emissions, coal burning, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves, etc.	Smog is a type of air pollution derived from vehicular emission from internal combustion engines and industrial fumes that react in the atmosphere with sunlight to form secondary pollutants that also combine with the primary emissions to form photochemical smog. Smog is also caused by large amounts of coal burning in an area caused by a mixture of smoke, sulphur dioxide and other components.
		9.5.3 Ozone	List the source, and if possible, the specific pollutants of concern e.g., vehicle emissions, factory smoke emissions, smoke from forest fires or wood stoves, wind dispersion of pollutants or sediments, etc.	Ozone is not emitted directly by car engines or by industrial operations, but formed by the reaction of sunlight on air containing hydrocarbons and nitrogen oxides that react to form ozone directly at the source of the pollution or many kilometres down wind.
		9.5.4 Type Unknown/Unrecorded		
	9.6 Excess Energy		Inputs of heat, sound, or light that disturb wildlife or ecosystems.	These inputs of energy can have strong effects on some species or ecosystems.
		9.6.1 Light Pollution	List the source, and if possible, the specific pollutants of concern e.g., lamps attracting insects, beach lights disorienting turtles, etc.	

		9.6.2 Thermal Pollution	List the source, and if possible, the specific pollutants of concern e.g., heated water from power plants, damaging atmospheric radiation resulting from ozone holes, etc.	
		9.6.3 Noise Pollution	List the source, and if possible, the specific pollutants of concern e.g., noise from highways or airplanes, sonar from submarines that disturbs whales, etc.	
		9.6.4 Type Unknown/Unrecorded		
10. Geological Events			Threats from catastrophic geological events.	Strictly speaking, geological events may be part of natural disturbance regimes in many ecosystems. But they need to be considered a threat if a species or habitat is damaged from other threats and has lost its resilience and is thus vulnerable to the disturbance.
	10.1 Volcanoes		Volcanic Events	
		List the specific problem.	Eruptions, emissions of volcanic gasses, etc.	
	10.2 Earthquakes/Tsunamis		Earthquakes and associated events.	
		List the specific problem.	Earthquakes, tsunamis, etc.	
	10.3 Avalanches and Landslides		Avalanches or landslides	
		List the specific problem.	Avalanches, landslides, mudslides, etc.	
11. Climate Change and Severe Weather			Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat.	Strictly speaking climatic events may be part of natural disturbance regimes in many ecosystems. But they are a threat if a species or habitat is damaged from other threats and has lost its resilience and is thus vulnerable to the disturbance. Many climatic events may also be increasing in frequency or intensity outside their natural range of variation due to human causes.
	11.1 Habitat Shifting and Alteration		Major changes in habitat composition and alteration.	This category focuses primarily on the habitat effects of climate change.
		List the specific problem.	Sea-level rise, desertification, tundra thawing, coral bleaching, etc.	

	11.2 Droughts	Periods in which rainfall falls below the normal range of variation.	Drought degrades the ecosystem and it is likely to cause species mortality but 1.2 Ecosystem Degradation should be coded under the stresses as the primary effect.
	List the specific problem.	Severe lack of rain, loss of surface water sources, etc.	
	11.3 Temperature Extremes	Periods in which temperatures exceed or go below the normal range of variation.	
	List the specific problem.	Heat waves, cold spells, oceanic temperature changes, disappearance of glaciers/sea ice, etc.	
	11.4 Storms and Flooding	Extreme precipitation and/or wind events.	
	List the specific problem.	Thunderstorms, tropical storms, hurricanes, cyclones, tornados, hailstorms, ice storms or blizzards, dust storms, erosion of beaches during storms, etc.	
	11.5 Other Impacts	Other impacts of climate change or severe weather events not covered above (list the specific type of impacts).	
12. Other Options		The threats classification scheme is intended to be comprehensive, but as there are often new and emerging threats, this option allows for these new threats to be recorded.	
	12.1 Other Threats	State the specific problem(s).	This should be captured in both the explanation text box and the Threats narrative.
	Additional Notes:		
	1. The Major Threats referred to in the 'Required and Recommended Supporting Information for IUCN Red List Assessments' as being required, are threats coded as having High or Medium impacts.		
	2. In the SIS database, threats are recorded via the Threats module using the "Add Threats" or "Quick Add to Threats" functions.		
	3. Note that threats 8.1.2, 8.2.2, 8.3.2, 8.3.2, 8.4.2 and 8.5.2 can only be added via the "Quick Add" function.		
	4. For each threat recorded, additional information is/may be recorded, some elements of which are required as part of the minimum documentation standards: timing of the threat (past, ongoing, future, unknown, etc,) [required]; scope (how much of the population is impacted by the threat) and severity (what is the impact of the threat) [optional]. The timing, scope and severity are used to calculate an impact score which is useful for analyses		

	and for distinguishing between major and minor threats. How each threat manifests itself by impacting on the habitat or directly or indirectly on the taxon being assessed itself is captured via the Stresses option [required].
	5. For some of the Biological Resource Use threats (5.1.1, 5.2.1, 5.3.1, 5.3.2, 5.4.1, 5.4.2) there is an additional question on whether or not "International trade is a significant driver?" [required].

Appendix G. Priority habitat spatial analysis measures and calculations.

The priority ranks assigned to private land parcels in the bioregion were the result of combining three equally weighted metrics to represent the ecological significance of habitat, landscape context, and species. First, a three-tiered equation was applied based on the size, representivity, and uniqueness of habitat occurrences in the bioregion. Second, each parcel was assigned a score indicating its level of landscape intactness (or natural cover). Thirdly, each parcel received a score based on the number of unique significant species observed on the parcel. Each of these three metrics contributed to 1/3 to the overall initial prioritization rank (Priority 1, 2, 3 or No Priority).

Several other factors were considered post-hoc to boost the prioritization of relevant private land parcels. Properties that were adjacent (within 30m) to existing protected areas were upgraded one priority rank (e.g. Priority 2 became a Priority 1). Parcels containing all or a portion of NAAP (Northern Appalachian-Acadian Ecoregional Plan) critical habitat occurrences were upgraded one priority rank. Parcels that contained a species at risk (Federal or Provincial) or globally significant (G1-G3) occurrence after 1995, and with a precision value of less than 2.7 (886 m literal range) were upgraded one priority rank. Parcels containing all or a portion of a significant community (see Significant Communities table) were upgraded one priority rank. Parcels within the Chignecto Isthmus wildlife corridor and with a value of Priority 3 or No Priority were upgraded one priority rank.

Data Pre-Processing

Biodiversity Target Data Sources:

Beaches, Dunes and Banks - All Beaches, Dunes and Banks were selected from the provincial resource inventory database (WT = BC and DU).

Salt marsh - Salt marsh was selected from the provincial resource inventory database (WT = CM).

Freshwater Wetlands – Six types of freshwater wetland were selected from the provincial resource inventory database: Bog, Fen, Emergent Wetland, Aquatic Bed, Forested Wetland and Shrub Wetland (WT = BO, FE, EW, AB, FW and SW, respectively).

Tidal Flats - Tidal flats were selected from the provincial wetland inventory database (WT = TF). See Additional Habitat Weighting for a description of Tidal Flat target use.

Aquatic and Riparian Areas - Riparian Areas were derived from the NAAP modelled floodplains layer. Forest and wetland communities within the provincial resource inventory database that overlapped with floodplain occurrences were selected to represent the riparian areas target. See Additional Habitat Weighting for a description of Riparian target use.

Coastal Islands – Coastal islands were manually selected from the New Brunswick cadastral layer.

Forest Mosaic - Using the provincial resource inventory database, forest stands were grouped together into communities using provincial community groupings. These groupings were further grouped into old forest communities (underlined) using the following methods adapted from the provincial Old Forest Community definition guidelines (NB ERR 2013):

- Mature and overmature age class categories were extracted (L1DS = M and O).
- All polygons with the following treatment attributes were deleted using the L1TRT (brackets) field:
- Clear Cut (CC)
- Plantation cleaning (CL)
- Fill Planting (FP)
- Planting (PL)
- Two pass cut (TP)

Old Acadian Forest Communities were queried and exported following the Provincial definitions:

- Old Tolerant Hardwood Habitat (OTHH)
- Tolerant Hardwood Pure (THP)
- Tolerant Hardwood-Softwood (THSW)
- Tolerant Hardwood-Intolerant Hardwood (THIH)
- Old Pine Habitat (PINE)
- Red Pine (RP)
- White Pine (WP)
- Old Spruce-Fir Habitat (OSFH)
- Eastern Cedar (CE)
- Eastern hemlock (EH)
- Red Spruce (RS)
- Black Spruce – moderate (BSM)
- Tolerant Softwood (TOSW)

- Softwood – Tolerant Hardwood (SWTH)
- Softwood Mix (SWMX)

Conservation Analysis

Three-tiered Equation

With the exception of cliffs, coastal islands, and riparian areas (see Additional Habitat Weighting, below), each of the habitat classifiers described above were scored between 0 and 1, with 1 representing habitat of very high conservation value. All target habitat occurrences were scored using a three-tiered equation that equally divides the scoring by habitat uniqueness, habitat representivity, and habitat patch size. The equation gives equal weight to each of the 3 tiers, which provided a conservation significance value for every habitat patch within the bioregion. To do this, a series of columns were created within each of the habitat shapefiles used in the prioritization analysis. Since the equations are area-based assessments, only polygon features are scored using the three-tiered equation. The columns were labelled according to the equation variables below (i.e. U1, U2, etc.) and filled in with the corresponding values from the equations. A final column labelled "score" is then used to take the average value of the 3 habitat equations:

$$Score = \frac{(Uniqueness + Representivity + Size)}{3}$$

Uniqueness:

Conceptually, variations in enduring features across the landscape (geology, climate, topography and soils) can potentially result in different ecological attributes of a habitat type (for example, high elevation bogs host different species assemblages than coastal blanket bogs). As a result, it is assumed that differences in habitats across ecodistricts may support different assemblages of species. The uniqueness score accounts for the rarity of habitats within each ecodistrict (U1), as well as the rarity of habitats within the Natural Area as a whole (U2), and averages these two values. The U1 and U2 equations are calculated for each unique habitat – ecodistrict pair (e.g. bogs in ecodistrict 4, Old Pine Habitat in ecodistrict 6, etc.).

$$U_1 = 1 - \left(\frac{Habitat_{NA-Eco}}{Habitat_{NA-Total}} \right)$$

$$U_2 = 1 - \left(\frac{Habitat_{NA-Total}}{Target_{NA-Total}} \right)$$

The variable Habitat refers to the type of habitat classifier (e.g. bog, old pine forest, rocky shoreline, etc.) that is nested within a particular biodiversity Target (e.g., Freshwater Wetlands, Forest Mosaic, Tidal Flats and Rocky Shores, etc.). The subscript NA-Eco denotes the area of each ecodistrict that intersects the NA boundary. The subscript NA-Total denotes the total area within the bioregion. The final uniqueness score is calculated as:

$$Uniqueness = \frac{(U_1 + U_2)}{2}$$

This method of calculating uniqueness gives equal weighting to U1 and U2 . U1 addresses the uniqueness of ecodistrict-specific habitat as compared to all other occurrences of the same habitat within the bioregion (e.g. uniqueness of coastal bogs as compared to all other bogs within the NA). U2 addresses the uniqueness of the habitat type in general (e.g. the uniqueness of bogs as compared to all other Freshwater Wetlands within the Bioregion). For habitat types represented by their own target (e.g. Salt Marsh), the U2 equation was not relevant and the final uniqueness score for these habitats was based on the output of the U1 equation.

Representivity:

Using the enduring feature approach discussed above, the representivity equations account for the spatial distribution of habitats within each ecodistrict (R2), prorated by the amount of ecodistrict area represented in the bioregion. The R1 and R2 equations are calculated for each unique habitat – ecodistrict pair (e.g. bogs in ecodistrict 4, Old Pine Habitat in ecodistrict 6, etc.).

$$R_1 = \frac{Eco_{NA}}{Eco_{Total}}$$

$$R_2 = \frac{Habitat_{NA\text{-}Eco}}{Habitat_{Eco}}$$

The variable Eco refers to the area of land represented by the ecodistrict. S ubscript Total denotes the total ecodistrict area and subscript NA denotes the portion of the ecodistrict that intersect the bioregion boundary. The variable Habitat refers to the type of habitat classifier (e.g. bog, old pine forest, rocky shoreline, etc.). The subscript NA-Eco denotes the area of each ecodistrict that intersect the bioregion boundary, and the subscript Eco refers to the total amount of each Habitat within the ecodistrict, regardless of the proportion that is within the NA boundary. The final representivity score is calculated as:

$$Representivity = 1 - \left(\frac{R_1}{R_2} \right)$$

Conceptually, if both R1 and R2 are equal, the habitat type is equally spread across the ecodistrict, both inside and outside the NA boundary (Representivity = 0). If R1 is smaller than R2, than a higher proportion of habitat is located within the NA, which results in a higher score (Representivity > 0). If R1 is larger than R2, than a lower proportion of habitat is located within the NA portion of the ecodistrict than outside of it. This results in a negative score (Representivity < 0), meaning that the habitat type is more represented outside the Bioregion. All negative values are converted to 0.

Size:

Size score (0-1) is calculated for each habitat occurrence by dividing the occurrence size by the minimum size criteria from the NAAP (Anderson et al. 2006) or from the NBDNR forest patch size criteria (NB ERR 2013).

$$Size = \frac{Habitat_{\text{Patch Size}}}{Habitat_{\text{Critical Patch Size}}}$$

Habitat occurrences that meet or exceed the minimum threshold values receive a score of "1" and if below the minimum receive a score from 0 to 0.99 depending on the size of the patch. Patches of habitat that are close to the minimum patch size will receive a higher score than those that are smaller. See table P1 for a summary of size criteria used within the analysis.

Table P1. Minimum size criteria for each habitat type within the prioritization analysis

Habitat Type	Minimum Size (Acres)	Minimum Size (Hectares)
Beaches, Dunes and Banks	20	8.1
Rocky Shores	10	4.0
Salt Marsh	60	24.3
Tidal Flats	100	40.5
Freshwater Wetlands (complex)	50	20.2
Riparian Areas	100	40.5
Acadian Forest Mosaic[5]		
Tolerant Hardwood (OTHH)	247.1	100
Intolerant Hardwood (OHWH)	74.1	30
Spruce / Fir (OSFH)	926.6	375
Pine (PINE)	24.7	10

[5] For old forest communities, patch sizes were adapted from the Provincial Old Forest Community and Wildlife Habitat Definitions (NBDNR 2013). The largest patch size for each community was used in the analysis to capture all species that were identified within the respective community type.

Other (OOFH)	926.6	375

Additional Habitat Weighting

Upland Buffers:

Freshwater wetland habitat occurrences were assigned buffers of 275 m (CWS, OMNR & OME 1998). All habitat occurrences that were within the buffers received an additional value of 0.2. Areas of permanent land conversion (urban areas, paved roads, etc.) were removed from the buffer layers so as not to prioritize non-natural areas.

Riparian Areas:

Habitat occurrences that overlap modelled riparian areas (see data pre-processing) received an additional value of 0.2.

Tidal Flats:

Tidal Flats in New Brunswick cannot be privately owned, and therefore do not overlap with the private land parcel layer. To account for this, land parcels adjacent to tidal flats received the 3-tiered equation value assigned to the respective tidal flat. This method is intended to capture the ecological significance of tidal flats by putting increased weight on the buffering uplands.

GIS Prioritization Analysis Steps

Acadian Forest community, freshwater wetland, salt marsh, beach, dune and tidal flat occurrences were scored based on the 3-tiered equation described above.

Target occurrences that overlapped with riparian areas or wetland buffers were assigned an additional 0.2 for each respective overlapping feature. All scores greater than 1 were recalculated to equal 1. The habitats were then combined and converted into a 10 m resolution raster using the final score as the cell values.

Using the “isectpolyrst” tool from the Geospatial Modelling Environment platform for ArcGIS 10.1, the maximum score occurring in each land parcel was transferred to that respective parcel.

Using the New Brunswick Resource Inventory Layer, an intactness layer was created by removing areas of anthropogenic influence and associated buffers to account for edge effect (i.e. human development, paved roads, agriculture, clear cuts, regenerating forests and forest plantations). Permanently converted areas (urban, rural and coastal development, paved roads, agriculture) were assigned a 300m buffer (ELI 2003), forestry roads and other loose surface roads were assigned a 200m buffer, and clearcut areas were assigned a 100m buffer.

Each patch of natural intact area was assigned a score between 0 and 1 using 1000 ha as the threshold patch size (i.e., patch sizes greater than 1000 Ha received a score of 1 and those less than 1000 Ha were given a score based on a sliding scale). An intactness 10 m resolution raster was created with the calculated scores from 0 to 1 as the cell values.

Using the Zonal Statistics as Table tool, the "majority" score of intactness found in each parcel (using PID as the identifier) was generated and transferred to that respective parcel using the join function.

Using the ACCDC (Atlantic Canada Conservation Data Centre) 2013 point occurrences, the total number of significant species per parcel was calculated (See section 3B for significant species definition criteria). Only point occurrences after 1995 and with a precision of <= 886 m were used. Using the Snap tool, species points within 100m of a land parcel (i.e. within water features) were snapped to the nearest land parcel to ensure that aquatic species were included in the analysis.

The species and parcel layer were intersected and the resulting table was imported into a pivot table in MS Excel 2010. The number of species (not occurrences) within each parcel was calculated and these values were joined back to the original parcel layer.

Parcels were assigned a score based on the number of significant species occurring within them: >= 3 species = 1, 2 species = 0.75 and 1 species = 0.5.

The three metrics calculated in steps 1 through 9, each with a score between 0 and 1, were summed together for each parcel in the NA (Habitat + Intactness + Species).

Final scores (0-3) were then classified using the Natural Break (Jenks) classification to represent the four priority categories (P1, P2, P3 and No Priority). Natural breaks assigns priority ranks based on natural groupings inherent in the score data by minimizing the variance within each rank, while maximising the variance between ranks.

Priority Ranking	Break Values/ Score
P1	> 1.27
P2	0.65 – 1.27
P3	0.28 – 0.64
No Priority	< 0.28

Fine-scale Analysis

Several other factors were considered to increase the priority of parcels that have additional ecological significance:

- Properties that were adjacent (within 30m) to existing Protected Natural Areas, NCC land and other conservation lands (see Protected Areas table) were upgraded one priority rank (e.g. Priority 2 becomes a Priority 1).
- Parcels containing a Northern Appalachian-Acadian Ecoregional Plan (Anderson et al. 2006) critical habitat occurrence were upgraded one priority rank.
- Parcels containing a significant community (see Significant Communities table) were upgraded one priority rank.
- Parcels that contained a species at risk or globally significant species (G1-G3G4) occurrence after 1995, and with a precision value of less than 2.7 (within 500m), were upgraded one priority rank.
- Coastal islands that did not contain any infrastructure (with the exception of lighthouses), had all respective parcels upgraded a priority rank.
- Parcels with a value of Priority 3 or No Priority that intersect the boundary of the Chignecto Isthmus Wildlife Corridor were upgraded one priority rank.

Finally, an additional column was created in the prioritization layer for parcels identified as high priority by an external expert or site visit findings by NCC staff. A comments field details the reason for the assigned rank and the name of the assigner.

Results

The results of the final prioritization are consistent with firsthand knowledge of conditions across the NB Northumberland Strait Bioregion, although properties should have a site visit conducted before securement proceeds. Much of the input habitat data is hand-delineated from aerial imagery, and as such is subject to error. Known error rates in habitat boundary delineations and species makeup of forested stands restricts precision and accuracy of the final prioritization results. The findings from site visits and ground-truthed occurrences should always be used to substitute a priority rank when site visit findings differ from the modelled priority rank.

Appendix H. IUCN conservation actions classification scheme version 2.0, including definitions and expositions.

IUCN - CMP Unified Classification of Conservation Actions Needed				Conservation actions are interventions that need to be undertaken to help improve the conservation status of the taxon being assessed. In selecting these, users are advised to not treat this as a wish list, but rather as a set of realistic key actions which can be achieved in the next five years. The Action-in-Place and the Threats to the taxon should be used to inform the selection of the Actions Needed.
Level of Classification			**Definition**	
1	**2**	**3**	**Examples**	**Exposition**
1 Land/Water Protection			Actions to identify, establish or expand parks and other legally protected areas.	This class contains all actions designed to directly protect biodiversity through parks, reserves, easements, or other similar means.
	1.1 Site/Area Protection		Establishing or expanding public or private parks, reserves, and other roughly equivalent to IUCN Categories I-VI (includes marine protected areas).	For many years, this was the primary action used by conservationists. The actual protected areas management of protected areas fall into 2.1 Site/Area Management.
		List the type of reserve.	National parks, nature reserves, marine protected areas (MPAs), town wildlife sanctuaries, private reserves, tribally owned hunting grounds, communal protected areas, etc.	
	1.2 Resource and Habitat Protection		Establishing protection or easements of some specific aspect of the resource on public or private lands outside of IUCN Categories I-VI.	This category is for efforts to legally protect some part of the overall resource rather than the entire entity.
		List the type of protection.	Easements, development rights, water rights, instream flow rights, wild & scenic river designation, etc.	

2. Land/Water Management			Actions directed at conserving or restoring sites, habitats and the wider environment.	This class contains all actions involved in directly managing habitats.
	2.1 Site/Area Management		Management of protected areas and other resource lands for conservation.	The establishment of protected areas goes into the appropriate category in 1. Land/Water Protection – this category covers the actual management of the land or water. Of particular concern are the many 'paper' parks or reserves which have been designated but lack proper implementation and management.
		List the specific action.	Maintenenance of habitat, site design, demarcating borders, erecting fences, training park staff, control of poachers, etc.	
	2.2 Invasive/Problematic Species		Controlling and/or preventing invasive and/or other problematic plants, animals, and pathogens.	This could arguably fit into 2.1 Site/Area Management and others, but it is such a vital action it gets its own category.
		List the specific species and action.	Cutting vines off trees, preventing ballast water discharge, etc.	
	2.3 Habitat and Natural Processes Restoration		Enhancing degraded or restoring missing habitats and ecosystem functions; dealing with pollution.	This category involves the restoration of degraded lands and natural processes as opposed to the protection of existing ones.
		List the specific restoration.	Creating forest corridors, prairie re-creation, riparian tree plantings, coral reef restoration, mangrove replanting, prescribed burns, breaching levees, dam removal, installing fish ladders, liming acid lakes, cleaning up oil spills , modifying land use policy (to reduce or stop logging and sedimentation), etc.	
3. Species Management			Actions directed at managing or restoring species, focused on the species of concern itself.	This class contains all actions involved in directly managing species. The difference between land/water management and species management is defined as follows: If the action targets two or fewer specific species, it is Species Management; if it targets three or more, it's Land/Water Management. For example fish ladders aimed at one salmon species fit in species

				recovery; fish ladders aimed at several different species fit in natural process restoration.
	3.1 Species Management		Managing specific plant and animal populations of concern.	Note that culling deer to save a rare plant that they are eating is 2.2 Invasive/Problematic Species Control whereas culling deer to manage the deer population itself fits here.
		3.1.1 Harvest Management	harvest management of wild mushrooms, setting fishing quotas, setting catch-size limits, etc.	Applies to any species that would benefit from harvest management or fishing effort controls.
		3.1.2 Trade Management	setting harvest quotas, trade regulations for specific populations,non CITES trade regulations, aquarium trade regulation, regulation of trade in non-timber forest products, etc.	
		3.1.3 Limiting Population Growth	Culling buffalo to keep population size within park carrying capacity, sterilization of animals, etc.	
	3.2 Species Recovery		Manipulating, enhancing or restoring specific plant and animal populations, vaccination programs.	
		List the action.	manual pollination of trees, artificial nesting boxes/platforms, clutch manipulation, supplementary feeding, disease/pathogen/parasite management, etc.	
	3.3 Species Re-Introduction		Re-introducing species to places where they formally occurred or benign introductions.	
		3.3.1 Re-Introduction		Re-introductions are to areas where the species formerly occurred preferably following the IUCN Re-introduction Guidelines.
		3.3.2 Benign Introduction		Benign introductions are to areas outside of the species' historic range, but within an appropriate habitat and done deliberately for conservation reasons.

	3.4 Ex-situ Conservation	Protecting biodiversity out of its native habitats.	This is one of the key strategies practiced by zoos, aquaria and botanical gardens interested in conservation.
	3.4.1 Captive Breeding/Artificial Propagation	Captive breeding of animals, propagation of plants from seeds or cuttings, artificial propagation of plants, etc.	
	3.4.2 Genome Resource Bank	Gene-banking, cryopreservation, etc.	
4. Education and Awareness		Actions directed at people to improve understanding and skills, and influence behavior.	This class obviously overlaps a bit with 7. External Capacity Building; actions in this class tend to target individuals rather than organizations.
	4.1 Formal Education	Enhancing knowledge and skills of students in a formal degree programme.	
	List the specific type of education.	Public schools, colleges & universities, continuing education, etc.	
	4.2 Training	Enhancing knowledge, skills and information exchange for practitioners, stakeholders, and other relevant individuals in structured settings outside of degree programmes.	This category refers to training outside of formal degree programmes.
	List the specific type of training and target audience.	Monitoring workshops or training courses in reserve design for park managers, learning networks or writing how-to manuals for project managers, stakeholder education on specific issues, improving species identification skills (especially of animal or plant parts in trade), training on how to set shark nets for beach protection to minimize bycatch of sharks and cetaceans, etc.	
	4.3 Awareness & Communications	Raising environmental awareness and providing information through various media or through civil disobedience.	This is a large category that involves many different efforts to raise awareness about conservation issues in specific stakeholder groups and the general public. There is a grey area between general awareness campaigns which belong in this category versus campaigns to enact specific legislation which belong in 5. Law & Policy. Many mainstream conservation

				organizations do not use the more disruptive and illegal forms of moral confrontation -- inclusion of them in an effort to make this taxonomy comprehensive should by no means constitute an endorsement of them.
		List the specific type of awareness.	Radio soap operas, environmental publishing, web blogs, puppet raising shows, door-to-door canvassing, tree sitting, protest marches, etc.	
5. Law & Policy			Actions to develop, change, influence, and help implement formal legislation, regulations, and voluntary standards.	This class contains a series of strategies aimed at using government powers at all levels to protect biodiversity. There is a sequence embedded in this class that involves enacting or changing the legislation, policy, or standard and then promoting compliance or enforcement of it. Some organizations do both, others only one or the other.
	5.1 Legislation		Making, implementing, changing, influencing, or providing input into formal government sector legislation or polices at all levels: international, national, state/provincial, local, tribal.	Public legislation refers to the official legal code governing society – what some people refer to as "hard law."
		5.1.1 International Level	List the type of legislation and the specific action being taken e.g., promoting conventions on biodiversity, wildlife trade laws like CITES, regional legislation like the European Habitats Directive, etc.	
		5.1.2 National Level	List the type of legislation and the specific action being taken e.g., work for or against government laws such as the US Endangered Species Act, influencing legislative appropriations, etc.	
		5.1.3 Sub-national Level	List the type of legislation and the specific action being taken e.g., State/Pprovincial: state ballot initiatives, providing data to state	

			policy makers, developing pollution permitting systems, dam relicensing Local: developing zoning regulations, countryside laws, species protection laws, hunting bans Tribal: creating tribal laws, etc.	
		5.1.4 Scale Unspecified	List the type of legislation and specific action being taken.	
	5.2 Policies & Regulations		Making, implementing, changing, influencing, or providing input into policies and regulations affecting the implementation of laws at all levels: international, national, state/provincial, local/community, tribal.	Policies and regulations are how legislation gets implemented – what some people refer to as "soft law." This is a relatively narrow definition of the word "policy."
		List the type of policy or regulation.	Input into agency plans regulating certain species or resources, and the specific action being taken working with local governments or communities to implement zoning regulations; promoting sustainable harvest of timber on state forest lands, etc.	
	5.3 Private Sector Standards &		Setting, implementing, changing, influencing, or providing input into voluntary standards & professional codes that govern private sector.	These are codes of practice that are adopted by an organization or industry on a voluntary (as opposed to mandated) basis. Mandatory laws and regulations fall under 5.1 Legislation or 5.2 Policies & Regulations.
		List the type of standard or code	Marine & Forest Stewardship Councils, Marine Aquarium Council, Conservation Measures Partnership (CMP) Open Standards, corporate adoption of forestry best management practices, sustainable grazing by a rancher, etc.	
	5.4 Compliance & Enforcement		Monitoring and enforcing compliance with laws, policies & regulations, and standards & codes at all levels.	Laws, policies, regulations, and standards are useless if they are not implemented and enforced. Some organizations merely try to monitor compliance whereas others have the power of enforcement.
		5.4.1 International Level		

		5.4.2 National Level		Select the relevant level(s) and list the action e.g., CITES enforcement, water quality standard monitoring, initiating criminal and civil litigation, etc.
		5.4.3 Sub-national Level		
		5.4.4 Scale Unspecified		
6. Livelihood, Economic and Other			Actions to use economic and other incentives to influence behaviour.	This class of actions has been gaining in popularity in the past few years.
	6.1 Linked Enterprises and Livelihood Alternatives		Developing enterprises that directly depend on the maintenance of natural resources or provide substitute livelihoods as a means of changing behaviours and attitudes.	In linked enterprises, the health of the enterprise directly depends on the health of the biodiversity - for example, a community homestay that depends on tourists coming to visit an intact coral reef. Livelihood alternatives are established to move people from destructive actions to non-destructive ones -- for example, a community homestay that keeps the operator from working as a logger.
		List the type.	Ecotourism, non-timber forest product harvesting, harvesting wild salmon to create value for wild population, etc.	
	6.2 Substitution		Promoting alternative products and services that substitute for environmentally damaging ones.	This category involves developing products and services explicitly to remove pressure from biodiversity.
		List the type.	Viagra for rhino horn, farmed salmon as a replacement for pressure on wild populations, promoting recycling and use of recycled materials, etc.	
	6.3 Market Forces		Using market mechanisms to change behaviours and attitudes.	This category includes both positive and negative incentives for conservation. This category deals with incentive-based standards; non-incentive standards go in 5.2 Policies & Regulations.
		List the type.	Certification, positive incentives, boycotts, negative incentives, grass and forest banking, valuation of ecosystem services such as flood control, etc.	
	6.4 Conservation Payments		Using direct or indirect payments to change behaviours and attitudes.	This category involves a direct payment for conservation behaviours.

		List the type.	Quid-pro-quo performance payments, resource tenure incentives, etc.	
	6.5 Non-Monetary Values		Using intangible values to change behaviours and attitudes.	This category cuts across the others in this class, but involves those cases where the incentives are not financial.
Optional Addition:				This option was in the Salafsky et al. (2008) paper, but was not included for use on the IUCN Red List because these needs would apply to every species and hence was not thought to be particularly useful or informative.
7. External Capacity Building Actions			To build the infrastructure to do better conservation.	Every organization has to develop its own capacity to design, implement, manage, and learn from its work. These basic functions are not considered part of this classification scheme. However, if a group does this type of work to help partner organizations, then it should be part of this class.
	7.1 Institutional & Civil Society Development		Creating or providing non-financial support & capacity building for non-profits, government agencies, communities, and for-profits.	Building conservation institutions.
		List the type.	Creating new local land trusts, providing circuit riders to help develop organizational capacity, etc.	
	7.2 Alliance & Partnership		Forming and facilitating partnerships, alliances, and networks of organizations.	Promoting cross-organizational informational sharing, learning, and collaboration.
		List the type.	Country networks, Conservation Measures Partnership (CMP), Cambridge Conservation Initiative (CCI), etc.	
	7.3 Conservation Finance		Raising and providing funds for conservation work.	Providing the financial resources for conservation.
		List the type.	Private foundations, debt-for-nature swaps.	
	Additional Notes:			
	1. Conservation Actions Needed are recorded in the SIS database via the Conservation module using the "Add Conservation Actions Needed" or "Quick Add to Conservation Actions Needed" functions.			