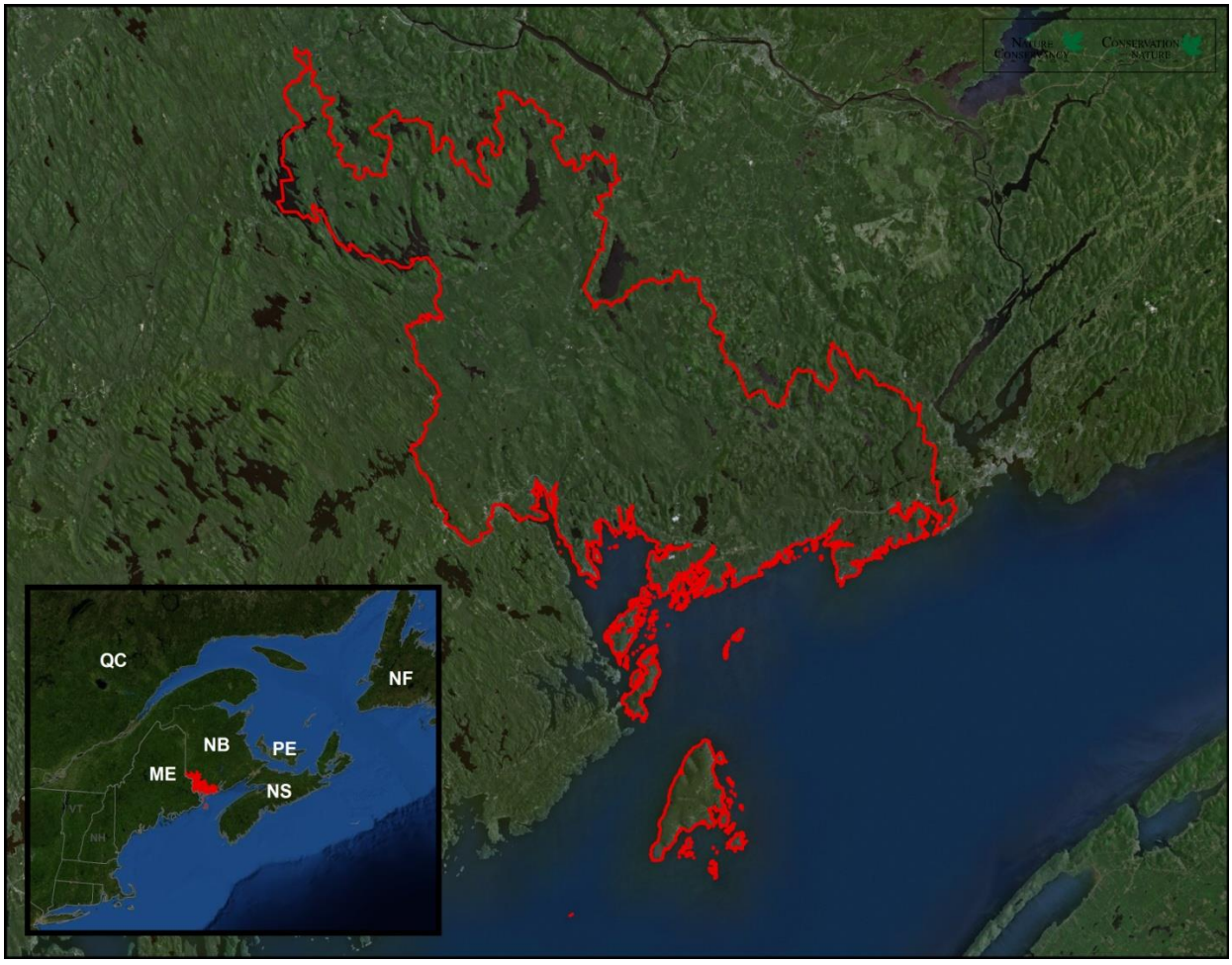
Outer Bay of Fundy (NB) Habitat Conservation Strategy
New Brunswick Eastern Habitat Joint Venture
Steering Committee
March 2015



Outer Bay of Fundy Bioregion
Habitat Conservation Strategy
EXECUTIVE SUMMARY

This Habitat Conservation Strategy was developed through collaboration among member organizations of the New Brunswick Eastern Habitat Joint Venture (EHJV) New Brunswick Steering Committee and partner conservation groups. These strategies are intended to respond to a need to better communicate, coordinate, and inform conservation actions taken by regional and local conservation organizations, to highlight opportunities for collaboration, and to identify on-the-ground action gaps. The purpose of this strategy is to identify and assess the current state of species and ecological communities of conservation priority for the NB Outer Bay of Fundy (NB OBoF) bioregion, to present a series of mapping approaches to identify their location within the bioregion, and to identify the planned conservation and stewardship actions of organizations within the bioregion to enhance partnerships, reduce redundancies, and facilitate decision-making. Each organization is guided by its own particular mission, vision, and/or guiding principles; as such, the information presented in this document is intended to serve as a transparent, helpful, decision-making tool for more detailed organizational prioritizations and prescriptive analyses.

A shared approach

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

In the first section (Conservation Context), each HCS presents descriptions, in general terms, of the spatial extent and ecological significance of the bioregion. Conservation priority species that are found within its boundaries are discussed, with a focus on species at risk, rare taxa, and Bird Conservation Region 14 priority birds. Also discussed are existing protected areas and conservation lands in the bioregion, and social and economic considerations relevant to regional conservation work. 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 discusses the significance of important habitat types for the identified conservation priority species. Threats to conservation priority habitats and species are also identified, assessed, and where possible, mapped at the bioregional scale. A series of mapping approaches to landscape prioritization of the bioregion are presented, including a habitat prioritization map (composite), a series of priority species composites derived from best available occurrence data for each species, and a Conservation Value Index (CVI) map, which combines the priority habitat and species prioritizations. For various reasons, including introduced bias, the CVI map, priority habitat composite, and various multi-species composites can present contrasting perspectives on spatial priorities. This is expected and also reflects the reality that contrasting approaches may be required for the conservation of different species, species' assemblages, and the habitats that host them (e.g., land acquisition versus

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

Finally, each HCS presents conservation and stewardship actions that organizations plan to undertake to mitigate identified threats and contribute to the conservation of priority habitats and the species they host over the course of a 5-year planning period. 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. 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) are strongly encouraged to make specific reference to relevant information contained within the appropriate HCS.

Goals

The conservation goals that have been identified to guide the development of the NB Outer Bay of Fundy Habitat Conservation Strategy are:

1) Identify key conservation areas that are critical for priority conservation species and habitats.
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 initiatives by the partnership and informing efforts to acquire land for conservation.
4) Support the management and protection of corridors between existing protected areas and other conservation lands through land securement, partnerships, and community outreach.
5) Support the recovery of populations of species at risk through collective conservation actions by the partnership.
6) Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7) Facilitate community involvement and greater understanding of biodiversity values, and inform local stewardship initiatives.

Vision

The NB Outer Bay of Fundy bioregion remains one of the most biologically rich and culturally significant landscapes in New Brunswick. Agriculture, tourism and resource extraction activities are conducted in a manner that promotes long-term sustainability as their utmost priority. Communities understand the connection between healthy ecosystems, economic prosperity and human well-being, and take pride in the natural heritage of their region. Coastal islands in particular are recognized as important habitat for colonial and migratory birds, and are stewarded as such. Both marine and terrestrial ecosystems are managed and conserved to promote healthy wildlife populations and maintain their full suite of biodiversity for the benefit of future generations.

Ecological Context

With approximately 50% of the entire New Brunswick coastline represented in the bioregion, conservation in the area has historically centred on the importance of coastal ecological systems and the diversity of species they support (Map 1). Much of this diversity is directly linked to the world famous Bay of Fundy tides, which push large volumes of water through the narrow island passages, such as those found in the Passamaquoddy Bay. Tidal forces produce upwellings that push nutrients and organic materials to the surface, creating high concentrations of phyto- and zooplankton. In turn, this forms the base of a food web that supports tremendous numbers of fish, marine mammals, seabirds, shorebirds and waterfowl. The offshore islands in the bioregion provide breeding, wintering and migratory stopover sites for several significant bird species. The Wolves Archipelago supports the highest concentration of overwintering Harlequin Duck (*Histrionicus histrionicus* pop. 1; SARA Special Concern) in New Brunswick. Machias Seal Island is one of the few known nesting sites in the province for Arctic Tern (*Sterna paradisaea*) and supports the largest Atlantic Puffin (*Fratercula arctica*) colony in the Maritimes (CWS, unpublished; Zelazny, 2007). The Quoddy Region is known for the large congregations of birds and marine mammals, including the North Atlantic Right Whale (*Eubalaena glacialis*; SARA Endangered), as well as the Fin Whale (*Balaenoptera physalus*; SARA Special Concern) and Harbour Porpoise (*Phocoena phocoena*; SARA Threatened) (COSEWIC 2005; COSEWIC 2006).

The Department of Fisheries and Oceans (DFO) has identified seven major coastline environments within the bioregion: 1a -Grand Manan Cliffs, 1b – Grand Manan Archipelago, 2a – Letete Passage and Islands, 2b –Passamaquoddy Bay and St. Croix Estuary, 2c - Letete Inner Reach, 3 – Maces Ledges, 4 – Musquash Marshes and Beaches (DFO 2012). Together these coastal units represent a diversity of landforms and specific habitat associations. DFO also has identified Ecologically and Biologically Significant Areas (EBSAs) for the Bay of Fundy (Buzeta 2014). If not in their entirety, important portions of some of these EBSAs already have been designated as protected areas. There are two Migratory Bird Sanctuaries designated by the federal government: Machias Seal Island and Grand Manan Island. Furthermore, there are five Canadian designated Important Bird Areas (IBAs) that have also been designated: Passamaquoddy Archipelago, The Wolves Archipelago, Grand Manan Archipelago, Machias Seal Island and Point Lepreau – Maces Bay. Though IBA designations do not offer legal protection of these sites, they serve an important role in highlighting their ecological significance.

The Northern Appalachian-Acadian Ecoregional Plan (NAAP; Anderson *et al.* 2006) described a number of critical ecological systems for the NB Outer Bay of Fundy Bioregion including beaches, rocky shores, salt marsh, tidal flats, freshwater wetlands, riparian systems, summits and sheltered forest coves. The NAAP also listed fifteen species that are considered “primary targets” - those that cannot be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention. Additionally, there are 36 federal (COSEWIC) species at risk in the Bioregion and 4 provincial species at risk that are not COSEWIC listed. Additionally, fifteen globally significant species (G1-G3G4) were also identified within the Bioregion, nine of which are COSEWIC listed.

Conservation Priority Habitats

Based on the habitat affinities of rare species, species at risk, and bird species identified as conservation priorities, the following seven habitat types were determined to be conservation priorities for the New Brunswick Outer Bay of Fundy bioregion:

1) Coastal Uplands (Beaches, Dunes and Cliffs)
2) Salt Marshes
3) Tidal Flats and Rocky Shores
4) Coastal Islands
5) Acadian Forest Mosaic
6) Freshwater Wetlands
7) Riparian and Aquatic Systems

Conservation Priority Habitats and Species

A map depicting the spatial location of conservation priority habitats within the New Brunswick Outer Bay of Fundy Bioregion was developed based on consideration of the uniqueness, representivity, and size of individual patches of priority habitat types (Map 2). A series of species composite maps were also developed based on the distribution of occurrence records of rare, at risk, and priority species, to estimate the likelihood of occurrence of significant species within the Bioregion. The scores generated through development of the priority habitat composite and the species composites were combined to yield a conservation value index for the New Brunswick Outer Bay of Fundy Bioregion (Map 3).

Threats

The following seven threats have been assessed as medium to high for these habitats:

Current:

2.4 Freshwater & Marine Aquaculture - Marine aquaculture (Threat Status: Medium)
4.1 Roads & Railroads - Road fragmentation (Threat Status: Medium)
5.3 Logging & Wood Harvesting - Incompatible forestry activities (Threat Status: High)
7.2 Dams & Water Management/Use - Dams and other aquatic barriers (Threat Status: Medium)
8.1 Invasive Non-Native/Alien Species (Threat Status: Medium)
9.3 Agriculture & Forestry Effluents (Threat Status: Medium)

Emerging:

11.1 Habitat Shifting & Alteration - Sea-level rise and erosion (Threat Status: Medium)

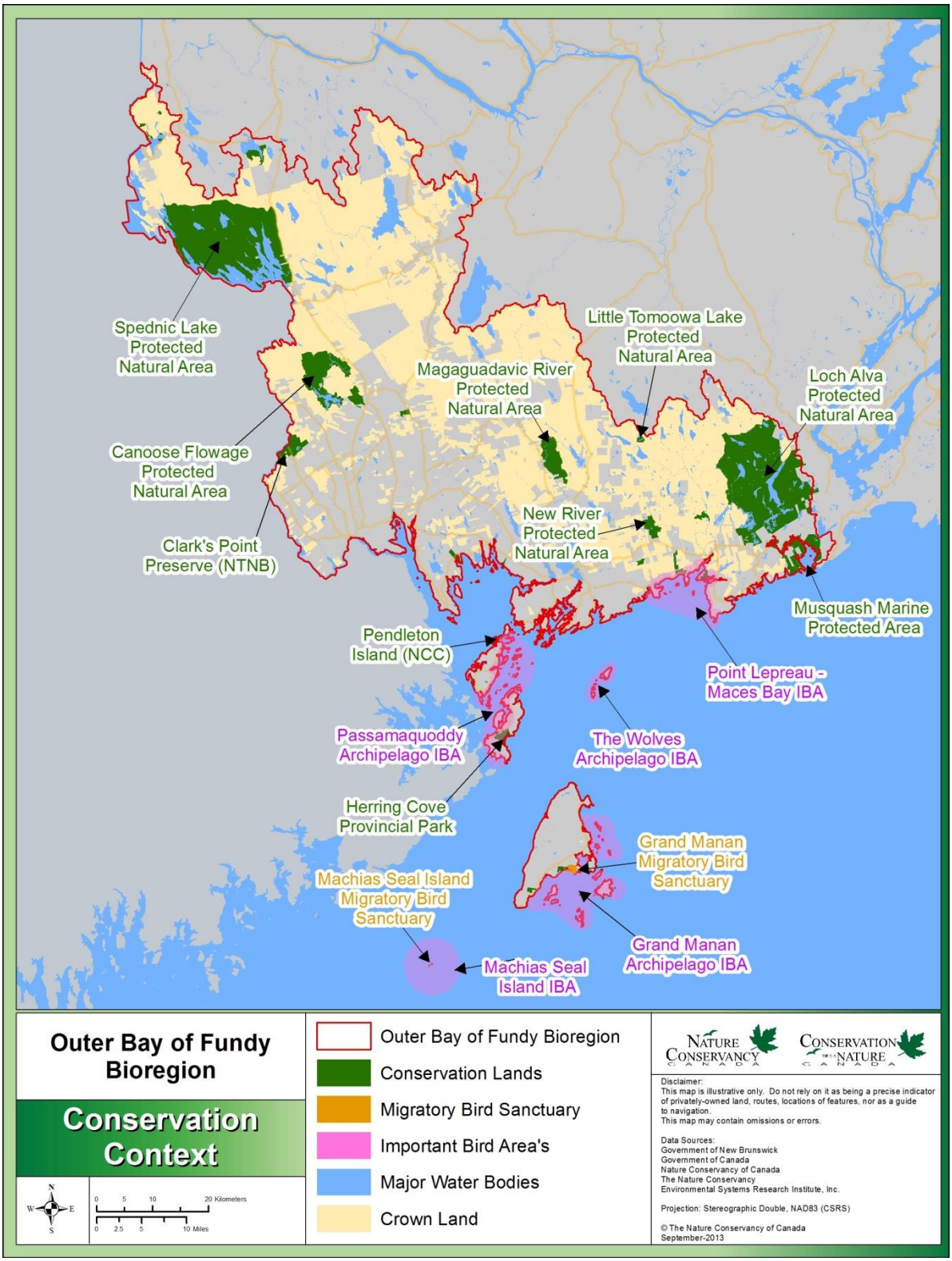
Overall Threat Status for the NB Outer Bay of Fundy bioregion: High

Conservation Actions

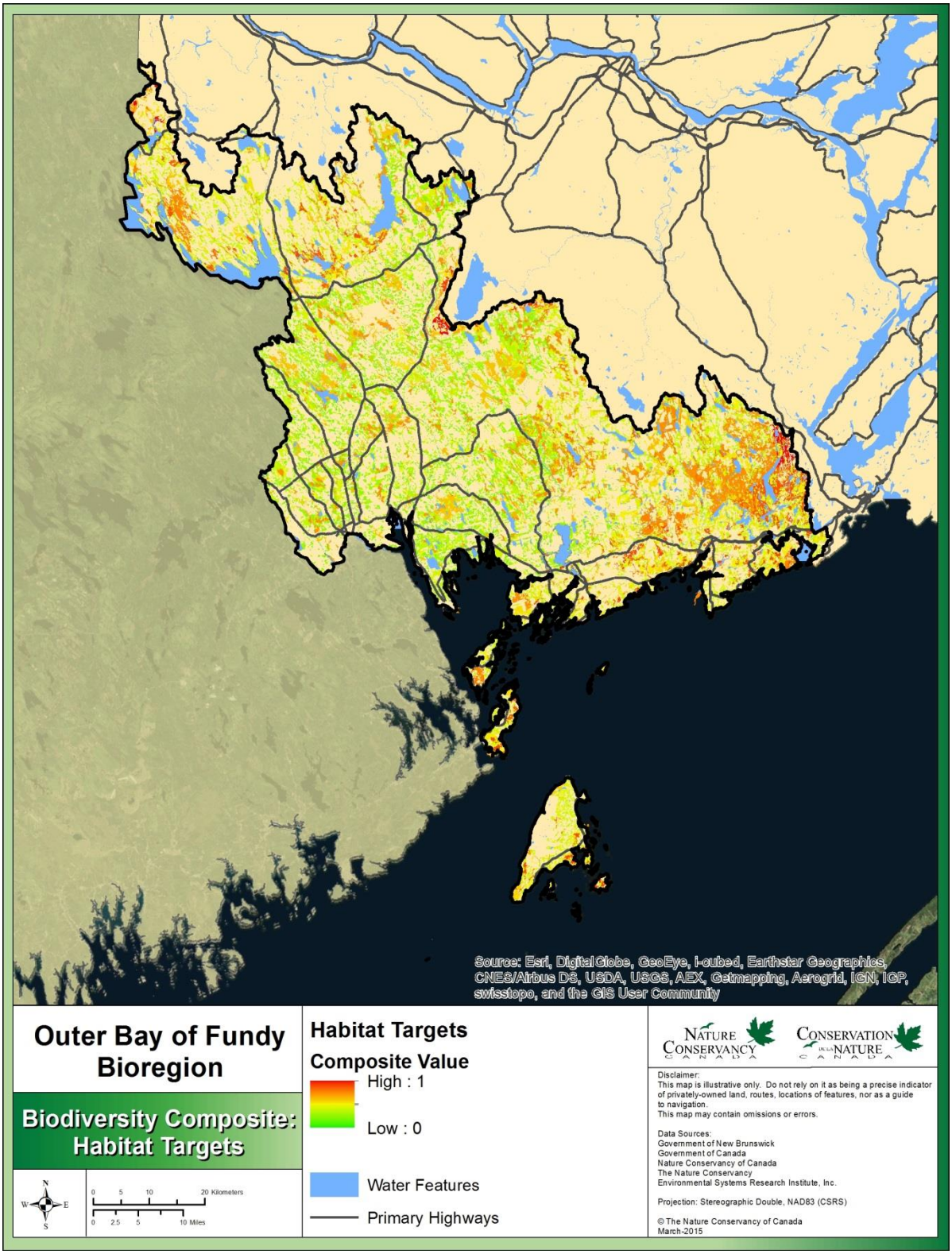
The conservation actions presented in this report are being undertaken and planned by organizations working in the NB Outer Bay of Fundy bioregion to mitigate identified threats and contribute to the conservation of priority habitats and the species they host over the course of a five-year planning period. Though they cannot be considered comprehensive, actions are presented for each partner organization. A more detailed list of conservation actions structured according to IUCN categories,

including links to the threats associated with each of the different conservation priority habitats, is presented in the body of the report (see Table 11, p. 79).

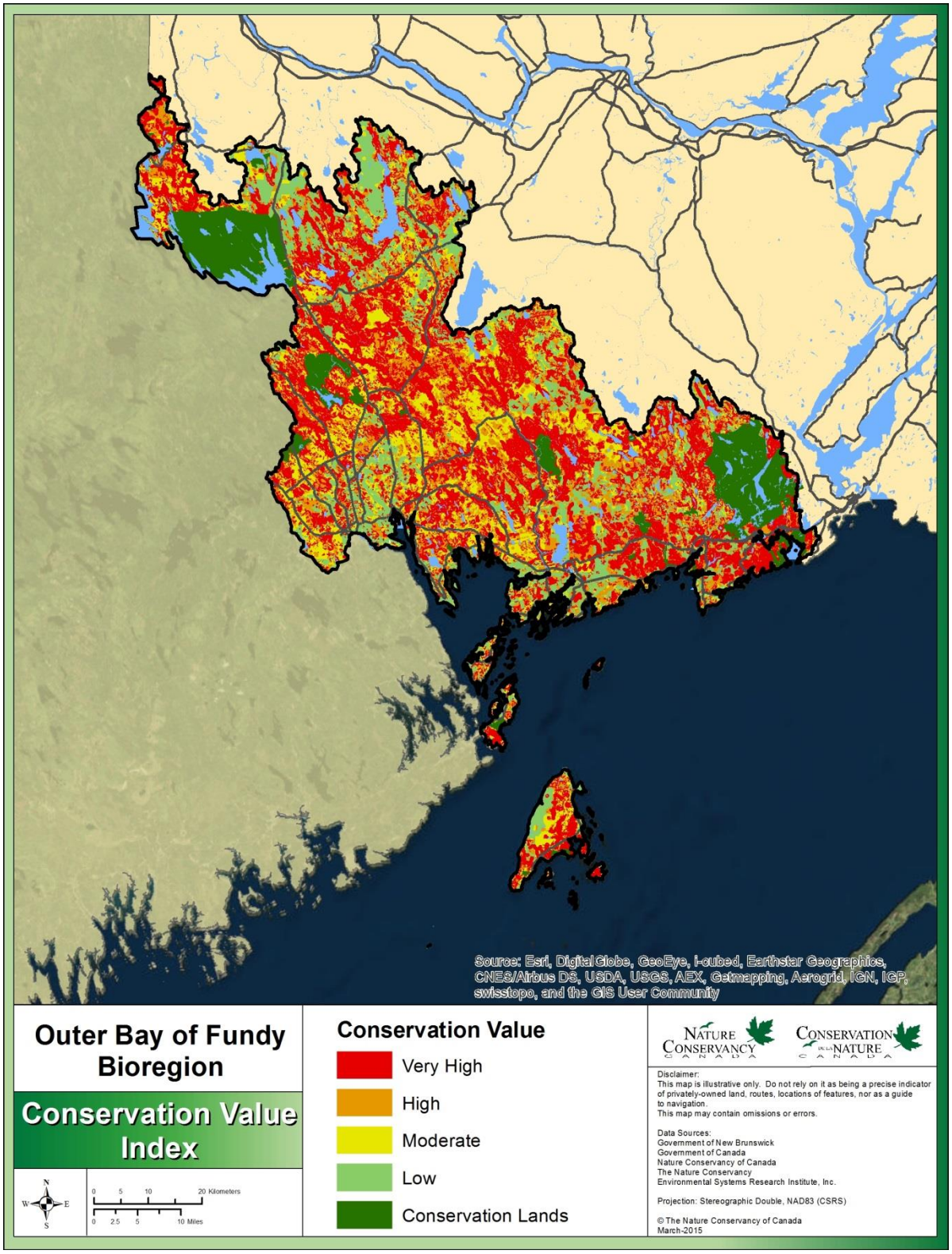
Map 1 - Conservation Context for Outer Bay of Fundy Bioregion



Map 2 – Conservation priority habitats for the Outer Bay of Fundy Bioregion.



Map 3 –Conservation value index for the Outer Bay of Fundy Bioregion.



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ACKNOWLEDGEMENTS

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Town of St. Stephen: Kingsley Bailey

Town of St. Andrews: Stan Chopiatny

Town of St. George: Jamie Carr

Village of Blacks Harbour: Heather Chase

1. CONSERVATION CONTEXT

A. Bioregion Scope

i. Location and Size

The Outer Bay of Fundy Bioregion is a complex of coastal, wetland and upland ecosystems situated within southwestern New Brunswick, adjacent to the Maine border on its western side (Figure 1). The total area of the Bioregion is 560,660 ha, of which 558,740 ha is terrestrial and 1,920 ha is inter-tidal. The coastline within the Bioregion is 1,140 kilometres long, representing approximately 50% of the province's entire coastline. The Bioregion falls within the Northern Appalachian – Acadian Ecoregion and encompasses portions of two subregions (Anderson *et al.,* 2006; Table 1). The Bioregion represents approximately 7.8% of the New Brunswick land base and contains portions of two provincial ecoregions and seven ecodistricts (Zelazny, 2007). All of Maritime Canada falls under the Atlantic Northern Forest (Bird Conservation Planning Region 14) in the North American Bird Conservation Initiative (NABCI) and is classified as the Atlantic Maritime Ecozone within the National Ecological Framework for Canada (ESWG, 1996).

Table 1. Ecological Land Classifications of the Outer Bay of Fundy Bioregion.

Classification Source	Classifier	Primary and Nested Classifications			
NAAP[1]	Ecoregion:	Northern Appalachian - Acadian			
	Subregion:	Gulf of Maine - Bay of Fundy - Minas Basin		Acadian 'Uplands'	
New Brunswick DNR[2]	Ecoregion:	4: Fundy Coast	5: Valley Lowlands		
	Ecodistrict(s):	4-1: Fundy Coastal	5-3: Meductic*	5-8: Magaguadavic	5-10: Mount Pleasant
			5-7: Cranberry	5-9: Yoho*	5-11: Kingston*
North American Bird Conservation Initiative[3]	BCR:	Bird Conservation Region (BCR) 14: Atlantic Northern Forest			
	MBU:	Marine Biogeographic Unit (MBU) 11: Scotian Shelf Marine Bioregion			
National Ecological Framework for Canada[4]	Ecozone:	Atlantic Maritime			

[1] Anderson *et al.* 2006
[2] Zelazny, 2007
[3] North American Bird Conservation Initiative Canada, 2012
[4] ESWG, 1996
*Represents <1% of the total Bioregion area.

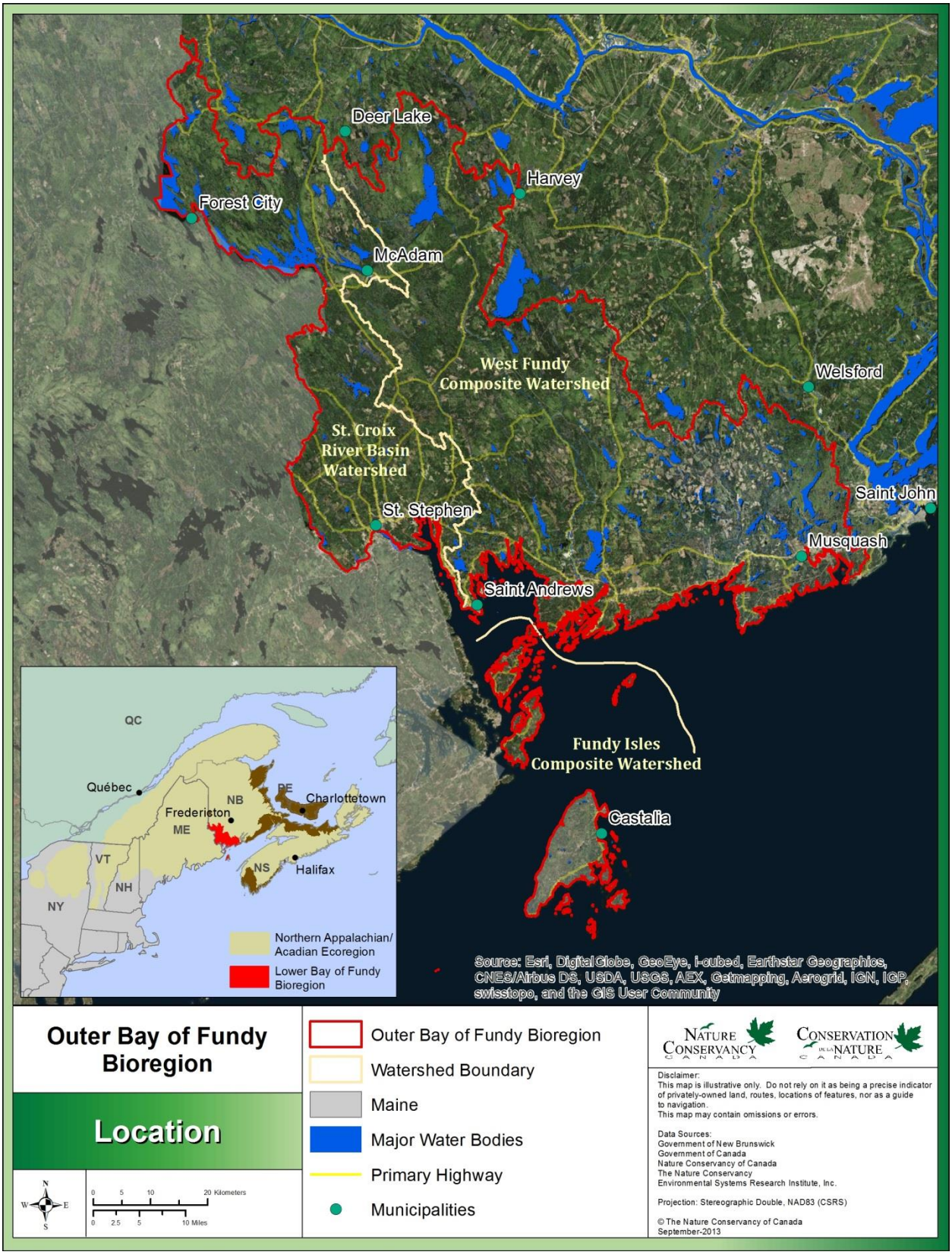


Figure 1. Location and boundary of the Outer Bay of Fundy Bioregion.

ii. Boundary Justification

The terrestrial boundary includes three primary watersheds that flow into the Outer Bay of Fundy. The size and shape of the boundary was delineated using the Fundy Isles Composite, West Fundy Composite and St. Croix River Basin watersheds of the Atlantic Seaboard Drainage Basin (NRC 2006). This encompasses all watersheds and estuaries stretching from the St. Croix along the Maine border to the Musquash estuary west of Saint John, and encompasses the basins of the Wawoig, Digdeguash, Magaguadavic, Pocologan, New River, Lepreau, and Musquash rivers. The boundary was chosen in order to capture the spatial origins of threats occurring in upper reaches of the watersheds that may have significant impacts on coastal and marine habitats (EC & PCA 2010). Additionally, the boundary encapsulates the numerous islands within the outer bay including the Passamaquoddy and Grand Manan Archipelagos, as well as Machias Seal Island, which represents the southern-most limit of the bioregion.

iii. Ecological Significance

With approximately 50% of the New Brunswick coastline represented in the bioregion, conservation has historically centred on the importance of the coastal ecological systems and the diversity of species they support (Figure 2). Much of this diversity is largely influenced by the world famous Bay of Fundy tides, which push large volumes of water through the narrow island passages, such as those found in the Passamaquoddy Bay. The force of the tides produce upwellings that push nutrients and organic materials to the surface. This helps foster productivity in the form of high concentrations of phyto- and zooplankton, constituting the base of a diverse and food web that supports tremendous numbers of fish, marine mammals, seabirds, shorebirds and waterfowl species (Buzeta 2014). The offshore islands in the bioregion provide breeding, wintering and migratory stopover sites of several significant bird species. The Wolves support the highest concentration of overwintering Harlequin Duck (*Histrionicus histrionicus* pop. 1) in New Brunswick, which is federally listed as a Species of Special Concern. Machias Seal Island is one of the few known nesting sites in the province for the Arctic Tern (*Sterna paradisaea*) and supports the largest Atlantic Puffin (*Fratercula arctica*) colony in the Maritimes (Zelazny, 2007). The Quoddy Region is known for the large congregations of birds and marine mammals, including the endangered North Atlantic Right Whale (*Eubalaena glacialis*) as well as the Fin Whale (*Balaenoptera physalus*) and Harbour Porpoise (*Phocoena phocoena*), the latter two of which are federally listed as Species of Special Concern (COSEWIC, 2005; COSEWIC, 2006a).

The Department of Fisheries and Oceans (DFO) has identified seven major coastline environments within the bioregion: 1a -Grand Manan Cliffs, 1b – Grand Manan Archipelago, 2a – Letete Passage and Islands, 2b –Passamaquoddy Bay and St. Croix Estuary, 2c - Letete Inner Reach, 3 – Maces Ledges, 4 – Musquash Marshes and Beaches (DFO, 2012). Together these coastal units represent a diversity of landforms and subsequent habitat associations. Five Canadian designated Important Bird Areas (IBAs) have also been identified: Passamaquoddy Archipelago, The Wolves Archipelago, Grand Manan Archipelago, Machias Seal Island and Point Lepreau – Maces Bay. Additionally, there are two Migratory Bird Sanctuaries designated by the federal government: Machias Seal Island and Grand Manan.

The Northern Appalachian-Acadian Ecoregional Plan (NAAP; Anderson *et al.* 2006) highlighted a number of critical ecological systems for the Outer Bay of Fundy Bioregion. These include beaches, rocky shores, salt marsh, tidal flats, freshwater wetlands, riparian systems, summits and sheltered forest coves. The NAAP also identified fifteen species that are considered "primary targets" - those that cannot be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention. Additionally, there are 36 federal (COSEWIC) species at risk in the Bioregion and 4 provincial species at risk that are not COSEWIC listed. Fifteen globally significant species (G1-G3G4) were also identified within the Bioregion, nine of which are COSEWIC listed.

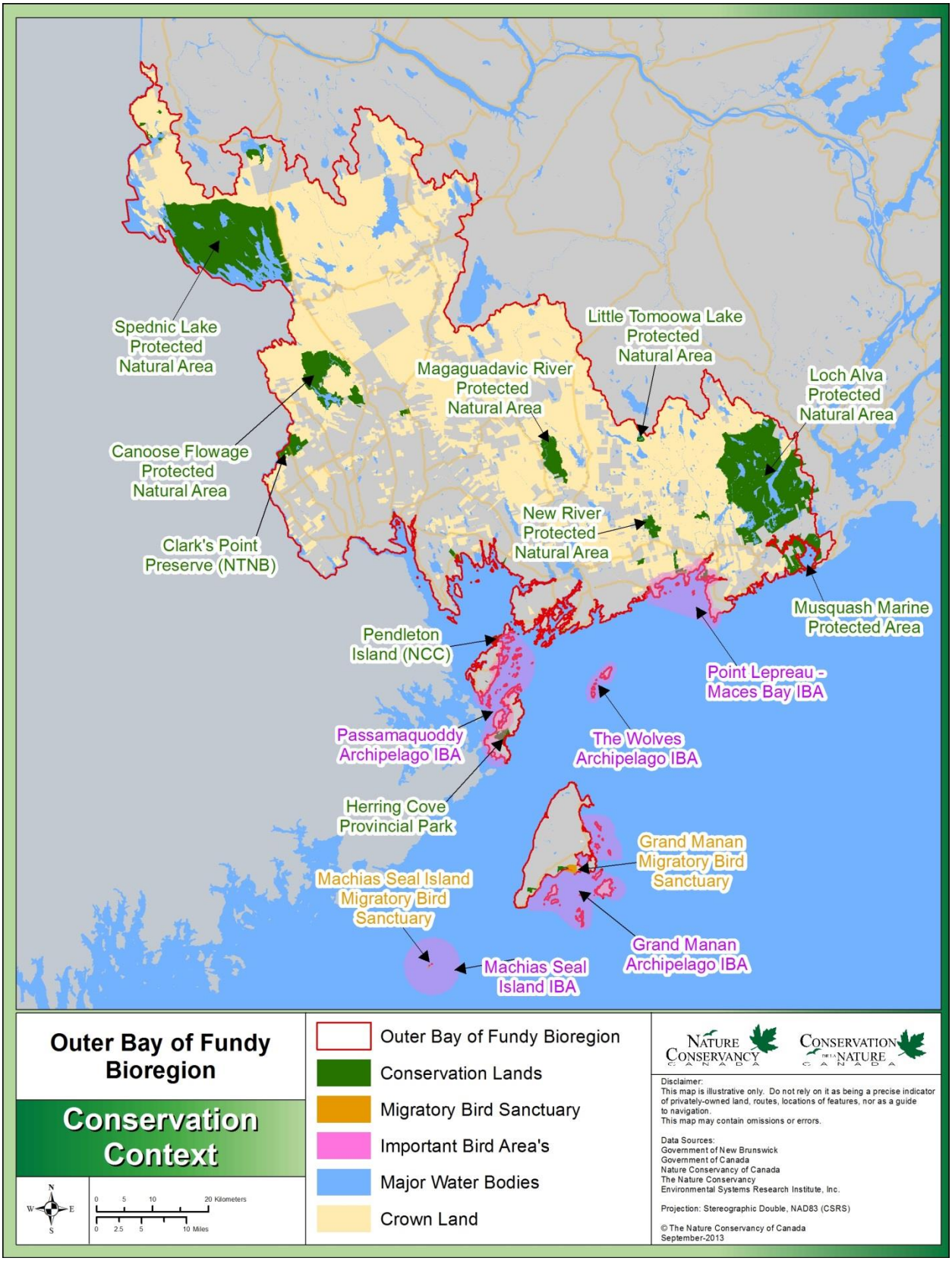


Figure 2. Designated and Conserved Lands in the Outer Bay of Fundy Bioregion.

B. ECOLOGICAL CONTEXT

i. Ecological Systems and Vegetation Communities

Acadian Matrix Forest

The forests in this Bioregion are part of the Acadian Forest region. This forest type is found in the Maritime Provinces and limited parts of northern New England and southern Quebec. Acadian Forest in New Brunswick is a mix of typical northern boreal conifer-dominated forest blended with those of temperate hardwood forest, which creates a remarkably diverse forest assemblage. Human influence over the past 200 years has greatly simplified the forest composition and age class structure. Old stand types are far less abundant than were historically found in this area (Erdle & Sullivan, 1998) and only 5% of Northern Appalachian - Acadian forest remains in pre-settlement condition (Davis *et al.*, 2013).

Along the Fundy coast, the cool, moist climate in conjunction with relatively moderate winter low temperatures has led to a mainly coniferous forest cover dominated by Red Spruce (*Picea rubens)* - an Appalachian endemic - together with Balsam Fir (*Abies balsamea*), Black Spruce (*Picea mariana*), White Spruce (*Picea glauca*) and Eastern Larch (*Larix laricina*). The most common hardwood species along the coast are White Birch (*Betula papyrifera)*, Yellow Birch (*Betula alleghaniensis*), American Mountain-ash (*Sorbus americana*) and Red Maple (*Acer rubrum*) (Zelazny, 2007). The inland portions of the Bioregion harbour a forest largely dominated by tree species with southern affinities. The northern and western areas of the bioregion are dominated by tolerant hardwood communities comprised of American Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum*), Yellow Birch, Red Maple, Red Oak (*Quercus rubra*) and White Ash (*Fraxinus americana*), interspersed with Red Spruce and Eastern Hemlock (*Tsuga canadensis*) communities. The central region is dominated by Eastern White Cedar (*Thuja occidentalis*) and a mixture of tolerant hardwood and tolerant softwood communities. The eastern portion of the West Fundy Composite watershed is primarily conifer dominated with Red Spruce and Balsam Fir bestrewn with tolerant hardwood and pine communities (Zelazny, 2007).

A number of unique forest communities occur in the region owing to the diversity of geological formations and soil types. Coastal Fog Forest dominated by Red Spruce is restricted to the Fundy Coast and contains a high diversity of rare and uncommon lichen species. Within this fog forest are coastal ravine habitats, which have unique microclimatic conditions and support a suite of boreal and arctic flora (Zelazny, 2007). The extreme north limit of the bioregion overlaps with the Appalachian Hardwood Forest (AHF) zone, where tolerant hardwood communities consisting of White Ash, American Basswood (*Tilia americana*), Eastern Hop-hornbeam (*Ostrya virginiana*) and Butternut (*Juglans cinerea*) occur. This community type is rare in the province and contains disjunct populations of many rare flora (Macdougall, 1997). Eastern White Cedar communities on limestone-rich soils are also present, and Red Pine (*Pinus resinosa*) and Eastern White Pine (*Pinus strobus*) communities can be found throughout the Mount Pleasant and Magaguadavic ecodistricts (Zelazny, 2007).

The contiguous transition of forest communities, or “forest matrix”, provides habitat for a wide range of plant and animal species. Through analysis of the historic size ranges of documented natural disturbance events, along with the area requirements of forest-interior breeding species in the region (Figure 3), Anderson *et al.*, (2006) determined that a 10,000 ha minimum matrix block in the Acadian

Forest would be able to withstand any natural disturbance (hurricanes, fire, ice storms) while maintaining all natural ecological processes.

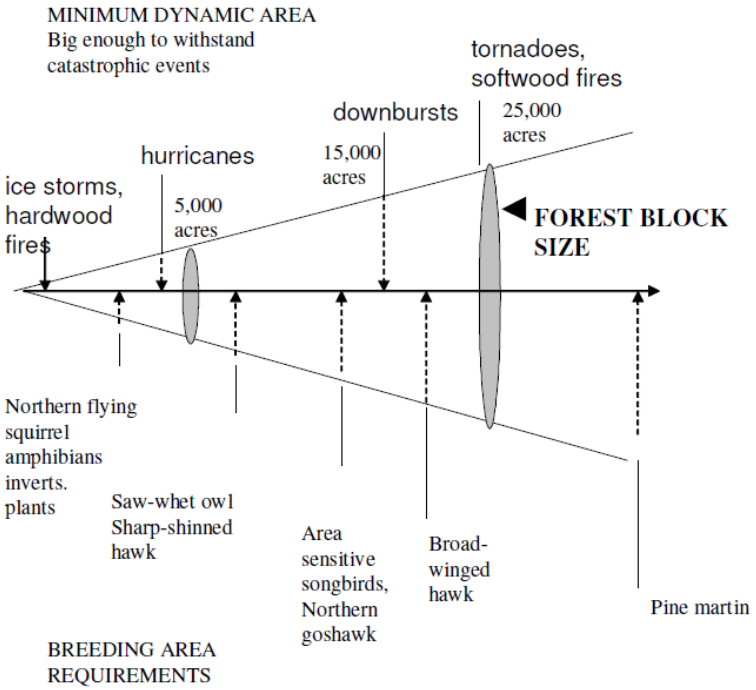


Figure 3. Scaling factors for matrix forming forest in the Northern Appalachian /Acadian ecoregion showing rationale for minimum core protected area (forest block size), from Anderson *et al.*, (2006).

Additionally, the NAAP identified two elevation-dependent ecological systems within the Bioregion, which have been included within the Acadian Forest Mosaic: sheltered forest coves and summits. Of the 3,000 ha of sheltered forest coves identified in the bioregion, 285 ha are considered critical (screening criteria: size=10 ha minimum), all of which occur on Grand Manan Island. Of the 3,200 ha of summits in the bioregion, 82 ha are considered critical (screening criteria: size=12 ha minimum) and these occur around Chamcook Mountain as well as a single occurrence on Grand Manan.

Riparian and Aquatic Systems

Riparian and aquatic systems refer to freshwater aquatic habitats, their adjacent uplands and the interface between the two. As such, these systems are considered ecotones, where boundaries exhibit a gradient between permanent water and seasonally flooded zones, and further extend into streamside terrestrial communities (Gregory et. al., 1991). Generally, riparian habitats are recognized as the most biodiverse, complex and dynamic terrestrial systems on the planet. This diversity is attributed to factors such as changing flooding regimes, microclimatic shifts in altitude, geomorphic processes related to channel formation and upland influences (Naiman, Decamps & Pollock, 1993). Improper forestry and agricultural practices are known to have negative impacts on riparian conditions and processes, as well as the species that depend on them, such as those caused by increases in watercourse temperature following forest harvesting (Moore, Spittlehouse & Story, 2007) and changes in watercourse chemistry due to agricultural runoff (Martin et. al., 1999).

Within the Outer Bay of Fundy Bioregion, a number of large river systems occur; these include the St. Croix, Waweig, Digdeguash, Magaguadavic, Pocologan, New River, Lepreau and Musquash rivers. There is also an abundance of lakes and ponds scattered across the Bioregion, with approximately 6% of the total area covered by fresh water. Intact aquatic systems are essential for a variety of anadromous fish species such as Atlantic Salmon, as well as numerous other species at risk within the bioregion, such as the threatened Lake Utopia Dwarf Smelt (*Osmerus mordax*), which is a naturally occurring endemic to Lake Utopia. In the northern part of the Bioregion, the majority of rare and vulnerable plant species are associated with streams and lakes, which are abundant in this heavily glaciated area (Zelazny, 2007). Notably, Van Brunt's Jacob's ladder (*Polemonium vanbruntiae*), a federally threatened species (COSEWIC 2002), grows along the riparian meadows of Dipper Harbour Creek and along the banks of Trout Lake. Within the bioregion, 7,780 ha of ecoregionally critical riparian habitat was identified in the NAAP (Size >=40 ha), all of which occurs along the St. Croix River.

Freshwater Wetlands

According to the New Brunswick provincial wetland inventory, over 62,370 ha of freshwater wetlands occur within the bioregion, of which 6,765 ha have been identified as ecoregionally critical in the NAAP (size >= 20 ha). The provincial inventory identifies 6 primary wetland types within the bioregion, the majority types being forest- and shrub-dominated wetlands (Figure 4).

One of the unique wetland types to the Bioregion are raised coastal bogs. The raised bogs are characterized as having deep depressions where expansion is restricted, whereas the more common flat bogs form in shallow depressions and expand into extensive complexes over time, including open pools and wet hollows. These "Fundy bogs" are also unique in that they typically contain extensive sedge carpets or "Scirpus lawns", which are restricted to small localized occurrences elsewhere in the province (Zelazny, 2007).

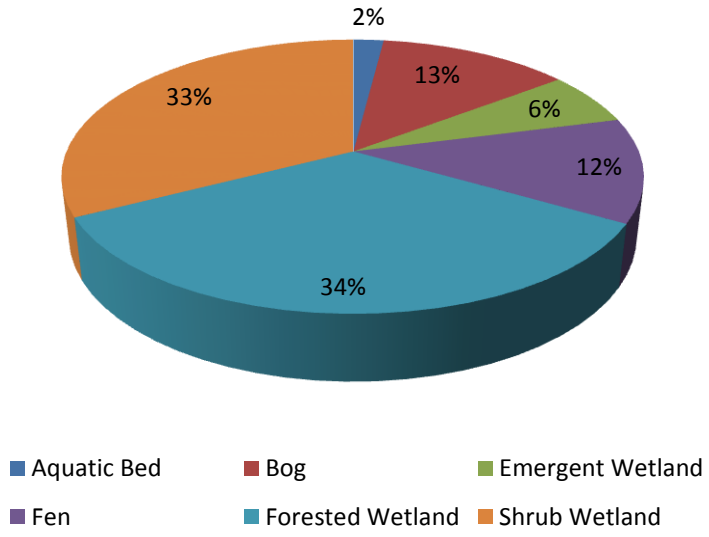


Figure 4. Composition of freshwater wetlands within the Outer Bay of Fundy Bioregion according to the provincial wetland classification.

Often overlooked, but of ecological significance, are seasonal vernal pools that occur throughout the Acadian Forest mosaic. Vernal pools are small (generally < 1 ha), isolated and shallow wetlands that lack permanent in- or out-flow and often contain open water for only a portion of the year (Lichko & Calhoun, 2003, Calhoun & de Maynadier 2008). Vernal pools provide critical breeding habitat for a variety of species such as the Wood Frog (*Lithobates sylvaticus*) and various mole salamanders (*Ambystoma* spp.), which have adapted to living in these temporary, predator-free pools. Vernal pools also provide foraging sites and refugia for a variety of wetland and non-wetland dependent flora, herptiles, waterfowl, forest interior passerines and mammals (Semlitsch & Bodie 1998; Gibbs, 2000; Snodgrass *et al.*, 2000).

Salt Marshes

Salt marshes are amongst the most biologically productive ecosystems in the world, and provide breeding, staging and feeding habitat for a wide variety of shorebird and waterfowl species (Hanson, 2004). Coastal marshes in the Bay of Fundy are unique in that they comprise extensive areas of both low and high salt marsh, an uncommon feature elsewhere within New Brunswick. Low salt marsh is inundated daily by tides and is dominated by Saltwater Cordgrass (*Spartina alterniflora*), whereas the high salt marsh occurs above the mean high tide level, is only periodically inundated and is dominated by Saltmeadow Cordgrass (*Spartina patens*) and Black-grass Rush (*Juncus gerardii*) (Zelazny, 2007). Brackish marsh is also present within the bioregion where the tidal estuaries interact with the outflow of major rivers, such as the Musquash. Although not as extensive as the salt marshes within the Inner Bay of Fundy, the salt marshes within the Outer Bay of Fundy act as a filtration system from run-off waters and are an important source of nutrients that support a variety of life within the coastal and marine habitats (Lotze & Milewski, 2002).

The critical size determined within the NAAP for a fully functioning salt marsh to support all of the species that depend on it was 24 ha or greater, unless they are part of a larger complex (Anderson et. al., 2006). Of the approximately 730 ha of salt marsh delineated within the provincial wetland inventory, approximately half has been retained as being critically important in the Outer Bay of Fundy bioregion.

Coastal Uplands (beaches, dunes and cliffs)

Extensive tracts of beach occur within the bioregion. These are mainly comprised of cobble and coarse sand interspersed with sandstone. Conversely, dunes are relatively scarce in the bioregion, with only 10 occurrences recorded. Some of the more characteristic species of these beaches and dunes include American Dunegrass (*Elymus mollis*), Seabeach Sandwort (*Honckenya peploides*) and American Searocket (*Cakile edentula*). These habitats provide roosting and foraging habitat for a variety of shorebird species. Within the NAAP, beaches were considered of critical importance if they were > 8 ha in size, found in relatively intact landscapes and corroborated by an expert or element occurrence to confirm its viability (Anderson et. al., 2006). Of the 623 ha of beach within the provincial wetland inventory, approximately 173 ha of critical beach were identified, the majority of which occur on offshore islands.

Cliffs within the Bioregion are generally restricted to the coastline and forested ravines, and particularly prevalent along the eastern coast of Grand Manan Island. The Department of Fisheries and Oceans (DFO, 2012) has categorized all shorelines within the Scotian Shelf Bioregion and have delineated

discrete boundaries for cliff habitat within the Outer Bay of Fundy; coastal sub-segment 1a -Grand Manan Cliffs. Although the nature of cliff habitat as linear features does not allow for area-based summaries as do other ecological systems, identifying cliffs is essential for assessing potential habitat of species such as the Peregrine Falcon (*Falco peregrinus*), which depends on these high elevation areas for nesting.

Intertidal Zone (Tidal Flats and Rocky Shores)

The Outer Bay of Fundy tidal flats are horizontal tracts of unconsolidated clays, silts, sands and organic materials that are alternately covered and uncovered by the tide. Most are sparsely vegetated, but during low tide, shorebirds use the flats as foraging habitat. The tidal flats also provide habitat for numerous invertebrate species including *Corophium* shrimp, 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 (Butler *et al.*, 1996a). Within the NAAP, critical tidal flat habitat was selected if it was > 40 ha or part of a larger complex, corroborated by an expert or element occurrence and was in a relatively intact landscape (Anderson *et. al.*, 2006). In total, 2125 ha of tidal flats occur within the bioregion according to the provincial wetland inventory. Of this, approximately 166 ha of critical tidal flats were identified within the NAAP.

Rocky shorelines are a prominent coastal feature within the bioregion owing to the rugged coastline. These habitats are classified as "primary coasts" within Atlantic Canada (Butler *et al.*, 1996b). Rocky shores are exceptionally productive and biologically rich systems, particularly within the Bay of Fundy. This productivity is expressed in terms of zonation, where specific plants and animals occur along the intertidal gradient related to tide height. Generally, the Bay of Fundy is recognized as having a greater diversity of intertidal zones than other coastal areas within eastern North America due to the extreme tidal ranges that occur here (up to 16 m). Five primary intertidal zones have been identified, each with its own specific biological characteristics: spray zone, black zone, barnacle zone, brown algae zone and Irish moss zone (Butler *et al.*, 1996b). Over 3,727 ha of rocky shoreline have been identified within the provincial wetland inventory, and 165 ha of these have been identified as critical habitat within the NAAP.

ii. Dominant Ecological Processes

Climate

The Outer Bay of Fundy Bioregion is characterized by a temperate climate with cold winters from December to March (-4.7°C to -2.5°C), with the warmest weather occurring in July and August (17.1 and 16.9°C, respectively), and with the most precipitation in May and October (115.9 and 122.6 mm, respectively) (WHSRN, 2009). Along the coast, the climate is moderated by strong tidal mixing; this also creates persistent summer fogs as the cool coastal air mixes with warm inland air, a process known as advection fog.

Geology

The geology of this region is characterized by both the oldest and youngest rocks in the province, ranging in age from Precambrian metasediments such as the marbleized limestone found near Saint John, to Jurassic mafic volcanic rocks that underlie most of Grand Manan Island (Zelazny, 2007). Inland

from the Fundy coastal ecoregion, the bedrock is primarily either granitic or calcareous sediment. In contrast, near the main riverbanks, the intertidal plains and salt marshes have soils composed mostly of clay and silt with some fine sand. Glacially derived sediments comprise much of the seabed of the Outer Bay, but sediment derived from coastal erosion accounts for local differences in bottom sediments.

Over 71,730 ha of calcareous soil ecosites occur within the bioregion, representing 13% of the total terrestrial area. The bedrock geology of these deposits consists of Silurian age calcareous sandstones, interspersed with slates and siltstones. Due to these easily eroded and rich calcareous sandstones, Eastern White Cedar is a dominant tree species in these areas. There are also extensive wetlands that occur within this calcareous zone. Various uncommon plant species also are found here; these are dependent upon the surface expression of these calcium rich deposits (Zelazny, 2007). The northern tip of the bioregion also enters the Appalachian Hardwood Forest (AHF) zone, a calcareous region that contains a regionally distinct assemblage of tree, herb and bryophyte species. This forest zone is unique to the Maritime Provinces and is a disjunct assemblage that does not occur again until southern Maine and central New England (MacDougall, 2007).

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), which ultimately dictate the biota and ecological processes that will occur there. Within the Outer Bay of Fundy bioregion, variations in these three factors across the landscape have led to a diversity of habitats. Large bogs and fens are common in the eastern portion of the bioregion, as are numerous lakes and associated habitat. Throughout the bioregion, we encounter labyrinths of stream channels dominated by shrub wetlands within smaller watercourse riparian areas, and larger floodplains where major rivers meander to the Bay of Fundy. Coastal wetlands occur mainly where major watercourses feed into the Bay of Fundy due to the extreme tidal range that occurs here.

Natural Disturbance Dynamics

The forests along the Fundy coast are almost entirely dependent on gap replacing natural disturbance regimes, where small canopy openings are created by tree mortality from old age, wind damage or slope failure. Wind disturbance is generally considered the major stand-replacing agent along the Fundy Coast, although this typically does not extend past 0.5 km (Betts & Forbes, 2005). These coastal forests are generally found along the fog belt and contain a variety of unique lichens and bryophytes that have adapted to persist in this unique environment. Gap disturbance regimes are most prominent inland as well, particularly in areas dominated by tolerant hardwood, cedar and mixedwood communities. Large-scale mortality from periodic insect outbreaks also occurs, such as those caused by the Spruce Budworm (*Choristoneura fumiferana*), and these epizootic outbreaks extend throughout the Bioregion wherever Balsam Fir is present. Large-scale events such as fire regimes are uncommon, particularly along the Fundy coast due to the cool, moist climate (Parks Canada, 2011).

The coastal systems of the Outer Bay of Fundy, like all coastal ecosystems, are by definition very dynamic. These systems are influenced by tides, salt, sediment structure, currents, wind, temperature, ice cover, and scouring (Butler *et al.* 1996a; 1996b). The duration and frequency of tidal flooding in the

coastal zone determines where species will occur (Olsen *et al.*, 2005; Bertness, 2007). Coastal marshes respond to gradual sea level rise by accreting vertically as well as migrating inland, provided there is a sufficient sediment supply, and that human activity on the upland does not prevent such inland migration (Redfield, 1972). The strong daily tidal currents that flow into the Outer Bay of Fundy continually reshape its shorelines and bottom. As the soft rocks within the Inner Bay of Fundy are eroded, some of the sediment is carried via tidal action into the outer Bay where it settles to form mud flats and salt marshes, as well as aiding sea-floor buildup. These mudflats, salt marshes and submarine deposits are transitory; they 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 the rate of deposition or the rate of erosion changes over time, the mud layers will change, enlarging, shrinking or disappearing altogether (Percy *et al.*, 1997; Percy 1999). In addition to these processes, rising sea level and changing tidal amplitude, ice scour and storms also modify and shape the Outer Bay of Fundy. The majority of the coastline within the Outer Bay of Fundy bioregion is comprised of rocky shorelines, which, unlike beaches and tidal flats, its structural characteristics are mostly determined by terrestrial-based processes such as glacial and tectonic forces.

iii. Significant Species

The following is a discussion of species that have been identified as significant in the Bioregion. Indeed, species are considered "significant" if the habitats within the Bioregion are particularly relevant to them, or if the species are considered of conservation concern. Appendix C and D each provide a list of significant species within the Outer Bay of Fundy Bioregion with their associated coarse and fine filter habitats, respectively. These lists include all federally or provincially listed species at risk, provincially- (S1 or S2) or globally- (G1-G3G4) rare or uncommon element occurrence records from the Atlantic Canada Conservation Data Centre (ACCDC), as well as all Bird Conservation Region (BCR) 14 and Marine Biogeographic Unit (MBU) 11 priority bird species that occur with regularity in the Bioregion (Environment Canada, 2013). For a complete glossary of definitions for Biodiversity and Conservation Ranks, see Appendix B. At least fifteen globally significant species (G1-G3G4) occur within the Bioregion, eight of which are federally listed species at risk. There are an additional 28 federally (COSEWIC) listed species found in the Bioregion, as well as 3 provincially listed species at risk, which are not federally listed (Table 2). Fifteen critical species targets identified within the NAAP occur within the Outer Bay of Fundy Bioregion, nine of which were previously identified as COSEWIC listed species.

Table 2. COSEWIC listed species and NB species at risk within the Outer Bay of Fundy Bioregion.

Common Name	Scientific Name	COSEWIC	NB Status
North Atlantic Right Whale	*Eubalaena glacialis*	END	END
Brook Floater	*Alasmidonta varicosa*	SC	SC
American Eel	*Anguilla rostrata*	THR	THR
Eastern Whip-poor-will	*Antrostomus vociferus*	THR	THR
Short-eared Owl	*Asio flammeus*	SC	SC
Fin Whale - Atlantic pop.	*Balaenoptera physalus*	SC	SC
Red Knot	*Calidris canutus rufa*	END	END
Canada Warbler	*Cardellina canadensis*	THR	THR
Bicknell's Thrush	*Catharus bicknelli*	THR	THR

Chimney Swift	*Chaetura pelagica*	THR	THR
Piping Plover	*Charadrius melodus melodus*	END	END
Snapping Turtle	*Chelydra serpentina*	SC	SC
Common Nighthawk	*Chordeiles minor*	THR	THR
Olive-sided Flycatcher	*Contopus cooperi*	THR	THR
Eastern Wood-pewee	*Contopus virens*	SC	SC
Monarch	*Danaus plexippus*	SC	SC
Blue Felt Lichen	*Degelia plumbea*	SC	SC
Leatherback Sea Turtle - Atlantic pop.	*Dermochelys coriacea*	END	END
Bobolink	*Dolichonyx oryzivorus*	THR	THR
Rusty Blackbird	*Euphagus carolinus*	SC	SC
Peregrine Falcon	*Falco peregrinus* pop. 1	SC	SC
Wood Turtle	*Glyptemys insculpta*	THR	THR
Bald Eagle	*Haliaeetus leucocephalus*	N/A	END
Barn Swallow	*Hirundo rustica*	THR	N/A
Red-necked Phalarope	*Phalaropus lobatus*	SC	N/A
Harlequin Duck (Eastern)	*Histrionicus histrionicus* pop. 1	SC	END
Wood Thrush	*Hylocichla mustelina*	THR	THR
Least Bittern	*Ixobrychus exilis*	THR	THR
Southern Twayblade	*Listera australis*	N/A	END
Canadian Lynx	*Lynx canadensis*	N/A	END
Little Brown Myotis	*Myotis lucifugus*	END	END
Pygmy Snaketail	*Ophiogomphus howei*	SC	SC
Rainbow Smelt - Large-bodied pop.	*Osmerus mordax* pop. 2	THR	THR
Rainbow Smelt - Small-bodied pop.	*Osmerus mordax* pop. 3	THR	THR
Harbour Porpoise - Northwest Atlantic pop.	*Phocoena phocoena*	SC	SC
Van Brunt's Jacob's-ladder	*Polemonium vanbruntiae*	THR	THR
Atlantic Salmon - Inner Bay of Fundy pop.	*Salmo salar* pop. 1	END	END
Roseate Tern	*Sterna dougallii*	END	END
Eastern Meadowlark	*Sturnella magna*	THR	THR

Environment Canada Priority Bird Species

In 2013, Environment Canada completed a strategy for NB BCR 14 and NB MBU 11/12. This strategy is designed to serve as a framework for implementing bird conservation for the region's priority bird species (Environment Canada, 2013). The strategy identifies a number of 'priority species'. These include those species that regularly occur in the region that are vulnerable due to population size, distribution, population trend, abundance, and other various threats. Some widely distributed and abundant 'stewardship' species are also included because they typify the national or regional avifauna or because they have a large proportion of their range or continental population in the region. Species of management concern are included as priority species when they are at, or exceed their desired population objectives but require ongoing management due to their socio-economic importance as game species or because of their impacts on other species or habitats. Eighty-two priority bird species listed in BCR 14 and MBU 11 are relevant to this HCS (Table 3; excluding marine birds that do not regularly breed or frequent shorelines within the bioregion).

Table 3. New Brunswick Bird Conservation Region 14 (BCR 14) and Marine Biogeographic Unit 11 (MBU 11) Priority Bird Species and those relevant to habitat conservation planning in Outer Bay of Fundy Bioregion (Adapted from Environment Canada, 2013).

Priority Species	Group	Population Objective[1]	SARA[2]	COSEWIC[3]	Provincial Listing[4]	National/Continental Concern	National/Continental Stewardship	BCR 14-NB	MBU 11-NB	Outer Bay of Fundy Bioregion Relevance
American Bittern	Waterbird	Increase 100%				√		√		√
American Black Duck	Waterfowl	Maintain current						√	√	√
American Golden-Plover	Shorebird	Assess / Maintain				√		√		√
American Redstart	Landbird	Maintain current						√		√
American Three-toed Woodpecker	Landbird	Assess / Maintain						√		√
American Woodcock	Shorebird	Increase 50%				√		√		√
Arctic Tern	Waterbird	Assess / Maintain							√	√
Bald Eagle	Landbird	Maintain current			RE			√		√
Bank Swallow	Landbird	Increase 100%						√		
Barn Swallow	Landbird	Increase 100%		TH				√		√
Barrow's Goldeneye (Eastern)	Waterfowl	Assess / Maintain	SC	SC				√	√	√
Bay-breasted Warbler	Landbird	Maintain current					√	√		√
Belted Kingfisher	Landbird	Assess / Maintain						√		√
Bicknell's Thrush	Landbird	Increase 50%	TH	TH		√		√		√
Black Scoter	Waterfowl	Assess / Maintain							√	
Black Tern	Waterbird	Assess / Maintain						√		
Black-backed Woodpecker	Landbird	Increase 50%						√		
Black-bellied Plover	Shorebird	Assess / Maintain				√			√	√
Black-billed Cuckoo	Landbird	Increase 100%				√		√		
Blackburnian Warbler	Landbird	Maintain current					√	√		√
Black-legged Kittiwake	Waterbird	Maintain current					√		√	√

Priority Species	Group	Population Objective[1]	SARA[2]	COSEWIC[3]	Provincial Listing[4]	National/Continental Concern	National/Continental Stewardship	BCR 14-NB	MBU 11-NB	Outer Bay of Fundy Bioregion Relevance
Black-throated Blue Warbler	Landbird	Maintain current						√		√
Black-throated Green Warbler	Landbird	Maintain current					√	√		√
Blue-headed Vireo	Landbird	Maintain current					√	√		√
Bobolink	Landbird	Increase 100%		TH		√		√		√
Bonaparte's Gull	Waterbird	Assess / Maintain				√			√	√
Boreal Chickadee	Landbird	Increase 100%						√		√
Canada Goose (North Atlantic)	Waterfowl	Maintain current						√	√	√
Canada Goose (Temperate)	Waterfowl	Decrease						√	√	√
Canada Warbler	Landbird	Increase 100%	TH	TH		√	√	√		√
Cape May Warbler	Landbird	Increase 100%						√		√
Chimney Swift	Landbird	Increase 100%	TH	TH		√		√		√
Common Eider	Waterfowl	Increase 50%							√	√
Common Goldeneye	Waterfowl	Increase 50% (BCR 14) Assess / Maintain (MBU 11)						√	√	√
Common Loon	Waterbird	Maintain current (BCR 14) Assess / Maintain (MBU 11)				√		√	√	√
Common Murre	Waterbird	Assess / Maintain				√			√	√
Common Nighthawk	Landbird	Increase 100%	TH	TH				√		√
Common Tern	Waterbird	Assess / Maintain						√	√	√
Dovekie	Waterbird	Assess / Maintain				√			√	
Dunlin	Shorebird	Assess / Maintain				√			√	√
Eastern Kingbird	Landbird	Increase 50%						√		√
Eastern Meadowlark	Landbird	Increase 50%		TH				√		√
Eastern Whip-poor-will	Landbird	Assess / Maintain	TH	TH		√		√		√

Priority Species	Group	Population Objective[1]	SARA[2]	COSEWIC[3]	Provincial Listing[4]	National/Continental Concern	National/Continental Stewardship	BCR 14-NB	MBU 11-NB	Outer Bay of Fundy Bioregion Relevance
Eastern Wood-Pewee	Landbird	Increase 100%						√		√
Evening Grosbeak	Landbird	Increase 100%						√		√
Great Cormorant	Waterbird	Assess / Maintain				√			√	√
Great Shearwater	Waterbird	Assess / Maintain				√	√		√	
Green Heron	Waterbird	Assess / Maintain						√		√
Green-winged Teal	Waterfowl	Increase 50%						√	√	√
Harlequin Duck (Eastern)	Waterfowl	Recovery objective	SC	SC	EN			√	√	√
Horned Grebe	Waterbird	Assess / Maintain	EN[7]	EN[7] SC[8]					√	
Hudsonian Godwit	Shorebird	Assess / Maintain				√			√	√
Killdeer	Shorebird	Increase 100%				√		√		√
Leach's Storm-Petrel	Waterbird	Assess / Maintain				√	√		√	√
Least Bittern	Waterbird	Recovery objective	TH	TH		√		√		√
Least Sandpiper[10]	Shorebird	Assess / Maintain				√			√	√
Lesser Yellowlegs	Shorebird	Assess / Maintain				√		√	√	√
Long-tailed Duck	Waterfowl	Assess / Maintain							√	
Magnolia Warbler	Landbird	Maintain current					√	√		√
Mallard	Waterfowl	Increase 100%						√		√
Manx Shearwater	Waterbird	Assess / Maintain				√			√	
Nelson's Sparrow	Landbird	Assess / Maintain				√		√		√
Northern Goshawk	Landbird	Increase 50%						√		√
Olive-sided Flycatcher	Landbird	Increase 100%	TH	TH		√		√		√
Peregrine Falcon (anatum)	Landbird	Assess / Maintain	SC	SC	EN			√		√
Pied-billed Grebe	Waterbird	Assess / Maintain				√		√		

Priority Species	Group	Population Objective[1]	SARA[2]	COSEWIC[3]	Provincial Listing[4]	National/Continental Concern	National/Continental Stewardship	BCR 14-NB	MBU 11-NB	Outer Bay of Fundy Bioregion Relevance
Piping Plover (melodus)	Shorebird	Recovery objective	EN	EN	EN	√		√	√	√
Purple Finch	Landbird	Maintain current						√		√
Purple Sandpiper	Shorebird	Assess / Maintain				√			√	√
Razorbill	Waterbird	Assess / Maintain				√			√	√
Red Knot (ssp. rufa)	Shorebird	Assess / Maintain	EN	EN		√			√	√
Red Phalarope	Shorebird	Assess / Maintain				√			√	
Red-necked Grebe	Waterbird	Assess / Maintain				√			√	
Red-necked Phalarope	Shorebird	Assess / Maintain		SC		√			√	
Red-shouldered Hawk	Landbird	Assess / Maintain						√		√
Red-throated Loon	Waterbird	Assess / Maintain				√			√	
Ring-necked Duck	Waterfowl	Increase 50%						√		√
Roseate Tern	Waterbird	Recovery objective	EN	EN					√	√
Rose-breasted Grosbeak	Landbird	Maintain current						√		√
Ruffed Grouse	Landbird	Assess / Maintain						√		√
Rusty Blackbird	Landbird	Increase 100%	SC	SC				√		√
Sanderling	Shorebird	Assess / Maintain				√			√	√
Semipalmated Sandpiper	Shorebird	Increase 100% (MBU 11)				√			√	√
Short-eared Owl	Landbird	Assess / Maintain	SC	SC				√		√
Solitary Sandpiper[10]	Shorebird	Assess / Maintain				√		√	√	√
Sooty Shearwater	Waterbird	Assess / Maintain				√			√	
Sora	Waterbird	Assess / Maintain				√		√		√
Spotted Sandpiper	Shorebird	Increase 50%				√		√		√
Surf Scoter	Waterfowl	Assess / Maintain							√	

Priority Species	Group	Population Objective[1]	SARA[2]	COSEWIC[3]	Provincial Listing[4]	National/Continental Concern	National/Continental Stewardship	BCR 14-NB	MBU 11-NB	Outer Bay of Fundy Bioregion Relevance
Thick-billed Murre	Waterbird	Assess / Maintain				√			√	
Tree Swallow	Landbird	Maintain current						√		√
Veery	Landbird	Increase 100%						√		√
Virginia Rail	Waterbird	Assess / Maintain				√		√		√
Whimbrel	Shorebird	Assess / Maintain				√		√	√	√
White-breasted Nuthatch	Landbird	Maintain current						√		
White-throated Sparrow	Landbird	Maintain current					√	√		√
Willet	Shorebird	Increase 50%				√			√	√
Wilson's Snipe	Shorebird	Increase 100%				√		√		√
Wood Duck	Waterfowl	Increase 50%						√		√
Wood Thrush	Landbird	Increase 100%	TH	TH		√		√		√
Yellow Rail	Waterbird	Assess / Maintain	SC	SC		√		√		
Yellow-bellied Sapsucker	Landbird	Maintain current					√	√		√

[1] Population objectives apply in all units where the species is priority (BCR 14-NB, MBU 11-NB) unless otherwise indicated.
[2] Species listed on Schedule 1 under the Species at Risk Act as Endangered (EN), Threatened (TH) or Special Concern (SC) (Species at Risk Public Registry 2012).
[3] Species assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012) as Endangered (EN), Threatened (TH) or Special Concern (SC).
[4] Species listed under New Brunswick's Endangered Species Act as Endangered (EN) or Regionally Endangered (RE) (New Brunswick 2004).

iv. Protected Areas and Conservation Lands

An extensive network of protected areas exists within the Outer Bay of Fundy Bioregion from a variety of private, provincial and federal initiatives, covering over 10% of the total area (62,428 ha; Table 4). There are 29 provincially designated Protected Natural Areas (PNA's), as well as three Provincial Parks. Private conservation lands are held by three organizations: Ducks Unlimited Canada (DUC), Nature Trust of New Brunswick (NTNB) and the Nature Conservancy of Canada (NCC). DUC and NCC have been especially active in the Musquash region and have secured important wetlands and coastal habitat there. The Nature Trust of New Brunswick has focused on land securement along the coast and within the St. Croix River Basin watershed. Outside the Bioregion, but within the St. Croix River Basin watershed on the U.S. side, significant conservation gains have been achieved by private land trusts. The Downeast Lakes Land Trust holds 13,637 ha of protected land in the Farm Cove Community Forest and are currently working on a campaign for the purchase of an 8,850 ha parcel adjacent to Farm Cove. Woodie Wheaton Land Trust holds approximately 1,200 ha of land around the Chiputneticook Lakes, as well as Birch Island, Little Birch Island and Greenland Island, covering some 13 ha in the Chiputneticook Lakes (Maine Dept. ACF, 2012).

In addition to the current and candidate conservation lands discussed above, five nationally designated Important Bird Area's (IBA's) have been identified within the Bioregion (Table 5), although these designations confer no actual protection to the areas identified.

Table 4. Existing Conservation Lands within the Outer Bay of Fundy Bioregion.

Landowner	Site Name	Area (ha)	% of the Bioregion
Ducks Unlimited	Musquash Estuary	371	0.07%
Canadian Wildlife Service	Machias Seal island	10	0.04%
	Grand Manan	222	
Nature Conservancy of Canada	Musquash Estuary	1,688	0.36%
	Grand Manan	115	
	Pendleton Island	121	
	Red Head Harbour	72	
	Simpson Island	22	
Nature Trust of New Brunswick	Caughey-Taylor	187	0.28%
	Belding's Reef	5	
	Chocolate Cove	25	
	Clark's Point	169	
	Dick's Island	2	
	L'Etang Islands	34	
	MacNichol	927	
	Meredith Houseworth Memorial Seashore	10	
	Navy Island	21	
	New River Island	17	
	Pagan Point	12	

	Pea Point	30	
	Seven Days Work Cliff	26	
	Southern Wolf Island	37	
	Thomas B. Munro Memorial Shoreline	26	
	Thompson Marsh	4	
	Western Isles	22	
NB Department of Tourism and Parks	New River Beach	365	0.12%
	Anchorage	119	
	Herring Cove	209	
New Brunswick Department of Natural Resources	Musquash Estuary	5	10.30%
	Whitehorse Island	2	
	Baillie Settlement	16	
	Gooseberry Cove	198	
	Little Tomoowa Lake	119	
	New River	721	
	St. Croix River Islands	6	
	Andersonville	565	
	Canoose Flowage	4,539	
	Caughey-Taylor, Crown Land Component	3	
	Clark Point	116	
	Cowlily Pond Brook	155	
	Dipper Harbour Back Cove	14	
	Hay Brook	34	
	High Duck Island	8	
	Loch Alva	22,036	
	Magaguadavic River	2,110	
	McPhersons Point	145	
	Monument Brook	58	
	North and South Green Islands	1	
	North Lake	58	
	Ovenhead	30	
	Pocologan	101	
	Ragged Falls	211	
	Round Meadow Cove	42	
	Salkeld Islands	8	
	Skiff Lake	479	
	Spednic Lake	25,779	
	Western Green Island	1	

Table 5. Important Bird Areas (IBA) within the Outer Bay of Fundy Bioregion.

IBA Code	IBA Name	IBA Criteria	Lat / Long	Elevation (m)	Size (km^2)
NS011	Grand Manan Archipelago	Globally Significant: Congregatory Species;	44.691° N 66.809° W	0 - 130	1000.76

		Colonial Waterbirds/Seabird Concentrations; Shorebird Concentrations. <u>Continentally Significant</u>: Congregatory Species. <u>Nationally Significant</u>: Colonial Waterbird/Seabird Concentrations.			
NB037	Quoddy Region	<u>Globally Significant:</u> Congregatory Species; Colonial Waterbirds/Seabird Concentrations; Shorebird Concentrations.	44.944° N 66.935° W	0	129.96
NB020	Point Lepreau / Maces Bay	<u>Globally Significant:</u> Congregatory Species; Waterfowl Concentrations. <u>Continentally Significant:</u> Congregatory Species; Shorebird Concentrations. <u>Nationally Significant:</u> Threatened Species.	45.105° N 66.52° W	0 - 10	102.39
NB004	The Wolves Archipelago	<u>Continentally Significant:</u> Congregatory Species.	44.963° N 66.717° W	0 - 28	21.21
NB019	Machias Seal Island	<u>Globally Significant:</u> Congregatory Species. <u>Continentally Significant:</u> Congregatory Species. <u>Nationally Significant:</u> Threatened Species; Congregatory Species.	44.502° N 67.101° W	0 - 5	81.7

C. Social and Economic Considerations

The geographic boundary of the Outer Bay of Fundy bioregion encompasses all of Charlotte County, a large portion of York County and relatively small portions of Sunbury, Queens, Kings and St. John Counties (NB Archives, 2014) in southern New Brunswick. Major communities within the bioregion all occur within Charlotte County and include: the town of St. Stephen (pop. 4,817), village of Grand Manan (pop. 2,377), town of St. Andrews (pop. 1,889), town of St. George (pop. 1,543), village of Blacks Harbour (pop. 982) and Campobello Island (pop. 925)(Statistics Canada 2012a). Grand Manan is accessible by ferry; Campobello Island can be accessed by crossing the Roosevelt international bridge at Lubec, Maine (USA) or, during the summer months, by the car ferries at Eastport, Maine and Deer Island, New Brunswick. The bioregion is located in close proximity to Saint John (pop. 70,063) (Statistics

Canada 2012b) which is the second most populated city in the province, the oldest incorporated city in Canada and the largest city (geographically) in New Brunswick. The western boundary of the Bioregion follows the New Brunswick (Canada) and Maine (USA) international border.

The City of St. Stephen is the most highly populated community in the bioregion. It is located on the international boundary between Canada and the U.S., along the east bank of the St. Croix River. The St. Croix is a Canadian Heritage River. It was visited most notably by French explorers Champlain and DeMons in the early 1600's. Indeed, one of the small islands in its channel was briefly, albeit unsuccessfully, settled before they moved to the present day site of Annapolis Royal in Nova Scotia. Later on, United Empire Loyalists settled permanently in the area in 1784. By 1800, the area had grown to be of great importance to both the lumber and shipbuilding industries; St. Stephen was an important port for shipping lumber overseas. Among other types of industry in the area, the Ganong family has been manufacturing chocolate and confectionaries since 1873, and currently employs 400 people (Spence, 2014).

Although the nearby city of Saint John's population has been steadily decreasing since the early 1970's, it remains the economic regional centre, as well as the regional centre for services related to health and education (City of Saint John, 2014). Saint John is expected to show economic growth in coming years, should several megaprojects go through (e.g. pipeline, second oil refinery). Musquash is the only community in this Bioregion that is considered part of the Greater Saint John Area.

The population of Charlotte County (26,080) represents 3.5% of the total population of the Province of New Brunswick (751,171). It has fluctuated very little since 2006, decreasing by only 1.3% (Statistics Canada, 2012b). Approximately 95% of residents of Charlotte County identify English as their primary language, while only 2.3% identify French as their primary language (Statistics Canada, 2012c). Approximately 5.3% of residents of Charlotte County identify themselves as being of North American Aboriginal ethnic origins, including First Nations, Inuit & Métis (Statistics Canada, 2013). Although there are no First Nations communities in the area currently, Mik'maq, Maliseet and Passamaquoddy have a long history of inhabitation along the Outer Bay of Fundy Coastline.

On the economic front, there have been discussions surrounding many different types of energy generation in this region recently. Although Grand Manan was deemed an ideal area for wind energy generation and a power sales agreement was reached in 2004 (WPM, 2004), no turbines have been constructed on the island to date (Faulkner, 2012). Harnessing tidal power as an energy source has long been discussed but also has not been pursued thus far; however, recent advancements to the technology have been made and implemented in nearby Maine which may result in this alternative, renewable energy source being used here in the future (CBC 2012). Most recently, as reported extensively in the news, there have been discussions of TransCanada Corp. building infrastructure for a project called the 'Energy East Pipeline,' – a $12 billion project that would ship oil from the Alberta Tar Sands to the Irving Oil Refinery in Saint John, NB. The route for the proposed pipeline has not yet been fully established. Nevertheless, there is a good chance that its path would cut through the bioregion. Many areas in New Brunswick, including this area, have been being tested recently as part of shale gas exploration (Commisso, 2013). It is important to note that liquefied natural gas is currently being transported underground through this bioregion, via a 30" diameter pipeline system which begins at the

Canaport LNG Terminal in Saint John and connects with the Maritimes & Northeast Pipeline System at the Canada-US border near St. Stephen (Emera NB, 2013).

The fishing industry is the keystone to the economy in southwestern New Brunswick. Traditional fisheries have been a mainstay here for centuries. Additionally, since the early 1980's, salmon aquaculture in the area has grown into a $225 million industry, annually contributing approximately $45 million in wages to the New Brunswick economy with the majority of those wages being earned in this area. It has also helped to revitalize the economy of communities in the area by providing employment. Blacks Harbour is home the world's largest sardine cannery, Connors Bros. Limited. It has been in business for over 100 year and employs approximately 1,500 people in the community. Although seaweed harvesting is traditional in Nova Scotia and Prince Edward Island, it is a fairly new practice in southern New Brunswick where pilot rockweed harvests began in 1992. Dulse has been harvested on Grand Manan for a considerable time, and some harvesting of other species such as Irish moss occur here as well (Ugarte 2007).

2. HABITAT, THREAT, AND SPECIES SPATIAL PRIORITIZATION

A. Conservation Priority Habitat Types

Priority habitats are the native biological entities (i.e., ecological systems, communities and/or species[1]) that the Habitat Conservation Strategy is aiming to conserve. The planning team selected priority habitats at a coarse enough scale to encompass the most significant elements of conservation concern that could be addressed at the Bioregion scale. HCS habitats encompass all species of conservation significance occurring in the Bioregion, including NAAP primary species, BCR 14 and MBU 11 priority bird species, species at risk, S1-S2 and G1-G3G4 ranked species, and are representative of the biodiversity of the Bioregion. The process used to identify priority habitats in this Bioregion included research of the literature, speaking with experts and iterative review with partners. As a result, priority habitats include seven ecological systems:

i) Coastal Uplands (Beaches, Dunes and Cliffs)
ii) Salt Marshes
iii) Tidal Flats and Rocky Shores
iv) Coastal Islands
v) Acadian Forest Mosaic
vi) Freshwater Wetlands
vii) Riparian and Aquatic Systems

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

Priority habitats are mapped in Figures 5 – 11. For each priority habitat type, a detailed viability assessment was undertaken for its size, condition and landscape context (Low 2003) using background habitat information collected from the Bioregion, a review of literature and expert opinion. The viability of the priority habitats can be ranked as 'poor', 'fair', 'good' or 'very good' (adapted from The Nature Conservancy). The current overall biodiversity habitat viability for the Outer Bay of Fundy Bioregion is ranked as 'good' (Table 6a).

i. Priority Habitat: Beaches, Dunes, and Cliffs

Habitat Definition 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 stablilzed with vegetation. Cliffs are defined as precipitous rock faces, which slough off rock fragments and shed water, while accumulating soil and nutrients at their bases. Within the context of this NA, cliffs refer to a distinct coastal cliff zone - the "Grand Manan Cliffs", which are characterized by Jurassic volcanic basalt deposits. These were spatially delineated as such (DFO, 2012). Beaches and dunes are 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; Cliff size > 10.1 ha; Landscape Context Index[2] (LCI) <= 30 (Anderson *et al.*, 2006; Figure 5).

Habitat/Species Type Beaches, Dunes and Cliffs: 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/Supratidal – Seas Cliffs and Rocky Offshore Islands; Marine Coastal/Supratidal – Coastal Sand Dunes.

Ecological Justification Beaches, Dunes and Cliffs: Beaches, dunes and cliffs are ecologically significant ecosystems as they support a number of rare and at risk species. 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 otherwise have a narrow restriction to this specific habitat type (Anderson *et al.* 2006). Sea cliffs provide nesting sites for a variety of bird species within the NA, including swallows, colonial nesters and raptors such as the Peregrine Falcon.

Landscape Context Assessment Beaches, Dunes and Cliffs: Very Good

The average Landscape Context Index[3] (LCI) for Beaches and Dunes in the Outer Bay of Fundy is 18, which is considered an indication that, on average, the habitat conservation priority is surrounded primarily by natural cover and has good landscape context that will contribute toward the long-term viability of the ecosystem type (calculated from NAAP data). Although coastal development is increasing provincially, the rugged terrain along the coast of the Bioregion has limited the amount of development in areas where beaches, dunes and cliffs occur. The New Brunswick Coastal Areas Protection Policy

[2] 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.

[3] Landscape Context Index (LCI) is a measure that refers to relative amount of development, agriculture, quarries, roads and other fragmenting features directly surrounding ecosystem occurrences. It provides an estimate of isolation of occurrence as well as potential future encroachment on the occurrence. See Anderson et al., (2006) for more details.

recommends restrictions on development in and around coastal habitats (NBDELG, 2002), but there is no legislative regulation controlling it. Within the Bioregion, approximately 47 ha (7.6%) of beaches and dunes have protected status, and 4.2 km (3%) of cliffs are protected.

Condition Assessment Beaches, Dunes and Cliffs: Good

Unlike the extensive beach/dune complexes along the Northumberland Straight and Acadian Peninsula, beaches and dunes within the Outer Bay of Fundy have received comparatively little impact from human disturbance. Most disturbances would arise from recreational foot traffic, such as beach combing and camping. However, the inaccessibility along the rugged Fundy coast, the relatively inaccessible islands and cold-water temperatures, largely restricts other harmful recreational uses. Few invasive species have been documented within these habitats, however Rugosa Rose (*Rosa rugosa*) is considered a growing threat to beach and dune habitat across Atlantic Canada (P. Noel, pers. comm.). Once established, this dense shrub can out-compete native plant species (Belliveau 2012).

Size Assessment Beaches, Dunes and Cliffs: Good

The average size of beaches and dunes are 3.1 and 1.4 ha respectively, and over 140 km of coastal cliff habitat has been identified (DFO 2012). Although the average beach and dune size is considerably less than the critical occurrence criteria (>8 ha), they are naturally small and disjunct in the bioregion due to the rugged coastline. There are 615 ha of beach and dune habitat within the bioregion, of which 173 ha are NAAP critical (Anderson *et al.*, 2006).

Overall Assessment for Beaches, Dunes and Cliffs: Good

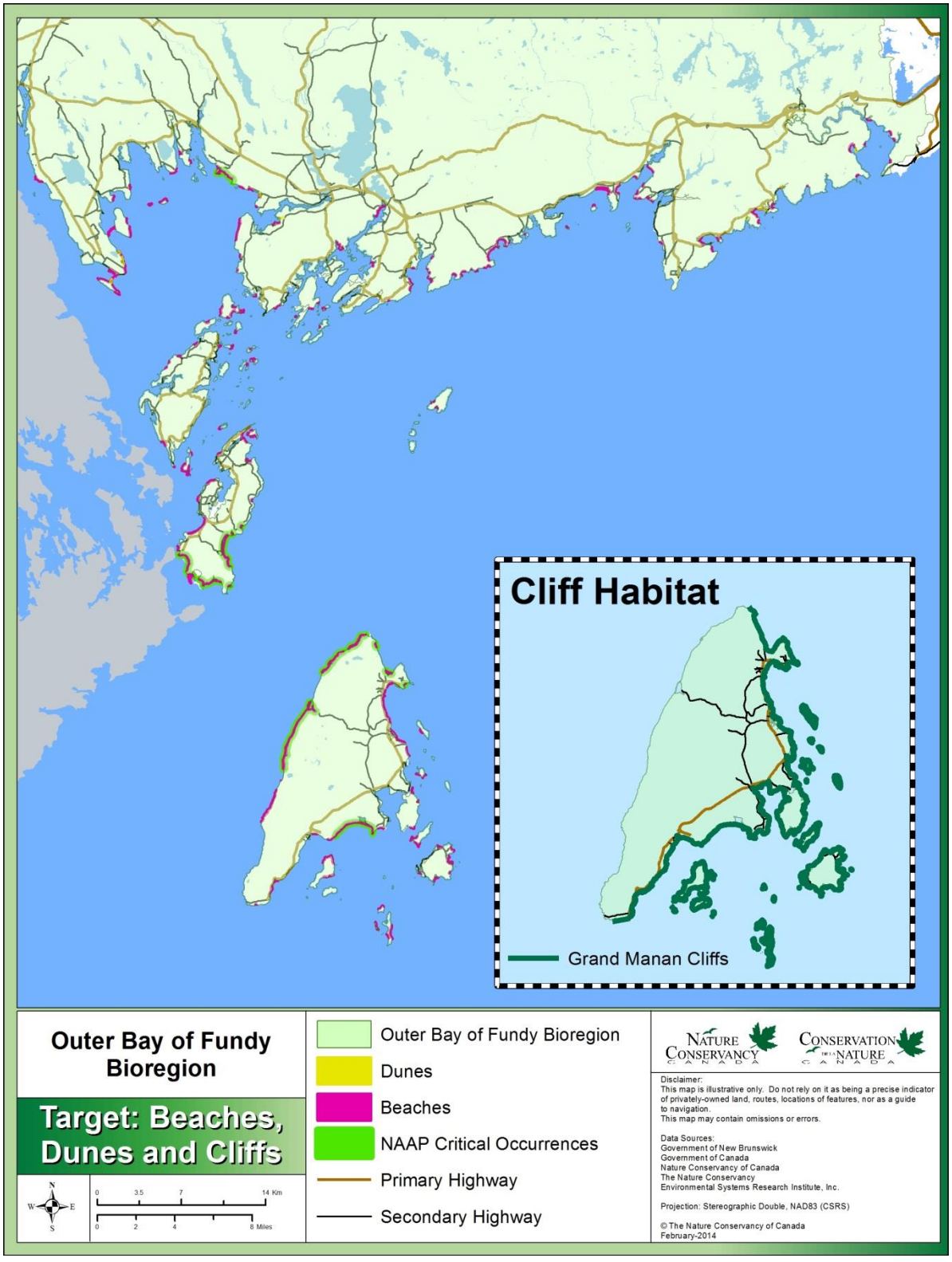


Figure 5. Beaches, Dunes and Cliffs in the Outer Bay of Fundy Bioregion.

ii. Priority Habitat: Salt Marshes

Habitat Definition Salt Marshes: 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). Within Maritime Canada, salt marshes are dominated by Spartina grasses and can be further classified by their temporal inundation patterns (high or low marsh) and salinity (saline or brackish marsh). Salt marshes are 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 marshes, a spatial buffer of 275 m was applied to all occurrences within the Bioregion (CWS, OMNR & OME, 1998). All provincially delineated salt marshes and NAAP critical occurrences are mapped in Figure 6.

Habitat/Species Type Salt Marshes: Marine Intertidal – Salt Marshes (Emergent Grasses).

Ecological Justification Salt Marshes: Although the average salt marsh within the Bioregion is small as compared to elsewhere in the Bay of Fundy (< 10 ha), they provide habitat for a number of rare species, including the Marsh Wren (*Cistothorus palustris*), Frankton's Saltbush (*Atriplex franktonii*) and Creeping Alkali Grass (*Puccinellia phryganodes*). The salt marshes in the Bioregion also provide foraging grounds for over 20 species of shorebird, waterfowl and colonial nesting bird species. Additionally, salt marshes are known to be critical breeding grounds for a variety of marine species (Heck *et al.* 1995). Furthermore, they 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.* 2001a; Hung & Chmura 2006).

Landscape Context Assessment Salt Marshes: Good
The average Landscape Context Index (LCI) for salt marshes in the Outer Bay of Fundy is 30, which is considered good, as calculated from NAAP data. Approximately 54% of upland habitat adjacent to salt marshes (within 275m) contains natural cover. The remaining 46% is mostly attributed to agriculture and rural development. The hardening of coastlines in these areas can result in insufficient sediment supply which in turn can limit the ability of salt marshes to migrate inland in response to natural and anthropogenic sea-level rise. The additional protection of uplands adjacent to tidal marshes (suggested 275m buffer; EC, OMNR, & OME, 1998) will help to protect the ecological functions and integrity of the habitat priority, maintain nesting areas for wildlife (e.g., waterfowl), and allow for landward migration in the face of sea-level rise due to climate change. Data on salt marsh accretion rates in the Outer Bay of Fundy suggest that sediment deficits are currently not a concern (Chmura *et al.*, 2001b). In total, 413 ha (57%) of tidal marshes in the Bioregion are currently under protected or conservation status, with the bulk of this protection located in the Musquash estuary.

Condition Assessment Salt Marshes: Good
Historically, large expanses of salt marsh were dyked and drained in the Bay of Fundy for use as agricultural land. Many of these dykes have been abandoned and the areas have undergone passive 'restoration' back to salt marsh, resulting in very little fully dyked land left within the bioregion. However, some salt marshes still have restricted tidal flow due to this historic infrastructure (dykes and aboiteaux) or undersized culverts. Tidal flow restrictions can result in decreased soil accretion and vegetation changes, which can result in decreased health of salt marsh habitat (Roman *et al.*, 1984;

Callaway 2005). New Brunswick's Wetland Protection Policy regulates the amount of development and resource extraction within 30m of a salt marsh, but localized infilling for development may still be a concern. The majority of species that use salt marsh habitat within the Bioregion are either NAAP critical species targets, BCR 14 priority birds or COSEWIC listed species. There are currently no invasive species of major concern reported for salt marshes within the Bioregion.

Size Assessment Salt Marshes: Good

In total, there are 730 ha of salt marsh identified in the Bioregion, of which 401 ha (55%) are critical according to the NAAP. Critical saltmarsh is restricted to the Musquash estuary and Campobello Island. The average size of salt marshes in the Bioregion is 9.8 ha, which is significantly less than the NAAP minimum size criteria. However, similar to the case with beaches and dunes, salt marsh occurrences are naturally small in the Bioregion due to the rugged coastline. When included as part of larger coastal complexes (marsh, tidal flat, beach, salt ponds, etc.), many occurrences meet the size criteria of coastal complexes > 40 ha (Anderson *et al.* 2006).

Overall Assessment Salt Marshes: **Good**

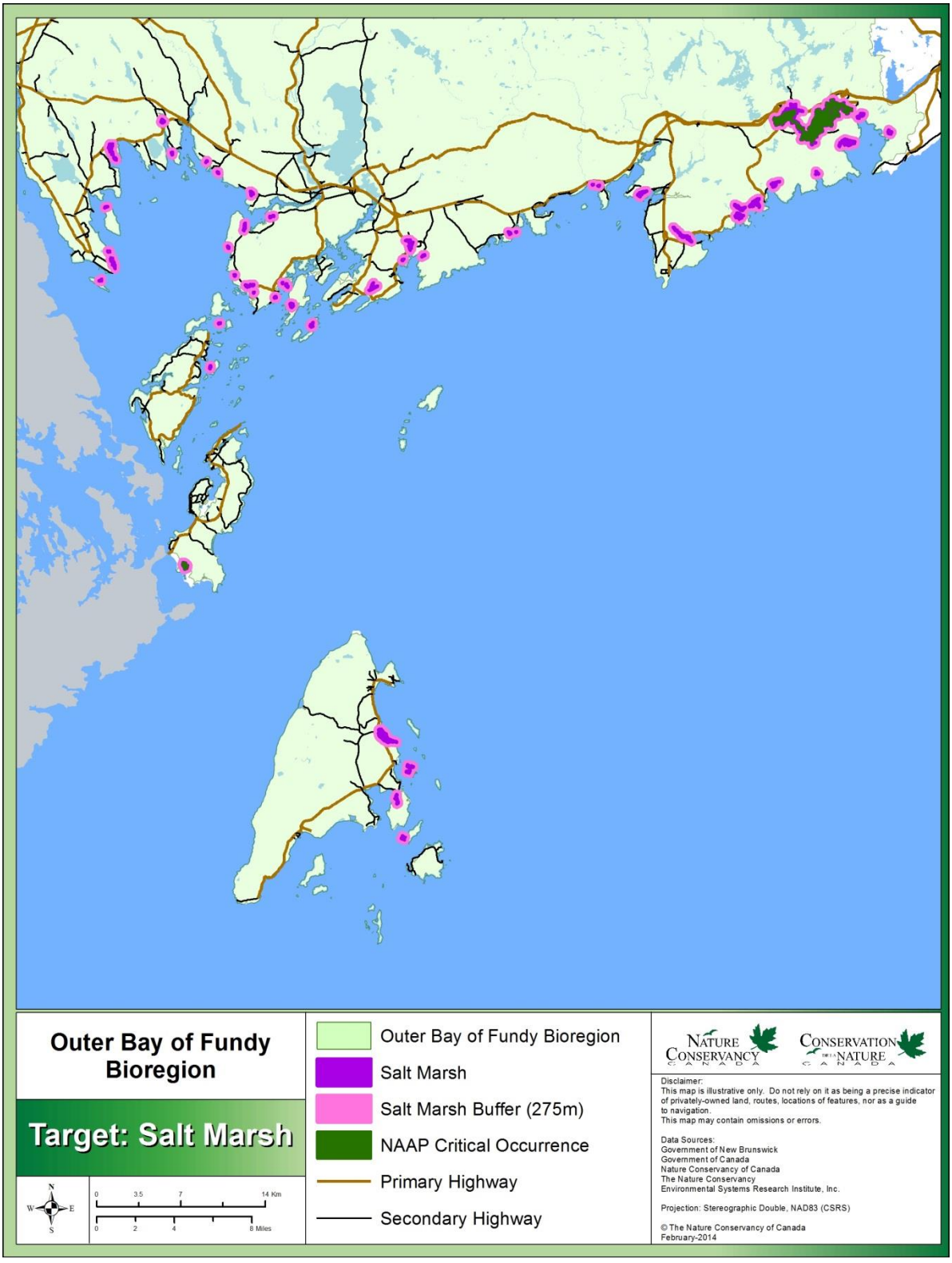


Figure 6. Salt Marshes in the Outer Bay of Fundy Bioregion.

iii. Priority Habitat: Tidal Flats and Rocky Shores

Habitat Definition Tidal Flats and Rocky Shores: 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, whereas rocky shores are defined as rockbound coast subject to salt spray and wave pounding. Tidal Flats and Rocky Shores are spatially delineated based on the New Brunswick Provincial Resource Inventory (WC = TF and RK). Critical occurrences were identified as: Tidal Flat size > 40 ha; Rocky Shore size > 4 ha; LCI < 30 (Anderson *et al.* 2006). All provincially delineated tidal flats and rocky shores, including NAAP critical occurrences are mapped in Figure 7.

Habitat/Species Type Tidal Flats and Rocky Shores: Marine Intertidal – Rocky Shorelines; Marine Intertidal – Mud Flats and Salt Flats.

Ecological Justification Tidal Flats and Rocky Shores: 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 in the intertidal zone. 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 (Butler *et al.* 1996a). Rocky shores are exceptionally productive and biologically rich systems, particularly within the Bay of Fundy. This productivity is expressed as *zonation*, where unique species assemblages occur along a gradient related to tide height. Generally, the Bay of Fundy is recognized for its diversity of zones because of the extreme tidal ranges that occur here. Five primary intertidal zones have been identified: spray zone, black zone, barnacle zone, brown algae zone and Irish moss zone (Butler *et al.* 1996b). Rockweed (*Acophyllum nodosum*) dominates the brown algae zone in the Bay of Fundy, though other related species (*Fucus* spp.) also are found in abundance (DFO 1998). Rockweed and the rockweed community is important for nutrient cycling, nitrogen and carbon sequestration, nutrient input into food webs. Rockweed is also provides important additional biodiversity value in terms of physical habitat structure for adult and larval fish, adult and young waterfowl, adult and larval invertebrates, as well as other algae (Larsen 2010, Seeley and Schlesinger 2012).

Landscape Context Assessment Tidal Flats and Rocky Shores: Good

The average Landscape Context Index (LCI) scores for tidal flats and rocky shores in the Outer Bay of Fundy are 31 and 14, respectively. These values are considered ‘good’ for tidal flats and ‘very good’ for rocky shorelines as calculated from NAAP data. Approximately 78% of the land adjacent to tidal flats and rocky shores (within 275m) contains natural cover across the Bioregion. The remaning 22% is attributed to agricultural land, roads and residential areas, which may affect the ability of tidal flats to migrate inland in response to natural and anthropogenic sea-level rise. The protection of uplands adjacent to tidal flats (suggested 275m buffer; EC, OMNR, & OME 1998) will help facilitate the landward migration in the face of sea-level rise due to climate change. Approximately 63 ha of rocky shore is currently under protected or conservation status, whereas tidal flats are entirely owned by the Crown, and are not under any conservation status.

Condition Assessment Tidal Flats and Rocky Shores: Good

The nature of tidal flats being inundated daily limits the amount of direct anthropogenic disturbance that occurs, with the exception of low-impact recreational activities (*e.g*. bird watching). However, rocky shores, and especially tidal flats, may be impacted by sedimentation or runoff from agriculture and forestry on adjacent lands. Similarly, effluents from marine aquaculture may affect tidal flat ecology. Significant species that depend on tidal flats and rocky shores are generally restricted to shorebirds and waterfowl, which include NAAP critical species, BCR 14 priority birds and COSEWIC listed species. To date, there have been no invasive species of major concern reported for tidal flats in the bioregion.

Size Assessment Tidal Flats and Rocky Shores: Good

Tidal flats and rocky shores make up the majority of coastal habitat within the Bioregion, with over 2,125 ha of tidal flat and 3,727 ha of rocky shore. Of this, 166 ha (8%) of tidal flats and 185 ha (5%) of rocky shores are critical according to the NAAP. The average size of tidal flats in the Bioregion is 13 ha, which is below the NAAP minimum size criteria. With the exception of a few large occurrences, tidal flats are naturally small in the Bioregion owing to the rugged coastline. Conversely, average rocky shore habitat size is 10 ha, which is twice as large as the NAAP minimum size criteria.

Overall Assessment Rank Tidal Flats and Rocky Shores: **Good**

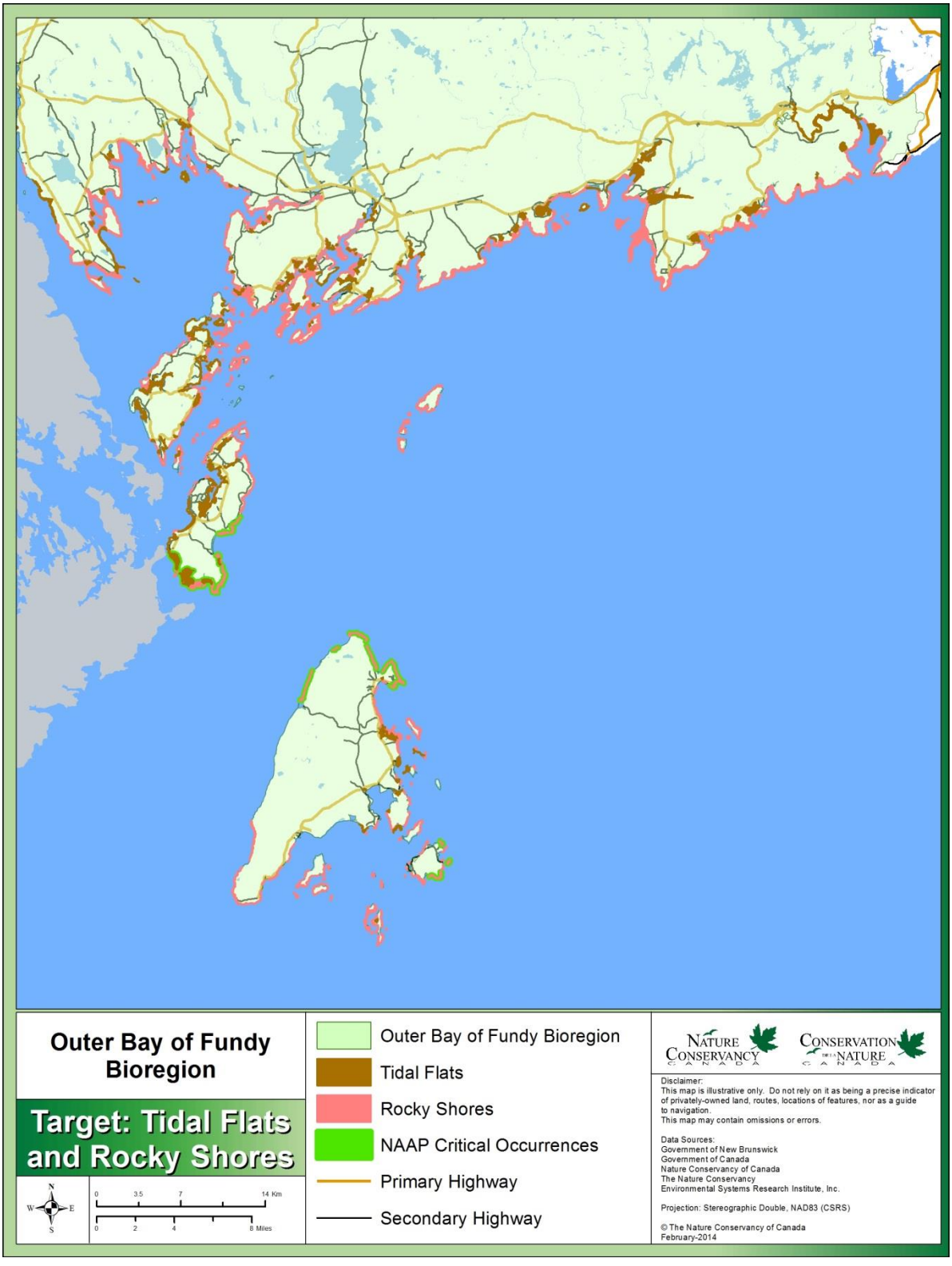


Figure 7. Tidal Flats and Rocky Shores in the Outer Bay of Fundy Bioregion.

iv. Priority Habitat: Coastal Islands

Habitat Definition Coastal Islands: Over 360 coastal islands and islets occur within the Bioregion, ranging between <0.01 – 4000 ha in size. The target definition is meant to encompass islands and islets that are relatively isolated from human disturbance and free of mammalian predators. For this reason, the target definition does not include Grand Manan, Campobello or Deer island, which are heavily populated. Coastal Islands are spatially delineated from the Provincial Limits polygon layer (SNB 2005), with mainland New Brunswick and the above islands removed (Figure 8).

Habitat/Species Type Coastal Islands: Marine Coastal/Supratidal – Seas Cliffs and Rocky Offshore Islands.

Ecological Justification Coastal Islands: Because of the inherent isolation from potential predators, coastal islands provide critical habitat for a variety of shorebirds, waterfowl and colonial nesters, some of which nest exclusively on islands. Fifteen colonial-nesting bird species have been identified in the NA, including rare and endangered species such as the Roseate Tern (*Sterna dougallii*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Black-crowned Night-heron (*Nycticorax nycticorax*) and Atlantic Puffin (*Fratercula arctica*). Many bird species also depend on these coastal islands as stopover sites before or after completing long oceanic migrations (Butler *et al.* 1996c).

Landscape Context Assessment Coastal Islands: Very Good
Human development on coastal islands in the Bioregion is largely restricted to Grand Manan, Campobello and Deer Island. Since many coastal islands are under private ownership, there is the potential for increased coastal development. However, only approximately 10% of islands in the bioregion contain some form of permanent human structure at this time. In total, 238 ha (7%) of coastal islands in the bioregion are currently under protected or conservation status, which does not include protected land on Grand Manan, Campobello or Deer island.

Condition Assessment Coastal Islands: **Very Good**
Islands are generally isolated by nature, but may be subject to varying levels of disturbance, based on their proximity to human settlement, as well as activities in the surrounding marine environment (*e.g.* marine aquaculture). At present, low levels of human habitation and use on most coastal islands in the Bioregion have resulted in minimal anthropogenic disturbance. As stated above, only approximately 10% of islands in the Bioregion contain a permanent structure or other anthropogenic disturbance.

Size Assessment Coastal Islands: Not Applicable
Islands in the Outer Bay of Fundy Bioregion are considered important regardless of size, especially given their use by a broad suite of significant species. There are 360 coastal islands located within the Bioregion, with an average size of 9.9 ha and a total combined area of 3,594 ha.

Overall Assessment Rank Coastal Islands: **Very Good**

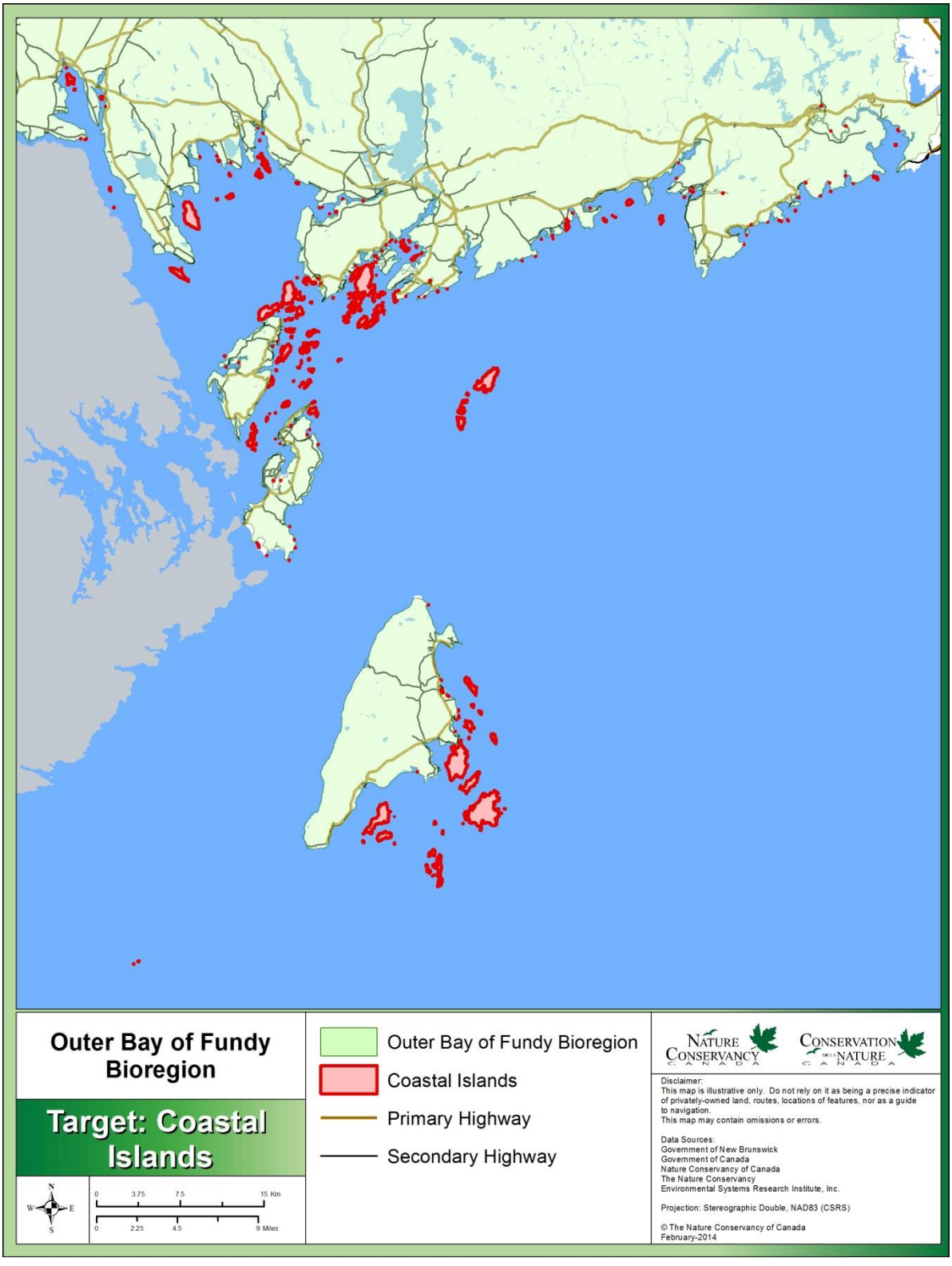


Figure 8. Coastal Islands in the Outer Bay of Fundy Bioregion.

v. Priority Habitat: Acadian Forest Mosaic

Habitat Definition Acadian Forest Mosaic: 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 characterisitics (Loo & Ives 2003; Stewart *et al.* 2003). Due to human influence across the region, forests have shifted to a less diverse forest of younger age-classes and early successional species (Loo & Ives 2003; Figure 9). See Appendix 1 for more detail on the classification of forest types delineated in this HCS. Critical occurrences 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).

Habitat/Species Type Acadian Forest Mosaic: Forest; Forest – Temperate

Ecological Justification Acadian Forest Mosaic: Across eastern North America, approximately five percent of the original Acadian Forest remains in pre-settlement condition (Davis *et al.* 2013). 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 favour boreal species, a phenomenon described as borealization (Simpson 2008). Specifically, forest communities comprised of shade-tolerant conifers, hardwoods and pines that are in a mature or overmature age-class 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*), Blue Felt Lichen (*Degelia plumbea*) and Wood Thrush (*Hylocichla mustelina*). Additionally, rare forest communities such as the Coastal Fog Forest are home to rare and endangered lichen and bryophyte species, and forests occurring on calcareous soils within the Bioregion support many unique flora, such as the White Adder's-Mouth (*Malaxis brachypoda*) and Small Yellow Lady's-Slipper (*Cypripedium parviflorum* var. *makasin*).

Landscape Context Assessment Acadian Forest Mosaic: Fair
According to Global Forest Watch, New Brunswick no longer contains any intact forest landscapes greater than 50,000 ha in size (Smith *et al*. 2015). Road density is very high in the Bioregion (see Threats – Road Fragmentation), resulting in a fragmented landscape. The Local Connectivity dataset (TNC 2012) provides an index of the structural connectivity between natural ecosystems across a landscape, where a value of 0 represents a completely intact landscape, and 100 is completely fragmented. Within the bioregion, the average index value for forests is 59, which is considered fair. Few large patches of intact forest remain, and of those patches, only 11% meet the minimum criteria to support old-forest dependant species. There is currently 40, 759 ha of forest (10%) under protected status, of which 1,019 ha (<3%) is classified as biologically mature Acadian forest. These forest communities are inadequately represented in the current network of protected areas.

Condition Assessment Acadian Forest Mosaic: Poor
Human influence over the past 200 years has simplified forest structure, composition and age class distribution, resulting in a decline in old forest communities in New Brunswick (Erdle & Sullivan, 1998). Recent industrial forestry practices, including widespread clearcut harvesting, have resulted in an abundance of young, even-aged, early-successional forest communities, while the abundance and age of

shade-tolerant, late-successional forest types has declined (Loo & Ives 2003; Mosseler *et al.*, 2003). Only 8% of the forest within the Bioregion is classified as biologically mature and only 11% of these old forest patches meet the minimum size criteria to support the various keystone species as determined by the New Brunswick Department of Natural Resources (see Appendix E for a description of the analysis). Forestry practices remain the dominant threat to forested ecosystems in the region, and the new Crown Forest Strategy introduced in 2014 (GNB 2014) will result in increased clearcut harvesting in previously designated conservation land.

Size Assessment Acadian Forest Mosaic: Good

Mosseler *et al.* (2003) suggest that old forest communities within the Acadian Forest used to occupy an estimated 50% of the land base prior to European settlement. Within the Bioregion, only 8% of forest is biologically mature according to the provincial resource inventory. However, in total there are 392,208 ha of forest, covering 70% of the Bioregion. Unlike permanently-converted land, the current forest still provides habitat for a variety of species, and can contribute to future old forest if harvesting practices are modified.

Overall Assessment Rank Acadian Forest Mosaic: **Fair**

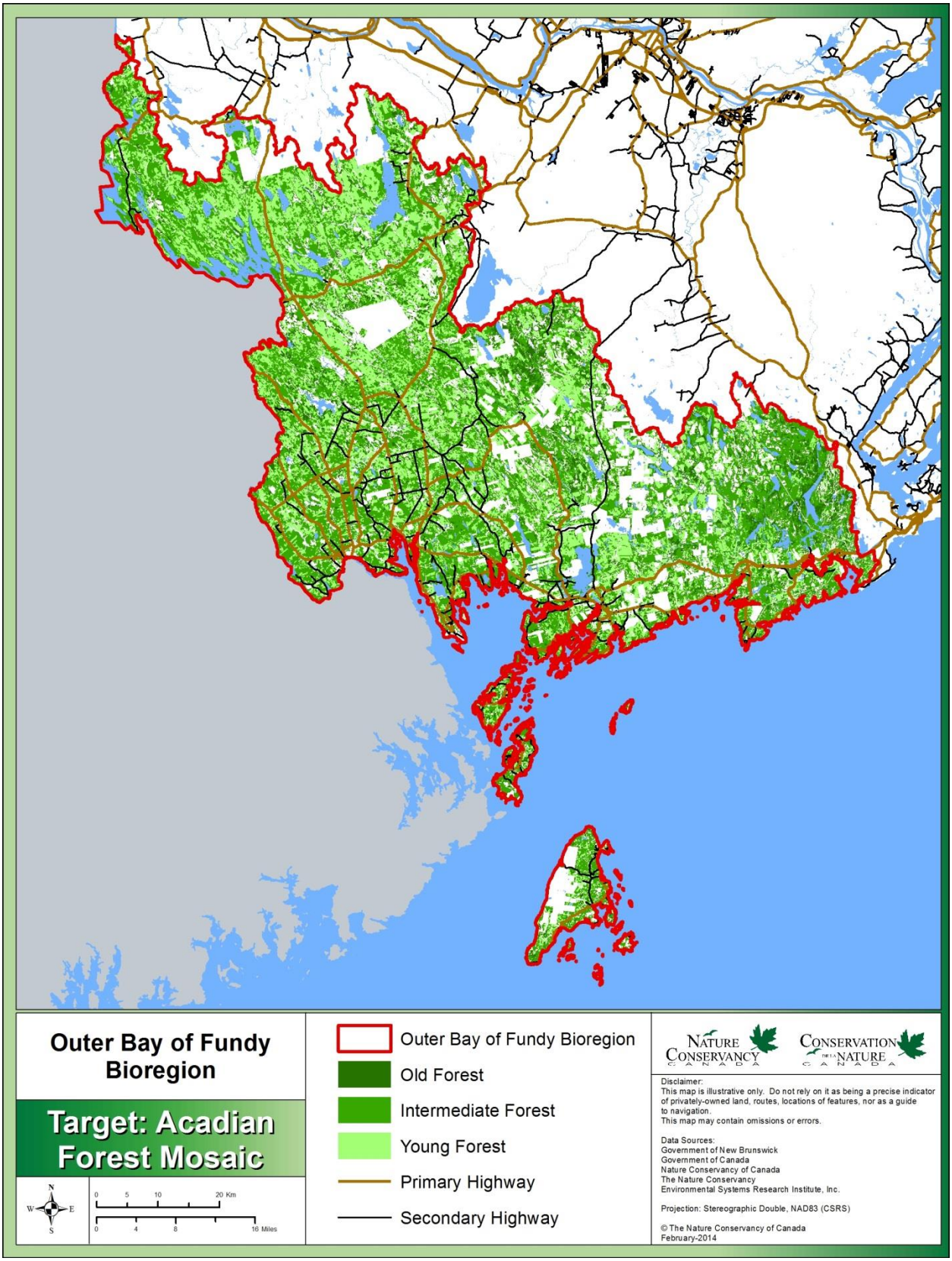


Figure 9. Acadian Forest Mosaic in the Outer Bay of Fundy Bioregion.

vi. Priority Habitat: Freshwater Wetlands

Habitat Definition Freshwater Wetlands: Freshwater wetlands refer to areas where the water table saturates the soil surface either permanently or periodically. The extent and type of freshwater wetlands that occur in a given watershed are a function of climate, land surface configuration, type of bedrock and soil (mineral or organic), degree of inundation and nutrient status of the water supply (Davis & Browne 1996). Within the bioregion (Figure 10), this includes bogs, fens, marshes, shrub swales, treed swamps and seasonal, vernal pools. With the exception of vernal pools, freshwater wetlands are 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).

Habitat/Species Type Freshwater Wetlands: 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].

Ecological Justification Freshwater Wetlands: Freshwater wetlands within the Bioregion contain a tremendous species diversity due to the topographical and climatic variations across the region. The majority of provincially significant species (S1-S2) depend on wetlands for at least a portion of their life cycle, and approximately one-third of all COSEWIC listed species within the Bioregion are wetland-dependant, such as the Least Bittern (*Ixobrychus exili*s), Wood Turtle (*Glyptemys insculpta*) and Van Brunt's Jacob's-ladder (*Polemonium vanbruntiae*). Calcareous wetlands in the Bioregion are of particular significance because of the assemblages of rare calciphillic plant species they support. Wetlands provide a number of ecosystem services in addition to wildlife habitat, such as flood control, water filtration and carbon sequestration (Woodward & Wui 2001).

Landscape Context Assessment Freshwater Wetlands: Good
The average Landscape Context Index (LCI) score for freshwater wetlands in the Outer Bay of Fundy is 16, which is considered 'good' (calculated from NAAP data). However, the provincial database greatly underestimates forested wetlands, which are accessed for wood harvesting and therefore not regulated as wetlands. Applying a 275 m buffer around mapped wetlands results in over 584,047 ha of the bioregion and approximately 34% of this has been altered by anthropogenic disturbance. In total, 5,012 ha (12%) of the freshwater wetlands in the Bioregion are currently under protected or conservation status.

Condition Assessment Freshwater Wetlands: **Fair**
New Brunswick currently has a Wetlands Protection Policy which requires a permit for work in or around (within 30 m) of a provincially mapped wetland. Many forested wetlands, however, are not provincially identified and subsequently do not receive any protection. The primary threats to freshwater wetlands are commercial forest harvesting within forested wetland, and invasive species in non-forested wetlands. Glossy False Buckthorn (*Frangula alnus*) and European Common Reed (*Phragmites australis australis*) are of particular concern, as they are aggressive wetland invaders. Other threats to wetlands (*e.g*. infilling for development, agricultural runoff, etc.) are generally localized within the Bioregion.

Size Assessment Freshwater Wetlands: Good

In total, there are 40,358 ha of freshwater wetlands in the bioregion, which makes up 7% of the total area. Of these, 6,761 ha were identified as NAAP critical, represented within 74 separate complexes. A 275 m buffer was included around all freshwater wetlands to protect the ecological functions and integrity of this priority habitat (CWS, OMNR & OME 1998). The average size of freshwater wetland occurrences in the Bioregion is 3.9 ha, and the average size of freshwater wetland complexes (all wetland types combined) is 6.3 ha. These values are considerably less than the NAAP minimum size criteria for critical occurrences, however this does not account for subsurface flow connectivity, which if mapped, would greatly increase the average wetland size.

Overall Assessment Rank Freshwater Wetlands: Good

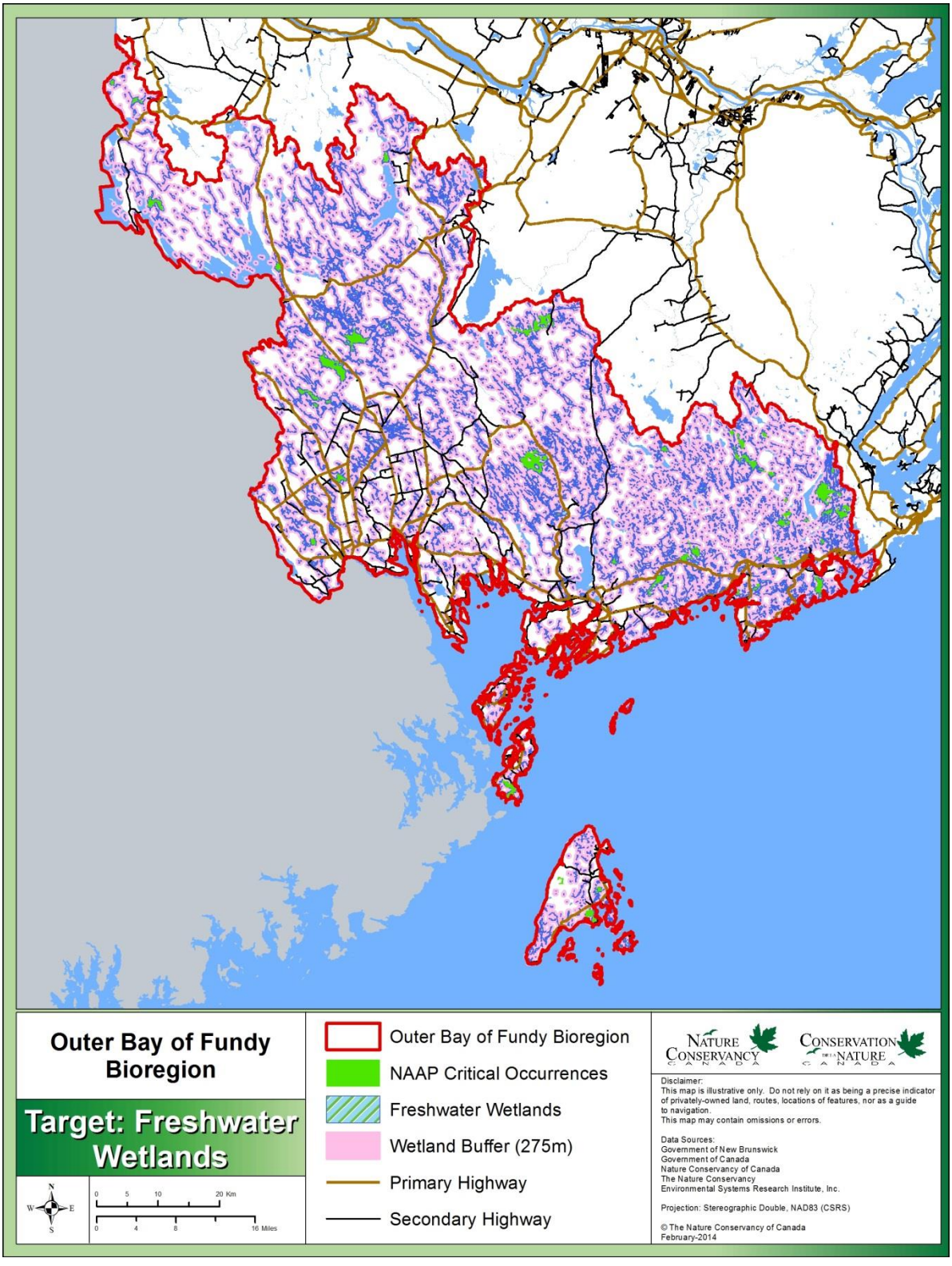


Figure 10. Freshwater Wetlands in the Outer Bay of Fundy Bioregion.

vii. Priority Habitat: Riparian and Aquatic Systems

Habitat Definition Riparian and Aquatic Systems: 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. Aquatic features were spatially delineated from the New Brunswick Provincial Resource Inventory (WATER_CODE = LK, PN, RV and WA). The method of spatially delineating riparian areas involved selecting wetland and forest polygons that overlapped with the coarse-scale, NAAP modelled, riparian ecosystem layer (TNC 2005). Critical occurrences were identified as: size > 40 ha complex; LCI < 20 (Anderson *et al.* 2006). All riparian systems are mapped in Figure 11.

Habitat/Species Type Riparian and Aquatic Systems: 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].

Ecological Justification Riparian and Aquatic Systems: 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, which reflects a wide diversity of biological, geological, and hydrological processes (Naiman, Decamps & Pollock 1993). The Outer Bay of Fundy is particularly well known for its large number of lakes and associated freshwater beaches, which contain Atlantic Coastal Plain Flora (Blaney *et al.* 2007). The Bioregion also contains the Canadian portion of the St. Croix River, which is recognized as an internationally significant watershed and a critical riparian system within the NAAP (Anderson *et al.* 2006). A diversity of rare aquatic species occur within the NA, including the endemic Lake Utopia Dwarf Smelt (*Osmerus mordax* pop. 3), American Eel (*Anguilla rostrata*), Pygmy Snaketail dragonfly (*Ophiogomphus howei*) and Brook Floater (*Alasmidonta varicosa*).

Landscape Context Assessment Riparian and Aquatic Systems: Good

The average Landscape Context Index (LCI) score for riparian systems in the Outer Bay of Fundy is 30, which is considered 'fair' (calculated from NAAP data; see Habitat Definition). Both human development and agriculture tend to concentrate near waterways. Historically, rich floodplains were cleared for agriculture, altering hydrological regimes through infilling of wetlands and road construction. However, approximately 77% of the modelled riparian areas contain natural cover. Current forest harvesting regulations in New Brunswick require that all forestry operations leave a minimum 30 m buffer (or greater) along watercourses. There is currently 566 ha (<2%) of modelled riparian habitat currently in protected status, and 9,935 ha (31%) of aquatic habitat is currently protected.

Condition Assessment Riparian and Aquatic Systems: Fair

Only approximately 23% of lands within the modelled riparian areas have been converted for development or agriculture, which is considered good. A number of fish species are in decline within the bioregion, such as American eel (*Anguilla rostrata*) and Atlantic Salmon (COSEWIC 2012, COSEWIC 2010). Declines are attributed to dams, erosion, sedimentation and agricultural runoff, among others. However, the St. Croix Gaspereau (*Alosa pseudoharengus*) population has dramatically rebounded since

the removal of a dam in 2013 (CBC 2015). Aquatic invasive species are of considerable concern within the bioregion, and the Magaguadavic River in particular is a hub of invasive fish species (Carr & Whoriskey 2009). Records of Rainbow trout (*Oncorhynchus mykiss*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*) and Chain Pickerel (*Esox niger*) all occur within the bioregion. The latter three species are voracious predators that both directly prey on and outcompete native fish species (Carr & Whoriskey 2009) and may have an impact of populations of rare invertebrates, such as the Pygmy Snaketail (COSEWIC, 2008). Chain Pickerel in particular is considered a high threat to Canadian biodiversity (CWF 2003).

Size Assessment Riparian and Aquatic Systems: Very Good

Riparian systems cover a large portion of the bioregion due to the high concentration of major river and lake systems that occur here. In total, there is 30,527 ha of modelled riparian habitat, and 32,033 ha of aquatic habitat, which combined cover 11% of the bioregion. Over 23% of modelled riparian habitat is considered NAAP Critical, all of which occurs within the St. Croix watershed. Average riparian habitat patch size is 65 ha, which over 62% greater than the minimal patch size according the NAAP.

Overall Assessment Riparian and Aquatic Systems: **Very Good**

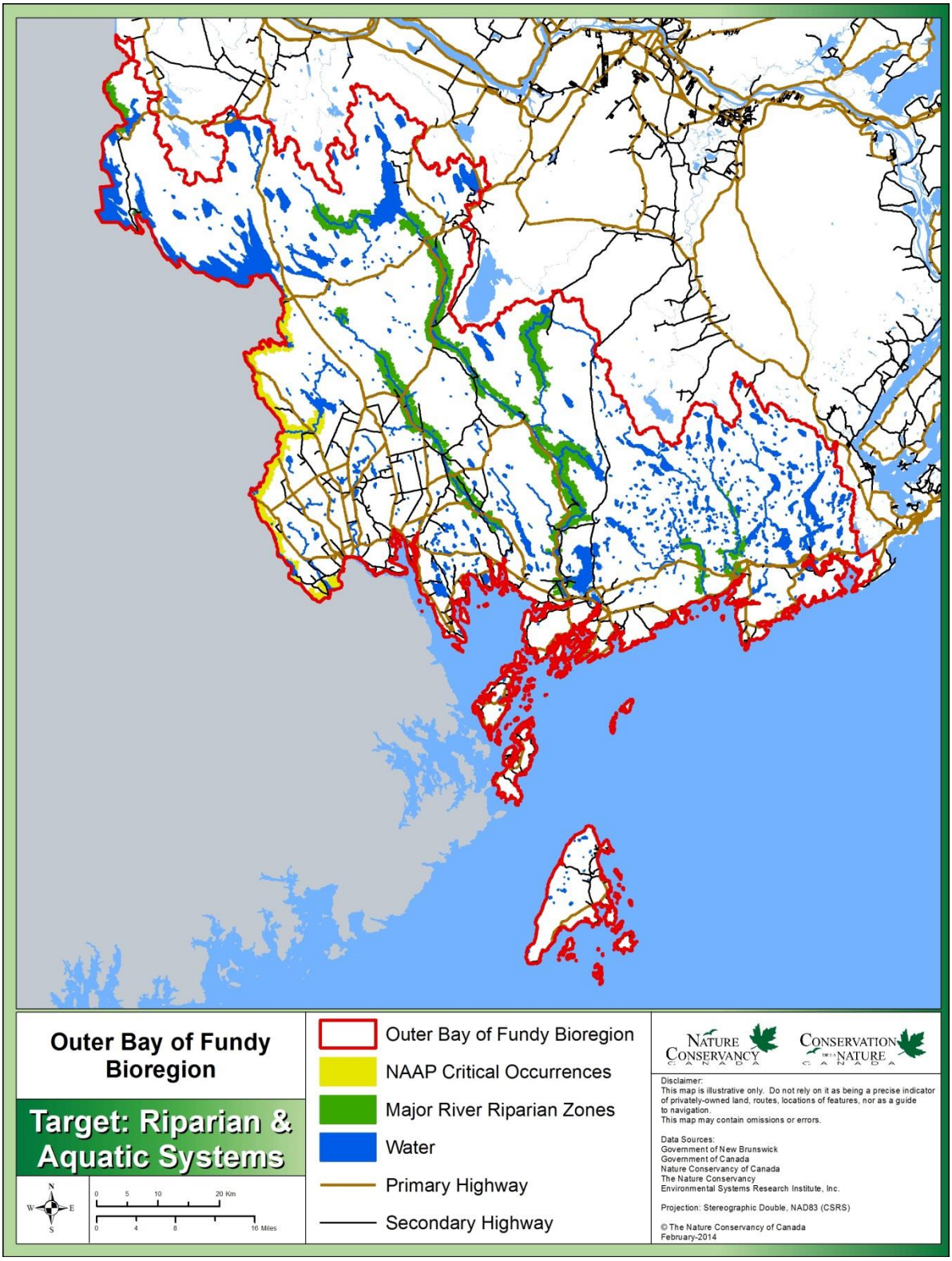


Figure 11. Aquatic and Riparian Areas in the Outer Bay of Fundy Bioregion

Summary Status of Priority Habitats

Table 6a. Assessment of the Habitat Conservation Priorities for the Outer Bay of Fundy Bioregion.

Biodiversity Habitat	Assessment			Overall Assessment
	Landscape Context	Condition	Size	
Beaches, Dunes and Cliffs	Very Good	Good	Good	Good
Salt Marshes	Good	Good	Good	Good
Tidal Flats and Rocky Shores	Good	Good	Good	Good
Coastal Islands	Very Good	Very Good	N/A	Very Good
Acadian Forest Mosaic	Fair	Poor	Good	Fair
Freshwater Wetlands	Good	Fair	Good	Good
Riparian and Aquatic Systems	Good	Fair	Very Good	Good
Overall Biodiversity Habitat Assessment for the Bioregion				**Good**

Table 6b. Description of the assessment ranks of ecological integrity of the conservation priority habitat types for the Outer Bay of Fundy 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.
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.

B. THREATS

i. Current 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 by the NB Outer Bay of Fundy Bioregion project team using past studies, local expert knowledge, and a review of the literature. The list of threats is seen as comprehensive for the bioregion's biodiversity habitats. These threats were assessed based on their scope, severity and irreversibility of damage to habitats over a 10-year period using the Conservation Action Planning Workbook (Low 2003), and were categorized using established international taxonomy (IUCN-CMP 2012), with local descriptions. Table 7 provides a summary of the threats identified from the NB Outer Bay of Fundy Bioregion. The overall threat status for the NB Outer Bay of Fundy Bioregion is "High". The geographic extent of each identified threat is indicated, where known, in Figures 14 through 19. Table 8 summarizes threat magnitude within the BCR 14 and MBU 11 plan (Environment Canada 2013), and

Table 7. Summary of threats[4] to the NB Outer Bay of Fundy bioregion priority habitats.

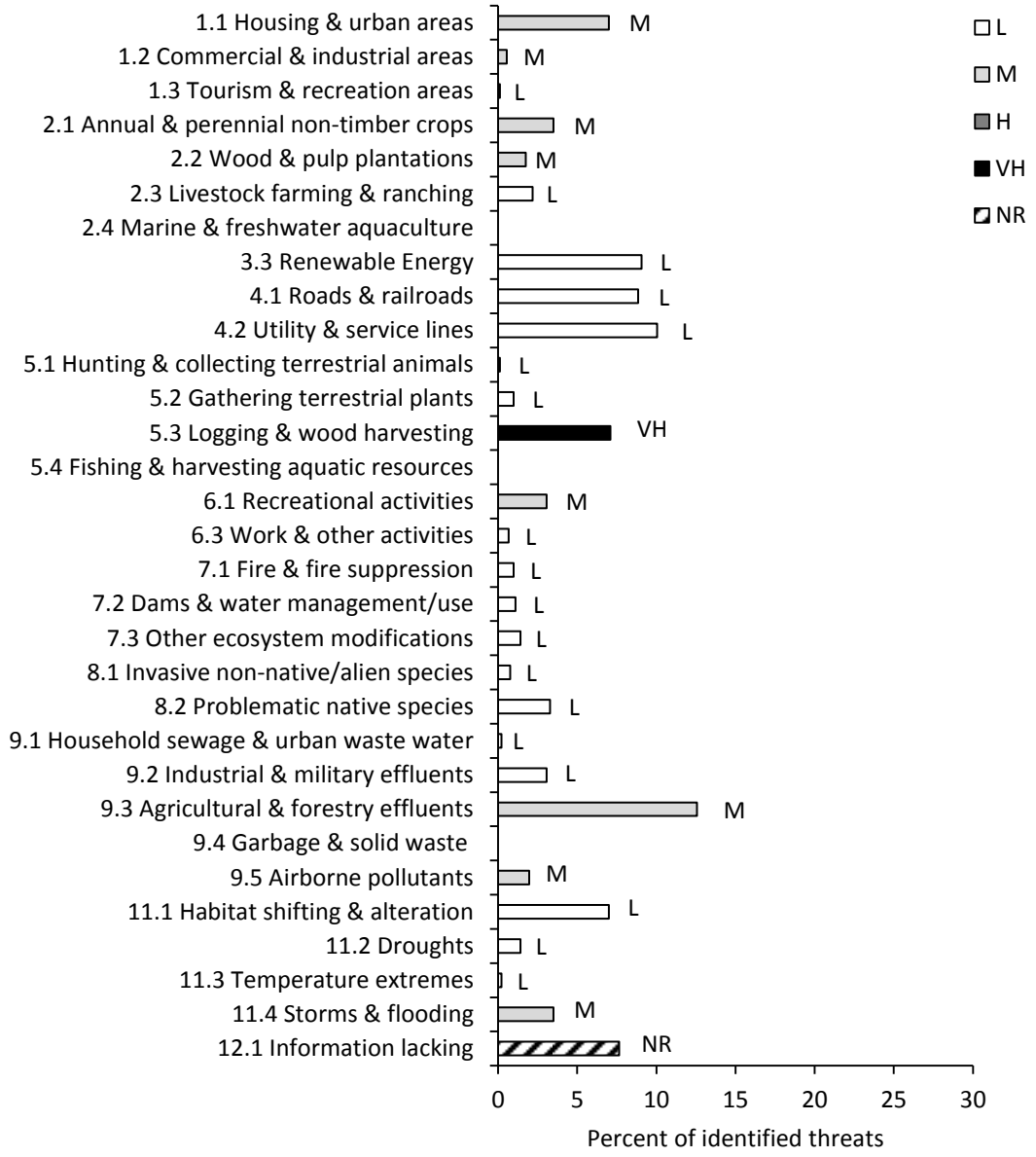
Threats[4] Across Habitats	Beaches, Dunes and Cliffs	Salt Marsh	Tidal Flats and Rocky Shores	Coastal Islands	Acadian Forest Mosaic	Freshwater Wetlands	Riparian and Aquatic Systems	Summary Threat Rank
1.1 Housing, cottage and rural development	Low	Low	Low	Low	Low	Low	Low	**Low**
2.2 Wood & Pulp Plantations	-	-	-	-	Medium	-	Low	**Low**
2.4 Marine aquaculture	-	Low	Medium	Medium	-	-	Low	**Medium**
4.1 Road fragmentation	-	-	-	-	High	Medium	Medium	**Medium**
5.3 Incompatible forestry practices	-	-	-	-	Very High	-	High	**High**
7.2 Dams and other aquatic barriers	-	-	-	-	-	Medium	High	**Medium**
8.1 Invasive Non-Native/Alien Species	Medium	Low	Medium	Medium	Low	Low	Medium	**Medium**
9.3 Agricultural & Forestry Effluents	-	-	-	-	-	Medium	Medium	**Medium**
Overall threat Status by priority habitat	**Low**	**Low**	**Medium**	**Medium**	**High**	**Medium**	**High**	**High**

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
-	The threat's impact on the habitat conservation priority is *negligible*
Unknown	The threat's impact on the habitat conservation priority is *unknown*

[4] Threat nomenclature is based on the IUCN classification of direct threats (IUCN-CMP 2012).

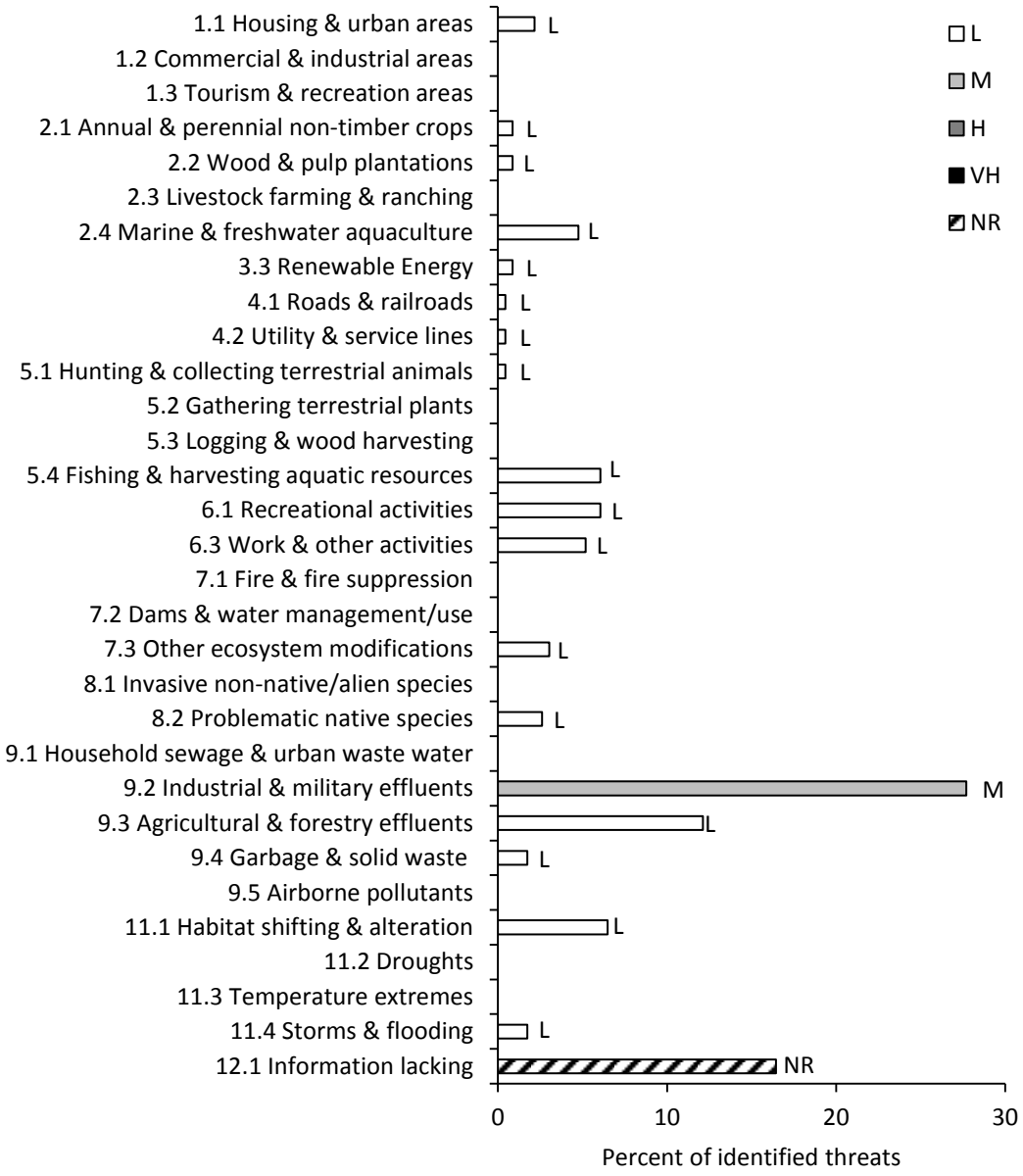
Table 8. Relative magnitude of identified threats to priority species within BCR 14 NB, and MBU 11 NB by threat category and broad habitat class. L = Low magnitude threats; M = Medium; H = High; VH = Very High. Blank cells indicate that no priority bird species had threats identified in the threat category / habitat combination. Adapted with permission from Environment Canada (2013).

Threat Category	**BCR 14 Habitat Classes**													**MBU 11 Habitat Classes**			
Broad Threat Categories Across Habitats	Coniferous forest	Deciduous forest	Mixed forest	Shrub/Early Successional	Herbaceous	Cultivated and Managed Areas	Urban	Wetlands	Inland Waterbodies	Coastal – Above High Tide	Riparian	Widespread	**Overall**	Marine Waters	Coastal– intertidal	Widespread	**Overall**
1. Residential & Commercial Development	L	L	L	L	L	M	H	M	L	M	M	L	**M**		L		**L**
2. Agriculture & Aquaculture	L	M	M			H		M		L	L		**M**	M	L		**L**
3. Energy Production & Mining	L	L	L		L							L	**L**		L	L	**L**
4. Transportation & Service Corridors	M	L	L		L			L		L	L	L	**L**		L		**L**
5. Biological Resource Use	VH	VH	H					H	L	L	H		**VH**	L	L		**L**
6. Human Intrusions & Disturbance					L		L	L	M	M	L		**M**		M		**L**
7. Natural System Modifications	L	L	L	L		L		L	L	M	L		**L**		M		**L**
8. Invasive & Other Problematic Species & Genes	L	L	L	L	L	L		L	L	M	L		**L**	L	L		**L**
9. Pollution	H	M	M	L	L	M	L	M	M	M	M		**M**	M	H		**M**
11. Climate Change & Severe Weather												H	**H**			M	**M**
Overall	**H**	**M**	**M**	**L**	**L**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**H**	**M**	**M**	**L**	**M**



Note: If 100 threats were identified in total for all priority species in BCR 14 NB, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). Progressive shading in the bars (from L: low, M: medium, H: high, to VH: very high) represents the rolled up magnitude of all threats in each threat subcategory in the BCR

Figure 12 - Identified IUCN categories of threats to priority bird species within BCR 14 NB expressed as percentage of total number of threats as well as magnitude of threat. Adapted with permission from Environment Canada (2013).



Note: If 100 threats were identified in total for all priority species in MBU 11 NB, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). Progressive shading in the bars (from L: low, M: medium, H: high, to VH: very high) represents the rolled up magnitude of all threats in each threat subcategory in the BCR.

Figure 13 - Identified IUCN categories of threats to priority bird species within MBU 11 NB expressed as percentage of total number of threats as well as magnitude of threat. Adapted with permission from Environment Canada (2013).

1.1 Housing & Urban Areas - Housing, cottage and rural development (Threat Status: Low)

The demand and pressure for development along coastal systems in New Brunswick has been increasing (NBDELG 2002, MacKinnon *et al.* 2011a). Although New Brunswick currently has a Coastal Areas Protection Policy (NBDELG 2002), coastal regions are still experiencing a phenomenon called "coastal squeeze", where natural habitats are being fragmented and disrupted by development of houses, cottages and roads. Habitat loss due to development is one of the main threats to species supported by coastal habitats (Sabine, 2002; NB EHJV, 2007). Wetlands and riparian areas are also threatened by habitat conversion and development (Environment Canada 2013). The Human Footprint Index (HFI; Woolmer *et al.* 2008), derived from layers of anthropogenic development and infrastructure, displays a certain level of disturbance across the landscape. Within the NA, the HFI shows that impacts from development are most severe along the coast, on coastal islands and along the St. Croix River (Figure 14). Due to the rugged coastline, development is not considered as significant a threat as elsewhere in the province, and < 3% of the Bioregion has been permanently converted from natural cover (Figure 15). For these reasons, the threat status of housing, cottage and rural development is considered low.

2.2 Wood & Pulp Plantations (Threat Status: Low)

According to the provincial forest inventory, over 18,600 ha of forest plantations are present in the Bioregion, representing 4.5% of the forested land base. This does not include industrial freehold (6.8% of the Bioregion by area) for which data was not available (Figure 16). Betts *et al.* (2005) suggests that plantations within New Brunswick have lower biodiversity value as 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 are associated with other fragmenting features such as roads and cut blocks. Specifically, conifer plantations in New Brunswick are known to reduce the breeding success of forest birds (Villard 2014), as well as decrease the abundance and diversity of amphibians (Waldick *et al.* 1999), bryophytes (Ross-Davis & Frego 2002) and vascular plants (Ramovs & Roberts 2005). However, the overall scope of forest plantations is low, and therefore the threat status of wood and pulp plantations is considered low at present.

2.4 Marine & Freshwater Aquaculture - Marine aquaculture (Threat Status: Medium)

New Brunswick is the second largest aquacultural producer in Canada. Most of this occurs in the Outer Bay of Fundy, and the industry continues to expand (SNB 2010; Surprenant 2010). Approximately 94% of sites focus on salmon production. The remaining 6% focus on a variety of marine and freshwater finfish, or marine shellfish (Surprenant 2010). There are over 130 active finfish aquaculture sites in the bioregion, not including freshwater sites, as these data were not available (Figure 17). The primary threats caused by aquaculture in the bioregion include improper discharge of waste, loss of coastal habitat and the use of chemicals such as antibiotics and pesticides (Harvey & Milewski 2007). Although the bulk of research has focused on the impacts of aquaculture on benthic communities (DFO 2003a) nutrient loading and the use of biocides, including illegal pesticides (CBC 2013), are recognized as impacting intertidal and subtidal zones due to the spread of these compounds by tidal action (DFO 2003b). Additionally, escaped farm salmon that breed with native salmon have been shown to cause fitness depression in native salmon populations, which potentially contributes to the extinction of

vulnerable populations (McGinnity *et al.* 2003). For these reasons, the threat status of marine aquaculture is considered medium.

4.1 Roads & Railroads - Road fragmentation (Threat Status: Medium)

Road construction has long been linked to habitat fragmentation and numerous negative impacts to numerous wildlife species, both directly and indirectly (Beazley *et al.* 2004). Forest roads fragment and open up interior habitats to forest harvesting and off-road vehicles. They also create potential opportunities for the spread of invasive species (Trombulak & Frissell 2000). Additionally, road networks, whether for logging or industrial purposes, can cause localized changes in wetland and watercourse hydrology and increase erosion and sedimentation to downstream water bodies (Forman & Alexander 1998). Road networks also interrupt natural ecological processes across the landscape such as groundwater flow and long-term gene dispersal of wide-ranging species (Lindenmayer & Franklin 2002). 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). Greater Fundy Ecosystem guidelines (Betts & Forbes 2005) suggest a maximum road density of 0.6 km/km^2 to promote the maintenance of biodiversity. Within the NA, road density is exceptionally high due to a number of population centres and extensive forest harvesting. There is a total of 7,021 km of roads in the NA, which equates to a road density of 1.26 km/km^2 (Figure 18). Forest road density is in excess of 0.92 km/km^2, the majority of which are gravel and located in the northern and eastern interior region of the NA. For these reasons, the threat status of road fragmentation is considered medium.

5.3 Logging & Wood Harvesting - Incompatible forestry practices: (Threat Status: High)

The World Wildlife Fund has classified the Acadian Forest as critically endangered, with logging identified as the primary cause of forest habitat loss (Davis *et al.* 2013; Environment Canada 2013). Improper forest management has influenced the composition and structure of forests, resulting in a landscape dominated by young, highly fragmented forest communities (Anderson & Olivero 2011). The primary harvesting technique used in New Brunswick is clear-cutting, which does not mimic the gap-replacement disturbance dynamics for most climax tolerant softwood and hardwood communities that naturally occur in the region. Additionally, herbicide application is widespread to favor conifer species in the regenerating cuts. As a result, much of the forest has transitioned to a composition of exposure-resistant 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 has been linked to declines of many insectivorous bird species (Environment Canada 2013). According to the provincial forest inventory, over 120,000 ha of forest have been clear-cut harvested within the NA, representing 30% of the forested land base, which does not include industrial freehold (6.8% of the bioregion by area) for which data was not available (Figure 16). Additionally, a legally-binding forest strategy 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). For these reasons, the threat status of incompatible forestry practices is considered high.

7.2 Dams & Water Management/Use - Dams and other aquatic barriers: (Threat Status: Medium)

Aquatic barriers in the Outer Bay of Fundy refer specifically to dams and improperly designed road-stream crossings (*i.e*. culverts). Forty dams have been identified within the NA, representing a significant

threat to riparian/aquatic systems and species (Figure 19). These barriers limit the access of fish species to spawning and nursing grounds and can create major changes in watercourse physical, chemical and biological characteristics (Bunn & Arthington 2002; Wells 1999), ultimately impacting riparian wetland and forest habitat. Rivers within the bioregion that are obstructed by dams include the St. Croix, Magaguadavic, L'Etang, Pocologan and Musquash (Wells 1999). At least six dams occur on the St. Croix River alone, which have significant impacts on migratory fish passage (IJC 2008). The exception to this is the Grand Falls dam, which was opened for passage in 2013 (ASF 2013). Improperly designed and/or installed road-stream crossings are another significant source of aquatic fragmentation, which may have a cumulative impact much greater than that of large dams (Jospe 2013). Culverts in particular are often barriers to fish passage and that of other aquatic organisms due to factors such as increased water velocity, low water depth, "hanging culverts" or large outflow drops (Tillinger & Stein 1996). Over 2000 potential culverts occur within the bioregion due to the extensive forest road network. There has been no consistent evaluation of their potential as aquatic barriers, but the likelihood of some impact for a proportion of them is significant. For these reasons, the threat status of dams and other aquatic barriers is considered high.

8.1 Invasive Non-Native/Alien Species: (Threat Status: Medium)

A number of invasive plant species have been signalled as threats within the bioregion; however, little is known about their spatial extent or cumulative impact on native biodiversity. Himalyan Balsam (*Impatiens glandulifera*) and Japanese Knotweed (*Fallopia japonica*) are both garden escapees that are now common within the Outer Bay of Fundy NA. Both species tend to invade riparian zones and associated embankments, where they form dense patches and crowd out native species (NBISC 2012). Along the coast, Japanese Rose (*Rosa rugosa*) is a highly adaptable invasive shrub of beach and dune habitat. Garbary *et al.* (2013) suggest that *R. rugosa* is a serious threat to headland and coastal island plant communities in the Bay of Fundy, as they crowd out all native vegetation. Woodland Angelica (*Angelica sylvestris*) is another invasive species of concern, and has been present in New Brunswick for many years but has recently begun spreading rapidly (NBISC 2012).

Small Mouth Bass (*Micropterus dolomieu*) is an aggressive fish species that was introduced in all watersheds within the bioregion, and has widely spread. Many native fish species are poor competitors with these invasive species, which reduce aquatic diversity through voracious and direct predation of native fishes (Brown *et al.* 2009). Large Mouth Bass (*Micropterus salmoides*) was also illegally introduced within the St. Croix River (French 2013) and has been found within the Magaguadavic (ASF 2006), along with Chain Pickerel (*Esox niger*) (Carr & Whoriskey 2009). These latter two species are also voracious predators of native fishes and are considered a high threat to Canadian aquatic biodiversity (Carr & Whoriskey 2009; CWS 2003, COSEWIC 2008a).

Coastal habitats such as tidal flats, rocky shores and salt marsh are also threatened by invasive marine species such as the Oyster Thief (*Codium fragile* spp. *tomentosoides*) and European Green Crab (*Carcinus maenas*). The Oyster Thief is a green alga, originally from Japan, which displaces native kelp and seaweed species, and uproots eelgrass beds (DFO 2013). The Oyster Thief is one of the most invasive seaweeds in the world, and considered a serious threat to coastal ecosystems throughout Maritime Canada (Percy *et al.* 2005). The European Green Crab affects natural coastal systems by directly preying on a wide variety of marine organisms, and by competition within other marine invertebrates for food

(Klassen & Locke 2007). It is one of the top ten unwanted species in the world due to its rapid colonization and voracious predation of native species (DFO 2013).

9.3 Agricultural & Forestry Effluents (Threat Status: Medium)

Agricultural and forestry effluents include the direct and indirect effects of nutrient loading and the release of sediments and pesticides into the natural environment. Although agriculture is not as prevalent in the bioregion as compared to elsewhere in the province, where it does occur, it is generally in close proximity to waterways. The impacts of agriculture along rivers include nutrient run-off, sedimentation and eutrophication of the receiving waters (Chow *et al.* 2011). Additionally, upland forests are heavily managed and may be subject to the application of a wide range of chemicals, such as herbicides, insecticides, fungicides and fertilizers, all of which leach into waterways. Studies have shown that exposure to glyphosate, the most common pesticide treatment in New Brunswick, can result in reduced growth of Atlantic salmon (*Salmo salar*) (DFO 2014), and is lethal to a number of amphibian species during their larval stage (Relyea 2005). Point-source effluent is also a concern within the bioregion. Instances include the St. George Pulp and Paper Mill, which discharges its effluent into the L'Etang estuary, and the Lake Utopia Fish Hatchery. The nutrient loading from the latter has been cited as a potential threat to the endemic Lake Utopia Dwarf Smelt (COSEWIC 2008). For these reasons, the threat status of agricultural and forestry effluent is considered medium.

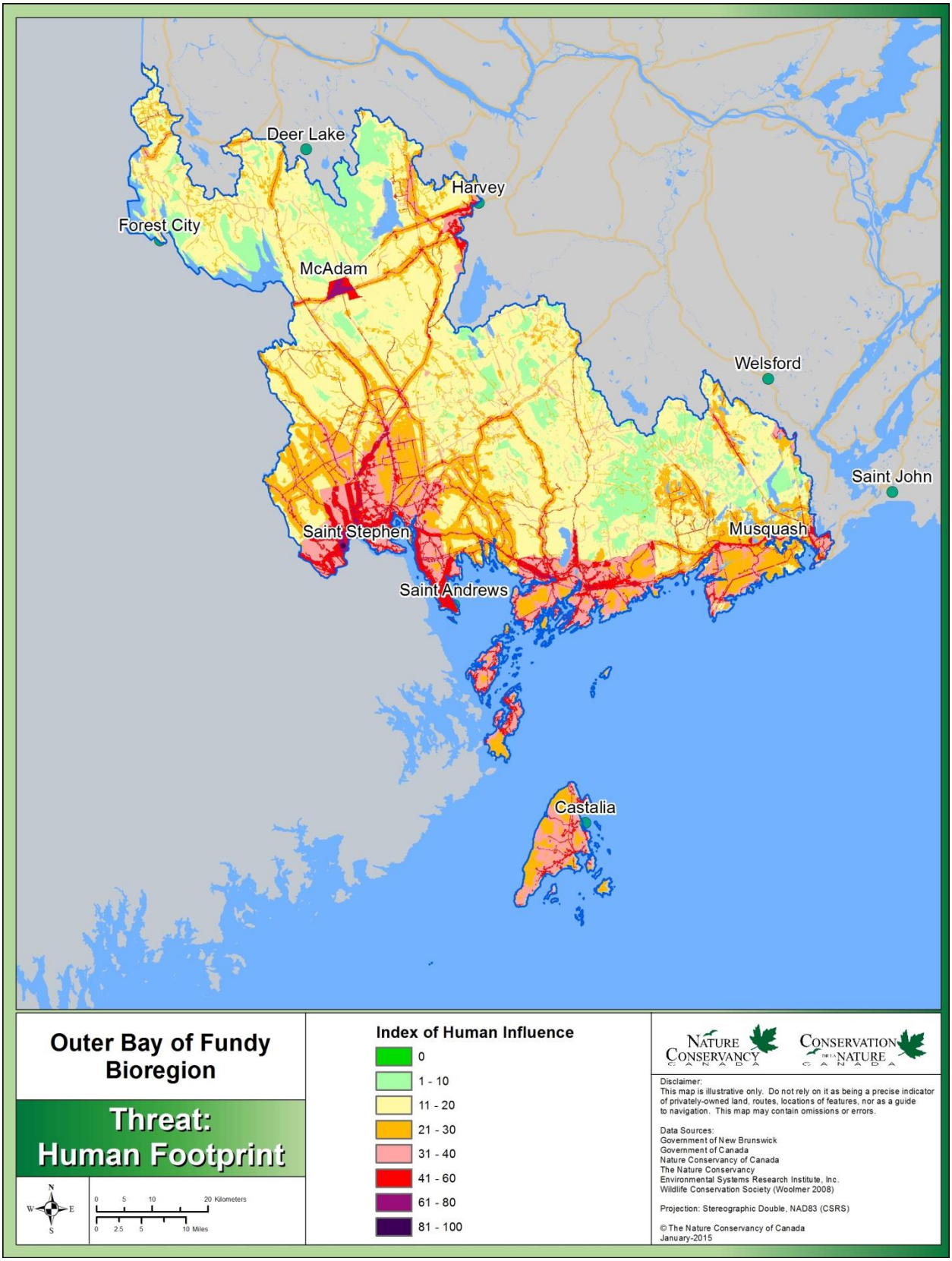


Figure 14. Human Footprint Index in the Outer Bay of Fundy Bioregion.

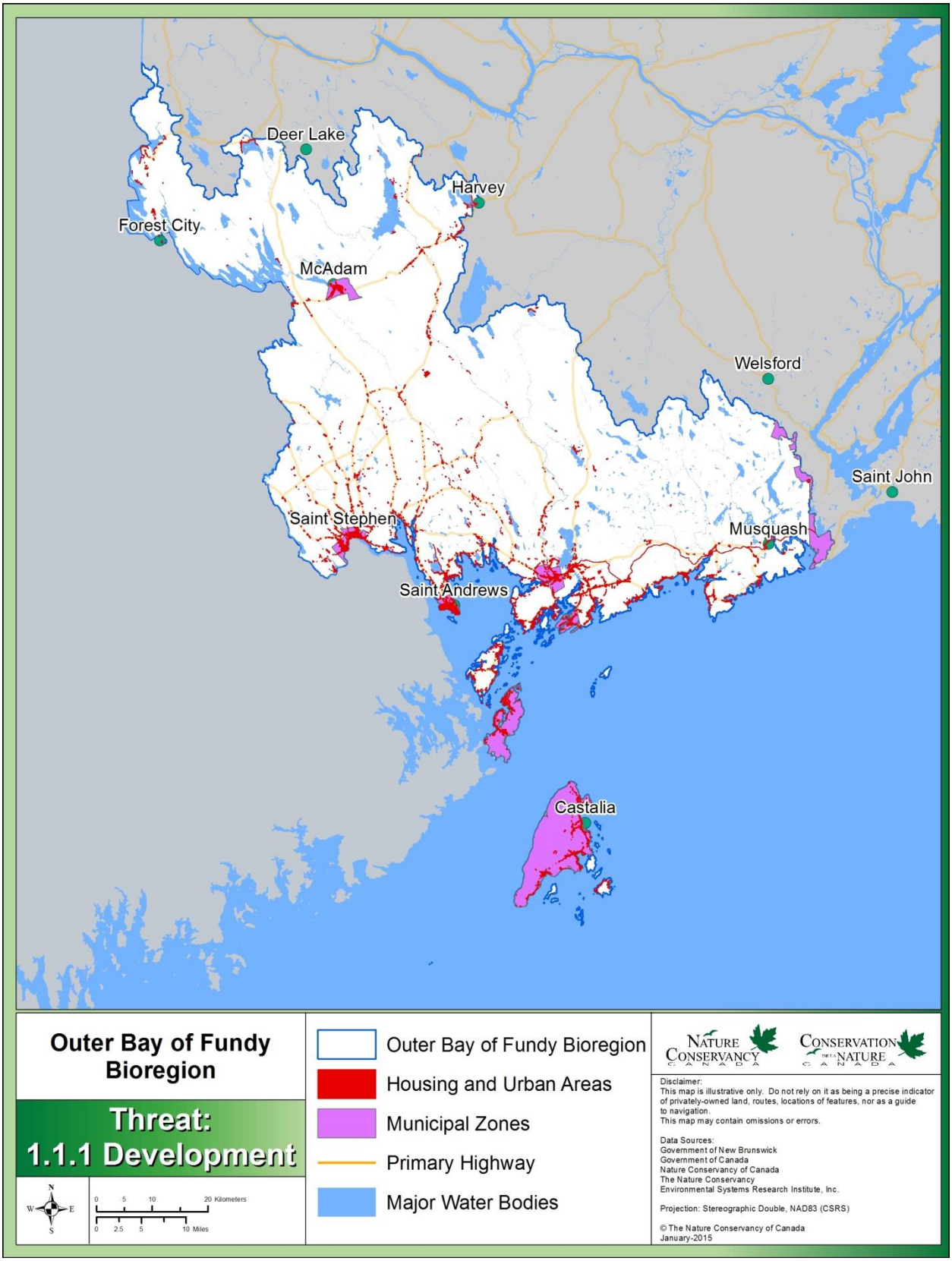


Figure 15. Housing, Cottage and Rural Development in the Outer Bay of Fundy Bioregion.

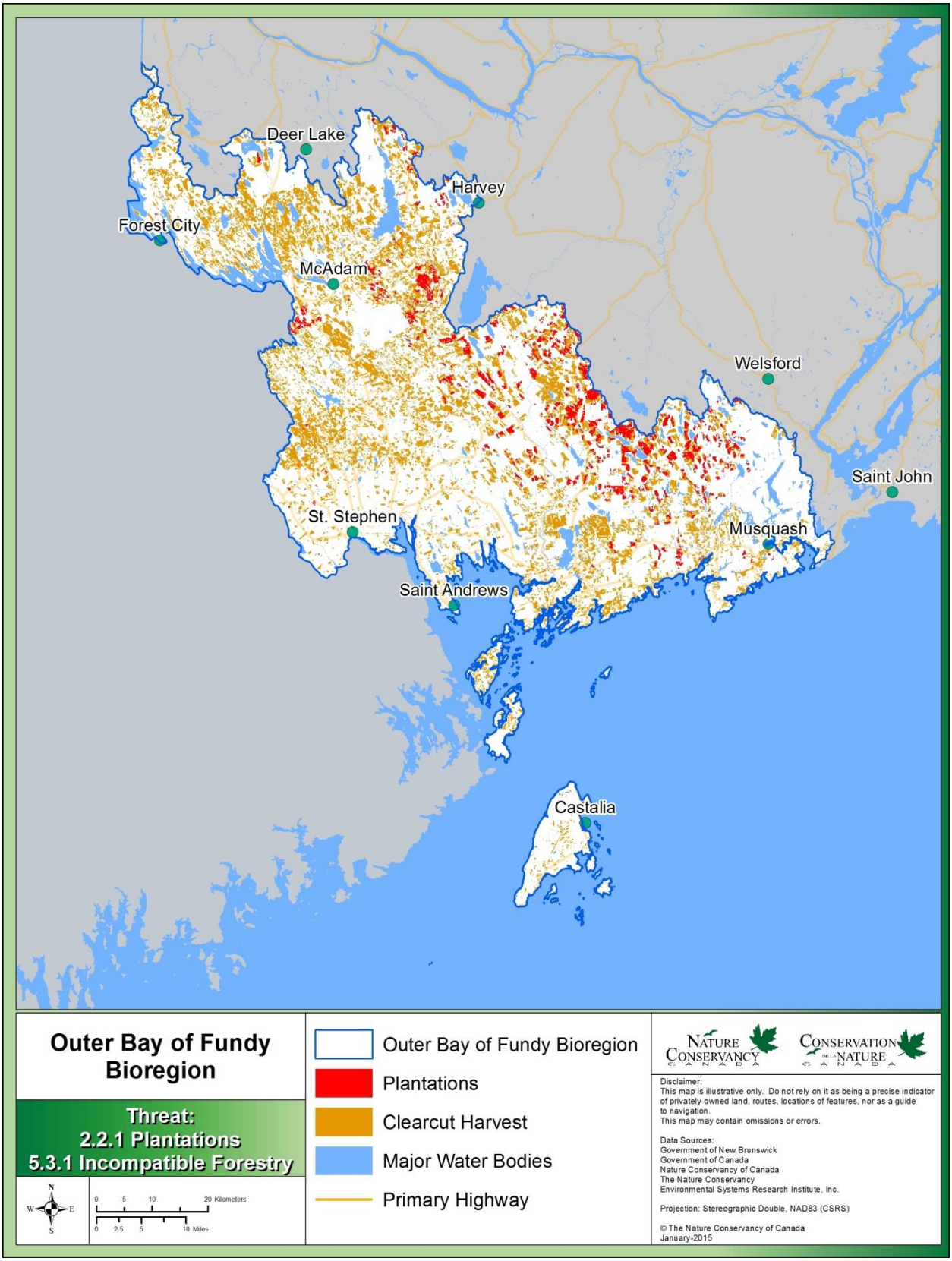


Figure 16. Incompatible Forestry and Forest Plantations in the Outer Bay of Fundy Bioregion.

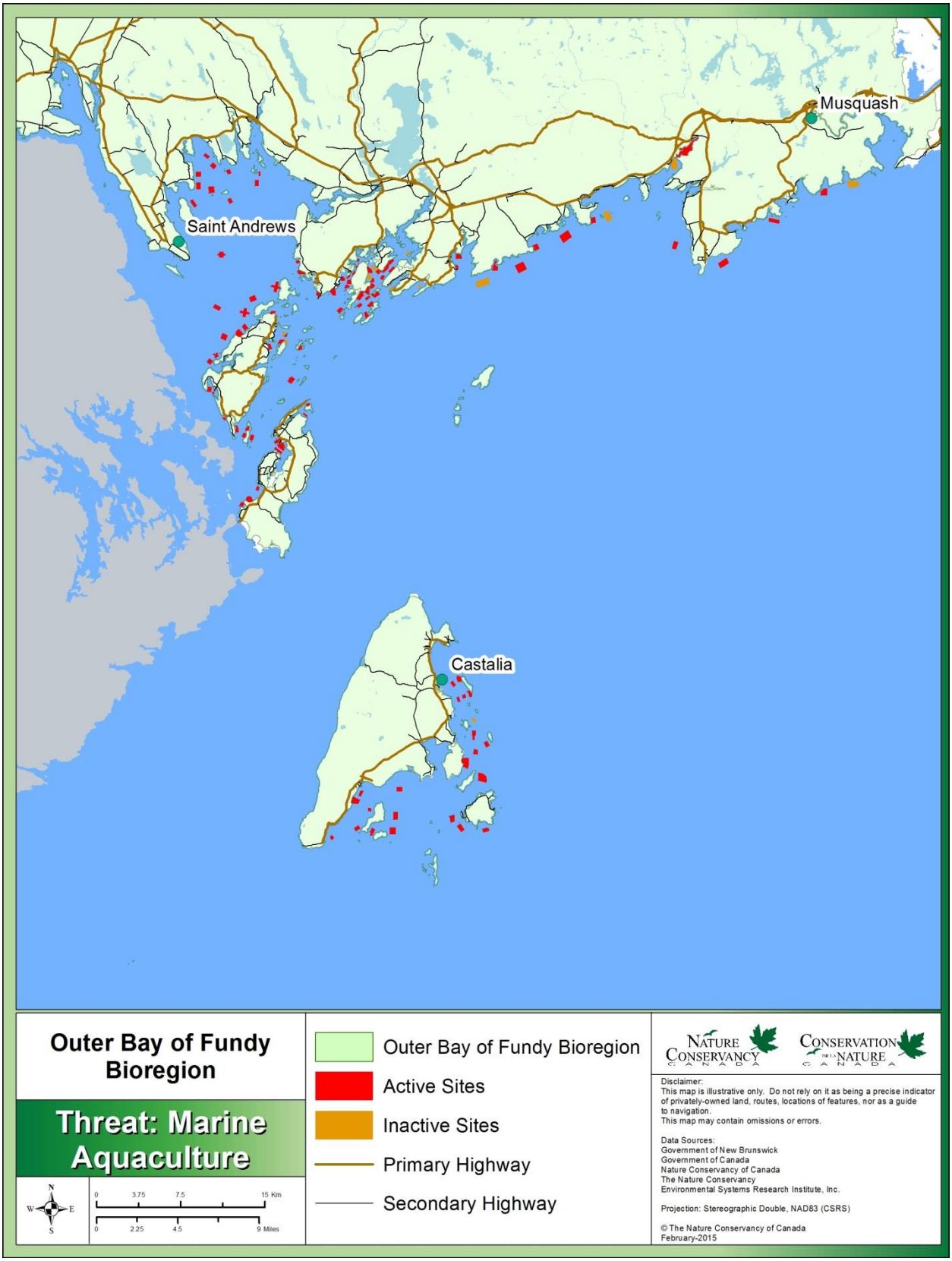


Figure 17. Marine aquaculture sites in the Outer Bay of Fundy Bioregion.

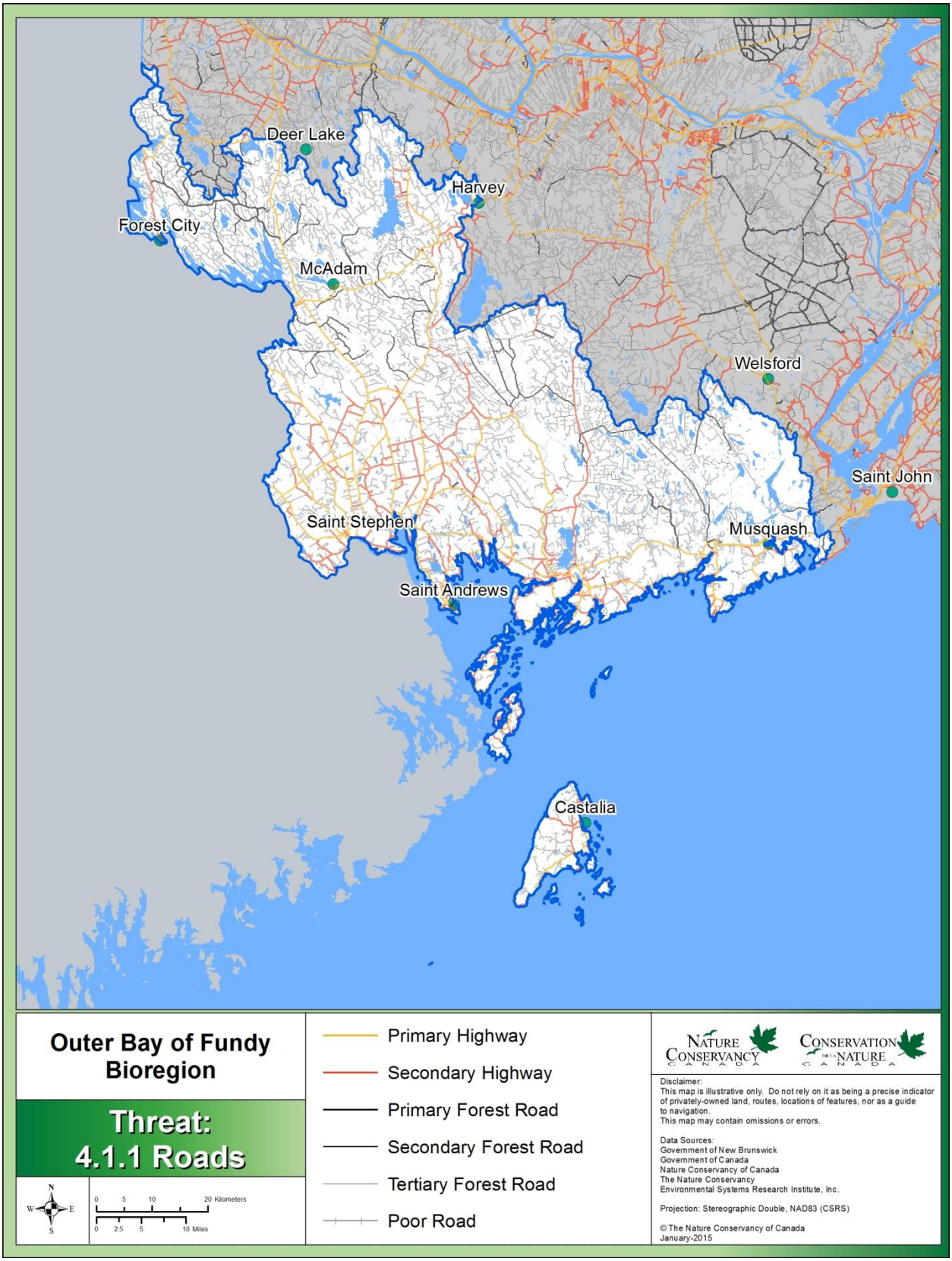


Figure 18. Road Fragmentation in the Outer Bay of Fundy Bioregion.

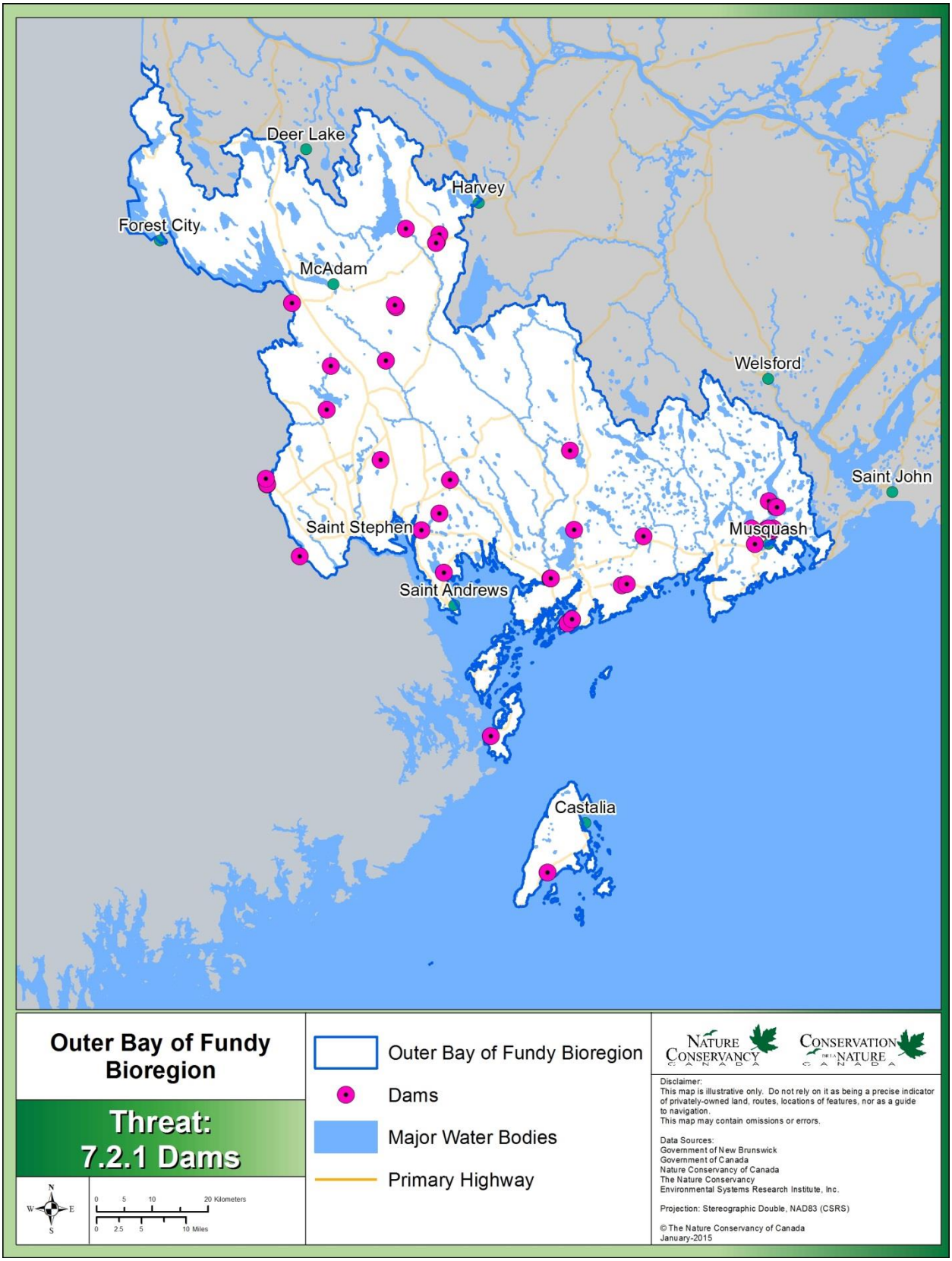


Figure 19. Aquatic Barriers in the Outer Bay of Fundy Bioregion.

ii. Emerging Threats

4.3 Shipping Lanes: (Threat Status: Low)

Within the marine area surrounding the Outer Bay of Fundy bioregion, active shipping lanes are present. Large tankers transport oil and other chemicals both to and from a petroleum refinery in Saint John. Although there have been no major spills to date, such a spill would impact coastal habitats throughout the Bay of Fundy, by the transport of these chemicals due to tidal action (Niu *et al.* 2014). Shipping traffic is likely to increase substantially in the future, notably with the development of a liquid natural gas facility in Saint John and further still with the potential Energy East Pipeline, a 4,600-kilometre pipeline that would carry 1.1-million barrels of crude oil per day from western Canada to refineries in the east (Angevine & Green 2013). Energy East's easternmost terminal may potentially be located in Saint John, which if approved, would increase the potential for oil and chemical spills enormously due to the drastic increase in shipping traffic within the Bay of Fundy. Since no oil spills have occurred to date, the threat status of shipping lanes is considered low.

11.1 Habitat Shifting & Alteration - Sea-level Rise and Erosion (Threat Status: medium)

Coastal changes in the bioregion due to climate change and accelerated sea level rise is predicted to be low due to the rugged and rocky coastline (NRC 2010). However, the increasing rate of sea-level rise may have a strong effect on some coastal habitats such as beaches and salt marshes (Singh *et al.* 2007). Nevertheless, there is evidence to support the ability of salt marshes in the Lower Bay to migrate inland with changing sea levels (Chmura *et al.* 2001b; Singh *et al.* 2007). Other threats to coastal systems from climate change include ocean acidification, ecosystem shifting and increased frequency and severity of weather events (DFO 2012b). Forests are also predicted to undergo changes such as species and forest community shifting, increased impacts from forest pests and pathogens and potential alterations in ecosystem processes due to physical and chemical changes in the soil (Rustad *et al.* 2014). Generally, predictions as to how, when, where and to what extent climate change will impact natural systems throughout the bioregion are not well understood. Even less well-understood is the natural resiliency of our systems to these changes. For this reason, the current threat status of climate change, sea-level rise and erosion is considered medium.

C. Spatial Analyses

As part of this Habitat Conservation Strategy, methodologies were developed with partners to define and combine a series of priority habitats with priority species occurrence composites to identify areas within the NB Outer Bay of Fundy bioregion that have high conservation value. The goal is to achieve the best possible impact of collective conservation actions in those areas that are the most critical for the defined conservation priority habitats and species. Three sets of maps were produced in the analyses which should be used together as decision-support tools: the priority habitat composite, priority species composite maps, and the conservation value index (CVI). 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, priority habitat 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). Though the CVI map can be consulted, other maps provided in this document may provide decision-support that is better suited to the mandate of a given conservation group or agency.

i. Habitat Spatial Prioritization

The purpose of the habitat spatial prioritization was to identify areas within the bioregion that have conservation value based on attributes of individual habitat patches independent of species occurrence data.

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., beaches) 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 used and the habitat classification methods employed in this step please refer to Appendices C and F.

Habitat patch weighting

The process for assigning priority ranks to habitats within the NS IBoF bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. Freshwater wetland and Acadian Forest mosaic habitat occurrences were scored using a three-tiered equation that equally divides the scoring by size (minimum patch size), representivity (by ecodistrict), and uniqueness (rarity within each ecodistrict and within the bioregion). All other habitat types were weighted according to size or presence/absence of certain characteristics. For a detailed explanation of the habitat weighting process, please refer to Appendix E. The methodology was deliberately designed to emphasize parcels of land that contain larger patches of priority habitats, were not adequately represented within an ecodistrict, and/or contain rare habitat occurrences. The more high quality priority habitats that an area contained, the higher the priority rank it received, and higher scores were given to areas with larger patches of ecosystems selected as priority habitats. Area measurements for the minimum patch size required to support biodiversity in each habitat type were used to comparatively rank habitats in order to avoid over-weighting small habitat patches. For each priority habitat type, final scores between 0 and 1 were assigned to each patch represented in the spatial dataset, with 1 representing high conservation value for priority species for that habitat type and 0 representing unsuitable habitat. Existing protected areas and other conservation lands were not included in the analysis.

Priority habitat composite

The first map produced presents a composite of the priority habitat types, but in order to create a decision support tool free from any bias inherent in the species data, species spatial information was excluded from this analysis. This map was produced by using an additive function that layered each habitat dataset and compiled the scores for each habitat patch. Scores making up the priority habitat composite include consideration of the uniqueness, representivity, and size of individual patches of priority habitat types as described above. Figure 20 presents the priority habitat composite for all priority habitat types; a detailed description of the methodology and specific scoring criteria used can be found in Appendix F.

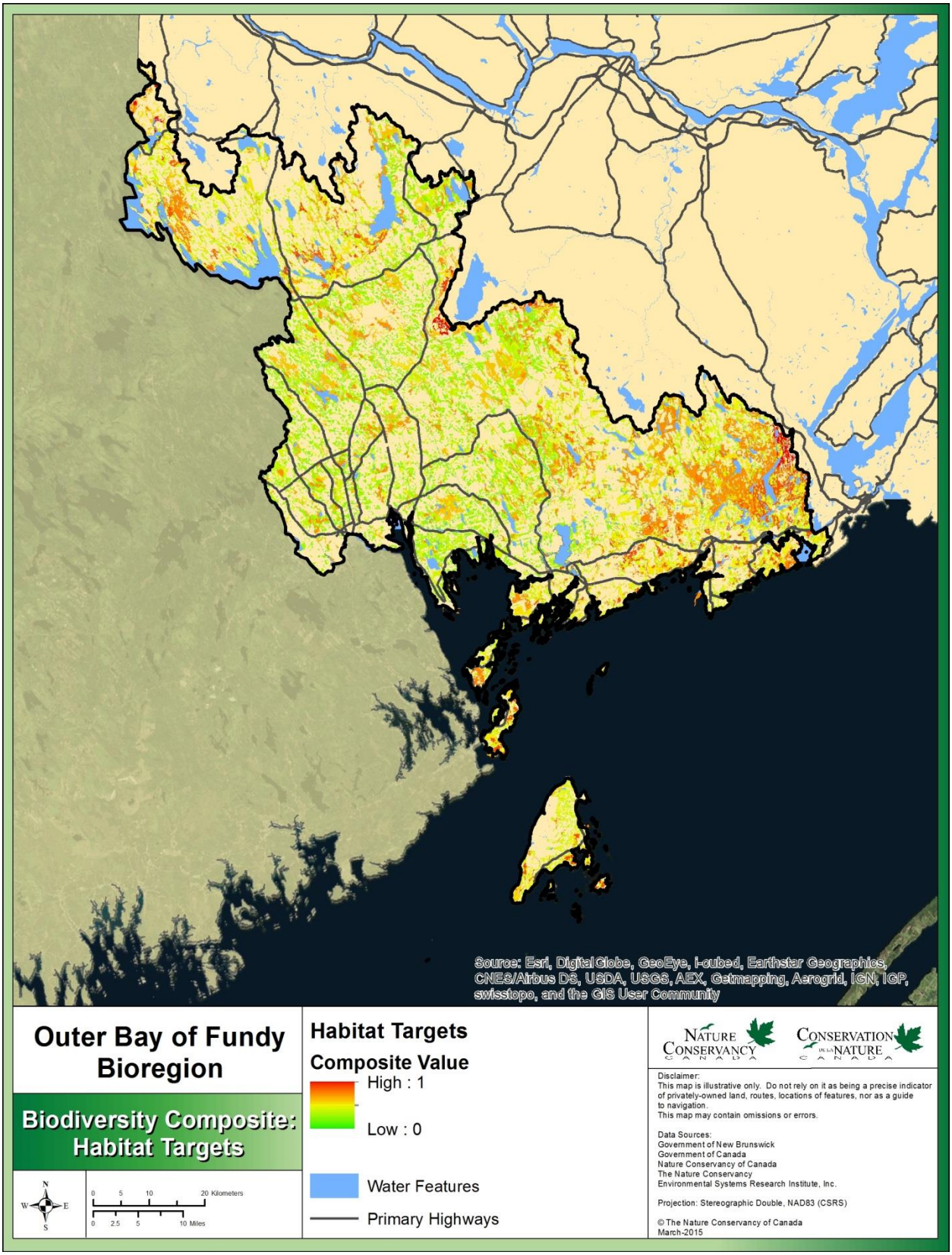


Figure 20. Priority habitat composite in the Outer Bay of Fundy Bioregion.

ii. Species Spatial Prioritization

Methodologies were also developed to map the likelihood of occurrence of priority species within the bioregion. These species composites consist of kernel density estimations of the likelihood of occurrence of priority species based on existing species occurrence data.

Species occurrence data

Spatial data were gathered for each priority species 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 F. 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 can be expected to reflect bias due to uneven effort intensity 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 intensive or survey approach. In order to improve future iterations of species maps, we encourage all those with any additional rare and priority species occurrence data to contribute their records to the Atlantic Canada Conservation Data Centre.

Priority species composites

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 21). 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). A detailed description of the methodology used and species data sources can be found in Appendix E. Lists of the priority species, including their conservation status, habitat associations, and occurrence data soures are provided in Appendix C.

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.

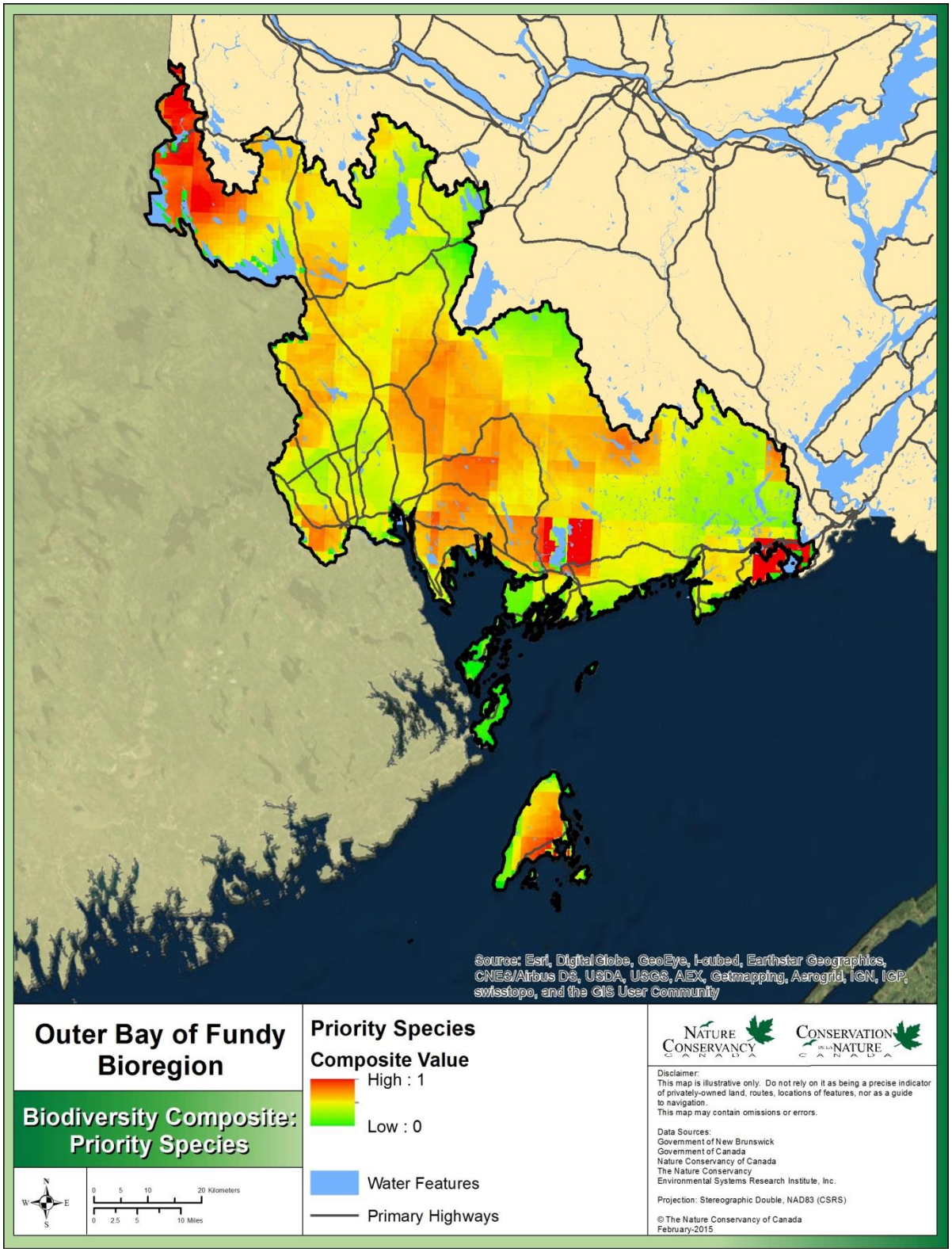


Figure 21. Species composite for the full list of rare and priority significant species in the Outer Bay of Fundy Bioregion.

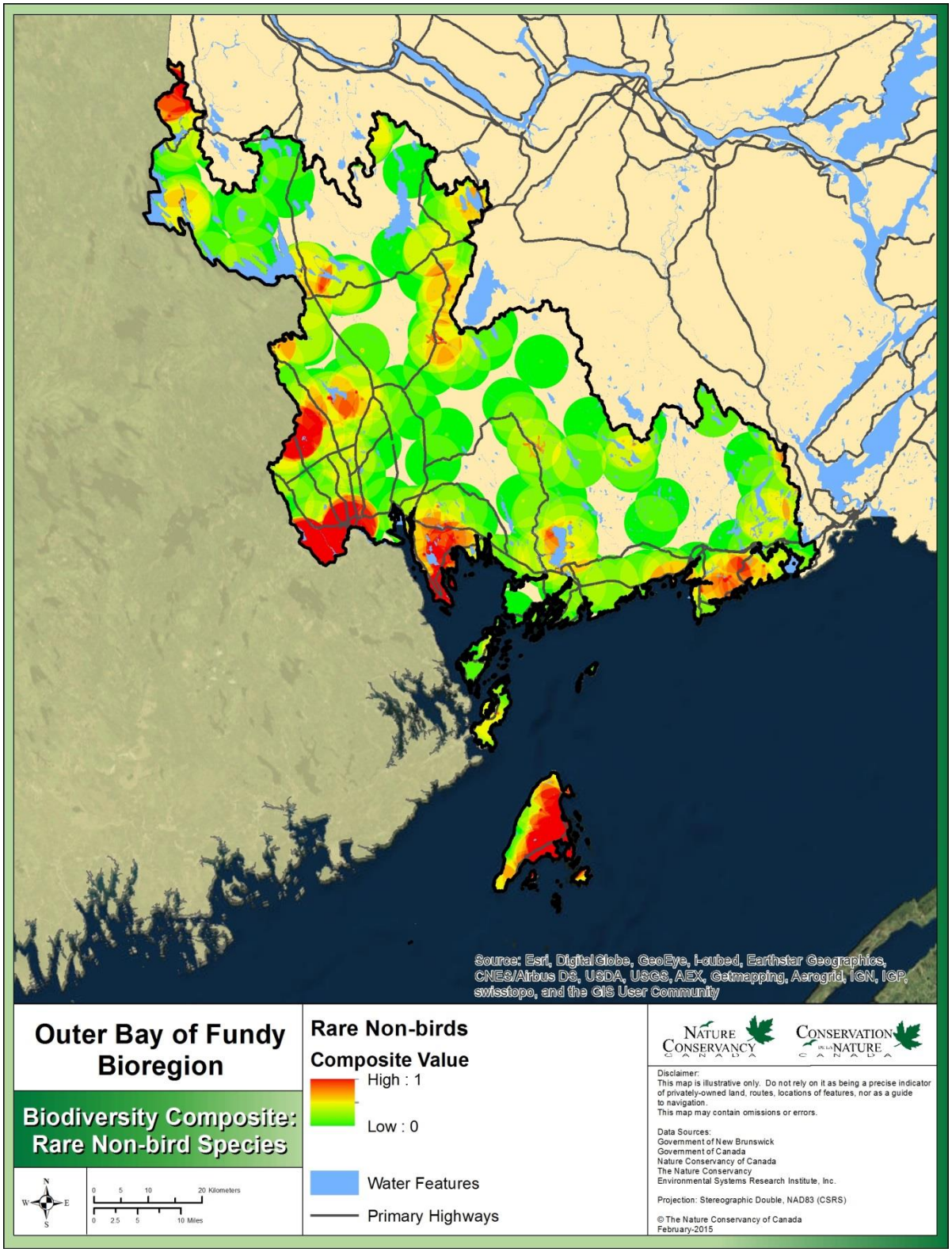


Figure 22. Species composite for rare non-bird significant species in the Outer Bay of Fundy Bioregion.

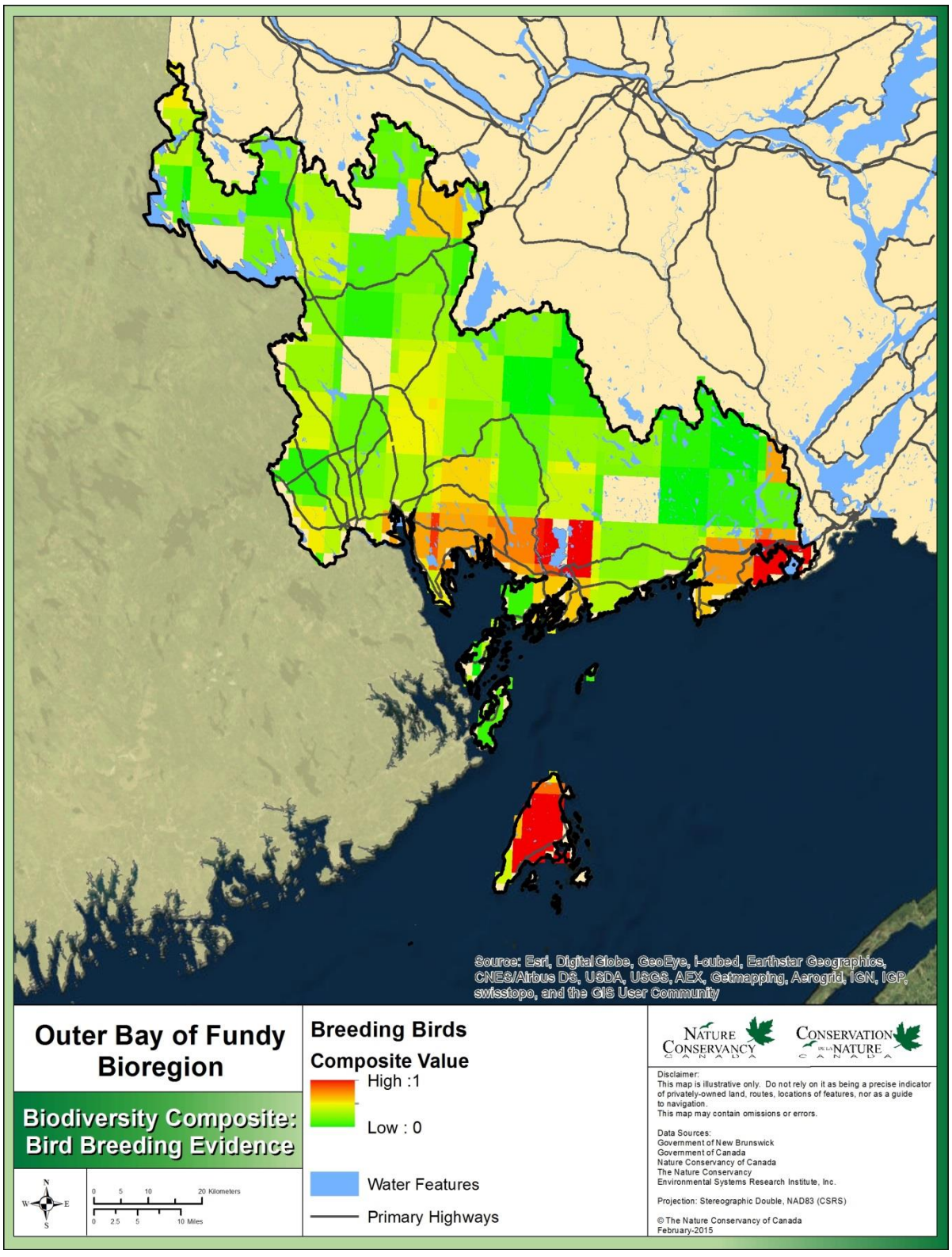


Figure 23. Species composite for rare and priority breeding bird species in the Outer Bay of Fundy Bioregion.

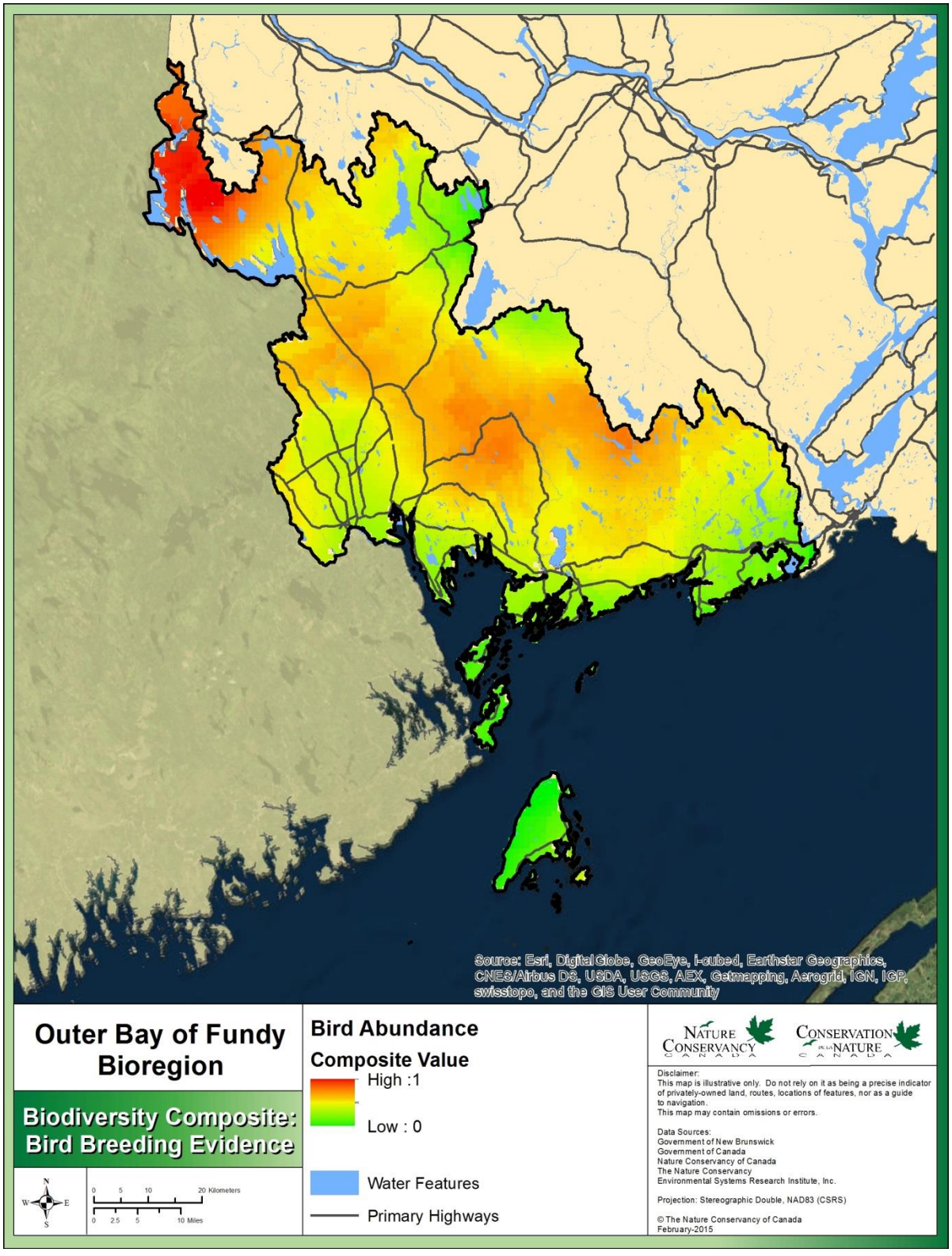


Figure 24. Species composite for rare and priority bird species in the Outer Bay of Fundy Bioregion (based on relative abundance).

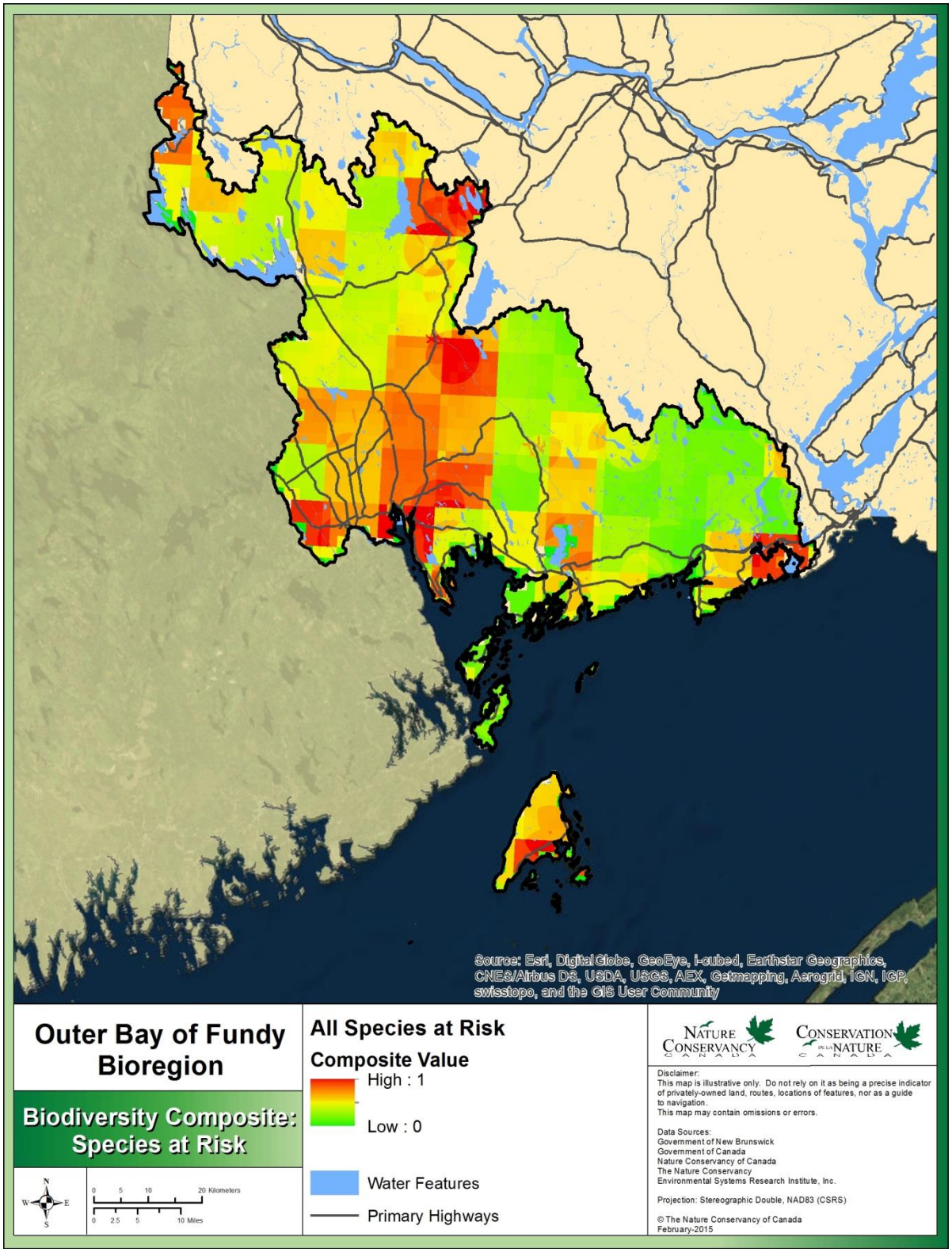


Figure 25. Species composite for species at risk in the Outer Bay of Fundy Bioregion.

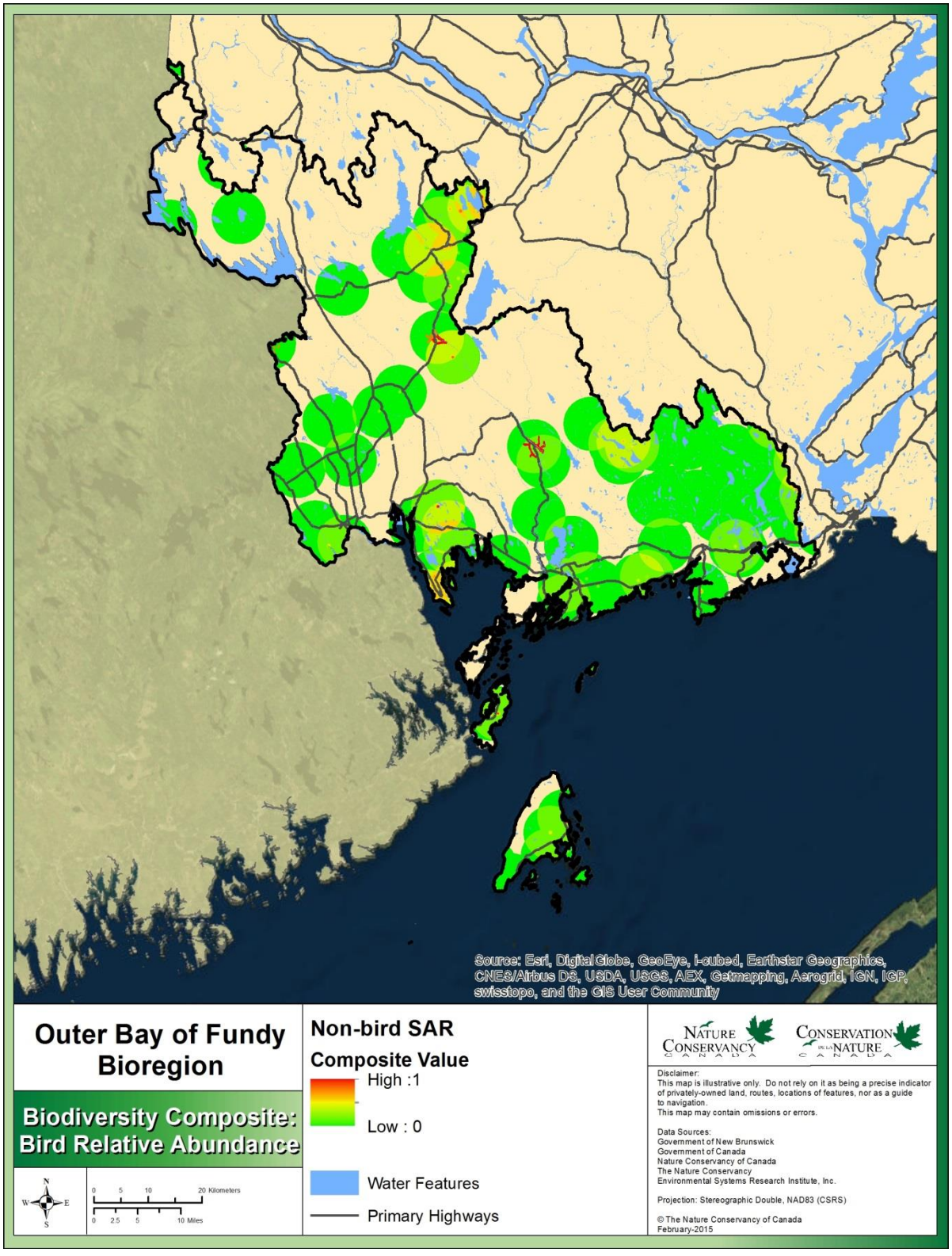


Figure 26. Species composite for non-bird species at risk in the Outer Bay of Fundy Bioregion.

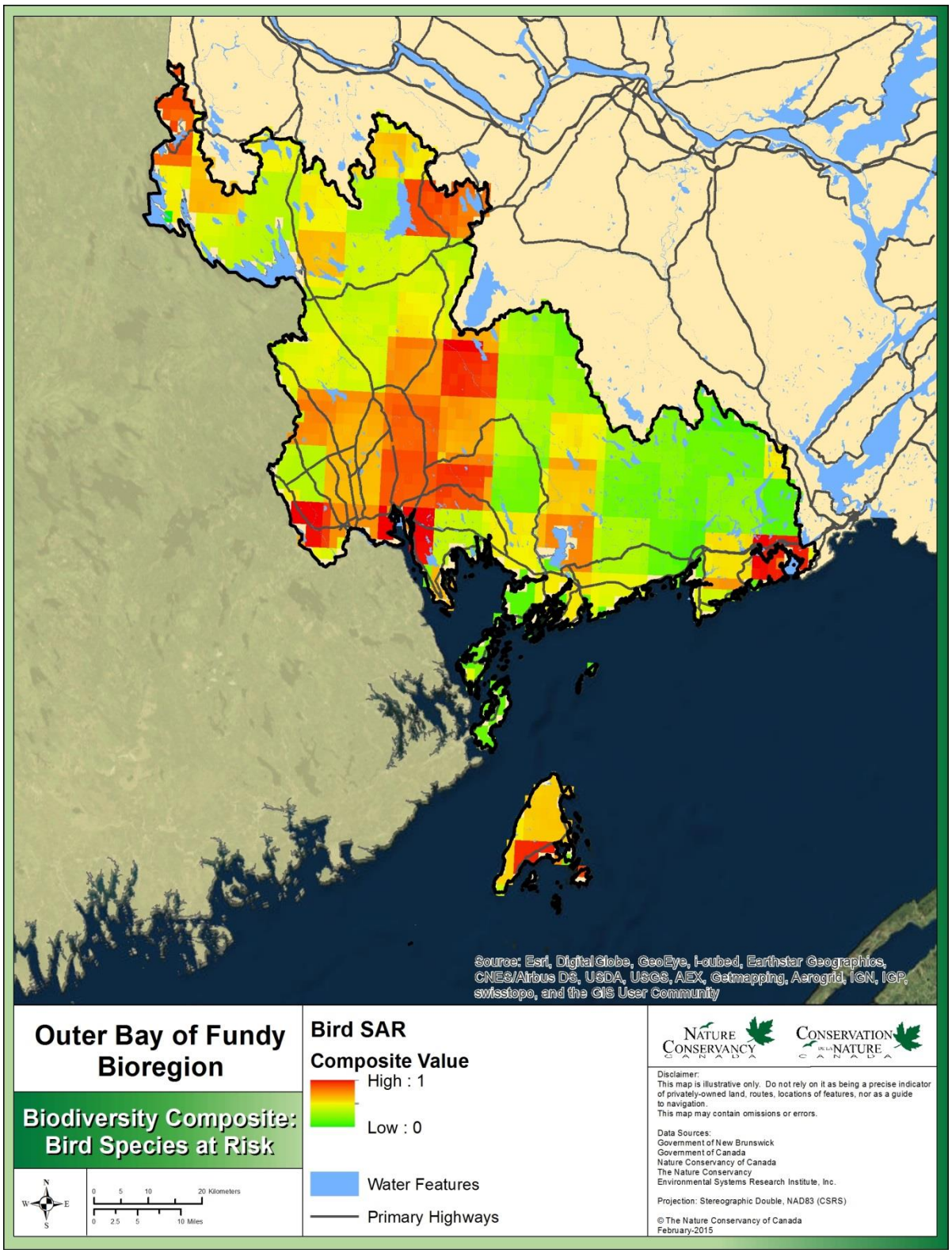


Figure 27. Species composite for bird species at risk in the Outer Bay of Fundy Bioregion (based on breeding evidence and relative abundance).

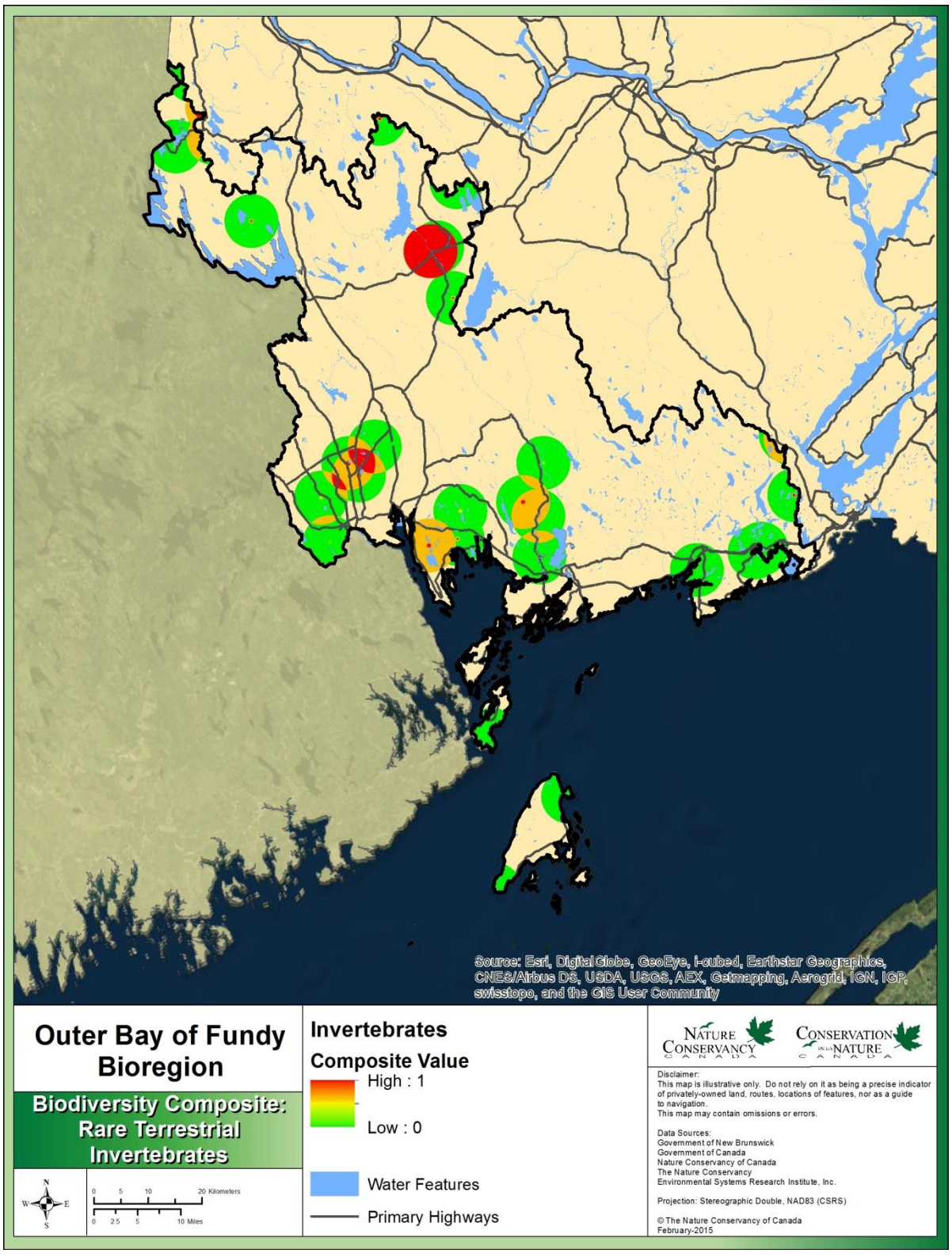


Figure 28. Species composite for rare terrestrial invertebrate species in the Outer Bay of Fundy Bioregion.

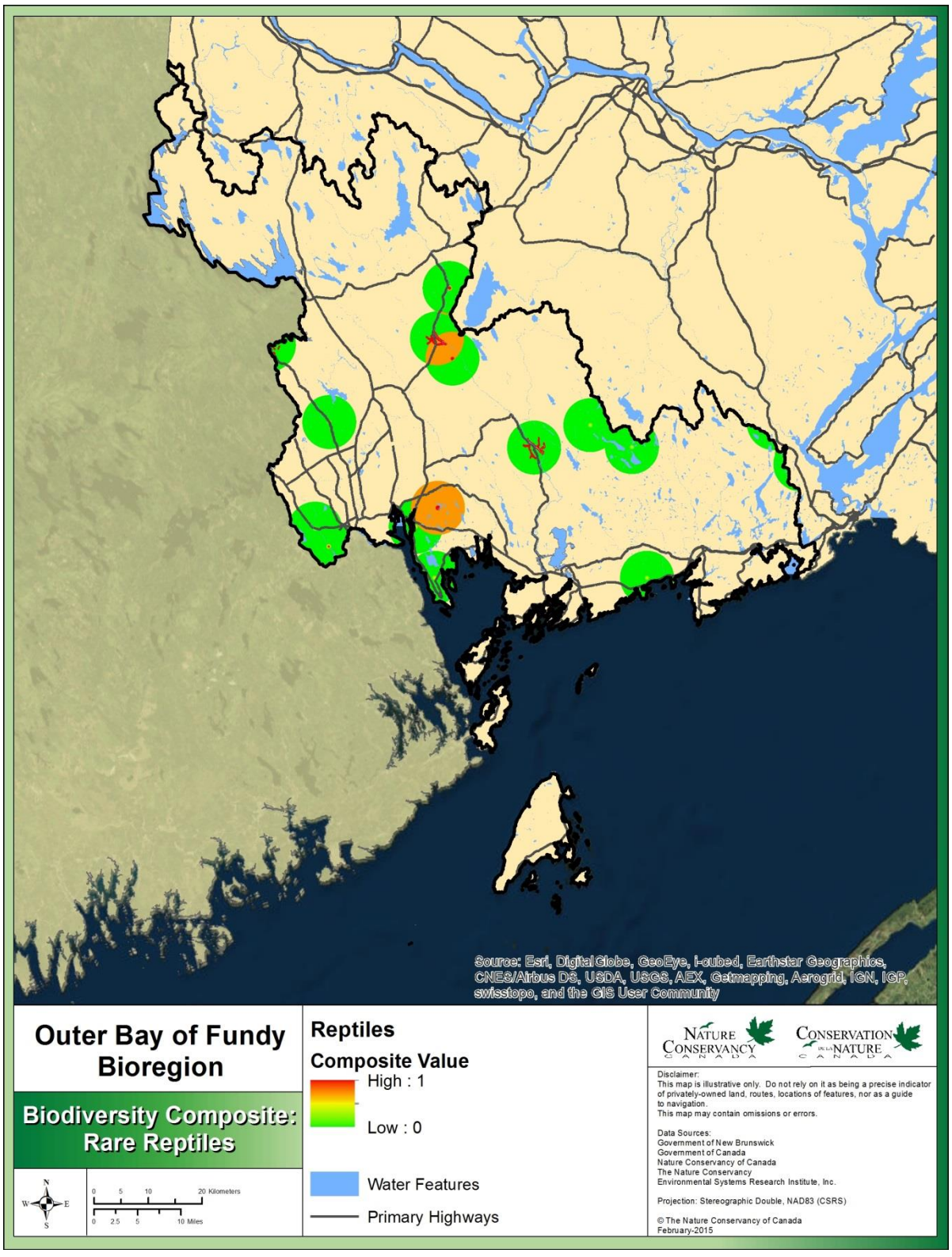


Figure 29. Species composite for rare reptiles in the Outer Bay of Fundy Bioregion.

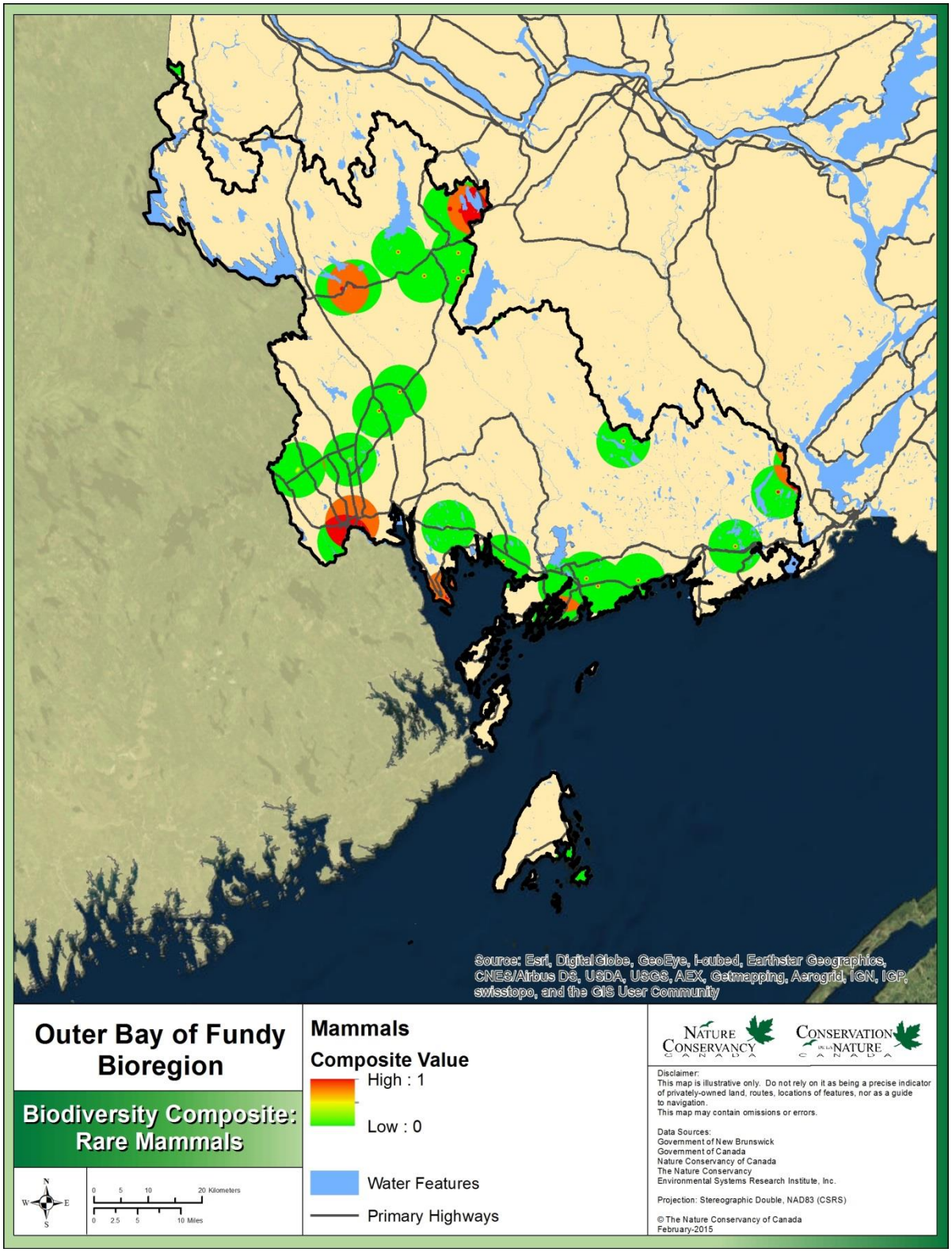


Figure 30. Species composite for rare mammals in the Outer Bay of Fundy Bioregion.

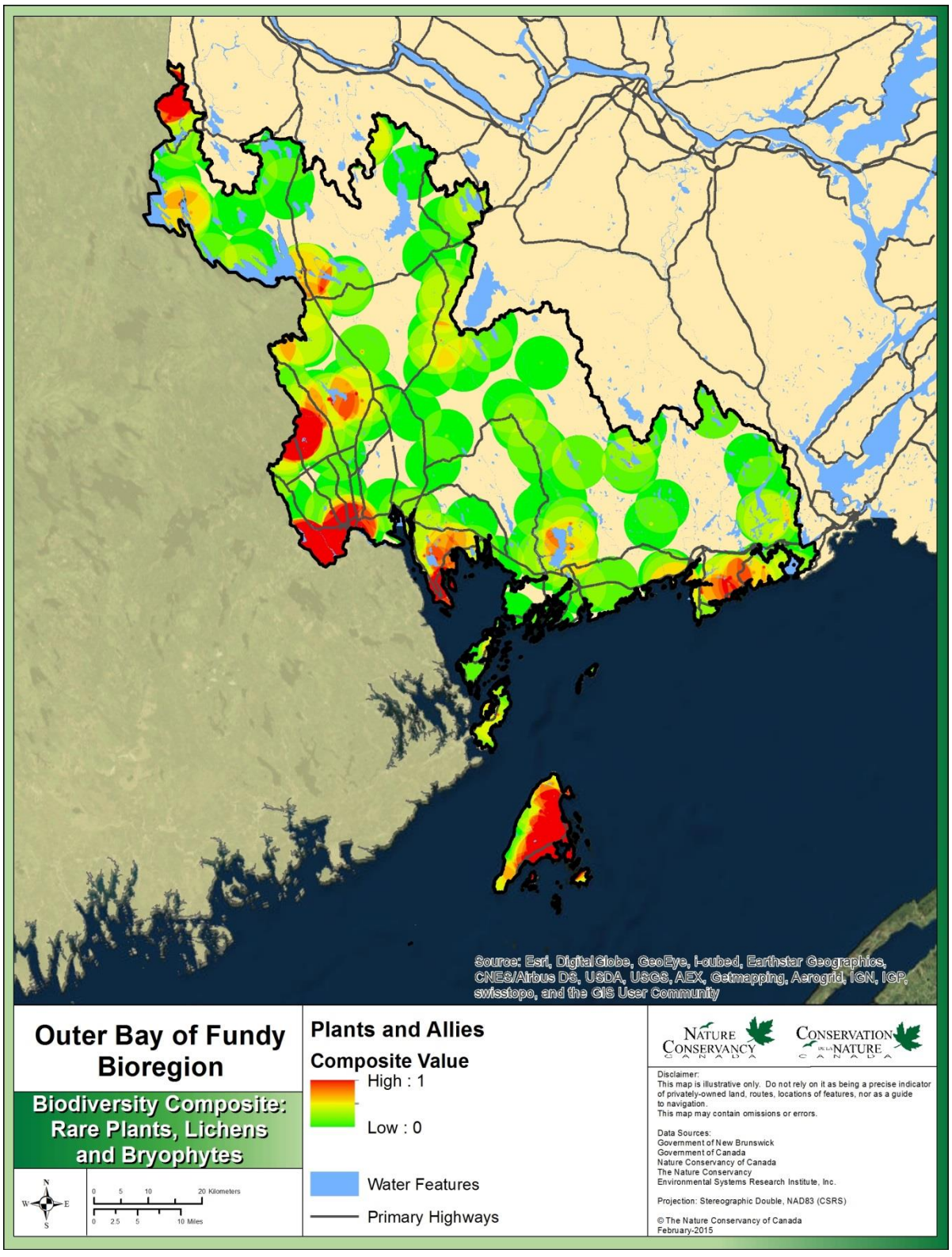


Figure 31. Species composite for rare plant and lichen species in the Outer Bay of Fundy Bioregion.

iii. Conservation Value Index

As part of this Habitat Conservation Strategy, methodologies were developed to define a Conservation Value Index to identify areas within the Outer Bay of Fundy Bioregion that have high conservation value, including significant species and priority habitats. The goal is to achieve the best possible impact of collective conservation actions in the bioregion in those areas that are the most critical for the defined habitat conservation priorities and significant species, while minimizing their associated threats.

The Conservation Value Index has two components: (1) a score based on attributes of the defined habitat conservation priorities, which includes consideration of the uniqueness, representivity, and size of individual patches of defined habitats (see Appendix E for a detailed description of the methodology), and (2) a score based on a kernel density estimation of the likelihood of occurrence of significant species within the Bioregion (see Appendix F for a detailed description of the methodology). The two scores were combined to yield the Conservation Value Index for the Outer Bay of Fundy Bioregion, which is presented in Figure 32. Table 9 presents a summary of the results of the analysis.

Survey information, conservation status and habitat dependency differs across the broad range of priority species included in calculating the overall Conservation Value Index. To address this issue, composite maps were also calculated for a number of subsets of the full list of significant species (Figures 21-31).

Table 9. Summary results of the conservation action prioritization in the Outer Bay of Fundy Bioregion.

Priority Ranking	Break Values/Scores	Acres	Hectares	% of Bioregion
Very High	>1	554,800	224,520	40
High	0.8 - 1	218,280	88,335	16
Moderate	0.6 – 0.8	211,836	85,727	15
Low	0 – 0.6	258,247	104,509	19
Protected	N/A	142,255	57,568	10
Total	**N/A**	**1,385,419**	**560,660**	**100**

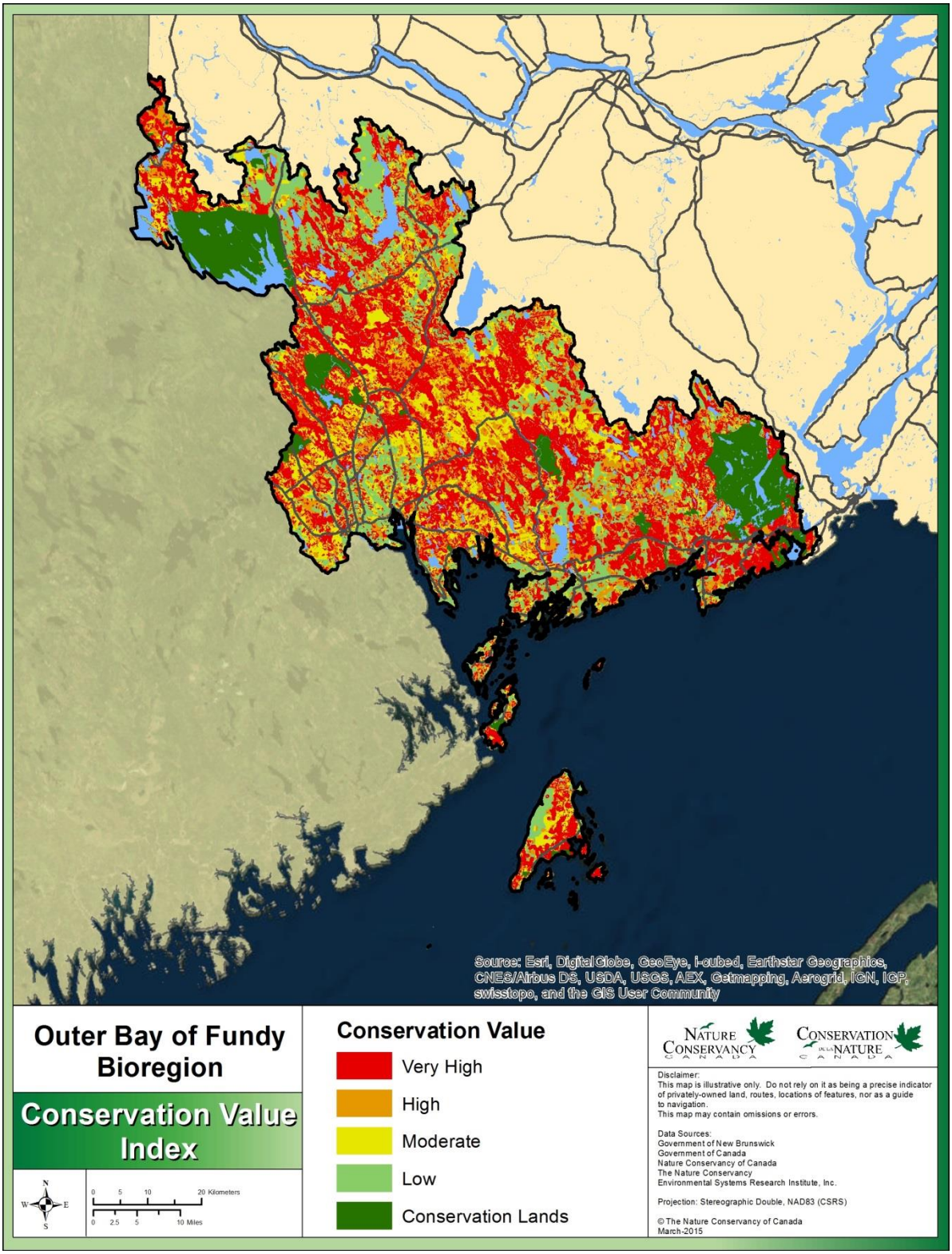


Figure 32. Conservation Value Index for the Outer Bay of Fundy Bioregion.

3. CONSERVATION STRATEGY

A. Vision

The New Brunswick Outer Bay of Fundy Bioregion remains one of the most biologically rich and culturally significant landscapes in New Brunswick. Agriculture, tourism and resource extraction are conducted in a manner that promotes long-term sustainability as the utmost priority. Communities understand the strong connection between healthy ecosystems, economic prosperity and human well-being, and take pride in the natural heritage of their region. Coastal islands in particular are understood to be critical habitat for colonial and migratory birds, and are stewarded as such. Both marine and terrestrial ecosystems are managed and conserved to promote healthy wildlife populations and maintain their full suite of biodiversity for the benefit of future generations.

B. Goals

Table 10. Conservation goals for the Outer Bay of Fundy Bioregion.

1. To increase the amount of large blocks of old growth Acadian Forest Mosaic habitat within the bioregion.
2. To maintain suitable coastal habitat for shorebirds, waterfowl and colonial nesting bird species throughout the bioregion.
3. To maintain a no net loss strategy for wetlands, and to restore tidal barriers and degraded wetlands throughout the bioregion.
4. To restore aquatic connectivity through the partial or complete removal of dams and other aquatic barriers within the bioregion.
5. To balance the economic use of marine resources with biodiversity conservation of all marine species in the bioregion.

C. Actions

i. Identified Knowledge and Action Gaps

While this plan strives to address and discuss the full range of habitat conservation priorities and threats to biodiversity in the NB Outer Bay of Fundy bioregion, it is not within the scope of the strategy to identify or in any way assign all potential conservation actions required to address all problems, questions, information gaps, or other activities associated with each priority or threat. This section will briefly discuss some of the identified gaps in knowledge, available information, and actions regarding the conservation priority habitat assessment and their threats.

The habitat and species composites are based on our current state of knowledge as it relates to the distribution of priority habitats and priority species and relies on existing spatial habitat data and species occurrence databases. Sampling effort varies substantially both among and between taxa, and spatially throughout the bioregion; therefore, data coverage is not meant to be construed as an exhaustive inventory of taxa in the bioregion. Additional occurrence records for species and taxa are known to exist but have not been provided to the Atlantic Canada Conservation Data Centre, and consequently were not available for the analyses. There were additional issues with combining different sources of data (e.g., ACCDC rare taxa occurrence records with MBBA II breeding evidence grids), and we sought to remedy this by providing species composites for subsets of the full list of priority species based on both

taxa and data sources used. The results of the analyses have not been verified through field surveys and are meant to guide more detailed conservation actions on the ground.

With regards to threats impacting conservation priority habitats and priority species in the NB Outer Bay of Fundy bioregion, further research and monitoring is required to determine the extent and severity of threats and the pathways through which they are impacting species and habitats, particularly for high priority threats and threats where severity is unknown.

Finally, in order to conserve the majority of the priority species identified in this habitat conservation strategy, conservation work needs to go beyond improving on the network of protected areas in the NB Outer Bay of Fundy bioregion. Conservation activities on managed landscapes through the research, development, and use of best practices are needed.

ii. Conservation Actions

The remainder of this section identifies the conservation actions planned for the next five-year period by the conservation partners to conserve the New Brunswick Outer Bay of Fundy bioregion's conservation priority habitats and species. Table 11 identifies which organizations and government agencies are working to conserve priority habitats and species in the New Brunswick Outer Bay of Fundy bioregion and lists those actions that are being and will be taken to target specific habitats and threats. Note that some actions, though important, may not directly address identified threats. Instead, these actions may advance important objectives, including monitoring, education and outreach, and partnerships. Readers are advised that this section is particularly important for planning purposes as this table presents opportunities to identify conservation action gaps and build partnerships strategically. Please note that action categories in this table are based on IUCN – CMP Unified Classification of Conservation Actions Needed (Version 2.0; Appendix H). Actions and measures of success are not listed in order of importance.

Table 11. Conservation Actions and Associated Information for the Outer Bay of Fundy Bioregion.

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
1. Securement					
1.1 Site/Area Protection: NTNB will pursue permanent protection of high conservation-value habitat within the St. Croix watershed and along the Fundy shore as opportunities for land donation or purchase arise.	BENEFICIAL	ALL	Habitat loss, development	NTNB will continue to place a high priority on protecting threatened habitats within the Outer Bay of Fundy bioregion including intact St. Croix River shoreline, mature forest, and Bay of Fundy coastline.	NTNB
1.2 Resource & Habitat Protection: Work with landowners to develop and conclude voluntary stewardship agreements on private land which will address specific threats to habitats and species at risk.	BENEFICIAL 1, 2, 3, 4, 7	ALL	Threat-specific	Negotiate and conclude voluntary stewardship agreements with a minimum of 10 landowners or 500 acres of private land.	NTNB
1.2 Resource & Habitat Protection: Improve forest connectivity, condition and landscape context on large industrial land within the Bioregion by 2020 through the adoption of FSC principles and / or voluntary	NECESSARY/			MOS-I: Forest connectivity, condition and landscape context are improved on large industrial land by 2020 through the adoption of FSC principles.	UNB

[1] ***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.

[2] Biodiversity Targets:

[3] Biodiversity threats:

[4] Proposed implementation measures for NACP annual progress report. More detailed measures for some actions will be developed as part of action implementation or through Property Management Plans.

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
designation of high conservation areas on industrial land.				The NB Forest Collaborative – a group including NGOs, academic researchers and J.D. Irving Limited is looking at FSC in New Brunswick and identifying High Conservation Value Forest Conserved Habitats on Crown and JDI freehold land.	
1.2 Resource & Habitat Protection: Update land prioritization within the Bioregion to account for new protected areas designated by the province by 20XX.	NECESSARY/	ALL	ALL	MOS-I: Prioritization within the Bioregion was updated by 20XX to account for new protected areas designated by the province under action 1.1.2.	NCC
2. Stewardship – Land/ Water Management					
2.1 Site Management: Train voluntary preserve stewards to monitor NTNB properties annually for impacts from use and respond to any potential threats to biodiversity targets.	NECESSARY	ALL	Recreational use	NTNB coastal and waterfront properties are monitored annually for impacts from public use and response actions developed as necessary to address problems.	NTNB
2.1 Site Management: Seasonal (June – November) Monthly Beach clean-up/monitoring in the Musquash Estuary Marine Protected Area	Necessary	beaches rocky shore	Marine Debris in MPA	Activity expected to be ongoing long term. Goal is to reduce risk from marine debris while contributing data on human induced stressors to the Musquash Estuary MPA Ecosystem Monitoring Framework	CCNB (funded by DFO)
2.1 Site Management: Identification and removal of submerged marine debris	Necessary	Intertidal, nearshore	Habitat disruption and degradation, animal entanglement risk, navigation hazard	Identify debris sites through focus groups, map debris using GIS, carry out removal or marking of highest priority sites.	Fundy North Fishermen's Association, CCNB, UNB
2.1 Site / Area Management: Maritimes Marsh Monitoring Program (BSC) works to: -assess effectiveness of EHJV conservation	NECESSARY 2, 3, 6, 7	Freshwater wetlands Salt Marsh	Habitat loss and degradation	• Quantify wetland bird abundance and distribution in a representative sample of habitats • Prioritize key wetlands for	BSC, with EHJV partners

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
efforts through monitoring of wetland-dependent species and habitats		Forested Wetlands (pilot in 2015, 2016)		conservation	
2.1 Site / Area Management: Implement critical Property Management Plan actions on NCC lands through 2020.	CRITICAL/	ALL		MOS-I: Critical Property Management Plan actions were implemented on all NCC-owned properties, both newly acquired and previously owned between 2015 - 2020.	NCC
2.1 Site / Area Management: Manage and monitor xx acres of habitat (including restored and secured habitat, impoundments, etc.) within the Bioregion				MOS-I: All DUC projects in the Bioregion are managed accordingly.	DUC
2.1 Site / Area Management: Ducks Unlimited Canada, in collaboration with DFO, to evaluate functionality and improve fish passage in many of the xx control structures they manage (including x fish ladders) within the Bioregion and work to improve the structures they manage by 2020				MOS-I xx Fish ladders and other DUC structures evaluated and any suggested improvements implemented by 2020.	DUC
2.1 Site / Area Management: Control the expansion of invasive species in the Bioregion and try to prevent the introduction of new invasive species through public education and targeted outreach to land owners and land managers.				MOS –I: New Brunswick Invasive Species Council (NBISC), held a minimum of two meetings per year. The public was made aware of existing and potential threats of invasive species though NBISC website and media interviews. Specific issues were addressed with the responsible land owner or land manager.	NBISC

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
2.1 Site / Area Management: Creating a baseline measurement of underwater noise frequency and amplitude between the Saint John Harbour and Passamaquoddy Bay.	BENEFICIAL	Nearshore, intertidal	Shipping lanes and tanker traffic	The creation of a dataset that is of use to researchers, industry, and regulators. The communication of key information to the public.	Eastern Charlotte Waterways Inc. (ECW)
2.1 Site / Area Management: Conducting an estuarine health assessment in Passamaquoddy Bay, Musquash Estuary, and Saint John Harbour that includes results for eutrophication indicators, bacterial contaminations, and environmental parameters.	BENEFICIAL	Nearshore, intertidal	Pollution, habitat loss	A health assessment of each estuary to be used as a baseline for future studies.	ECW
2.1 Site / Area Management: Reassessing freshwater health in the Outer Bay of Fundy complex of watersheds from Lepreau to Digdeguash, comparing results with an identical study completed 20 years ago.	BENEFICIAL	Saltmarsh, intertidal	Pollution, habitat loss, invasive species	A comparative analysis of freshwater quality in the Outer Bay of Fundy watershed complex.	ECW
2.1 Site / Area Management: Assessing vulnerability to coastal acidification in Passamaquoddy Bay, completed in partnership with Dalhousie University.	BENEFICIAL	Saltmarsh, intertidal, nearshore	Climate change	Measurements for alkalinity on either side of the salinity gradient in Passamaquoddy Bay, leading to an accurate assessment of its acidification buffering capacity.	ECW

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3. Stewardship - Species Management					
3.1 Species Management NTNB and its partners and volunteer stewards will monitor target species and their habitat on NTNB preserves and easements.	BENEFICIAL	ALL	ALL	Collect baseline data for target species; Contribute to the detection of population trends over the long-term.	NTNB, Nature NB, ACCDC
3.1 Species Management: With the Saint John Naturalist's Club (SJNC) complete monitoring of migrating waterfowl in the Bay of Fundy (at the Point Lepreau Bird Observatory PLBO), use SJNC's data from PLBO to estimate population size and annual peak migration dates for waterfowl passing PLBO.	NECESSARY	Marine	Development, climate change	Accurate migrating population estimates for waterfowl in the Bay of Fundy Meaningful assessment of population trends for waterfowl species migrating through the Bay of Fundy	University of New Brunswick (Saint John) Saint John Naturalist Club
3.1 Species Management Species Monitoring: Nocturnal Owl Survey – ongoing since 2001; occurs throughout the Maritimes but includes survey routes in OBoF	NECESSARY 1,6	ALL	Monitoring Habitat loss and degradation	• Track long-term trends throughout province of multiple species Engage citizen scientists in tracking health of Maritime owl populations	BSC, NBDNR
3.1 Species Management Maritime Marsh Monitoring Program: -Monitors abundance and distribution of wetland-dependent species; occurs throughout NB but including at marshes in the OBoF (Musquash, St. George). -assess biodiversity in forested wetlands (start 2016)	BENEFICIAL	Freshwater marsh Salt Marsh Forested wetland (pilot)	Monitoring Habitat loss and degradation	• Track long-term trends throughout province of multiple species	BSC
3.1 Species Management Motus Wildlife Tracking system: -Allows year-round tracking of multiple species for which migration routes, stopovers, wintering sites, and local-scale landscape use patterns are unknown	NECESSARY (some species) BENEFICIAL	ALL	Habitat loss and degradation Barriers to migration	• Spatial and temporal movement patterns of focal species identified. • Maritimes-wide coverage of motus network to ensure maximum detection ability for multiple tracked species	BSC, EC, Acadia University

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
-helps focus conservation efforts at key sites needed for year-round stewardship of target species -Telemetry towers occur throughout the Maritimes but with specific towers in the OBOF at Pt. Lepreau, Grand Manan, Machias Seal Island.				• Partners benefit from use of network for tracking their own species of interest.	
3.1 Species Management: Grand Manan Whale and Seabird Research Station is undertaking a long-term study examining the production rates, egg quality, and location of egg-carrying female lobsters in the Bay of Fundy, particularly the large females.	BENEFICIAL	nearshore	Species overharvesting	Long-term data related to population trends, reproduction rates, and movement patterns of Bay of Fundy Lobsters will help guide the management of the commercial lobster fishery in the Bay of Fundy region.	GMSRS
3.1 Species Management: Grand Manan Whale and Seabird Research Station continues to promote the Harbour Porpoise Release Program (HPRP) to assist local fishermen in the Bay of Fundy in safely releasing harbour porpoises from their weirs. GMWSRS also provides guidelines for safely releasing larger non-target species from herring weirs.	NECESSARY	nearshore	Species loss	Since 1991, more than 700 harbour porpoises have been released from herring weirs around Grand Manan Island – GMSRS will continue to pursue this work and at the same time conduct long-term monitoring of the health of this species.	GMSRS
3.1 Species Management: Grand Manan Whale and Seabird Research Station conducts a daily offshore species census during the whale watching season around Grand Manan Island. Species occurrence records include nesting coastal seabirds, seals, and other marine mammals.	BENEFICIAL	Nearshore, offshore	Species loss	All coastal seabirds are counted, except for black-backed and herring gulls unless included in a large feeding aggregation. Species occurrence data can be made available from GMSRS upon request.	GMSRS
3.1 Species Management: The New Brunswick Museum (NBM) intends to continue conducting coastal flowering plant surveys on Kent Island in the Bay of Fundy.	BENEFICIAL	Rocky shoreline, coastal forest	Species loss		NBM

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.1 Species Management: The NBM is organizing an international mycological conference and intensive multi-day survey event for 2016.	BENEFICIAL	Rock outcrops, Acadian Forest Mosaic,		For event details contact Dr. Stephen Clayden.	NBM
3.1 Species Management: The NBM continues to undertake lichen survey work in the St. Croix River watershed region.	BENEFICIAL	Acadian Forest Mosaic			NBM
3.1 Species Management: The Atlantic Salmon Federation monitors all fish returns at the St. George fishway on the Magaguadavic River. All wild salmon and aquaculture salmon escapee interactions are recorded, and invasive alien species are removed from the waterway.	BENEFICIAL	Aquatic	Species loss, loss of genetic diversity		ASF, DFO
3.1 Species Management: The Atlantic Salmon Federation manages wild Atlantic salmon populations in the Magaguadavic River through an unfed fry and fall parr stocking program which will transition to a cross-breeding stocking program which will release cage-reared adult salmon in 2016.	NECESSARY	Aquatic	Species loss	The transition to cross-bred, cage-reared adult Atlantic salmon releases is being made in an attempt to improve the resilience of released individuals.	ASF
3.1 Species Management: The Atlantic Salmon Federation conducts electrofishing surveys of New River, Pocologan River, Dideguash River, and Dennis Stream.	BENEFICIAL	Aquatic, riparian		This survey program has collected over 15 years of species data since its inception. Data available from the ASF upon request. The survey focuses on juvenile Atlantic salmon, however, all fish species are recorded.	ASF

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.1 Species Management: In 2014 the Atlantic Salmon Federation provided staff to monitor the fish ladder counting station on the St. Croix River to monitor annual Alewife returns to the river. The ASF also conducted tagged Alewife tracking in 2014 and 2015 to identify the upstream extent of returning Alewife in the St. Croix system.	BENEFICIAL	Aquatic	Dams and other barriers to upstream movement of species	Data available from the ASF upon request.	ASF
3.2 Species Recovery: Participate annually in active recovery planning meetings for Species at Risk.	NECESSARY	ALL	ALL	MOS-I: Attend working group meetings for species recovery teams (annually) and support recovery strategies for Species at Risk. Establish working groups for other species at risk in the bioregion.	EC, GNB, EHJV partners
3.2 Species Recovery: Conduct waterfowl surveys in the bioregion, including breeding waterfowl surveys (Eastern Waterfowl Survey) and wintering waterfowl surveys (Triannual American Black Duck "Winter" Survey).	BENEFICIAL	Freshwater wetlands	ALL	Collect baseline data for breeding and wintering waterfowl species; Detection of population trends over the long-term.	EC PNB
3.2 Species Recovery: EHJV partners to undertake Habitat Supply Analysis at the provincial scale.	NECESSARY	ALL	ALL	This **work** constitutes an analysis of past, present, and future forest and wetland bird habitat supply on crown and private lands in New Brunswick.	GNB & EHJV partners
3.2 Species Recovery: Work with EC Canadian Wildlife Service (CWS) staff to identify appropriate groups / agencies to address necessary recovery actions to protect species at risk in the bioregion.	NECESSARY	ALL	Threat-specific 2.1.2	Best management practices are applied in priority habitats including wetlands, forests, identified critical habitat, and in grasslands/agro-ecosystems to protect grassland birds as well as monitoring species at risk in the bioregion.	EC GNB NCC NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.2 Species Recovery: Enhance data management and information on biodiversity in the bioregion through annual submission of species records to the Atlantic Canada Conservation Data Centre (ACCDC)	BENEFICIAL	ALL		MOS: Baseline and annual monitoring information of rare species is submitted to ACCDC every year.	ACCDC
3.2 Species Recovery: Continue to monitor known species at risk on all nature preserves within the bioregion.	NECESSARY	ALL		MOS: Species populations are monitored regularly by knowledgeable professionals on all nature preserves with known species at risk.	NTNB
3.2 Species Recovery: Strengthen partnership with Atlantic Conservation Data Centre (ACCDC) through annual submission of monitoring findings on conservation lands.	BENEFICIAL	ALL		MOS: baseline and annual monitoring information of rare species is submitted to ACCDC every year.	NCC EC Nature NB DUC PNB NTNB
4. Communications, Education and Awareness					
4.3 Awareness & Communications NTNB will continue to implement its Communications Strategy to raise awareness of the need for land conservation and by promoting the province's natural heritage through maintaining public access to NTNB nature preserves.	BENEFICIAL	ALL	n/a	MOS – a successful communications strategy will bring increased NTNB membership, improved social and traditional media coverage, and a general increase in conservation awareness among New Brunswickers over time.	NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
4.3 Awareness & Communications: Increasing awareness and education NTNB will share information and increase awareness about threats to SAR and provide stewardship tips for private landowners throughout the bioregion via preserve steward training workshops.	BENEFICIAL	ALL		MOS: volunteer stewards and neighbouring landowners adjacent to NTNB preserves will participate in NTNB steward training workshops to increase their knowledge and capacity for managing sensitive species and habitat.	NTNB
4.3 Awareness and Communications: Education and outreach program specifically highlighting the Musquash Marine Protected Area	Beneficial			MOS - Increase awareness of and visitations to the Musquash Estuary MPA. Engage schools to include Musquash related content into their lessons and give presentations to interested classes. Assist with filming of an educational / promotional video. Hosting annual Musquash Paddle.	CCNB (Funded by DFO)
4.3 **Awareness & Communications** Maritime Marsh Monitoring Outreach: - Using citizen science to encourage local stewardship of freshwater and saltwater wetland habitats -Distribute monitoring toolkit and hold community workshops for Marsh Monitoring and wetland-associated birds (begin in 2016)	BENEFICIAL	Freshwater wetland Salt Marsh		MOS - increased volunteer involvement with the program and improved knowledge of wetland biodiversity across a broader region in NB.	BSC
4.3 Awareness & Communications Nocturnal Owl Survey: engage citizen sciences in tracking long-term trends of owls in NB	BENEFICIAL	ALL		MOS: surveys by citizen scientists provide representative coverage across NB and citizen scientists interested in the health of Maritime owl populations.	BSC
4.3 Awareness & Communications DUC to reach out to approximately 1000 school youth yearly through the Project Webfoot	BENEFICIAL/	ALL	ALL	MOS-I: Elementary school youth from Grades 4-6 are given the opportunity to apply their learning and connect with nature through the interactive and education al outreach program provided by	DUC

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
				DUC's Project Webfoot.	
5. Government Relations, Law & Policy					
5.1 Sub-national Level Legislation: DUC actively participates as a member of the provincial wetland policy long term strategy stakeholder review. DUC works closely with the Department of the Environment to deliver compensation needs, work with municipalities, evaluate policy needs, and improve permitting efficiency.	BENEFICIAL	Riparian systems Freshwater wetlands	Threat-specific	Wetland conservation policies are a top national priority of Ducks Unlimited.	DUC
5.1 National Level Legislation: EC Implements and enforces the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promotes the Federal Policy on Wetland Conservation.	NECESSARY	ALL	Threat-specific	EC Implements and enforces the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promote the Federal Policy on Wetland Conservation.	EC
5.1 Sub-national Level Legislation: Examine options for conservation of tidal flat habitat (submerged crown land).	NECESSARY	intertidal, nearshore	Habitat loss	Required research and consultation to determine best options for conservation of tidal flats is completed by 2018.	Province of NB, CWS, DFO
5.2 Policy and Regulations: The Atlantic Salmon Federation works alongside government regulators an aquaculture and fishing industry representatives to improve protection of wild Atlantic salmon populations by encouraging stringent regulation, reporting, and enforcement of the federal Code of Containment and other industry regulations.	BENEFICIAL	Aquatic, nearshore, intertidal	Aquaculture impacts on wild populations		ASF
5.2 Policies & Regulations NTNB will complete and adopt organizational policies, including a Land Acquisition Strategy	BENEFICIAL	ALL	ALL	Organizational Policies in place by March 31, 2016	NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
and Preserve Management Policy.					
5.2 Policies & Regulations NB Department of Environment & Local Government will enact and enforce an updated Provincial Wetland Polity	NECESSARY	wetlands	Habitat loss, development		NB DELG
5.2 Policy and Regulations: CCNB continues to examine and evaluate impacts resulting from industrial activity (including pipelines, export terminals, tanker traffic, mining and oil and gas exploration) and presents recommendations for mitigating these impacts should this project proceed.	BENEFICIAL	ALL		MOS – a successful advocacy campaign would result in the consideration and adoption of operational recommendations presented to the National Energy Board and consideration and adoption of recommendations presented to the Government of New Brunswick regarding an independent Environmental Impact Assessment process and increased research in critical areas.	CCNB
5.2 Policy and Regulations: CCNB continues to undertake environmental policy review and makes recommendations to the following files: Government of Canada Fisheries Act (and the Aquaculture Activities Regulations which fall under Act), Canadian Environmental Protection Act, Canadian Environmental Assessment Act, and Government of Canada Navigable Waters Act.	BENEFICIAL	Intertidal, nearshore, beaches		MOS - a successful policy review campaign would result in the adoption of the amendments proposed by CCNB, which would strengthen these Acts and improve their ability to protect the habitats and species under their jurisdiction.	CCNB
6. Livelihood, Economic & Other Incentives					
6.1 Linked Enterprises & Livelihood Alternatives CCNB Buy Local initiative	BENEFICIAL		Agricultural effluents	Database of local food and other products, available via website or app, to reduce consumption of carbon intensive products. Though social media and web blogs promote consumption of local products.	CCNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
7. Philanthropy, Marketing and Capacity Building					
7.1 Institutional & Civil Society Development The International St Croix River Watershed Board will continue to facilitate policy and financial support for the operation of the fish count operations at the Milltown Dam.	BENEFICIAL	Aquatic / riparian	Barriers to fish passage	The International St Croix River Watershed Board works to prevent and resolve cross-border conflicts over the St. Croix River boundary by facilitating solutions and supporting projects / activities that manage the ecological health of the watershed and maintain compliance of the river's dams with International Joint Commission Orders.	ISCRWB
7.2 Alliance & Partnership Development: Continue to attend meetings to develop new, and enhance existing partnerships. EC will focus on the ongoing development of the OBoF Habitat Conservation Strategy as a basis for decision support relating to funding and other habitat conservation activities, and to assist other conservation organizations and community groups through provision of decision support.	NECESSARY	ALL	ALL	Attend partnership meetings; provide stewardship or conservation planning support for habitat conservation initiatives.	EC
7.2 Alliance & Partnership Development: Attend partnership meetings and any relevant ecotourism development meetings on on-going basis to build & strengthen partnerships.	NECESSARY/	ALL	ALL	MOS-I: Attend partnership meetings and any relevant ecotourism development meetings; provide conservation input into tourism initiatives.	NTNB

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Personal Communications

Paula Noel. Program Manager. The Nature Conservancy of Canada, 180- 924 Prospect Street, Fredericton, New Brunswick, E3B 2T9.

5. APPENDICES

APPENDIX A: List of Abbreviations

Acronyms	Full reference
ATV	All-terrain-vehicle
ACCDC	Atlantic Canada Conservation Data Centre
BD	Beaches/Dunes
BSC	Bird Studies Canada
CAP	Conservation Action Planning
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DUC	Ducks Unlimited Canada
EC	Environment Canada
EHJV	Eastern Habitat Joint Venture
FM	Forest Mosaic
FW	Freshwater Wetland
IBA	Important Bird Area
IUCN-CMP	International Union for the Conservation of Nature and Natural Resources – Conservation Measures Partnership
LCI	Landscape Context Index
MBBA	Maritime Breeding Bird Atlas
MOS	Measure of Success
Bioregion	Bioregion
NAAP	Northern Appalachian - Acadian Ecoregional Plan
NABCI	North American Bird Conservation Initiative
NAWCA	North American Waterfowl Conservation Act
NB	New Brunswick
NB DNR	New Brunswick Department of Natural Resources
NB EHJV	New Brunswick Eastern Habitat Joint Venture
NWA	National Wildlife Area
Pers. comm.	Personal Communication
Pers. obs.	Personal observation
SAR	Species at Risk
SM	Salt Marsh

APPENDIX B: Glossary of Biodiversity and Conservation Ranks

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): is a national committee of experts that assesses and designates which wild species are in danger of disappearing from Canada. COSEWIC assigns the following status to species:

Extinct (EXT)	A species that no longer exists
Extirpated (EXP)	A species no longer existing in the wild in Canada, but occurring elsewhere in the wild
Endangered (END)	A species facing imminent extirpation or extinction throughout its range
Threatened (THR)	A species likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
Special Concern (SC)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species
Not At Risk (NAR)	A species that has been evaluated and found to be not at risk
Data Deficient (DD)	A species for which there is insufficient information to support a status designation

Species at Risk (SAR): species 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.

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. The factors considered in assessing conservation status include the total number and condition of occurrences; population size; range extent and area of occupancy; short- and long-term trends in these previous factors; scope, severity, and immediacy of threats, number of protected and managed occurrences, intrinsic vulnerability and environmental specificity.

Global Ranks

Rank	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.

Variant Ranks

Rank	Definition
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 (e.g., GU should be

	used rather than G1G4).
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.

Rank Qualifiers

Rank	Definition
?	**Inexact Numeric Rank**—Denotes some uncertainty about the numeric rank (e.g. G3? - Believed most likely a G3, but some chance of either G2 or G4).
Q	**Questionable taxonomy**—Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.
C	**Captive or Cultivated Only**—At present extant only in captivity or cultivation, or as a reintroduced population not yet established.

Sub-national (Provincial) Rank (S-RANK): provincial ranks are used by natural heritage member programs to set conservation priorities for rare species and vegetation communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of a province. 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.

Subnational (S) 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 20-40 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#	**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).

APPENDIX C: List of Significant Species for the Outer Bay of Fundy Bioregion with Coarse Resolution Habitat Associations

Scientific name	Common name	COSEWIC status	Prov. status	G Rank	S Rank	Other status	Other notes[2]	Associated targets						
								Beach, Dune & Cliff	Salt Marshes	Tidal Flats & Rocky Shores	Coastal Islands	Riparian Systems	Freshwater Wetlands	Acadian Forest Mosaic
Bird														
Accipiter cooperii	Cooper's Hawk			G5	S1S2B									X
Accipiter gentilis	Northern Goshawk			G5	S4	^								X
Actitis macularius	Spotted Sandpiper			G5	S4B	^		X				X		
Aegolius funereus	Boreal Owl			G5	S1S2B								X	X
Aix sponsa	Wood Duck			G5	S2S3B	^						X		X
Alca torda	Razorbill			G5	S1B, S3N	# +					X			
Ammodramus nelsoni	Nelson's Sparrow			G5	S4B	^			X					
Anas clypeata	Northern Shoveler			G5	S2B							X	X	X
Anas crecca	Green-winged Teal			G5	S4S5B	^ +						X	X	X
Anas platyrhynchos	Mallard			G5	S5B, S4N	^						X	X	X
Anas rubripes	American Black Duck			G5	S5B, S4N	^ +						X	X	X
Anas strepera	Gadwall			G5	S2B								X	X
Antrostomus vociferus	Eastern Whip-poor-will	THR	THR	G5	S2B	^								X
Ardea herodias	Great Blue Heron			G5	S4B		CN		X		X		X	
Asio flammeus	Short-eared Owl	SC	SC	G5	S3B	^			X			X	X	
Asio otus	Long-eared Owl			G5	S2S3							X	X	X
Aythya collaris	Ring-necked Duck			G5	S5B	^							X	
Aythya marila	Greater Scaup			G5	S1B, S2N					X			X	
Bartramia longicauda	Upland Sandpiper			G5	S1B	#							X	

Bonasa umbellus	Ruffed Grouse			G5	S5	^								X
Botaurus lentiginosus	American Bittern			G4	S4B	^			X				X	
Branta canadensis	Canada Goose			G5	S4B, S4M	^ +						X	X	X
Bucephala clangula	Common Goldeneye			G5	S4B, S5M, S4N	^ +						X	X	
Buteo lineatus	Red-shouldered Hawk			G5	S2B	^							X	X
Butorides virescens	Green heron			G5	S1S2B	^	CN				X	X	X	X
Calidris alba	Sanderling			G5	S4M, S1N	+		X		X		X		
Calidris alpina	Dunlin			G5	S4M	+		X		X			X	
Calidris canutus rufa	Red Knot	END	END	G5	S3M	+		X		X				
Calidris maritima	Purple Sandpiper			G5	S3M, S3N	+		X		X				
Calidris minutilla	Least Sandpiper			G5	S4M	+		X		X		X		
Calidris pusilla	Semipalmated Sandpiper			G5	S4M	# +		X		X		X		
Cardellina canadensis	Canada Warbler	THR	THR	G5	S3S4B	^						X	X	X
Catharus bicknelli	Bicknell's Thrush	THR	THR	G4	S2S3B	# ^								X
Catharus fuscescens	Veery			G5	S4B	^							X	X
Chaetura pelagica	Chimney Swift	THR	THR	G5	S2S3B	^							X	X
Charadrius melodus melodus	Piping Plover	END	END	G3	S2B	# ^ +		X		X				
Charadrius vociferus	Killdeer			G5	S3B	^		X					X	
Chordeiles minor	Common Nighthawk	THR	THR	G5	S3B	^							X	X
Chroicocephalus philadelphia	Bonaparte's Gull			G5	S5M	^ +				X				
Chroicocephalus ridibundus	Black-headed Gull			G5	S2M, S1N						X			
Cistothorus palustris	Marsh Wren			G5	S2B				X				X	
Clangula hyemalis	Long-tailed Duck			G5	S4N	+			X			X	X	
Coccothraustes vespertinus	Evening Grosbeak			G5	S3S4B, S4S5N	^								X
Contopus cooperi	Olive-sided Flycatcher	THR	THR	G4	S3S4B	^							X	X
Contopus virens	Eastern Wood-pewee	SC	SC	G5	S4B	^								X
Dolichonyx oryzivorus	Bobolink	THR	THR	G5	S3S4B	^	GB							
Empidonax traillii	Willow Flycatcher			G5	S1S2B							X	X	X

Eremophila alpestris	Horned Lark			G5	S2B		GB							
Euphagus carolinus	Rusty Blackbird	SC	SC	G4	S3B	^						X	X	X
Falco peregrinus pop. 1	Peregrine Falcon	SC	SC	G4T4	S1B	# ^		X		X				X
Fratercula arctica	Atlantic Puffin			G5	S1S2B		CN	X		X	X			
Fulica americana	American Coot			G5	S2B							X	X	X
Gallinago delicata	Wilson's Snipe			G5	S4B	^						X	X	X
Gallinula chloropus	Common Moorhen			G5	S1S2B							X	X	
Gavia immer	Common Loon			G5	S4B, S5M, S4N	^ +						X		
Haemorhous purpureus	Purple Finch			G5	S4S5B	^								X
Haliaeetus leucocephalus	Bald Eagle		END	G5	S3B	^		X				X		X
Riparia riparia	Bank Swallow	THR		G5	S2S3B, S2S3M	^		X				X	X	
Hirundo rustica	Barn Swallow	THR		G5	S3B	^		X				X		X
Histrionicus histrionicus pop. 1	Harlequin Duck (Eastern)	SC	END	G4T4	S1B, S1N	^ + #				X	X	X		
Hylocichla mustelina	Wood Thrush	THR	THR	G5	S1S2B	^								X
Ixobrychus exilis	Least Bittern	THR	THR	G5	S1S2B	^			X				X	
Larus argentatus	Herring Gull			G5	S5B, S5N		CN	X		X	X			
Larus marinus	Great Black-backed Gull			G5	S5B, S5N		CN	X		X	X			
Leucophaeus atricilla	Laughing Gull			G5	S1B			X		X	X			
Limosa haemastica	Hudsonian Godwit			G4	S4M	+		X	X	X				
Megaceryle alcyon	Belted Kingfisher			G5	S5B	^						X	X	X
Melanitta nigra	Black Scoter			G5	S3M, S2S3N	+				X		X	X	
Melanitta perspicillata	Surf Scoter			G5	S4M, S4N	+				X		X	X	
Morus bassanus	Northern Gannet			G5	SHB, S5M, S5N		CN	X		X	X			
Numenius phaeopus hudsonicus	Whimbrel			G5	S4M	^ +		X		X		X		
Nycticorax nycticorax	Black-crowned Night-			G5	S1S2B		CN	X	X				X	

	heron													
Oceanodroma leucorhoa	Leach's Storm-Petrel			G5	S2B	+	CN	X		X	X			
Oxyura jamaicensis	Ruddy Duck			G5	S1B, S4N				X			X	X	
Phalacrocorax auritus	Double-crested Cormorant			G5	S5B		CN			X	X	X		
Phalacrocorax carbo	Great Cormorant			G5	S2N, S2M	+		X		X	X			
Phalaropus fulicarius	Red Phalarope			G5	S3M	+		X						
Phalaropus lobatus	Red-necked Phalarope	SC		G4G5	S3M	+		X	X					
Phalaropus tricolor	Wilson's Phalarope			G5	S1B			X	X	X				
Pheucticus ludovicianus	Rose-breasted Grosbeak			G5	S4B	^								X
Picoides dorsalis	American Three-toed Woodpecker			G5	S3?	^							X	X
Pinicola enucleator	Pine Grosbeak			G5	S2S3B, S4S5N									X
Pluvialis dominica	American Golden-plover			G5	S3M	^		X		X				
Pluvialis squatarola	Black-bellied Plover			G5	S4M	+		X	X	X				
Podiceps grisegena	Red-necked Grebe			G5	S3M, S2N	+		X		X			X	
Poecile hudsonica	Boreal Chickadee			G5	S4	^								X
Pooecetes gramineus	Vesper Sparrow			G5	S2B		GB							
Porzana carolina	Sora			G5	S4B	^			X				X	X
Progne subis	Purple Martin			G5	S1S2B							X	X	X
Rallus limicola	Virginia Rail			G5	S3B	^							X	X
Rissa tridactyla	Black-legged Kittiwake			G5	S1B, S4N	+	CN	X		X	X			
Scolopax minor	American Woodcock			G5	s5B	^							X	X
Setophaga caerulescens	Black-throated Blue Warbler			G5	S5B	^								X
Setophaga castanea	Bay-breasted Warbler			G5	S4B	^						X		X
Setophaga fusca	Blackburnian Warbler			G5	S5B	^								X
Setophaga magnolia	Magnolia Warbler			G5	S5B	^							X	X
Setophaga ruticilla	American Redstart			G5	S5B	^							X	X
Setophaga tigrina	Cape May Warbler			G5	S4B	^								X

Setophaga virens	Black-throated Green Warbler			G5	S5B	^							X	X
Somateria mollissima	Common Eider			G5	S4	+		X	X	X				
Somateria spectabilis	King Eider			G5	S2N			X	X	X				
Sphyrapicus varius	Yellow-bellied Sapsucker			G5	S5B	^								X
Stelgidopteryx serripennis	Northern Rough-winged Swallow			G5	S1S2B							X	X	X
Sterna dougallii	Roseate Tern	END	END	G4	S1B	# +	CN	X	X		X			
Sterna hirundo	Common Tern			G5	S3B	^ +	CN	X	X		X			
Sterna paradisaea	Arctic Tern			G5	S1B	+	CN	X	X		X			
Sturnella magna	Eastern Meadowlark	THR	THR	G5	S1S2B	^	GB							
Tachycineta bicolor	Tree Swallow			G5	S4B	^						X	X	X
Toxostoma rufum	Brown Thrasher			G5	S2B									X
Tringa flavipes	Lesser Yellowlegs			G5	S5M	^ +		X	X	X				
Tringa semipalmata	Willet			G5	S2S3B	+		X	X	X				
Tringa solitaria	Solitary Sandpiper			G5	S2B, S5M	^ +		X	X	X				
Troglodytes aedon	House Wren			G5	S1B							X	X	X
Tyrannus tyrannus	Eastern Kingbird			G5	S3S4B	^						X	X	X
Uria aalge	Common Murre			G5	S1B, S3N	+	CN	X		X	X			
Vireo solitarius	Blue-headed Vireo			G5	S5B	^								X
Zonotrichia albicollis	White-throated Sparrow			G5	S5B	^						X	X	X
Fish														
Anguilla rostrata	American Eel	THR	THR	G4	S5							X		
Osmerus mordax pop. 2	Rainbow Smelt - Lake Utopia Large-bodied Population	THR	THR	G5TNR	S1							X		
Osmerus mordax pop. 3	Rainbow Smelt - Lake Utopia Small-bodied Population	THR	THR	G5TNR	SNR	#						X		
Prosopium cylindraceum	Round Whitefish			G5	S2							X		
Salmo salar	Atlantic Salmon			G5	S2	#						X		

Salmo salar pop. 1	Atlantic Salmon - Inner Bay of Fundy pop.	END	END	G5TNR	S2	#						X		
Fungi or Lichens														
Degelia plumbea	Blue Felt Lichen	SC	SC	GNR	S1									X
Nephroma laevigatum	Mustard Kidney Lichen			G5?	S2									X
Peltigera collina	Tree Pelt Lichen			G3G4	S1									X
Pseudevernia cladonia	Light-and-dark Lichen			G2G4	S3									X
Invertebrates														
Alasmidonta undulata	Triangle Floater			G4	S2							X		
Alasmidonta varicosa	Brook Floater	SC	SC	G3	S1S2	#						X		
Celithemis martha	Martha's Pennant			G4	S2							X	X	
Danaus plexippus	Monarch	SC	SC	G5	S3B								X	
Enallagma geminatum	Skimming Bluet			G5	S2							X	X	
Enallagma signatum	Orange Bluet			G5	S1S2							X	X	
Enallagma vesperum	Vesper Bluet			G3	S1							X	X	
Hetaerina americana	American Rubyspot			G5	S2							X	X	
Ischnura posita	Fragile Forktail			G4	S1							X	X	
Ladona exusta	White Corporal			G4	S2							X	X	
Lestes eurinus	Amber-Winged Spreadwing			G5	S2							X	X	
Lestes vigilax	Swamp Spreadwing			G5	S2							X	X	
Ophiogomphus colubrinus	Boreal Snaketail			G5	S3							X	X	
Ophiogomphus howei	Pygmy Snaketail	SC	SC	G5	S3	#						X	X	
Pachydiplax longipennis	Blue Dasher			G5	S2							X	X	
Pantala hymenaea	Spot-Winged Glider			G5	S2							X	X	
Plebejus idas	Northern Blue			G4	S3								X	X
Satyrium acadica	Acadian Hairstreak			G4	S3							X	X	
Strymon melinus	Grey Hairstreak			G4	S3							X	X	
Stylurus scudderi	Zebra Clubtail			G5	S1							X		
Mammals														

Balaenoptera physalus	Fin Whale - Atlantic pop.	SC	SC	G3G4	S2S3		PM							
Eptesicus fuscus	Big Brown Bat			G5	S2?							X		X
Eubalaena glacialis	North Atlantic Right Whale	END	END	G1	S1		PM							
Globicephala melas	Long-finned Pilot Whale			G5	S2S3		PM							
Lasiurus borealis	Eastern Red Bat			G5	S2?									X
Lasiurus cinereus	Hoary Bat			G5	S2?							X		X
Lynx canadensis	Canadian Lynx		END	G5	S1	#							X	X
Myotis lucifugus	Little Brown Myotis	END	END	G3	S1							X	X	X
Phocoena phocoena (NW Atlantic pop.)	Harbour Porpoise - Northwest Atlantic pop.	SC	SC	G4G5	S4		PM							
Non-vascular plant														
Bryum salinum	a Moss			G2G4	S1			X						
Dicranum spurium	Spurred Broom Moss			G5	S1S2									X
Porella pinnata	Pinnate Scalewort			G5	S1S3							X		
Reboulia hemisphaerica	Purple-margined Liverwort			G5	S1S3			X						
Rhytidiadelphus loreus	Lanky Moss			G5	S1									X
Sphagnum angermanicum	a Peatmoss			G4	S1								X	
Sphagnum centrale	Central Peat Moss			G5	S2								X	
Sphagnum lindbergii	Lindberg's Peat Moss			G5?	S2								X	
Sphagnum macrophyllum	a Sphagnum			G3G5	S1								X	
Sphagnum platyphyllum	Flat-leaved Peat Moss			G5	S1?								X	
Tomentypnum falcifolium	Sickle-leaved Golden Moss			G3G5	S1								X	
Turtles														
Chelydra serpentina	Snapping Turtle	SC	SC	G5	S4							X	X	X
Dermochelys coriacea (Atlantic pop.)	Leatherback Sea Turtle - Atlantic pop.	END	END	G2	S1S2N		PM	X						
Glyptemys insculpta	Wood Turtle	THR	THR	G3	S3							X	X	X
Vascular Plants														

Agalinis neoscotica	Nova Scotia Agalinis			G4	S2								X	
Alisma subcordatum	Southern Water Plantain			G4G5	S1							X	X	
Alnus serrulata	Brookside Alder			G5	S2							X		
Antennaria howellii ssp. petaloidea	Pussy-Toes			G5T4T5	S1							X		X
Antennaria parlinii	a Pussytoes			G5	S1							X		
Atriplex franktonii	Frankton's Saltbush			G2G4	S2				X					
Barbarea orthoceras	American Winter-cress			G5	S2							X		
Blysmus rufus	Red Bulrush			G5	S2				X	X				
Callitriche hermaphroditica	Northern Water-starwort			G5	S2							X	X	
Callitriche terrestris	Terrestrial Water-Starwort			G5	S1							X	X	
Cardamine parviflora var. arenicola	Small-flowered Bittercress			G5T5	S1							X		X
Carex granularis	Limestone Meadow Sedge			G5	S2								X	
Carex gynocrates	Northern Bog Sedge			G5	S2								X	X
Carex merritt-fernaldii	Merritt Fernald's Sedge			G5	S1									X
Carex prairea	Prairie Sedge			G5	S2							X	X	
Carex rostrata	Narrow-leaved Beaked Sedge			G5	S1S2							X		
Carex tenuiflora	Sparse-Flowered Sedge			G5	S2								X	X
Carex vacillans	Estuarine Sedge			GNR	S2				X					
Cephalanthus occidentalis	Common Buttonbush			G5	S2							X	X	
Chamaesyce polygonifolia	Seaside Spurge			G5?	S1			X						
Chenopodium simplex	Maple-leaved Goosefoot			G5	S1									X
Cinna arundinacea	Sweet Wood Reed Grass			G5	S1								X	
Crataegus jonesiae	Jones' Hawthorn			G4G5	S1									X
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper			G5T4T5	S2								X	X
Danthonia compressa	Flattened Oat Grass			G5	S1									X

Desmodium glutinosum	Large Tick-Trefoil			G5	S1							X		X
Dichanthelium dichotomum	Forked Panic Grass			G5	S1							X	X	X
Dichanthelium linearifolium	Narrow-leaved Panic Grass			G5	S2									X
Draba arabisans	Rock Whitlow-Grass			G4	S1									X
Drosera rotundifolia var. comosa	Round-leaved Sundew			G5TNR	S1?								X	
Eleocharis flavescens	Pale Spikerush			G5	S1								X	
Elodea nuttallii	Nuttall's Waterweed			G5	S2							X	X	
Epilobium coloratum	Purple-veined Willowherb			G5	S2?							X	X	
Eragrostis pectinacea	Tufted Love Grass			G5	S2?									X
Euphrasia randii	Rand's Eyebright			G5	S2			X						X
Galium brevipes	Limestone Swamp Bedstraw			G4?	S1								X	
Gentiana rubricaulis	Purple-stemmed Gentian			G4?	S1								X	
Glyceria obtusa	Atlantic Manna Grass			G5	S1								X	
Gratiola aurea	Golden Hedge-Hyssop			G5	S1								X	
Hedeoma pulegioides	American False Pennyroyal			G5	S2									X
Hepatica nobilis var. obtusa	Round-lobed Hepatica			G5T5	S2									X
Hieracium kalmii	Kalm's Hawkweed			G5	S1							X		X
Hypericum dissimulatum	Disguised St John's-wort			G5	S2							X	X	
Juncus greenei	Greene's Rush			G5	S1									X
Listera auriculata	Auricled Twayblade			G3G4	S2S3	#						X	X	
Listera australis	Southern Twayblade		END	G4	S2								X	X
Lomatogonium rotatum	Marsh Felwort			G5	S1							X	X	
Lonicera oblongifolia	Swamp Fly Honeysuckle			G4	S2								X	X
Lysimachia hybrida	Lowland Yellow Loosestrife			G5	S1							X	X	X
Lysimachia quadrifolia	Whorled Yellow			G5	S1								X	X

	Loosestrife													
Malaxis brachypoda	White Adder's-Mouth			G4Q	S1								X	X
Minuartia groenlandica	Greenland Stitchwort			G5	S1									X
Myriophyllum humile	Low Water Milfoil			G5	S2							X	X	
Najas gracillima	Thread-Like Naiad			G5?	S2							X	X	
Nuphar lutea ssp. rubrodisca	Red-disked Yellow Pond-lily			G5T3T5	S2							X	X	
Orobanche uniflora	One-Flowered Broomrape			G5	S2			X					X	X
Osmorhiza longistylis	Smooth Sweet Cicely			G5	S2?								X	X
Pedicularis canadensis	Canada Lousewort			G5	S1									X
Piptatherum canadense	Canada Rice Grass			G5	S2									X
Platanthera flava var. herbiola	Pale Green Orchid			G4?T4Q	S1								X	X
Platanthera huronensis	Fragrant Green Orchid			G5T5?	S2?								X	
Podostemum ceratophyllum	Horn-leaved Riverweed			G5	S2							X		
Polemonium vanbruntiae	Van Brunt's Jacob's-ladder	THR	THR	G3G4	S1	#						X	X	
Polygala paucifolia	Fringed Milkwort			G5	S2									X
Polygala sanguinea	Blood Milkwort			G5	S2								X	
Polygonum amphibium var. emersum	Water Smartweed			G5T5	S2							X	X	
Polygonum careyi	Carey's Smartweed			G4	S2							X	X	
Potamogeton bicupulatus	Snailseed Pondweed			G4	S1S2							X	X	
Potamogeton vaseyi	Vasey's Pondweed			G4	S2							X	X	
Proserpinaca palustris var. crebra	Marsh Mermaidweed			G5T5	S2							X	X	
Proserpinaca pectinata	Comb-leaved Mermaidweed			G5	S1							X	X	
Pseudognaphalium macounii	Macoun's Cudweed			G5	S2									X
Puccinellia phryganodes	Creeping Alkali Grass			G5	S2				X					

Quercus macrocarpa	Bur Oak			G5	S2							X		X
Ranunculus flabellaris	Yellow Water Buttercup			G5	S2							X	X	
Ranunculus longirostris	Eastern White Water-Crowfoot			G5	S2							X	X	
Ranunculus sceleratus	Cursed Buttercup			G5	S1							X	X	
Rubus pensilvanicus	Pennsylvania Blackberry			G5	S2?									X
Sagina nodosa	Knotted Pearlwort			G5	S2			X				X		
Salix myricoides	Bayberry Willow			G4	S2?							X		
Scrophularia lanceolata	Lance-leaved Figwort			G5	S2								X	
Senecio pseudoarnica	Seabeach Ragwort			G5	S1			X						
Solidago altissima	Tall Goldenrod			G5	S2								X	
Spiranthes cernua	Nodding Ladies'-Tresses			G5	S2								X	
Spiranthes ochroleuca	Yellow Ladies'-tresses			G4	S1									X
Symphyotrichum novi-belgii var. crenifolium	New York Aster			G5TNR	S2?				X			X	X	
Symphyotrichum racemosum	Small White Aster			G4G5	S2							X		X
Symplocarpus foetidus	Eastern Skunk Cabbage			G5	S2								X	X
Triadenum virginicum	Virginia St John's-wort			G5	S1							X	X	
Triglochin gaspensis	Gaspé Arrowgrass			G3G4	S3				X					
Utricularia radiata	Little Floating Bladderwort			G4	S3							X	X	
Vaccinium boreale	Northern Blueberry			G4	S1									X
Vaccinium corymbosum	Highbush Blueberry			G5	S1								X	X
Viburnum acerifolium	Maple-leaved Viburnum			G5	S1									X
Viburnum lentago	Nannyberry			G5	S2							X		X
Viburnum recognitum	Northern Arrow-Wood			G4G5	S2							X	X	X
Viola novae-angliae	New England Violet			G4	S2									X
Viola sagittata var. ovata	Arrow-Leaved Violet			G5T5	S1							X		X
Woodwardia virginica	Virginia Chain Fern			G5	S2							X	X	
Zizania aquatica var. aquatica	Indian Wild Rice			G5T5	S2							X	X	

[1] Other Status: ^ = Bird Conservation Region (BCR) 14 Priority Bird Species (Environment Canada 2013).
+ = Marine Biogeographic Unit (MBU) 11 Priority Bird Species (Environment Canada 2013).
# = Northern Appalachian-Acadian Ecoregional Plan - Primary Species Targets (Anderson *et al.* 2006)

[2] CN = Colonial-nesting bird species; GB = Grassland bird species; PM = Pelagic marine species

APPENDIX D: List of Significant Species for the Outer Bay of Fundy Bioregion with Fine Resolution Habitat Associations

Scientific name	Common name	Coastal						Freshwater Wetlands						Riparian / Aquatic			Forest			Marine	Data Source	Habitat Notes
		Beach / Dune	Salt marsh	Rocky Shore	Cliff	Tidal Flat	Coastal Islands	Aquatic Bed	Bog	Fen	Emergent WL	Shrub WL	Forested WL	Aquatic	Riparian	Floodplain	Coniferous	Deciduous	Mixedwood			
Birds																						
Accipiter cooperii	Cooper's Hawk																X	X	X		1	Primarily mature forest
Accipiter gentilis	Northern Goshawk																X	X	X		1	Primarily mature forest
Actitis macularius	Spotted Sandpiper	X		X		X					X	X		X	X						1	Beaches and riparian
Aegolius funereus	Boreal Owl											X					X		X		1	Dense conifer forest
Aix sponsa	Wood Duck										X		X			X					1	Mature forest near water
Alca torda	Razorbill			X	X		X													X	1	Coastal areas / pelagic
Ammodramus nelsoni	Nelson's Sparrow		X																		2	Salt Marsh
Anas clypeata	Northern Shoveler					X		X			X			X							1	Open water / emergent
Anas crecca	Green-winged Teal							X			X	X		X							1	Open water / emergent
Anas platyrhynchos	Mallard		X					X			X	X		X							1	Open water / emergent
Anas rubripes	American Black Duck		X					X			X	X		X							1	Open water / emergent
Anas strepera	Gadwall							X			X	X		X							1	Open water / emergent
Antrostomus vociferus	Eastern Whip-poor-will																	X	X		1	Open deciduous / mixed forest
Ardea herodias	Great Blue Heron		X	X			X	X			X		X		X	X					1	Wetlands / coastal

Asio flammeus	Short-eared Owl		X						X		X	X				X					1	Herbaceous / shrub cover
Asio otus	Long-eared Owl										X						X	X	X		1	Herbaceous wetland and forest
Aythya collaris	Ring-necked Duck						X	X			X			X							1	Open water / emergent
Aythya marila	Greater Scaup										X			X						X	1	Ope water and wetlands
Bartramia longicauda	Upland Sandpiper								X		X										1	Dry patches in wetlands
Bonasa umbellus	Ruffed Grouse																	X	X		1	Mature forest with coarse woody debris
Botaurus lentiginosus	American Bittern		X						X	X	X	X									1	Wetlands
Branta canadensis	Canada Goose		X					X			X			X							1	Open water / emergent
Bucephala clangula	Common Goldeneye							X					X	X		X					1	Mature forest near water
Buteo lineatus	Red-shouldered Hawk												X			X		X	X		1	Deciduous forest and swamp
Butorides virescens	Green heron										X				X	X					1	Marsh and shoreline
Calidris alba	Sanderling	X				X	X								X						1	Beach, mudflat & shoreline
Calidris alpina	Dunlin	X				X	X		X	X	X				X	X					1	Beach, mudflat & shoreline
Calidris canutus rufa	Red Knot	X				X	X														1	Coastal areas
Calidris maritima	Purple Sandpiper	X		X		X	X														1	Coastal areas
Calidris minutilla	Least Sandpiper	X		X		X	X		X	X	X				X	X					1	Wetlands and coastal areas
Calidris pusilla	Semipalmated Sandpiper	X		X		X	X				X				X	X					1	Wetlands and coastal areas
Cardellina canadensis	Canada Warbler											X	X		X	X		X			1	Wet forest and shrubland
Catharus bicknelli	Bicknell's Thrush																X				1	High elevation conifer forest
Catharus fuscescens	Veery											X						X	X		1	Forest with dense understorey
Chaetura pelagica	Chimney Swift												X				X	X			1	Mature Pine and Poplar
Charadrius melodus melodus	Piping Plover	X				X	X														1	Beaches
Charadrius vociferus	Killdeer	X									X										1	Beach and emergent marsh
Chordeiles minor	Common Nighthawk	X							X		X						X		X		1	Mature forest, herbaceous WL
Chroicocephalus ridibundus	Black-headed Gull		X	X			X							X						X	1	Coastal areas
Cistothorus palustris	Marsh Wren		X								X										1	Emergent marsh
Clangula hyemalis	Long-tailed Duck							X						X							1	Large water bodies

Coccothraustes vespertinus	Evening Grosbeak															X		X		1	Old spruce-fir forest
Contopus cooperi	Olive-sided Flycatcher							X								X		X		1	Old Spruce-fir near water
Contopus virens	Eastern Wood-pewee																X	X		1	Old tolerant hardwood
Dolichonyx oryzivorus	Bobolink									X										1	Herbaceous
Empidonax traillii	Willow Flycatcher										X	X			X		X	X		1	Deciduous wetland / forest
Euphagus carolinus	Rusty Blackbird							X				X			X	X		X		1	Moist and swampy forest
Falco peregrinus pop. 1	Peregrine Falcon	X			X		X													1	Beaches for foraging
Fratercula arctica	Atlantic Puffin						X												X	1	Coastal islands / pelagic
Fulica americana	American Coot					X		X	X	X	X		X	X	X	X				1	Wetlands and coastal areas
Gallinago delicata	Wilson's Snipe							X	X	X	X	X	X	X	X	X				1	Wetland and riparian
Gallinula chloropus	Common Moorhen							X			X	X	X	X	X	X				1	Wetland and riparian
Gavia immer	Common Loon													X					X	1	Large water bodies
Haemorhous purpureus	Purple Finch																X	X		1	Moist forest
Haliaeetus leucocephalus	Bald Eagle				X		X					X		X	X	X	X	X		1	Mature forest near water
Hirundo rustica	Barn Swallow				X					X					X					1	Open areas near water
Histrionicus histrionicus pop. 1	Harlequin Duck (Eastern)			X			X												X	1	Coastal islands / pelagic
Hylocichla mustelina	Wood Thrush																X	X		1	Mature forest with dense understorey
Ixobrychus exilis	Least Bittern		X							X										1	Emergent wetland
Larus argentatus	Herring Gull	X	X	X		X	X													1	Coastal areas
Larus marinus	Great Black-backed Gull	X	X	X		X	X													1	Coastal areas
Leucophaeus atricilla	Laughing Gull	X	X	X		X	X													1	Coastal areas
Limosa haemastica	Hudsonian Godwit	X	X			X	X		X	X	X				X	X				1	Herbaceous and coastal areas
Megaceryle alcyon	Belted Kingfisher				X		X					X		X	X					1	Water bodies with cover
Melanitta nigra	Black Scoter					X	X	X			X			X		X				1	Open water, mostly coastal
Melanitta perspicillata	Surf Scoter						X	X	X	X	X			X	X	X				1	Coastal areas and wetlands
Morus bassanus	Northern Gannet			X	X		X												X	1	Coastal / pelagic

Numenius phaeopus hudsonicus	Whimbrel	X		X		X			X		X	X			X	X					1	Coastal and herbaceous-shrub
Nycticorax nycticorax	Black-crowned Night-heron		X	X		X		X			X	X	X			X					1	Wetlands and coastal areas
Oceanodroma leucorhoa	Leach's Storm-Petrel			X			X													X	1	Coastal / pelagic
Oxyura jamaicensis	Ruddy Duck		X								X			X	X	X					1	Herbaceous / open water
Phalaropus fulicarius	Red Phalarope	X																		X	1	Beach / pelagic
Phalaropus lobatus	Red-necked Phalarope	X																		X	1	Beach / pelagic
Phalaropus tricolor	Wilson's Phalarope	X	X			X	X				X										1	Wetlands and coastal areas
Pheucticus ludovicianus	Rose-breasted Grosbeak												X		X	X		X			1	Hardwood forests / riparian
Picoides dorsalis	American Three-toed Woodpecker												X				X		X		1	Black Spruce forest
Pinicola enucleator	Pine Grosbeak																X	X	X		1	Second growth forest
Pluvialis dominica	American Golden-plover	X				X	X														1	Coastal areas and herbaceous
Pluvialis squatarola	Black-bellied Plover	X	X			X	X														1	Coastal areas and herbaceous
Podiceps grisegena	Red-necked Grebe										X			X	X						1	Herbaceous / open water
Poecile hudsonica	Boreal Chickadee																X				1	Old spruce-fir forest
Pooecetes gramineus	Vesper Sparrow																				1	Grassland
Porzana carolina	Sora										X	X	X		X	X					1	Wetlands
Progne subis	Purple Martin		X			X					X				X	X	X	X	X		1	Open areas near water
Rallus limicola	Virginia Rail							X			X										1	Emergent wetlands
Rissa tridactyla	Black-legged Kittiwake			X	X		X													X	1	Coastal cliffs / pelagic
Scolopax minor	American Woodcock												X		X			X	X		1	Hardwood forests / riparian
Setophaga caerulescens	Black-throated Blue Warbler																	X	X		1	Mature tolerant hardwood
Setophaga castanea	Bay-breasted Warbler															X	X		X		1	Old Spruce-fir forest
Setophaga fusca	Blackburnian Warbler																X	X	X		1	Old mixedwood
Setophaga magnolia	Magnolia Warbler								X								X				1	Dense conifer forest

Setophaga ruticilla	American Redstart											X				X	X	X		1	Forest with dense understorey
Setophaga tigrina	Cape May Warbler															X				1	Old spruce-fir forest
Setophaga virens	Black-throated Green Warbler										X					X		X		1	Mature forest and shrub
Somateria mollissima	Common Eider	X	X	X			X												X	1	Coastal areas
Somateria spectabilis	King Eider			X			X												X	1	Coastal areas / pelagic
Sphyrapicus varius	Yellow-bellied Sapsucker																X	X		1	Old intolerant hardwood
Stelgidopteryx serripennis	Northern Rough-winged Swallow				X						X				X					1	Herbaceous
Sterna dougallii	Roseate Tern			X		X	X												X	1	Coastal areas / pelagic
Sterna hirundo	Common Tern	X	X				X												X	1	Islands in large waterbodies
Sterna paradisaea	Arctic Tern		X	X			X							X					X	1	Coastal areas / pelagic
Sturnella magna	Eastern Meadowlark																			1	Grasslands
Tachycineta bicolor	Tree Swallow									X		X		X	X	X	X	X		1	Tree cavities near water
Toxostoma rufum	Brown Thrasher																X			1	Thickets in deciduous forest
Tringa flavipes	Lesser Yellowlegs	X	X			X			X	X	X		X		X	X					1	Coastal areas and wetlands
Tringa semipalmata	Willet	X	X	X		X					X				X	X					1	Coastal areas and wetlands
Tringa solitaria	Solitary Sandpiper		X			X			X	X	X		X		X	X	X	X	X		1	Forested WL and coastal areas
Troglodytes aedon	House Wren											X	X		X	X	X	X	X		1	Dense thickets in forest
Tyrannus tyrannus	Eastern Kingbird										X	X	X			X	X	X	X		1	Forest edges near water
Uria aalge	Common Murre			X	X		X													X	1	Rocky coasts / pelagic
Vireo solitarius	Blue-headed Vireo																X		X		1	Old spruce-fir forest
Zonotrichia albicollis	White-throated Sparrow								X	X	X	X	X				X	X	X		1	Forest with shrubby areas
Fish																					
Anguilla rostrata	American Eel												X							1	Catadromous
Osmerus mordax pop. 2	Rainbow Smelt												X							1	Lake Utopia
Osmerus mordax pop. 3	Rainbow Smelt												X							1	Lake Utopia
Prosopium cylindraceum	Round Whitefish												X							1	Lakes, large and medium rivers

Salmo salar	Atlantic Salmon												X							1	Anadromous
Salmo salar pop. 1	Atlantic Salmon												X							1	Anadromous
Fungi or Lichens																					
Degelia plumbea	Blue Felt Lichen													X			X	X		2	Fog forest and moist old forest
Nephroma laevigatum	Mustard Kidney Lichen			X	X												X			3	Coastal rock / deciduous forest
Peltigera collina	Tree Pelt Lichen															X	X	X		1	Moist forest
Pseudevernia cladonia	Light-and-dark Lichen															X				4	Coastal fog forest
Invertebrates																					
Alasmidonta undulata	Triangle Floater												X							1	Small, gravelly / sandy streams
Alasmidonta varicosa	Brook Floater												X							1	Shallow rivers and streams
Celithemis martha	Martha's Pennant							X			X			X	X	X				5	Vegetated ponds / lakes
Danaus plexippus	Monarch										X	X								1	Milkweed dependant
Enallagma geminatum	Skimming Bluet							X			X			X	X					6	Open, muddy ponds / lakes
Enallagma signatum	Orange Bluet							X			X			X	X					6	Ponds / lakes / streams
Enallagma vesperum	Vesper Bluet							X			X			X	X					6	Ponds / lakes / streams
Hetaerina americana	American Rubyspot													X	X					6	Wide, open streams / rivers
Ischnura posita	Fragile Forktail							X			X			X	X					6	Ponds / lakes / streams
Ladona exusta	White Corporal							X			X			X	X					6	Ponds / lakes / streams
Lestes eurinus	Amber-Winged Spreadwing							X			X			X	X					6	Ponds / lakes / streams
Lestes vigilax	Swamp Spreadwing								X	X		X		X						6	Shallow, acidic water
Ophiogomphus colubrinus	Boreal Snaketail							X						X	X					6	Lakes, streams
Ophiogomphus howei	Pygmy Snaketail													X	X					6	Rivers and streams
Pachydiplax longipennis	Blue Dasher							X						X	X	X				6	Slow moving water
Pantala hymenaea	Spot-Winged Glider							X						X		X				6	Temporary ponds / pools
Plebejus idas	Northern Blue								X		X						X			7	coniferous forest / bogs
Satyrium acadica	Acadian Hairstreak											X		X	X	X				7	Willow-lined streams / marshes
Strymon melinus	Grey Hairstreak											X			X					7	Open weedy areas

Stylurus scudderi	Zebra Clubtail												X	X						5	Sand-bottom streams and rivers
Mammals																					
Balaenoptera physalus	Fin Whale - Atlantic pop.																		X	1	Pelagic
Eptesicus fuscus	Big Brown Bat											X				X	X	X		1	Wooded areas
Eubalaena glacialis	North Atlantic Right Whale																		X	1	Pelagic
Globicephala melas	Long-finned Pilot Whale																		X	1	Pelagic
Lasiurus borealis	Eastern Red Bat													X	X		X	X		1	Large deciduous trees near water
Lasiurus cinereus	Hoary Bat													X	X	X	X	X		1	Large trees near water
Lynx canadensis	Canadian Lynx											X				X		X		1	Old conifer forest
Myotis lucifugus	Little Brown Myotis							X	X	X		X			X		X	X		1	Forest and wetlands
Phocoena phocoena (NW Atlantic pop.)	Harbour Porpoise																		X	1	Pelagic
Non-vascular plant																					
Bryum salinum	a Moss	X		X																8	Dune slacks and coastal soil
Dicranum spurium	Spurred Broom Moss							X								X				8	Acidic bogs and conifer forest
Porella pinnata	Pinnate Scalewort													X						8	Rocky riparian areas
Reboulia hemisphaerica	Purple-margined Liverwort															X	X	X		8	Rich moist open areas
Rhytidiadelphus loreus	Lanky Moss															X				8	Fog forest
Sphagnum angermanicum	a Peatmoss							X	X											8	Acidic moist areas
Sphagnum centrale	Central Peat Moss								X			X								8	Rich sedge fens
Sphagnum lindbergii	Lindberg's Peat Moss								X											8	Nutrient poor / medium fens
Sphagnum macrophyllum	a Sphagnum						X	X					X	X						8	Margins of lakes / ponds
Sphagnum platyphyllum	Flat-leaved Peat Moss						X	X	X				X	X						8	Margins of lakes / ponds / bogs
Tomentypnum falcifolium	Sickle-leaved Golden Moss							X	X											8	Bogs / fens
Turtles																					

Chelydra serpentina	Snapping Turtle							X			X	X	X	X	X	X					1	All freshwater habitats
Dermochelys coriacea (Atlantic pop.)	Leatherback Sea Turtle - Atlantic pop.	X																		X	1	Pelagic. Nests on beaches
Glyptemys insculpta	Wood Turtle								X		X		X	X	X	X		X			1	Streams and adjacent uplands
Vascular Plants																						
Agalinis neoscotica	Nova Scotia Agalinis							X			X			X	X						9	Swales and pond edges
Alisma subcordatum	Southern Water Plantain													X	X						9	Wet riparian areas
Alnus serrulata	Brookside Alder														X						9	Gravelly shoreline
Antennaria howellii ssp. petaloidea	Pussy-Toes														X						9	Shorelines
Antennaria parlinii	a Pussytoes														X						9	Shorelines
Atriplex franktonii	Frankton's Saltbush	X	X																		9	Salt marsh and beach
Barbarea orthoceras	American Winter-cress														X	X					9	Beaches, sandy / gravel shores
Blysmus rufus	Red Bulrush		X																		9	Brackish marshes
Callitriche hermaphroditica	Northern Water-starwort							X													9	Also found in brackish waters
Callitriche terrestris	Terrestrial Water-Starwort																		X		9	Ditchside
Cardamine parviflora var. arenicola	Small-flowered Bittercress																X				9	Ledges in dry woods
Carex granularis	Limestone Meadow Sedge														X	X					9	Shores and grassy meadows
Carex gynocrates	Northern Bog Sedge								X				X								9	Bogs / cedar swamps
Carex merritt-fernaldii	Merritt Fernald's Sedge														X						9	Sandy thickets / gravel banks
Carex prairea	Prairie Sedge								X				X				X				9	Alkaline boggy area
Carex rostrata	Narrow-leaved Beaked Sedge														X	X					9	Wet shores / meadows
Carex tenuiflora	Sparse-Flowered Sedge								X	X											9	Rich fens / boggy meadows
Carex vacillans	Estuarine Sedge		X																		8	Salt marsh
Cephalanthus occidentalis	Common Buttonbush										X				X	X					9	Swamps and stream margins

Chamaesyce polygonifolia	Seaside Spurge	X																		9	Coastal sand / gravel
Chenopodium simplex	Maple-leaved Goosefoot															X	X	X		9	Moist rocky woods
Cinna arundinacea	Sweet Wood Reed Grass											X			X					9	Alluvial woods
Crataegus jonesiae	Jones' Hawthorn													X	X	X	X	X		9	Woods and shore thickets
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper													X	X					9	Calcareous riverbanks and cliffs
Desmodium glutinosum	Large Tick-Trefoil															X	X	X		9	Rich, rocky woods
Dichanthelium dichotomum	Forked Panic Grass															X				9	Sandy pine woods
Dichanthelium linearifolium	Narrow-leaved Panic Grass															X				9	Softwood forest
Draba arabisans	Rock Whitlow-Grass													X						9	Dry calcareous ledges
Drosera rotundifolia var. comosa	Round-leaved Sundew							X	X											9	Bogs
Eleocharis flavescens	Pale Spikerush									X										8	Wet areas
Elodea nuttallii	Nuttall's Waterweed						X						X							9	Shallow, quiet waters
Epilobium coloratum	Purple-veined Willowherb													X		X	X	X		9	Open, seepy areas
Eragrostis pectinacea	Tufted Love Grass													X	X					9	Sandy shores
Euphrasia randii	Rand's Eyebright			X	X															9	Exposed coastal headlands
Galium brevipes	Limestone Swamp Bedstraw													X						9	Swampy lakeshore
Gentiana rubricaulis	Purple-stemmed Gentian									X	X									9	Moist meadows / thickets
Glyceria obtusa	Atlantic Manna Grass							X												9	Bog edges
Gratiola aurea	Golden Hedge-Hyssop						X						X	X						9	Muddy lakes and shores
Hedeoma pulegioides	American False Pennyroyal													X		X		X		9	Ledges and dry, gravelly soil
Hepatica nobilis var. obtusa	Round-lobed Hepatica																X	X		9	Mixed / deciduous forest
Hieracium kalmii	Kalm's Hawkweed															X	X	X		9	Forest edges
Hypericum dissimulatum	Disguised St John's-wort															X		X		9	Damp, open areas
Juncus greenei	Greene's Rush									X										9	Wet meadows

Listera auriculata	Auricled Twayblade										X	X		X	X					9	Alder thickets / cedar swamps
Listera australis	Southern Twayblade							X				X				X				9	Black spruce bogs
Lomatogonium rotatum	Marsh Felwort									X				X						9	Wet meadows and shores
Lonicera oblongifolia	Swamp Fly Honeysuckle								X	X		X								9	Calcareous fens / swamps
Lysimachia hybrida	Lowland Yellow Loosestrife									X				X	X					9	Wet meadow
Lysimachia quadrifolia	Whorled Yellow Loosestrife																			9	Wet meadow
Malaxis brachypoda	White Adder's-Mouth											X				X				9	Calcareous cedar swamp
Minuartia groenlandica	Greenland Stitchwort															X	X	X		8	Rocky / gravelly slopes
Myriophyllum humile	Low Water Milfoil						X						X		X					9	Shallow acidic water
Najas gracillima	Thread-Like Naiad						X						X							9	Aquatic
Nuphar lutea ssp. rubrodisca	Red-disked Yellow Pond-lily						X						X							9	Slow moving waters
Orobanche uniflora	One-Flowered Broomrape									X	X					X	X	X		9	Dampe thickets, woods, meadows
Osmorhiza longistylis	Smooth Sweet Cicely															X	X	X		9	Moist woods / clearings
Pedicularis canadensis	Canada Lousewort															X	X	X		9	Open dry woods
Piptatherum canadense	Canada Rice Grass															X	X	X		9	Sandy barrens and rocky clearings
Platanthera flava var. herbiola	Pale Green Orchid													X	X					9	Open grassy floodplain
Platanthera huronensis	Fragrant Green Orchid							X	X	X										9	Bogs, fens sedge meadows
Podostemum ceratophyllum	Horn-leaved Riverweed												X							9	Fast moving water
Polemonium vanbruntiae	Van Brunt's Jacob's-ladder									X	X	X		X	X					9	Swampy areas
Polygala paucifolia	Fringed Milkwort																	X		9	Moist, acid mixedwood
Polygala sanguinea	Blood Milkwort															X	X	X		9	Open woods / clearings
Polygonum amphibium var. emersum	Water Smartweed												X							9	Aquatic
Polygonum careyi	Carey's Smartweed						X			X	X	X								9	Open swamp margins

Potamogeton bicupulatus	Snailseed Pondweed								X					X							9	Muddy water
Potamogeton vaseyi	Vasey's Pondweed								X					X							9	Muddy water
Proserpinaca palustris var. crebra	Marsh Mermaidweed							X						X							9	Shallow, acid water
Proserpinaca pectinata	Comb-leaved Mermaidweed													X							9	Shallow, acid water
Pseudognaphalium macounii	Macoun's Cudweed																X	X	X		9	Clearings and disturbed areas
Puccinellia phryganodes	Creeping Alkali Grass		X																		9	Sandy / gravelly openings in saltmarsh
Quercus macrocarpa	Bur Oak												X		X	X					9	Swampy woods / bottomlands
Ranunculus flabellaris	Yellow Water Buttercup							X						X							9	Shallow, quiet waters
Ranunculus longirostris	Eastern White Water-Crowfoot							X						X	X						8	Ponds, lakes, streams
Ranunculus sceleratus	Cursed Buttercup		X												X						9	Damp areas and salt marsh edges
Rubus pensilvanicus	Pennsylvania Blackberry																X	X	X		9	Clearings and disturbed areas
Sagina nodosa	Knotted Pearlwort																X	X	X		9	Rocky ground
Salix myricoides	Bayberry Willow																X	X	X		9	Gypsum cliffs and woods
Scrophularia lanceolata	Lance-leaved Figwort																X	X	X		9	Open woods and fields
Senecio pseudoarnica	Seabeach Ragwort	X																			9	sandy / gravelly beaches
Solidago altissima	Tall Goldenrod												X			X					9	Alluvial meadows
Spiranthes cernua	Nodding Ladies'-Tresses																X	X	X		9	Sandy openings and springy slopes
Spiranthes ochroleuca	Yellow Ladies'-tresses																X	X	X		9	Open disturbed areas
Symphyotrichum novi-belgii var. crenifolium	New York Aster											X			X	X					9	Thickets and gravelly shores
Symphyotrichum racemosum	Small White Aster														X	X	X	X	X		9	Wet woods, fields and shores
Symplocarpus foetidus	Eastern Skunk Cabbage											X	X								9	Alder thickets / swampy woods
Triadenum virginicum	Virginia St John's-wort										X	X	X								9	Marshy / swampy areas
Triglochin gaspensis	Gaspé Arrowgrass		X																		9	Salt marsh

Utricularia radiata	Little Floating Bladderwort												X							9	Shallow water
Vaccinium boreale	Northern Blueberry								X								X				9	Peaty barrens
Vaccinium corymbosum	Highbush Blueberry											X	X		X	X					9	Shoreline swamps / thickets
Viburnum acerifolium	Maple-leaved Viburnum																	X			9	Deciduous forest
Viburnum lentago	Nannyberry											X	X		X						9	Shoreline swamps / thickets
Viburnum recognitum	Northern Arrow-Wood											X			X	X					9	Streambanks / thickets
Viola novae-angliae	New England Violet														X						9	Gravelly shores and ledges
Viola sagittata var. ovata	Arrow-Leaved Violet																X	X	X		9	Dry open ground
Woodwardia virginica	Virginia Chain Fern								X	X			X								9	Acid bogs and swamps
Zizania aquatica var. aquatica	Indian Wild Rice		X								X										9	Shallow herbaceous water

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APPENDIX E: Methodology: Conservation Actions Prioritisation

1. Purpose of Analysis

The prioritization methodology used in this report identified areas within the Outer Bay of Fundy Bioregion where conservation efforts should be concentrated. The goal is to achieve the best possible impact in the areas that are the most critical for the defined priority habitats, while minimizing threats to those habitats.

2. Conservation Prioritization

The process for assigning priority ranks within the Outer Bay of Fundy Bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. Wherever possible, weighting criteria included size (e.g. minimum patch size), representivity (by ecodistrict) and uniqueness (rarity within each ecodistrict and within the bioregion). The methodology was deliberately designed to promote parcels of land that contained larger patches of priority habitats, those that were not adequately represented within current protected areas and rare/priority species and habitat occurrences. The more high quality priority habitats an area contained, the higher the priority rank it received. Promoting small extents of multiple priority habitats was avoided by selecting minimum size criteria for habitat-based biodiversity habitats. Higher scores were given to areas with larger patches of ecosystems selected as biodiversity habitats. Existing protected areas and other conservation lands were included in the analysis.

3. Data Pre-Processing

Biodiversity Target Data Sources:

- **Beaches, Dunes and Cliffs** - All beaches and dunes were selected from the provincial resource inventory database (WT = BC and DU). Cliffs were delineated from the Bay of Fundy coastline classification (DFO 2012). See Additional Habitat Weighting for a description of Cliff target data use.
- **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 and Rocky Shores** - Tidal flats and rocky shores were selected from the provincial wetland inventory database (WT = TF and RK). 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 (TNC 2005). 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. From this selection, coastal islands highlighted as Ecologically and Biologically Significant Areas in the Bay of Fundy (Buzeta 2014) were used within this analysis.

- **Forest Mosaic** - Using the provincial resource inventory database (NBDNR 2008), 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 (NBDNR 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)

Cleaning the Data

The first step prior to the prioritization analysis was to clean the GIS data before assignment of weights on the habitats was calculated. In order to avoid weighting polygons based on topographic errors, all polygons of the same habitat type were dissolved in ArcGIS to eliminate any insignificant boundaries between contiguous patches. The selected patches were then dissolved to form new contiguous polygons. Area of each patch was recalculated using “Calculate Geometry” and weights were then assigned based on the new area of the dissolved polygons.

Conservation Analysis

Three-tiered Equation

For each target habitat, final scores between 0 and 1 were assigned, with 1 representing ecologically significant habitat best suited for nested targets. All target habitat occurrences (except cliffs, coastal islands and riparian areas – see below) were scored using a three-tiered equation that equally divides the scoring by habitat uniqueness, representivity and size:

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

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 specie assemblages than coastal blanket bogs). As a result, it is assumed that differences in habitats between ecodistricts could support different assemblages of specialist species. The uniqueness calculation accounts for the rarity of habitat types within each ecodistrict and within the Natural Area as a whole. The uniqueness score is determined by the average of two area based assessments:

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

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

Habitat refers to the type of habitat (*e.g.* bog) that is nested within a particular biodiversity *Target* (e.g., Freshwater Wetlands). Subscript *NA-Eco* denotes the portion of ecodistrict area that is within the Bioregion and subscript *NA-Total* denotes the total area within the Natural Area. The final uniqueness score is calculated as:

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

This method of calculating uniqueness gives equal weighting to each of the base assessments. U_1 addresses the uniqueness of ecodistrict-specific habitat as compared to all other occurrences of the same habitat within the Bioregion (*e.g.* uniqueness of bogs along the Fundy coast as compared to all other bogs within the NA). U_2 addresses the uniqueness of the habitat type in general (*e.g.* the uniqueness of bogs as compared to all other Freshwater Wetlands within the NA). For habitat types represented by their own target (*e.g.* Salt Marsh), the U_2 equation was not relevant and the final uniqueness score for these habitats was based on the output of the U_1 equation.

Representivity:
Using the enduring feature approach discussed above, representivity is calculated using two area based assessments (R_1 and R_2), as follows:

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

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

where *Eco* refers to the area of land represented by the Ecodistrict in total (subscript *Total*) and within the NA (subscript *NA*). The subscript *Eco* refers to the total amount of each *Habitat* within the Ecodistrict, regardless of the proportion that is within the bioregion boundary. The final representivity score is calculated as:

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

This method of calculating representivity accounts for the total area each Ecodistrict represents within the bioregion boundary (R_1) and this number is prorated by the percent of habitat that occurs within the portion of the Ecodistrict within the bioregion. Conceptually, if both R_1 and R_2 are equal, the habitat type is equally represented across the Ecodistrict, both inside and outside the bioregion boundary (*Representivity* = 0). If R_1 is smaller than R_2, than a higher proportion of habitat is located within the bioregion portion of the Ecodistrict, which results in a higher score (*Representivity* > 0). If R_1 is larger than R_2, than a lower proportion of habitat is located within the bioregion 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 portion of the Ecodistrict. 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 (NBDNR 2013).

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

Habitat occurrences that meet or exceed the minimum threshold 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 E1 for a summary of size criteria used within the analysis.

Table E1. Minimum size criteria for each habitat type within the Outer Bay of Fundy analysis

Habitat	Minimum Size (Acres)	Minimum Size (Hectares)
Beaches and Dunes	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[1]		
Tolerant Hardwood (OTHH)	247.1	100
Intolerant Hardwood (OHWH)	74.1	30
Spruce / Fir (OSFH)	926.6	375
Pine (PINE)	24.7	10
Other (OOFH)	926.6	375

Additional Habitat Weighting

- **Calcareous Ecosites**:
  Habitat occurrences that overlap calcareous ecosites (Zelazny, 2007) received an additional value of 0.2.
- **Upland Buffers**:
  Salt marsh and freshwater wetland habitat occurrences were assigned buffers of 275 m (EC, 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.
- **Cliffs**:
  As linear features, cliffs could not be assigned a significance score based on the three-tiered equation. To account for this, parcels of land that intersected the delineated cliff layer were assigned an additional value of 0.2.

Species Analyses

As part of collaboration with the Canadian Wildlife Service and other conservation organizations within the Maritime region, a biodiversity composite was developed for New Brunswick. The objective of the composite was to determine "biodiversity hotspots" across the province, which was then used within the bioregion boundary to determine areas of high conservation value. See Appendix F for a complete methodology of the New Brunswick Biodiversity Composite.

Combining the Data

[1] For old forest communities patch sizes were adapted from the Provincial Old Forest Community and Wildlife Habitat Definitions (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.

Once all vector layers (shapefiles) and species composites (GRIDS) were prepared, each was converted into raster format using a cell size of 10m. A small cell size was based on the error of the data layers and was used in order to ensure the resolution of the data would not be generalized. All rasters were then overlaid and added together to give an overall scoring across the bioregion (using the Cell Statistics tool). Each biodiversity habitat was weighted the same when the final score was calculated. Table E2 shows the list of all rasters that were combined for prioritization with their respective scoring.

Table E2. List of rasterized layers used in the bioregion analysis with their respective scoring range.

Prioritization Raster	Scoring Values
Beaches and Dunes	0 - 1
Salt marsh	0 - 1
Tidal Flats	0 - 1
Acadian Forest Mosaic	0 - 1
Freshwater wetlands	0 - 1
Buffers (salt marsh and freshwater wetlands)	0 – 0.2
General biodiversity species composite	0.2 - 1
Species-at-risk composite	0.2 - 1
Calcareous Areas	0 – 0.2
Riparian Areas	0 – 0.2
Cliffs	0 – 0.2

Species Analyses

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RESULTS

The results of the final prioritization (Figure 20; Table E3) seem to be consistent with firsthand knowledge of conditions across the Outer Bay of Fundy Bioregion, although the results of this analysis should be used in combination with field visits and local knowledge. A P3 rank does not indicate that an area is of little conservation value, rather it is of lesser conservation value than P1 or P2 areas.

Summary Table

Table E3: Summary results of the property prioritization in the NB Outer Bay of Fundy Bioregion.

Priority Ranking	Break Values/Scores	Acres	Hectares	% of Bioregion
Very High	>1	554,800	224,520	40
High	0.8 - 1	218,280	88,335	16
Moderate	0.6 – 0.8	211,836	85,727	15
Low	0 – 0.6	258,247	104,509	19
Protected	N/A	142,255	57,568	10
Total	**N/A**	**1,385,419**	**560,660**	**100**

APPENDIX F: Biodiversity Composite Methodology

Analyses rely on priority biodiversity species lists established by consensus according to objective selection criteria, recognising that important data gaps exist for several taxa. Specifically, species within these lists include ACCDC ranked S1, S2, or S3 with a G1, G2, or G3 ranking; BCR 14 'priority species' by province; COSEWIC Endangered, Threatened, and Special Concern. Species for which occurrence is considered accidental, specifically birds, were excluded from lists. Priority species habitat associations (where this information is available) can be considered for the purpose of more objective identification of priority habitats. In other words, tallies based on occurrence of priority species within certain habitat types can help inform the selection of habitat priorities if none are identified otherwise (see section on habitat data, below).

2.2 SPECIES DATA SOURCES

Data layers, data sources and data types used to describe species spatial distribution:

Data layers	Data source	Source data type
Occurrence of mammals, reptiles, amphibians, vascular plants, non-vascular plants, lichens, etc.	AC CDC	Points
Relative abundance of birds	MBBA point count	Points, counts
Breeding evidence of birds	MBBA breeding evidence	Polygons (10X10 km squares), breeding evidence categories
Occurrence and abundance of rare and colonial bird species	MBBA rare/colonial species	Points, counts
Occurrence and abundance of shorebirds	CWS Atlantic Canada Shorebird Survey database	Points, counts
Occurrence and abundance of colonial birds	CWS Atlantic Region Colonial Waterbird database	Points, counts
Occurrence and abundance of coastal waterfowl	CWS Atlantic Canada Coastal Waterfowl Survey database	Polygons (irregular blocks), counts
Occurrence of SAR critical habitat	CWS Atlantic Region Critical Habitat Mapping Database	Polygons (irregular)

Atlantic Canada Conservation Data Centre (ACCDC) data

Species Occurrence Data

The ACCDC dataset contains point data records for a large number of species occurring in Atlantic Canada (mostly Maritimes). Points within the ACCDC database with low geographic certainty, and species that were not appropriate for the analyses were excluded from the dataset. All records with higher geographic certainty (according to the ACCDC data) were retained and then classified into broad groups consisting of: Aquatic, Mammal, Bird, Reptile/Amphibian, Insect, or Plant. Next, G and S ranks for these species were assessed. Only species with a ranking of S1 or S2, or S3 with a global ranking of G1, G2 or G3, were retained. All species listed by COSEWIC were retained, regardless of their S or G rankings.

Species listed as BCR priority species were retained, regardless of S or G rankings. Those not already listed in the ACCDC were added to the list. However, information from the ACCDC dataset for BCR priority species was retained for analyses only if information could not be obtained via the original data sources (i.e., MBBA, CWS).

Habitat associations were determined (where possible) for each species, based on information within datasets, specific studies, or expert advice.

Maritimes Breeding Bird Atlas (MBBA) data

Point Count Data

During development of the Maritimes Breeding Bird Atlas, species relative abundance maps were derived from point data records originating primarily from priority squares (approximately ¼ of all squares in the Maritimes). These point count data were used by Bird Studies Canada to derive species relative abundance maps for the Maritimes on behalf of the Maritimes Breeding Bird Atlas. Methodologies for creating these relative abundance maps since have changed and this set will not be used within the publication.

Breeding Evidence Data

Confirmed = 0.5 (for each Atlas; max value of 1)
Probable = 0.3 (for each Atlas; max value of 0.6)
Possible = 0.1 (for each Atlas; max value of 0.2)

Rare/Colonial Species Data

Colonial buffer = 500 m

CWS data

Atlantic Canada Shorebird Survey Data

This dataset began as the Maritimes Shorebird Survey (MSS), following initial efforts by Canadian Wildlife Service employees to monitor migrating shorebirds at a limited number of sites. The program now enlists skilled volunteer contributors from throughout Atlantic Canada and now includes a small (and growing) number of sites in Newfoundland and Labrador. Repeated within-season surveys follow a defined protocol and typically occur during spring, summer and fall periods at established locations.

Atlantic Colonial Waterbird Data

This database contains records of individual colony counts, by species, for known colonies located in Atlantic Canada. Although some colonies are surveyed annually, most are visited much less frequently. Methods used to derive colony population estimates vary markedly among colonies and among species.

Atlantic Coastal Waterfowl Survey Data

This dataset is derived from aerial surveys of waterfowl (e.g., ducks and geese) occurring within coastal and inshore waters of Atlantic Canada, and organised within polygons rather than by points. The sampling unit for these databases is the coastal (and inshore) waterfowl 'block'. Coastal waterfowl

'block' polygons were established at the beginning of these monitoring programs and have remained fixed over time. Polygon sizes differ geographically (within and among EC CWS Regions) and are irregularly shaped. 'Blocks' were initially designed to reflect prominent coastline features that separate coastal segments, inshore bays and estuaries, and thus define functionally distinct habitat units (for waterfowl). Records include counts of birds of each species observed within each polygon during each survey visit.

Although observers attempt to identify individuals or flocks of birds to species, this is not always possible. Incidental records (i.e., not gathered consistently) of other bird species, mostly marine, can be found within these databases. In particular, incidental records include coastal and inshore zone species not well captured through other surveys (e.g., loons, grebes, gulls, shorebirds, and cormorants).

Atlantic Region Species at Risk Critical Habitat Mapping

Mapping of Critical Habitat for Species at Risk in the Atlantic Region has involved identifying the unique aspects of each species' habitat and illustrating those elements through a GIS model. Through field work data and GIS applications, spatial reference that reflects the sensitivity of species and their respective habitats was created for 23 species. The model for the identification of Critical Habitat for Species at Risk will continue to be used to identify habitat for new species, as well as to refine the data available for existing Species at Risk.

SPECIES DATA STEPS

ACCDC data

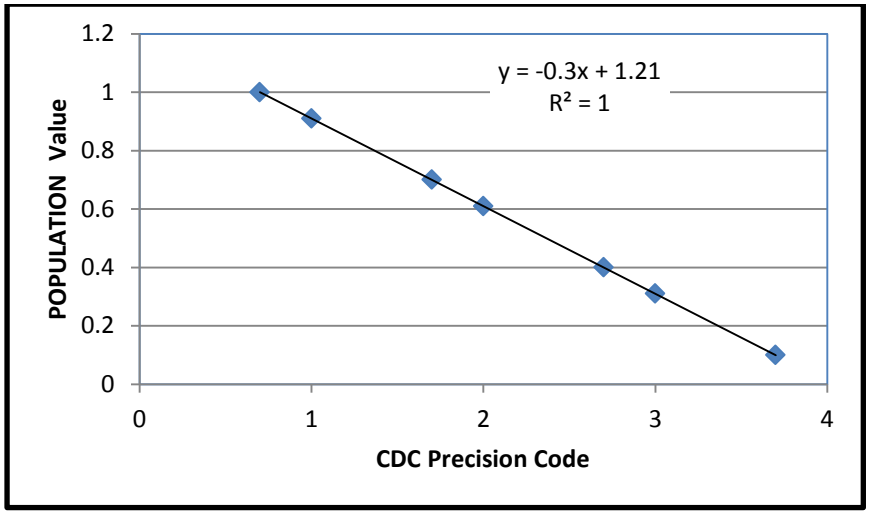
1) Generate point process layers (shapefiles) for each species within the dataset. All records must have a CDC Precision Code value of 3.7 or less (see Table F1).

2) Generate 'Primary Buffers' by conducting kernel density analysis for each species, using a 500 m radius, a 10m output cell size and the appropriate 'POPULATION' parameter value (Figure F1). This approach attributes more value to pixels closest to the centroid with more precise observations.

Table F1: ACCDC precision code, definitions, spatial context, unit size and range of values within the dataset.

prec	*common speech*	*example*	*unit size*	*literal range (m)*
6.0	within province	province	1000.0km	562.3 - 1778.3
5.7	in part of province	'NW NB'	500.0km	281.2 - 889.1
5.0	within in county	county	100.0km	56.2 - 177.8
4.7	within 50s of kilometers		50.0km	28.1 - 88.9
4.0	within 10s of kilometers	BBA grid	10.0km	5.6 - 17.8
3.7	within 5s of kilometers		5.0km	2.8 - 8.9
3.0	within kilometers	topo grid	1.0km	0.6 - 1.8
2.7	within 500s of meters		500.0m	281.2 - 889.1
2.0	within 100s of meters	ball field	100.0m	56.2 - 177.8
1.7	within 50s of meters		50.0m	28.1 - 88.9
1.0	within 10s of meters	boxcar	10.0m	5.6 - 17.8
0.7	within 5s of meters		5.0m	2.8 - 8.9
0.0	within meters ***NOT USED***	pace	1.0m	0.6 - 1.8
-1.0	within 10s of centimeters	fingernail	0.1m	0.1 - 0.2

Figure F1: Population values derived for the purpose of informing the kernel density point process using precision code values found within the ACCDC dataset. Linear equation can be used to populate a new attribute field with POPULATION value information.



3) Conduct buffer analysis to derive 'Secondary buffers' for each species, using a 5000 m radius. Use a fixed value of 0.2 for pixels within the secondary buffer.
4) Combine Primary and Secondary buffers for each species (at the provincial geographic scale) to create species rasters with pixel values ranging from 0 to 1 (Maritimes scale).
5) Overlay rasters from the suite of species to derive multi-species 'Biodiversity Composites'.

MBBA point count

1) These data can be used to represent the relative abundance of breeding priority bird species detected during the course of point count surveys.
2) Relative abundance rasters were derived from point count information by Bird Studies Canada.
3) Final decisions on quality and appropriateness of individual rasters were made 'a priori' by MBBA and BSC staff.
4) All rasters were reclassified such that values range between 0 and 1.

MBBA breeding evidence

1) These data can only be used to represent evidence of breeding of priority bird species as determined during the course of breeding evidence surveys. These data specifically were used for species not captured adequetaly during the course of point count surveys.
2) The highest level of breeding evidence was determined, by species, for each square, for each of two Atlas periods (1986-1991; 2006-2011).
3) Raster values were derived using this breeding evidence data according to following rules: Confirmed = 0.5; Probable = 0.3; Possible = 0.1.
5) Rasters for both Atlas periods were summed such that combined values for a given species range from 0 to 1.

MBBA rare and colonial

1) To represent breeding priority bird species

2) Use rare and colonial data records
3) Derive rasters using colonial data only for species not captured adequately in either point count or breeding evidence datasets.
4) Buffer colonies by 500 m
5) Values within buffer area given value of 1. Kernel density estimator, range from 0.2 to 1.
6) 'Rare' species records to be used 'a posteriori' for verification of specific areas and land parcels.

ACSS data: shorebirds
1) These data were used to represent predominantly non-breeding priority shorebird species surveyed during the spring or Fall migration periods.
2) Use species abundance data (counts, by shorebird survey site, by species)
3) Derive rasters using count data for species not captured adequately through other surveys.
4) Create rasters for each species such that combined values for a given species range from 0 to 1.

ACW data: colonial waterbirds
1) To represent non-breeding priority bird species
2) Use species abundance data (counts, by colony survey site, by species)
3) Derive rasters using count data for species not captured adequately through other surveys.
4) Create rasters for each species such that combined values for a given species range from 0 to 1.

AR SAR CH mapping data
1) To represent Atlantic Region Species at Risk for which Critical Habitat (CH) mapping has been initiated.
2) Map CH polygons, for Endangered and Threatened priority species, instead of using layers for species derived using other datasets.
3) Buffer CH polygons by 5 km
4) CH polygons given value of 0.8, surrounding buffer given value of 0.2, for a total ranking of 1 for CH polygons.

SPECIES DATA COMPOSITES

Results:
Overlaying the rasters for the suite of priority species creates a biodiversity composite. These biodiversity composites can be adapted to illustrate biodiversity hotspots, hotspots for particular suites of species, hotspots for species associated with target habitats (based on species-habitat matrices), etc.
NOTE: A batch processing tool was developed by NCC to automate steps 1) through 5), with the exception of establishing the target list of species considered.
Tool: The tool currently creates both Primary and Secondary buffers (rasters). The tool also normalizes the individual kernel density rasters (max value of 0.8) and adds to them the fixed primary buffer values (fixed value of 0.2), such that the total for each resulting species raster varies between 0-1.