Nova Scotia Inner Bay of Fundy Habitat Conservation Strategy

Final Report to Environment Canada
by the Mersey Tobeatic Research Institute

March 2015

EXECUTIVE SUMMARY

This Habitat Conservation Strategy (HCS) was developed through collaboration among member organizations of the Eastern Habitat Joint Venture (EHJV) Nova Scotia Steering Committee and partner conservation groups. It is intended to be one of a series of HCS with contiguous boundaries that will consider all areas of the province. 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 HCS is to identify and assess the current state of species and ecological communities of conservation priority for the Nova Scotia Inner Bay of Fundy (NS IBoF) 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.

Ecological context

Situated in central Nova Scotia, the Nova Scotia Inner Bay of Fundy (NS IBoF) bioregion encompasses eight primary watersheds that empty into the Minas Basin and Chignecto Bay. In addition to the world's highest tides, the NS IBoF bioregion boasts one of the richest coastal estuarine environments on the planet, containing sites of global significance to migratory shorebirds and fish. The complex geographic landscape of the Inner Bay of Fundy also makes it one of the most ecologically diverse bioregions in Atlantic Canada, containing a suite of both unique and representative habitat types and has long been recognised as an area of ecological significance. Two National Wildlife Areas, two Migratory Bird Sanctuaries, three Important Bird Areas and two Ramsar wetlands of international importance occur within the bioregion (Summary—Figure 1). The boundary of the bioregion also encompasses the Bay of Fundy Western Hemispheric Shorebird Reserve. Consequently, the region contains a high concentration of rare species and ecological communities, including 25 species listed on Schedule 1 of the *Species at Risk Act* and 27 species listed in the *Nova Scotia Endangered Species Act*.

Goals

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

1) Identify areas that are important for conservation priority habitats and species.
2) Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3) Maintain healthy, intact, and fully functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
4) Support the management of and protect 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, further informed by federal and provincial resources on species at risk.
6) Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7) Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

Conservation priority habitats

Based on habitat affinities of rare species, species at risk, and priority bird species, but independently of spatial patterns of species occurrence, the following nine habitat types were determined to be conservation priorities for the NS IBoF bioregion:

1) Coastal beaches and cliffs
2) Tidal flats
3) Salt marshes
4) Coastal islands

5) Barrens
6) Caves and calcareous sites
7) Aquatic and riparian systems
8) Freshwater wetlands
9) Late-successional Acadian Forest Mosaic

A map was generated depicting the spatial location of overall conservation priority habitats based on habitat uniqueness, representivity, and patch size (Summary—Figure 2). This overall conservation priority habitat composite does not incorporate information on occurrence records of rare and endangered species, or conservation priority birds. Different perspectives on species-based prioritizations are presented in the priority species composite maps in Figures 26 to 36 (p. 96 to 103) which illustrate the distribution of 11 priority species assemblages derived from best available occurrence data for each species. The reader is cautioned that best available occurrence data for most species remains incomplete, to varying degrees, with availability being a function of survey timing and survey effort, leading to variable, but important bias in some related maps. As such, multi-species composite maps and all other maps derived from the individual species maps are also vulnerable to bias.

The integration of priority habitat data (the priority habitat composite) and priority species information (the priority species composite for all priority species) results in the Conservation Value Index (CVI) map for the bioregion (Summary—Figure 3). This map was developed to identify sites within the NS IBoF bioregion that have the highest conservation value in terms of priority habitat attributes and priority species, given the available data. Given that no single map can be expected to provide one ‘best’ answer, the reader is advised to compare and contrast the priority habitat composite map with the Conservation Value Index (CVI) map when using this document for decision support. To supplement these figures Appendix C presents a summary of the species presented in each map, and the dataset used to represent these species.

Threats

The following threats (following IUCN nomenclature) have been identified as medium to high across the conservation priority habitats:

Current:

- 1.1 Housing and urban areas
- 2.1 Annual and perennial non-timber crops (incompatible agricultural practices)
- 2.2 Wood and pulp plantations
- 4.1 Roads and railroads (road network)
- 5.3 Logging and wood harvesting (incompatible forestry practices)
- 7.2 Dams and water management/use (dams and other aquatic barriers)

Emerging:

- 8.1 Invasive non-native/alien species/diseases
- 11.1 Habitat shifting and alteration
- 11.4 Storms and flooding

Conservation Actions

The following summary presents the conservation actions undertaken by organizations working in the NS IBoF 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 Table 16 (p. 95).

Government of Canada – Environment Canada

- Implement and enforce the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promote the Federal Policy on Wetland Conservation.
- Contribute to Marine Protected Area Network planning within the Scotian Shelf marine bioregion, and to the identification of Ecologically and Biologically Significant Areas and other habitat classification schemes that contribute towards the goal of protecting 10% of coastal and marine areas by 2020 (in partnership with the DFO, PC).
- Offer support to ENGOs, communities, aboriginal organizations, and academia via employment programs, including the Science Horizons Youth Internship Program and the International Environmental Youth Corps.
- Offer support to ENGOs, communities, aboriginal organizations, and academia via Community Action Programs for the Environment, including work on habitat and ecological system conservation/stewardship through direct and in-kind support (e.g., EcoAction Community Funding Program, Environmental Damages Fund, National Conservation Plan – National Wetland Conservation Fund, National Conservation Plan – Gulf of Maine Initiative, Atlantic Ecosystem Initiatives, Ecological Gifts Program, Habitat Stewardship Program – Prevention Stream, Aboriginal Fund for Species at Risk – Prevention Stream).
- Offer support to ENGOs and aboriginal organizations for work specifically on species at risk via the Habitat Stewardship Program and Aboriginal Fund for Species at Risk.
- Engage and consult with all partners in the development of SAR recovery documents, and support activities described within recovery documents for the schedule of studies for SAR and the identification of their critical habitat within the NS IBoF bioregion (in partnership with EC, NSDNR, Academic Institutions, NSNT, NCC, MTRI).
- Support the EHJV and provide science guidance to conservation partners on actions and priorities for migratory birds and SAR including development, refinement, and implementation of this HCS and of the NS Bird Conservation Region 14 Strategy.
- Continue management activities associated with Chignecto-John Lusby Marsh and Boot Island National Wildlife Areas and Amherst Point and Kentville Migratory Bird Sanctuaries.
- Inform and implement the North American Waterfowl Management Plan (NAWMP) and conduct waterfowl surveys as required by the plan (in partnership with the EHJV).

Province of Nova Scotia

- Designate 68 000 ha of new protected areas under the 14% Protected Areas Initiative.
- Complete a gap analysis for the province’s system of protected areas.
- Assess air quality and climate change using lichens within permanent sample plots.
- Complete ecological risk assessments to assess threats to species and ecosystems within existing and proposed protected areas. Create a spatial layer of sensitive habitats and ecosystems to aid in planning and an action plan for protected area managers.

- Continue to locate, map and assess potential old growth stands on private and public lands using adaptations of the NSDNR's old forest scoring methods to refine parcel prioritization, inform conservation efforts, and help maintain old forests and associated biodiversity for landscape connectivity according to Nova Scotia's Old Forest Policy.
- Undertake wildlife and environmental enforcement activities (EC Wildlife Enforcement, Environmental Enforcement); address illegal hunting and disturbance, illegal activities and habitat destruction (in partnership with EC).

<u>Eastern Habitat Joint Venture</u>

- Inform and implement the North American Waterfowl Management Plan (NAWMP) and conduct waterfowl surveys as required by the plan (in partnership with the EC).
- Engage in partnerships with agricultural producers and practitioners to improve the conservation and restoration of wetland habitat in the agricultural landscape, primarily through the promotion and delivery of Agricultural Biodiversity Conservation (ABC) Plans and identification of Beneficial Management Practices (BMP's) that promote the maintenance or enhancement of biodiversity on farms.

<u>Nature Conservancy of Canada</u>

- Work collaboratively with partners and neighbours to manage NCC conservation lands in the bioregion, including the development of management plans and baseline inventories, and undertake priority site management activities. Monitor key threats, and where possible, take direct action to mitigate threats posing an imminent impact to conservation priority habitats.
- Conduct a landscape connectivity analysis in the Chignecto Isthmus region to identify optimal connectivity corridors between core protected areas/natural habitats with results to be communicated with relevant decision makers and planners.
- Establish a structure to facilitate collaboration and strategic decision making regarding invasive species control techniques (e.g., Invasive Species Alliance; in partnership with MTRI).
- Participate in the review and update of the Nova Scotia Mineral Resources Act and seek appropriate mechanisms for resolution of conflicts between private conservation lands and sub-surface rights (in partnership with NSNT).

<u>Nova Scotia Nature Trust</u>

- Create baseline reports and management plans for all properties formally protected by NSNT in the bioregion. Manage protected sites for biodiversity conservation through regular monitoring and stewardship activities.
- Address habitat threats through the education and engagement of stakeholders, landowners, and landusers.
- Participate in the review and update of the Nova Scotia Mineral Resources Act and seek appropriate mechanisms for resolution of conflicts between private conservation lands and sub-surface rights.

<u>Bird Studies Canada</u>

- Continue to work together through the coordination of volunteers and partners in shorebird monitoring (including threat monitoring), staging habitat protection (e.g., addressing threats at roosting sites), and stewardship at sites adjacent tidal flats of NS IBoF, including joint monitoring collaborations, outreach, and volunteer celebration events (in partnership with Environment Canada).
- Engage with international partners in shorebird conservation to improve information sharing.

- Continue to systematically monitor population levels of Chimney Swift at known roost sites through a citizen-science monitoring and conservation program to advance knowledge of nesting ecology, and to increase awareness of this species at risk in the Maritimes. Continue to solicit the public for sightings of Chimney Swift and nest locations (in partnership with EC).

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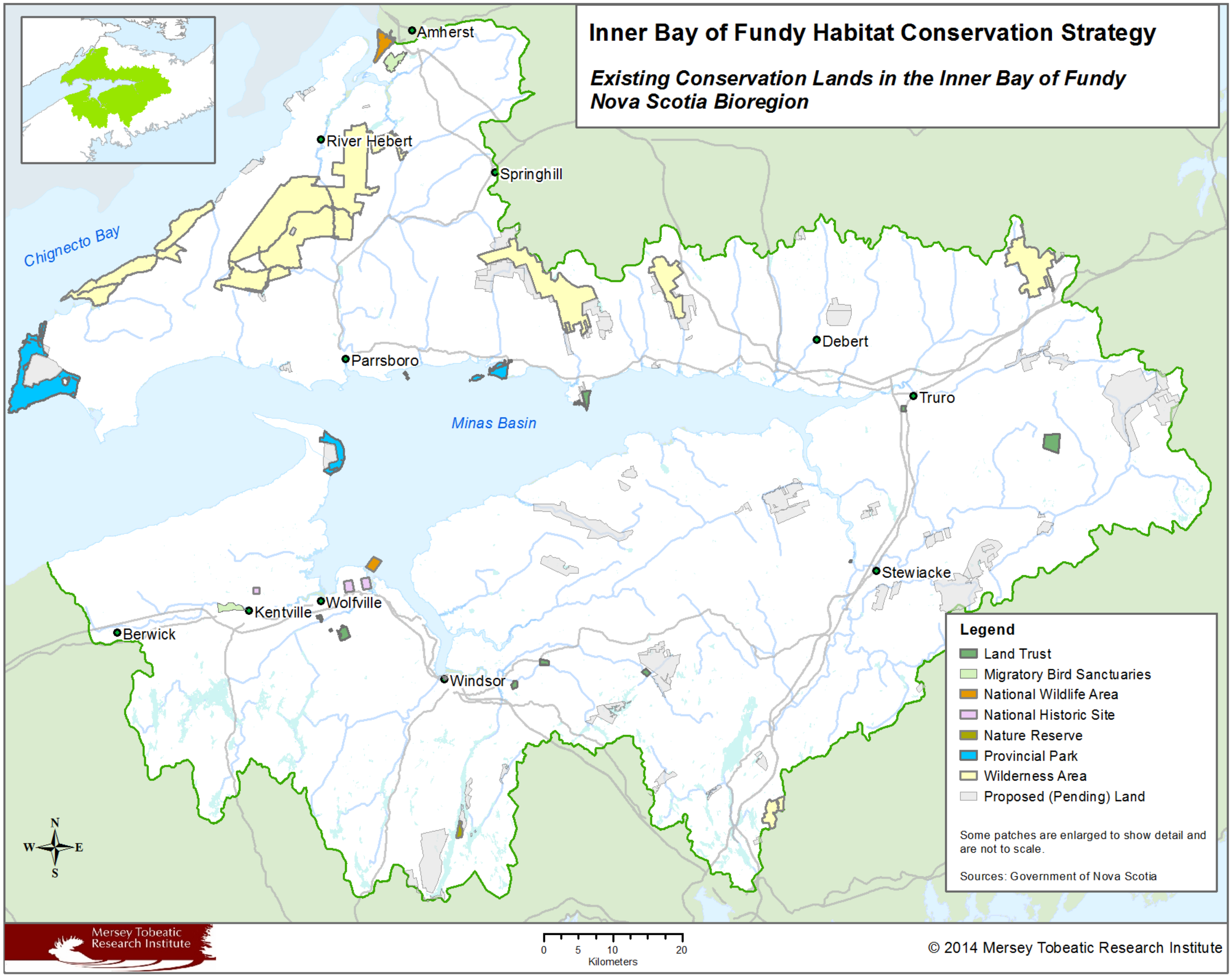
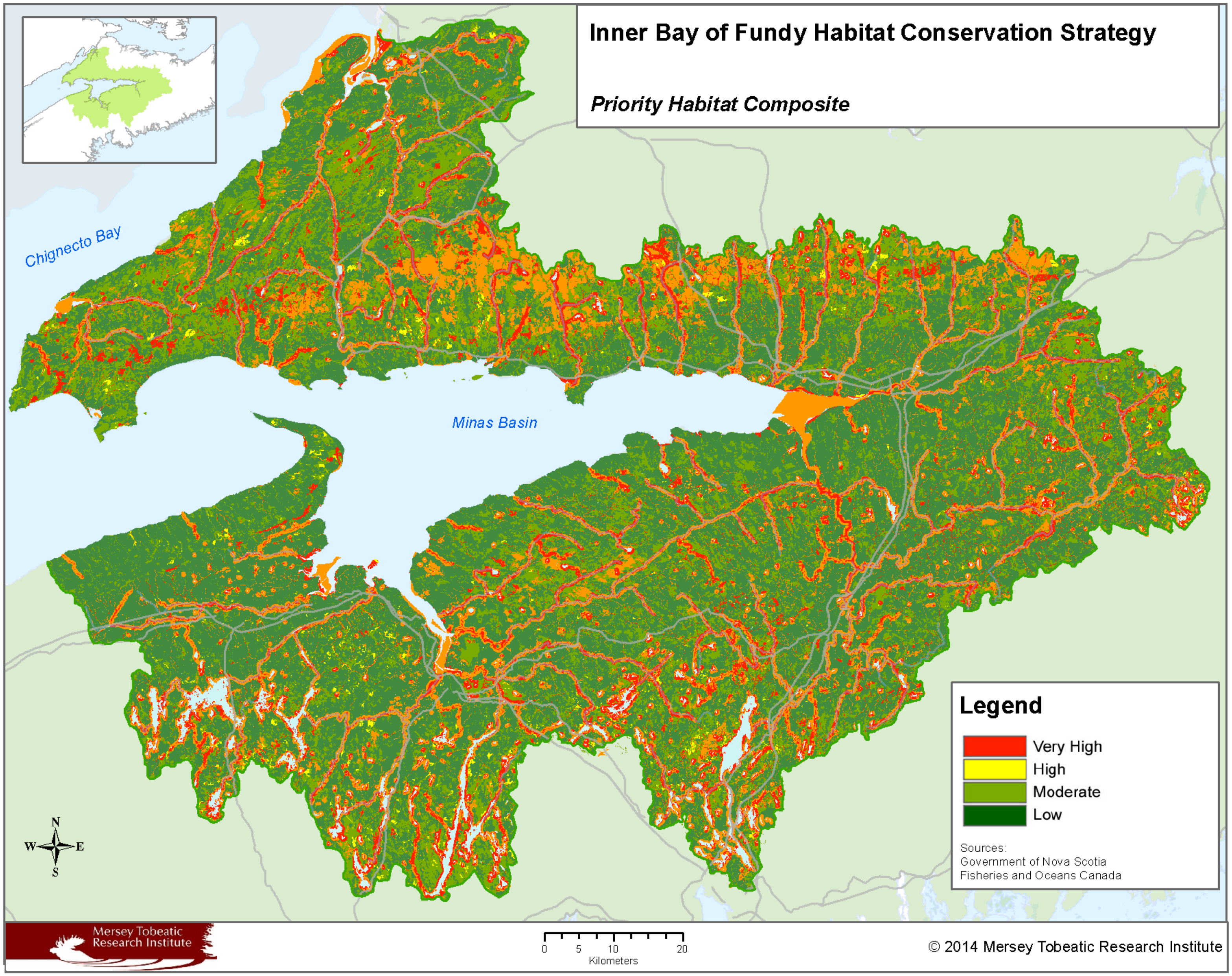
- Continue to locate, map and assess potential old growth stands on private and public lands to refine parcel prioritization, inform conservation efforts, and help maintain old forests and associated biodiversity for landscape connectivity according to Nova Scotia's Old Forest Policy (in partnership with NSDNR and NCC).
- Continue to maintain the Nova Scotia Bat Conservation website (www.batconservation.ca) and engage the public on bat conservation issues. Increase public awareness of White Nose Syndrome in Nova Scotia bats and promote the proper use of bat houses through the Backyard Biodiversity project (in partnership with NSDNR, Saint Mary's University, CCWHC).
- Collaborate with the Province of Nova Scotia and other stakeholders regarding changes to the Code of Forest Practice for Crown Land.
- Continue to assist small woodland owners in NS IBoF bioregion to certify their woodlands under one collective Forest Stewardship Council (FSC) group certification and provide training and education opportunities as a tool for woodlot owner engagement and support for sustainable woodland management. Continue current research to explore awareness and attitudes of forest product consumers, and investigate marketing strategies to support locally produced certified forest products (in partnership with FNSWO).

Atlantic Coast Conservation Data Centre (ACCDC)

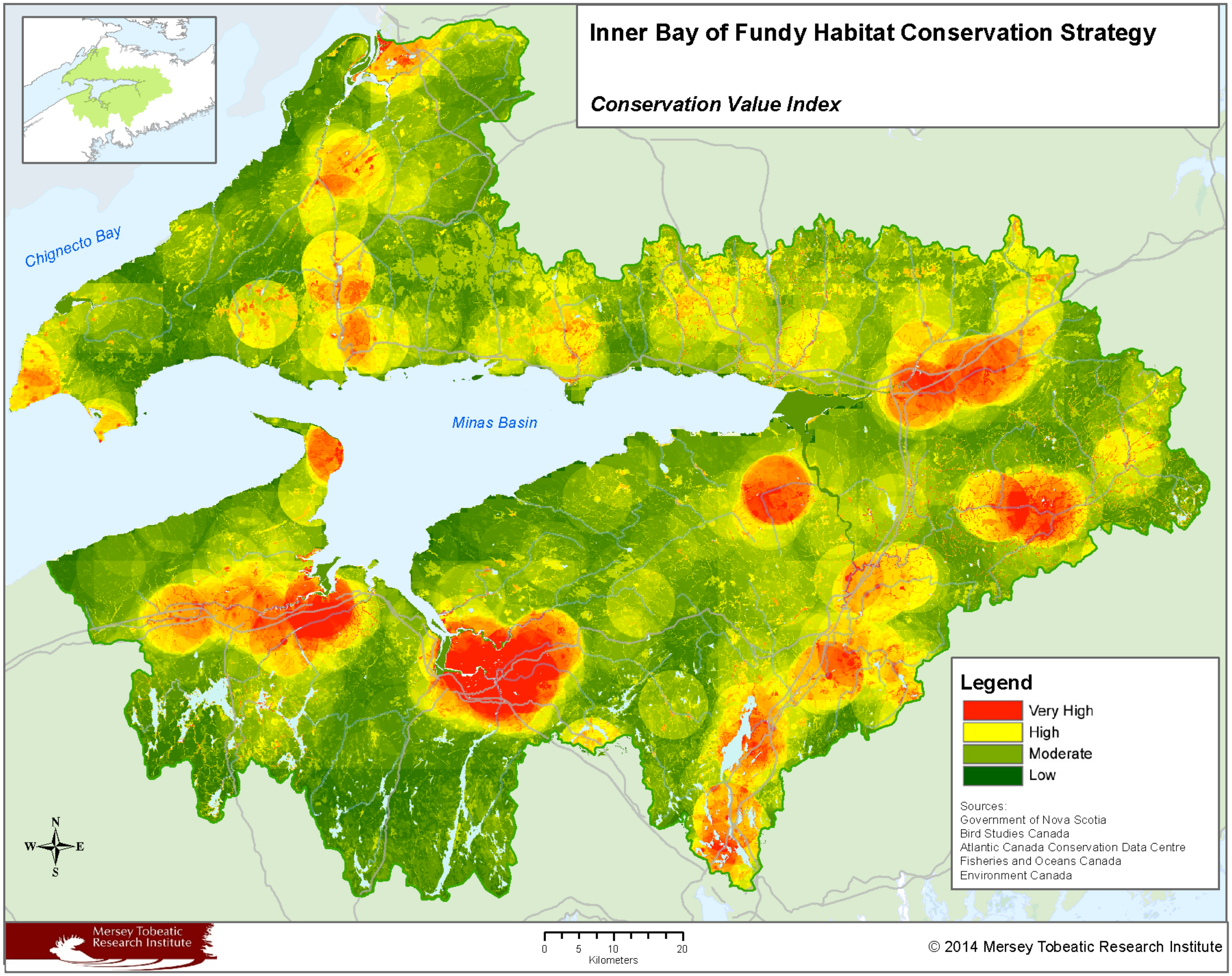
- Enhance data management and information on biodiversity in the bioregion through the maintenance of the most comprehensive and current database on the distribution of biological diversity in Atlantic Canada.



Summary—Figure 1. Conservation context and overall land tenure in the Nova Scotia Inner Bay of Fundy bioregion. Permanently protected land includes federal, provincial, and land trust holdings.



Summary—Figure 2. Priority habitat composite for the Nova Scotia Inner Bay of Fundy bioregion.



Summary—Figure 3. Conservation Value Index (CVI) for the Nova Scotia Inner Bay of Fundy bioregion.

ACKNOWLEDGEMENTS

The primary authors of this document were Lisa Isaacman, Lesley Farrow, and Michael Elliot, Mersey Tobeatic Research Institute.

Primary authors and partners involved in the development of this Habitat Conservation Strategy would like to thank the following individuals for their contributions:

Mersey Tobeatic Research Institute: Brad Toms, Alain Belliveau

Environment Canada: Al Hanson, Colleen McNeil, Alana Plummer, Karel Allard, Matthew Mahoney, Samara Eaton, Denis Doucet

Acadia University: Ruth Newell, Graham Daborn

Atlantic Canada Conservation Data Centre: Sean Blaney, James Churchill

Bird Studies Canada: Eva Dickson

CB Wetland and Environmental Specialists: Tony Bowron

Fern Hill Institute for Plant Conservation: Nick Hill

Fisheries and Oceans Canada: Jamie Gibson, Kimberly Robichaud-Leblanc

Nature Conservancy of Canada: Pat Nussey, Craig Smith, Josh Noseworthy

Nova Scotia Department of Fisheries and Aquaculture: John MacMillan, Ashley Sprague

Nova Scotia Department of Natural Resources, Forestry Division: Catherine Fraser

Nova Scotia Department of Natural Resources, Wildlife Division: Mark Elderkin, Sean Basquill, John Brazner, Frances MacKinnon

Nova Scotia Environment: Rob Cameron, Kermit deGooyer, Dave MacKinnon, Chuck Sangster

Nova Scotia Nature Trust: Katie Porter, Peter Green

Saint Mary's University: Danika van Proosdij, Hugh Broders

Wildlife Conservation Society Canada: Gillian Woolmer

Thanks to the official sponsors of the Maritimes Breeding Bird Atlas (Bird Studies Canada, Environment Canada - Canadian Wildlife Service, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, Prince Edward Island Department of Agriculture and Forestry) for supplying Atlas data, and to the thousands of volunteer participants who gathered data for the project.

Cover image courtesy of Google Earth. Image Landsat, Data SIO, NOAA, U.S. Nave, NGA, GEBCO.

TABLE OF CONTENTS

List of Tables

List of Figures

1. CONSERVATION CONTEXT

A. Bioregion Scope

i. Location and Size

The Nova Scotia Inner Bay of Fundy (NS IBoF) bioregion is a complex of coastal, aquatic, and forest ecosystems situated within central Nova Scotia (Figure 1 inset). Bioregions are geographic areas defined by natural boundaries (i.e., physical and environmental features), including watershed boundaries and soil and terrain characteristics. The NS IBoF bioregion was defined (see Boundary Justification) for the purpose of this habitat conservation strategy and is not otherwise a recognized ecological or management area. The total area of the bioregion is 1,052,170 ha, which accounts for approximately 18% of Nova Scotia's land base. The coastline of the bioregion is approximately 702 km long, representing 9.5% of the province's entire coastline.

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 under the National Ecological Framework for Canada (Ecological Stratification Working Group 1996). Under The Nature Conservancy's Ecoregional Assessment Framework, the bioregion falls within the Northern Appalachians - Acadian Ecoregion and encompasses portions of four subregions (Anderson *et al.* 2006). Based on the Nova Scotia Department of Natural Resources (NS DNR) ecological land classification system, the bioregion contains portions of six Ecoregions, each of which has one or more Ecodistricts (Neily *et al.* 2003) (Table 1). The majority (30%) of the bioregion falls within the Valley and Central Lowlands Ecoregion on the south side of Minas Basin, the Annapolis Valley and around Cobequid Bay, followed by the Nova Scotia Uplands Ecoregion (22%) in the Cobequid Hills and Uplands. Nova Scotia Environment uses a different classification system, which delineates the bioregion into 16 Natural Landscapes (NSDEL 2002; Table 1). These areas are similar, but not 100% congruent, to the NSDNR Ecodistricts. Along the coastline, the boundary includes five DFO coastal sub-segments: Upper Bay of Fundy Tidal Flats and Marshes, Cape Chignecto Cliffs, Cobequid Bay Tidal Flats and Salt Marshes, Minas Basin Tidal Flats, and North Mountain Bedrock Cliffs (Greenlaw *et al.* 2013). The majority (84%) of the land in the bioregion is privately-owned, with provincial crown land making up almost all of the remainder. Less than 1% is federal crown or First Nations lands.

ii. Boundary Justification

The boundary of the NS IBoF bioregion in this Habitat Conservation Strategy (HCS) was defined based on provincially-delineated primary watershed units. Watersheds are widely recognized as an important planning and management unit, providing the opportunity to address broad-scale threats occurring in the upper reaches of watersheds that may have significant impacts on the lower reaches of those watersheds, including coastal and marine targets. Watershed management is also a common practice in other jurisdictions, and an attractive landscape unit for local watershed and stewardship groups. The bioregion is comprised of eight primary watersheds that flow into the Inner Bay of Fundy from Nova Scotia (Figure 1). This includes all watersheds emptying into the Minas Channel, Minas Basin, Cobequid Bay and the Nova Scotia side of Chignecto Bay.

Table 1. Ecological land classifications for the Nova Scotia Inner Bay of Fundy bioregion.

NAAP Subregion[1]	NS DNR Ecoregion[2] (% Bioregion)	Ecodistrict[2]	NS Natural Landscape[3]
Gulf of Maine, Bay of Fundy, Minas Basin	Fundy Shore (7%)	North Mountain	North Mountain Ridge
		Parrsboro Shore	Minas Basin Headlands
			Chignecto Slopes
NS Hills and Drumlins	Valley and Central Lowlands (30%)	Annapolis Valley	Annapolis Valley
		Minas Lowlands	Cobequid Tidal Bay
		Central Lowlands	Walton River Clay Plain
			Shubenacadie River Rolling Plain
	Eastern (10%)	Rawdon/Wittenburg Hills	Interior Ridges (Rawdon Hills)
		Eastern Interior	Central Quartzite Hills and Plains (Shubenacadie Lake)
	Western (12%)	Valley Slope	South Mountain Foothills
		South Mountain	South Mountain Rolling Plain
Acadian 'Uplands'	Nova Scotia Uplands (22%)	Cobequid Slopes	South Cobequid Foothills
		Central Uplands	
		Cobequid Hills	Cobequid Mountain
Northumberland/Bras D'Or Lowlands	Northumberland/Bras D'Or (12%)	Cumberland Hills	Chignecto Slopes
			Cumberland Foothills
		Chignecto Ridges	Chignecto Ridged Plain

[1]*Northern Appalachians-Acadian Plan (NAAP; Anderson et al. 2006)*
[2]*Nova Scotia Department of Natural Resources (Neily et al. 2003). Ecodistricts comprising less than 1% of bioregion are omitted from list.*
[3]*Nova Scotia Department of Environment and Labour (2002)*
** NS DNR Ecodistricts and NS Natural Landscapes are similar, but not 100% congruent. Both are used by provincial agencies, and therefore, presented here.*

iii. Ecological significance

The bioregion boasts a wide variety of representative and significant ecological features. Expansive coastline with significant tidal flats, salt marsh complexes, and tidal rivers provide internationally recognized stop-over and feeding grounds for resident and migratory shorebirds and fish communities. Between 1 and 2 million shorebirds stage on the mud flats of the Inner Bay of Fundy (Chignecto, Minas Basin, and Cobequid Bay) in the fall before their southern migration. Gypsum and limestone–associated habitats, including rich calcareous forests and wetlands, and karst topography with caves, sinkholes and cliffs, support a unique suite of flora, and a significant proportion of the province's bat hibernacula. Basalt cliffs and exposed headlands support cliff-nesting birds and rare arctic alpine plants. Diverse aquatic and riparian habitats, including fertile floodplains, support a rich diversity of characteristic and rare species. Significant Acadian Forest communities include mature tolerant hardwood stands and coastal fog forest, a humid forest type only found in the NS IBoF bioregion. Remnant patches of sand, coastal, and inland barrens can also be found in the bioregion.

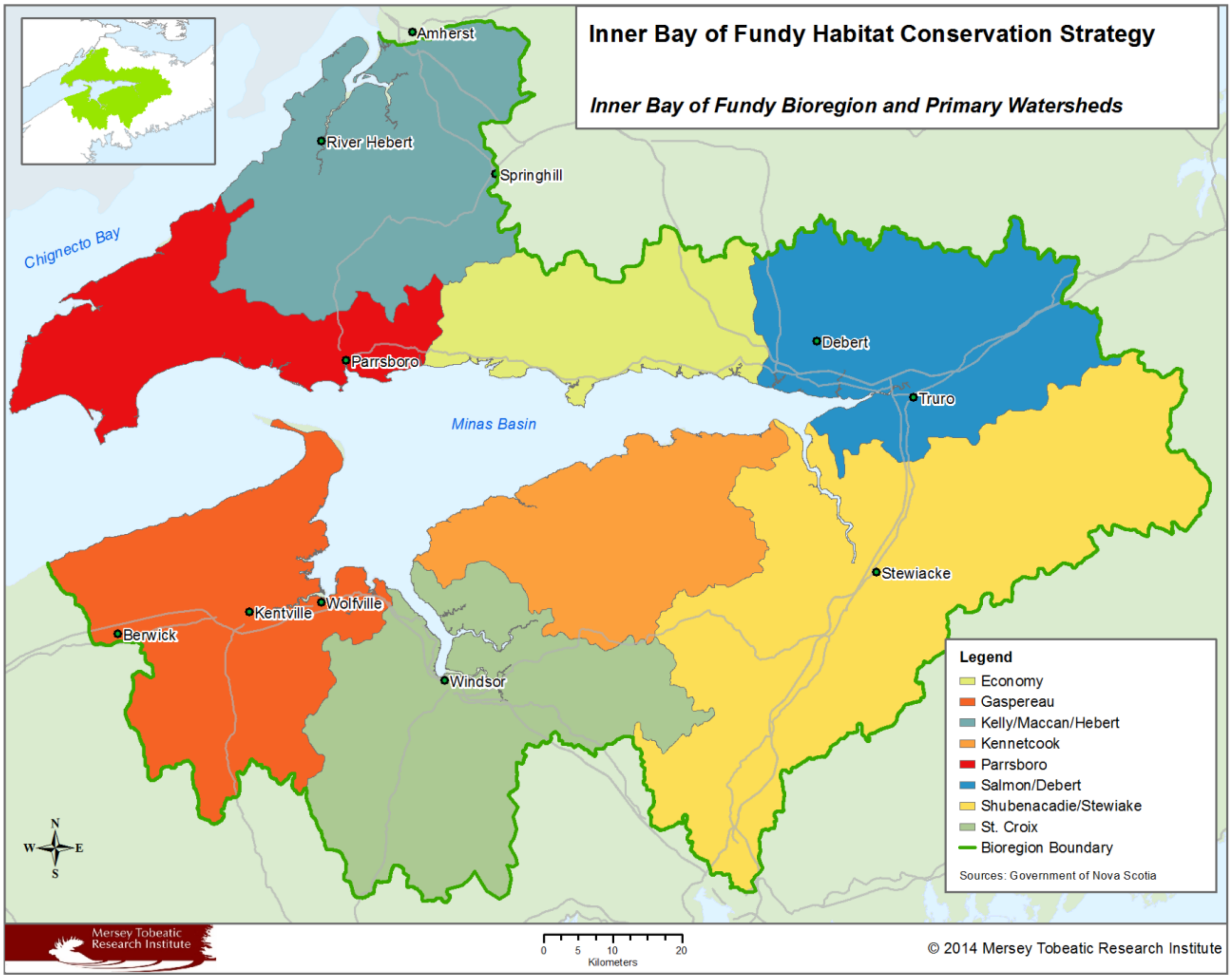


Figure 1. Primary watersheds comprising the Nova Scotia Inner Bay of Fundy bioregion.

B. Ecological context

i. Climate and Geology

Given the extensive geographic area of the NS IBoF bioregion, significant temperature and precipitation variation occurs. Overall, the NS IBoF bioregion is characterized by a temperate climate with cold winters from December to March (-4.7°C to -2.5°C), warmest weather in July and August (17.1°C and 16.9°C, respectively), and the greatest precipitation in May and October (115.9 mm and 122.6 mm, respectively; WHSRN 2009). Along the coast, the climate is moderated by strong tidal mixing with persistent summer fogs as the cool coastal air mixes with warm inland air (advection fog). On the south shore of the Minas Basin, the interior of the bioregion is generally characterized by warmer summers and milder winters than the coast (Neily *et al.* 2003). Sheltered between the North and South Mountains, the lowlands of the Annapolis Valley in the Gaspereau watershed record some of the hottest summer temperatures, mildest winters, and lowest precipitation within the province. These climatic features, in addition to the fertile soils, make the Annapolis Valley one of Nova Scotia's most prominent agricultural areas. On the north shore inland area, summers tend to be warm and winters are long and cold. The Cobequid Mountains receive the greatest snowfall on the mainland (>300 cm/year). However, microclimatic variation is common in the hilly upland areas where local weather varies widely between sheltered and exposed conditions.

The present geological landscape of the bioregion is diverse, reflecting its variable bedrock material and extensive glacial history, which includes repeated glaciation events until approximately 12 000 years before present (Davis & Browne 1996). Thirty percent of the bioregion lies within the Valley and Central Lowlands Ecoregion, where elevation is typically less than 50 m above sea level (Neily *et al.* 2003). Carboniferous shale, sandstone, gypsum and limestone underlie the imperfectly drained, fine textured soils on the gently undulating to moderately rolling plains of the Shubenacadie/Stewiacke, Kennetcook, and St. Croix watersheds. One of the most characteristic geological features of this bioregion is its karst topography, including sinkholes and caves, which are common in areas underlain by gypsum, most notably in the Kennetcook and St. Croix watersheds (Neily *et al.* 2003). Underlying the Annapolis Valley and Minas Basin shore sections are Triassic sandstones, which provide the parent material for the very coarse to moderately coarse sandy soils. In contrast to these lowlands, North Mountain is a steep-sided basalt ridge which represents the highest elevations in the Minas Basin, most notably at Cape Blomidon (Parker *et al.* 2007). Basalt cliffs and exposed rocky outcrops are found along the Fundy shore, particularly at Cape Split on North Mountain, as well as Cape d'Or and along the Parrsboro shore.

The second largest ecoregion (22%) is the Nova Scotia Uplands Ecoregion which includes the inlands of the Economy and Salmon/Debert watersheds. Parallel faults, juxtaposed resistant basalt and erodible sandstone form a varied landscape of hills, lowlands, bays, cliffs and headlands (Neily *et al.* 2003). The Cobequid Mountains offer some of the highest points in mainland Nova Scotia, with some elevations exceeding 300 m. The region is rugged where streams have cut into deep canyons and descend to the lowlands through a series of waterfalls and rapids. The soils of the Cobequid Mountains are dominated by coarse gravelly to stony sandy loams derived from igneous and metamorphic rocks and often form just a thin layer over the bedrock, especially on hilly topography.

ii. Conservation priority species

Conservation Priority species are objectively defined as:

- Any species with a federal assessment (COSEWIC) of Special Concern, Threatened or Endangered (including all species on Schedule 1 of the *Species at Risk Act*)
- Any species at risk with a provincial listing (*Nova Scotia Endangered Species Act*) of Vulnerable, Threatened, or Endangered
- Any species with a provincial rank of S1, S2, or S3 (with a global rank of G1, G2, or G3) by the Atlantic Canada Conservation Data Centre (ACCDC)
- Any Bird Conservation Region (BCR) 14 or Marine Biogeographic Unit (MBU) 11 priority bird species that occurs with regularity in the bioregion

The bioregion contains a total of 45 species at risk, with 37 species listed under SARA and/or the NS ESA (Table 2). See Appendix B for definitions of Conservation Ranks. See Appendix C for the complete list of priority species found within the NS IBoF bioregion and their conservation status. This HCS primarily targets terrestrial species; the treatment of aquatic species is cursory in this report. Note that overwintering species that are essentially marine were excluded from the list of priority species (e.g., Barrow's Goldeneye, Harlequin Duck).

Table 2. Nationally assessed and provincially listed species at risk in the Nova Scotia Inner Bay of Fundy bioregion, listed alphabetically by common name within their respective taxonomic group.

Common Name	*Scientific Name*	COSEWIC[1]	SARA[2]	NS ESA[3]
Invertebrates				
Brook Floater	*Alasmidonta varicosa*	Special Concern	Special Concern	Threatened
Monarch	*Danaus plexippus*	Special Concern	Special Concern	
Skillet Clubtail	*Gomphus ventricosus*	Endangered	Endangered	
Fishes				
American Eel	*Anguilla rostrata*	Threatened		
Atlantic Salmon	*Salmo salar*	Endangered	Endangered	
Atlantic Sturgeon	*Acipenser oxyrinchus*	Threatened		
Striped Bass	*Morone saxatilis*	Endangered		
Birds				
Bank Swallow	*Riparia riparia*	Threatened		
Barn Swallow	*Hirundo rustica*	Threatened		Endangered
Bicknell's Thrush	*Catharus bicknelli*	Threatened	Special Concern	Endangered
Bobolink	*Dolichonyx oryzivorus*	Threatened		Vulnerable
Canada Warbler	*Cardellina canadensis*	Threatened	Threatened	Endangered
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened	Endangered
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened	Threatened
Eastern Meadowlark	*Sturnella magna*	Threatened		
Eastern Whip-poor-will	*Antrostomus vociferus*	Threatened	Threatened	Threatened
Eastern Wood-pewee	*Contopus virens*	Special Concern		Vulnerable
Least Bittern	*Ixobrychus exilis*	Threatened	Threatened	
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened	Threatened
Peregrine Falcon (anatum/tundrius ssp.)	*Falco peregrinus anatum/tundrius*	Special Concern	Special Concern	Vulnerable

Common Name	*Scientific Name*	COSEWIC[1]	SARA[2]	NS ESA[3]
Piping Plover (melodus ssp.)	*Charadrius melodus melodus*	Endangered	Endangered	Endangered
Red Knot (rufa ssp.)	*Calidris canutus rufa*	Endangered	Endangered	Endangered
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern	Endangered
Savannah Sparrow (princeps ssp.)	*Passerculus sandwichensis princeps*	Special Concern	Special Concern	
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	
Wood Thrush	*Hylocichla mustelina*	Threatened		
Reptiles				
Snapping Turtle	*Chelydra serpentina*	Special Concern	Special Concern	Vulnerable
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatened	Threatened
Mammals				
Little Brown Myotis	*Myotis lucifugus*	Endangered		Endangered
Long-tailed Shrew	*Sorex dispar*		Special Concern	
Moose (Mainland NS)	*Alces alces americana*			Endangered
Northern Myotis	*Myotis septentrionalis*	Endangered		Endangered
Tri-colored Bat	*Perimyotis subflavus*	Endangered		Endangered
Lichens				
Blue Felt Lichen	*Degelia plumbea*	Special Concern		Vulnerable
Boreal Felt Lichen	*Erioderma pedicellatum*	Endangered	Endangered	Endangered
Eastern Waterfan	*Peltigera hydrothyria*	Threatened		
Mosses				
Pygmy Pocket Moss	*Fissidens exilis*	Special Concern		
Vascular Plants				
Black Ash	*Fraxinus nigra*			Threatened
Branched Bartonia	*Bartonia paniculata ssp. paniculata*	Threatened	Threatened	
Butternut	*Juglans cinerea*	Endangered	Endangered	
Eastern White Cedar	*Thuja occidentalis*			Vulnerable
Prototype Quillwort	*Isoetes prototypus*	Special Concern	Special Concern	Vulnerable
Ram's Head Lady slipper	*Cypripedium arietinum*			Endangered
Spotted Pondweed	*Potamogeton pulcher*			Vulnerable

Fishes

Four priority fish species are known to occur in the bioregion. The major river systems along the Fundy Coast and the tributaries which feed them are particularly biodiverse due to the mixing of fresh- and salt-water at the river mouths and the strong tidal influence. Rare and at-risk species that depend on the bioregion's aquatic habitats to complete their lifecycle include the anadromous[1] Striped Bass, Atlantic Salmon and Atlantic Sturgeon, and the catadromous[2] American Eel.

The Inner Bay of Fundy Atlantic Salmon population completes its lifecycle entirely within the Inner Bay of Fundy and the river systems that feed it, making it ecologically and genetically distinct from other Atlantic Salmon populations (DFO 2010). Inner Bay of Fundy salmon populations have decreased dramatically since the early 20th century and there is believed to be less than 200 individuals left in the wild. In the Stewiacke River, it is estimated that the mean population size declined by more than 99% between 1987 and 2001. Seven of the ten rivers containing freshwater Critical Habitat occur in the bioregion, the most important being the Gaspereau and Stewiacke Rivers (DFO 2013). As well, 15 of the 19 salmon rivers identified as important estuarine habitat for this species are located within the bioregion, including the Shubenacadie River, which also contains the only remaining spawning population of Striped Bass in the Bay of Fundy.

Birds

There are 108 significant bird species that occur regularly in the bioregion, of which 78 are listed as priority species for conservation or management action under the *Bird Conservation Strategy for BCR 14 and MBU 11* (Environment Canada 2013; Table 3). The BCR/MBU priority species include those that regularly occur in the region that are vulnerable due to population size, distribution, population trend, abundance, and threats. Some widely distributed and abundant 'stewardship' species are also included because they typify the national or regional avifauna and/or because they have a large proportion of their range and/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 impact on other species or habitats.

Between 1 and 2 million shorebirds stage on the mud flats of the Inner Bay of Fundy (Chignecto, Minas Basin, and Cobequid Bay) in the fall before their southern migration. The Semipalmated Sandpiper is by far the most numerous, with between 75-95% of the global population using the Bay of Fundy (WHSRN 2009; IBA 2012). There are frequently flocks of 100,000 birds, and flocks of up to 400,000 have been recorded. Smaller numbers of Semipalmated Plover, Black-bellied Plover, Least Sandpiper, White-rumped Sandpiper, Dunlin, Short-billed Dowitcher, Sanderling, and a variety of other shorebirds also use the extensive coastal habitats. Species such as Willet and Great Blue Heron breed and nest in the region. The Minas Basin is also an important site for the endangered Peregrine Falcon which nests along the cliffs in the southern Minas Channel and feeds on migrating shorebirds along the mudflats in the basin (Parker *et al.* 2007; COSEWIC 2007a).

The large expanses of coastal and freshwater wetlands within the bioregion provide critical breeding and staging ground for a variety of waterfowl and marsh birds. Within the Chignecto Ramsar site and National Wildlife Area, salt marshes support substantial flocks of Canada Geese and lesser numbers of American Black Duck, Green-winged Teal, and Northern Pintail (CWS 2001b). The freshwater wetlands support high abundances of most species commonly found in the region, along with the regular

[1] *spawn in freshwater but migrate to the ocean to feed*
[2] *those that spawn in saltwater but migrate to freshwater to feed*

occurrence of regionally rare species such as Gadwall, Redhead, Ruddy Duck, Virginia Rail, Common Moorhen, American Coot, and Black Tern.

Reptiles

Two priority reptiles, the Wood Turtle and Snapping Turtle, are known to occur in the bioregion. The Wood Turtle is a semi-aquatic, North America endemic species. Streams, lakes, and ponds are used for mating and hibernation, while upland sites (within 300 m of a watercourse) are used for foraging and nesting (COSEWIC 2007b). Riparian shrub wetlands and forested riparian areas are considered the preferred terrestrial habitat for this species, although they are known to use a range of upland sites, including agricultural lands and roadside ditches. Snapping Turtles inhabit ponds, shallow bays, river edges, and slow streams, preferably with slow-moving water, a soft mud bottom, and dense aquatic vegetation (COSEWIC 2008). They nest on sand or gravel banks.

Mammals

There are seven priority mammal species identified in the NS IBoF bioregion. Historically, Acadian Forests in the bioregion have supported a number of keystone mammals. Human encroachment, hunting, disease, and habitat loss and fragmentation have had a significant impact on the bioregion's mammal populations. Wolves have been extirpated from the province since the mid 1800's, and it is thought that very few ever lived in Nova Scotia (NSDNR 2013). Prior to European settlement, Woodland Caribou were common throughout Nova Scotia. They have been extirpated from mainland Nova Scotia since the early 1900's, with over-hunting, habitat loss, climate change, and competition and disease associated with an increase in the number of white-tailed deer (*Odocoileus virginianus*) cited as contributing factors to their decline (MTRI 2008; NSDNR 2013). In much the same way, the mainland Nova Scotia population of the Eastern Moose, the most abundant large mammal in the province when European settlers arrived in the 1600's, has experienced significant declines. Despite hunting restrictions since the early 1900's their numbers have continued to decline, with an estimated 1000-1200 individuals within isolated sub-populations across mainland Nova Scotia, the largest of which is in the Cobequid Mountains (estimated at 600 individuals; NSDNR 2007). Consequently, the population was formally listed as Endangered under the *Nova Scotia Endangered Species Act* (NS ESA) in 2003. The factors affecting their decline are numerous, complex and not well understood, but may include historical over hunting, poaching, habitat loss, climate change, increased road access to moose habitat, acid precipitation, mineral deficiencies in their diet, and competition, disease and parasites associated with an increase in the number of white-tailed deer in the province (NSDNR 2007).

Canada Lynx (*Lynx canadensis*), which formerly occurred in areas with suitable habitat across Nova Scotia, have been extirpated from the bioregion and are currently found only in the Cape Breton Highlands in a small, isolated population (MTRI 2008; NSDNR 2013). Similarly, the American Marten, which was trapped extensively throughout Nova Scotia since the 1700's, was thought to be extirpated from mainland Nova Scotia and restricted to a small, isolated population in Cape Breton, however recent records have confirmed the existence of marten in southwest Nova Scotia (NSDNR 2013).

Three species of primarily forest bats, the Little Brown Myotis, the Northern Myotis, and the Tri-colored Bat, inhabit the mature forests of the bioregion and utilize gypsum caves and abandoned mines as over-wintering, summer roosting, and swarming habitat (Moseley 2007). The majority of known hibernacula sites in Nova Scotia for these three species are located within the bioregion (H. Broders, pers. comm. 2014). These three species were recently designated as Endangered by COSEWIC (2012c) and the NS ESA (2013). The COSEWIC assessment and subsequent provincial listing were primarily in response to the spread of a fungal pathogen responsible for White Nose Syndrome (WNS) that has decimated bat populations throughout eastern North America (COSEWIC 2012c). The condition is caused by *Pseudogymnoascus destructans*, a cold-loving fungus introduced from Europe that thrives in cave conditions and as such, impacts bat population directly during the winter hibernation period (Blehert 2012; Lorch *et al.* 2011). White Nose Syndrome is thought to disrupt patterns of torpor and possibly result in death by starvation or dehydration (Cryan *et al.* 2010; Reeder *et al.* 2012), and is responsible for the death of an estimated 5.7 and 6.7 million hibernating bats since 2006 in the northeastern United States and eastern Canada (COSEWIC 2012c). The Little Brown Myotis, the most abundant species in the region currently affected by WNS, has experienced the most dramatic population declines, with an average decline of 73% within 2 years of infection at 115 infected sites and 91% at 54 sites with greater than 2 years of exposure to WNS in the northeastern United States (Frick *et al.* 2010). Mortality rates of infected sites in Ontario, Quebec, and New Brunswick are over 80% (COSEWIC 2012c). First documented in Nova Scotia in April 2011, WNS decimated five known Nova Scotia hibernacula in the winter of 2012-2013, with declines in the range of 91 to >99% in one year (H. Broders, per. comm.; Meller 2013). Researchers believe that WNS could lead to local extinctions of the Little Brown Myotis, as well as other species (Frick *et al.* 2010); therefore, it is prudent to protect any surviving animals which may be genetically predisposed to surviving the infection, as well as the habitats that host them (e.g., known and potential hibernacula).

Flora

There are 186 priority vascular plants, 16 priority lichens, and 18 priority bryophytes known to occur in the bioregion, including two of Nova Scotia's rarest native tree species, Black Ash and Eastern White Cedar. Once relatively common throughout the region, these swamp and floodplain-associated species have experienced considerable declines in the province. Black Ash is currently known from only 35-40 sites in Nova Scotia; however mature individuals are rare with only 12 known to exist in the province (NSDNR 2013b). Eastern White Cedar is found within the bioregion in at least two sites in the Parrsboro and Kelly/Maccan/Hebert watershed (Newell 2005).

Remnant populations of arctic alpine flora, such as Rosy Pussytoes and Robbin's Milkvetch, are found on the exposed erodible basalt cliffs at Cape Blomidon (Cape Split) and Chignecto (Cape Chignecto, Cape Sharp, Cape D'Or, and the Parrsboro shore). Rare populations of Wild Leek, Hepatica, Blue Cohosh, and other Appalachian deciduous herbs are found in the rich hardwood forest floodplains/intervals in Hants County (especially along the Meander, Herbert, and Salmon Rivers; N. Hill, K. Porter, pers. comm. 2014). Calcareous plants occur in the areas of karst topography, such as the endangered Ram's Head Lady Slipper and Leatherwood (N. Hill, pers. comm. 2014). The bioregion also contains some of the rarest lichens and bryophytes in the province, some of which are not recorded elsewhere on mainland Nova Scotia (e.g. Olive Beard Moss and Pygmy Pocket Moss found in karst sites; Anderson and Neily 2010). Many of these species have experienced drastic declines. Absence of recent sightings in the coastal forests of Cape Chignecto suggest a few rare species, such as Vole Ears Lichen and Boreal Felt Lichen, may have disappeared from historic sites in the bioregion (Environment Canada 2007; COSEWIC 2009a).

Table 3. Priority bird species in Bird Conservation Region 14, and Marine Biogeographic Unit 11 in Nova Scotia and justification for their priority status (Environment Canada 2013). Species are listed alphabetically by common name within their respective pillar group.

Common Name	*Scientific Name*	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 11	Population Objective
Landbirds							
American Redstart	*Setophaga ruticilla*				y		Maintain current
Bald Eagle	*Haliaeetus leucocephalus*				y		Maintain current
Bank Swallow	*Riparia riparia*	TH			y		Increase 100%
Barn Swallow	*Hirundo rustica*	TH		EN	y		Increase 100%
Bay-breasted Warbler	*Dendroica castanea*				y		Increase 50%
Belted Kingfisher	*Megaceryle alcyon*				y		Increase 50%
Bicknell's Thrush	*Catharus bicknelli*	TH		EN	y		Increase 50%
Black-and-white Warbler	*Mniotilta varia*				y		Maintain current
Black-billed Cuckoo	*Coccyzus erythropthalmus*				y		Assess / Maintain
Blackburnian Warbler	*Dendroica fusca*				y		Maintain current
Black-throated Green Warbler	*Dendroica virens*				y		Maintain current
Blue-headed Vireo	*Vireo solitaries*				y		Maintain current
Bobolink	*Dolichonyx oryzivorus*	TH		VU	y		Increase 100%
Boreal Chickadee	*Poecile hudsonica*				y		Increase 100%
Canada Warbler	*Cardellina canadensis*	TH	TH	EN	y		Increase 50%
Cape May Warbler	*Dendroica tigrina*				y		Increase 50%
Chimney Swift	*Chaetura pelagica*	TH	TH	EN	y		Increase 100%
Common Nighthawk	*Chordeiles minor*	TH	TH	TH	y		Increase 100%
Eastern Kingbird	*Tyrannus tyrannus*				y		Increase 100%
Eastern Whip-poor-will	*Antrostomus vociferus*	TH	TH	TH	y		Assess / Maintain
Eastern Wood-Pewee	*Contopus virens*	SC		VU	y		Increase 50%
Evening Grosbeak	*Coccothraustes vespertinus*				y		Maintain current
Gray Catbird	*Dumetella carolinensis*				y		Increase 100%

[1] *Committee on the Status of Endangered Wildlife in Canada; EN = Endangered, TH = Threatened, SC = Special Concern*
[2] Species at Risk Act *(2003); EN = Endangered, TH = Threatened, SC = Special Concern*
[3] Nova Scotia Endangered Species Act *(1999); EN = Endangered, TH = Threatened, VU = Vulnerable*

Common Name	Scientific Name	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 11	Population Objective
Gray Jay	*Perisoreus canadensis*				y		Assess / Maintain
Magnolia Warbler	*Dendroica magnolia*				y		Maintain current
Mourning Warbler	*Oporornis philadelphia*				y		Maintain current
Nelson's Sparrow	*Ammodramus nelsoni*				y		Assess / Maintain
Northern Parula	*Parula Americana*				y		Maintain current
Olive-sided Flycatcher	*Contopus cooperi*	TH	TH	TH	y		Assess / Maintain
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	SC	SC	VU	y		Assess / Maintain
Pine Grosbeak	*Pinicola enucleator*				y		Increase 50%
Purple Finch	*Carpodacus purpureus*				y		Maintain current
Ruffed Grouse	*Bonasa umbellus*				y		Increase 50%
Rusty Blackbird	*Euphagus carolinus*	SC	SC	EN	y		Increase 100%
Savannah Sparrow	*Passerculus sandwichensis princeps*	SC	SC		y		Recovery objective
Short-eared Owl	*Asio flammeus*	SC	SC		y		Increase 50%
Spruce Grouse	*Falcipennis canadensis*				y		Increase 50%
Tree Swallow	*Tachycineta bicolor*				y		Maintain current
Veery	*Catharus fuscescens*				y		Maintain current
White-throated Sparrow	*Zonotrichia albicollis*				y		Maintain current
Shorebirds							
American Golden-Plover	*Pluvialis dominica*				y		Assess / Maintain
American Woodcock	*Scolopax minor*				y		Increase 50%
Black-bellied Plover	*Pluvialis squatarola*					y	Assess / Maintain
Dunlin	*Calidris alpine*					y	Assess / Maintain
Hudsonian Godwit	*Limosa haemastica*					y	Assess / Maintain
Killdeer	*Charadrius vociferous*				y		Maintain current
Least Sandpiper	*Calidris minutilla*					y	Assess / Maintain
Lesser Yellowlegs	*Tringa flavipes*				y	y	Assess / Maintain
Piping Plover	*Charadrius melodus melodus*	EN	EN	EN	y	y	Recovery objective
Purple Sandpiper	*Calidris maritima*					y	Assess / Maintain
Red Knot	*Calidris canutus rufa*	EN	EN	EN		y	Assess / Maintain
Red Phalarope	*Phalaropus fulicarius*					y	Assess / Maintain

Common Name	*Scientific Name*	COSEWIC[1]	SARA[2]	NS ESA[3]	BCR 14	MBU 11	Population Objective
Red-necked Phalarope	*Phalaropus lobatus*					y	Assess / Maintain
Sanderling	*Calidris alba*					y	Assess / Maintain
Semipalmated Sandpiper	*Calidris pusilla*					y	Assess / Maintain
Solitary Sandpiper	*Tringa solitaria*				y	y	Assess / Maintain
Spotted Sandpiper	*Actitis macularius*				y		Increase 100%
Whimbrel	*Numenius phaeopus*				y	y	Assess / Maintain
Willet	*Tringa semipalmata*					y	Increase 50%
Wilson's Snipe	*Gallinago delicate*				y		Increase 100%
Waterbirds							
American Bittern	*Botaurus lentiginosus*				y		Increase 50%
Black-legged Kittiwake	*Rissa tridactyla*					y	Maintain current
Common Loon	*Gavia immer*				y	y	Maintain current (BCR 14); Assess / Maintain (MBU 11)
Great Cormorant	*Phalacrocorax carbo*					y	Assess / Maintain
Pied-billed Grebe	*Podilymbus podiceps*				y		Maintain current
Red-throated Loon	*Gavia stellate*					y	Assess / Maintain
Sora	*Porzana Carolina*				y		Maintain current
Virginia Rail	*Rallus limicola*				y		Assess / Maintain
Waterfowl							
American Black Duck	*Anas rubripes*				y	y	Maintain current
Canada Goose (Temperate-breeding in Eastern Canada)	*Branta Canadensis*				y	y	Decrease
Common Eider	*Somateria mollissima*					y	Maintain current
Common Goldeneye	*Bucephala clangula*					y	Assess / Maintain
Green-winged Teal	*Anas crecca*				y		Increase 50%
Long-tailed Duck	*Clangula hyemalis*					y	Assess / Maintain
Mallard	*Anas platyrhynchos*				y		Maintain current
Ring-necked Duck	*Aythya collaris*				y		Increase 50%
Surf Scoter	*Melanitta perspicillata*					y	Assess / Maintain
White-winged Scoter	*Melanitta fusca*					y	Assess / Maintain

iii. Significant sites

A number of areas in the bioregion have been designated as nationally or globally-significant ecological sites (Figure 2). The bioregion is within the Bay of Fundy Hemisphere Shorebird Reserve under the Western Hemisphere Shorebird Reserve Network (WHSRN), recognized for its international importance for shorebirds. Two of Nova Scotia's three Ramsar[1] Wetlands of International Importance are located within the bioregion, the St. Croix and Kennetcook Watersheds and the Kelly/Maccan/Hebert Watershed[1] (Table 4). Three nationally-designated Important Bird Areas (IBA) have also been identified within the bioregion (Table 5). While legal protection is not directly attached to these designations, they do enhance recognition and encourage commitment by landowners to manage the sites for conservation.

Table 4. Ramsar sites located within the Nova Scotia Inner Bay of Fundy bioregion (CWS 2001a,b).

Site	Reason for Designation	Size (ha)
Chignecto[1]	The site contains the John Lusby National Wilderness Area and Amherst Point Migratory Bird Sanctuary recognized for high productivity freshwater wetlands and as an important staging area for waterfowl.	1,020
Southern Bight-Minas Basin[2]	The extensive salt marshes and tidal flats of this site support the largest numbers of mixed species of shorebirds during fall migration in all of North America. Minas Basin is a critical component of the Bay of Fundy Hemisphere Shorebird Reserve under the WHSRN.	26,800

Table 5. Important Bird Areas located within the Nova Scotia Inner Bay of Fundy bioregion (IBA 2012).

Site	IBA Criteria	Habitats	Size (ha)
Southern Bight, Minas Basin	**Globally Significant:** Congregatory Species, Shorebird Concentrations	Salt marshes/brackish marshes, tidal rivers/estuaries, mud or sand flats (saline), inlets/coastal features (marine), arable & cultivated lands, improved pastureland	22,192
Cobequid Bay	**Globally Significant:** Congregatory Species, Shorebird Concentrations	Salt marshes/brackish marshes, tidal rivers/estuaries, mud or sand flats (saline), inlets/coastal features (marine), arable & cultivated lands	47,768
Upper Cumberland Basin	**Globally Significant:** Congregatory Species, Shorebird Concentrations	Mixed woods (temperate), salt marshes/brackish marshes, tidal rivers/estuaries, mud or sand flats (saline), freshwater marsh	19,301 (only small portion in bioregion)

[1] *The Ramsar Convention is an intergovernmental treaty dedicated to the conservation of rare or unique wetlands and their biodiversity. Sites designated under Ramsar are selected based on being considered representative, rare or unique wetland types found within the bioregion or of international importance for conserving biological diversity.*

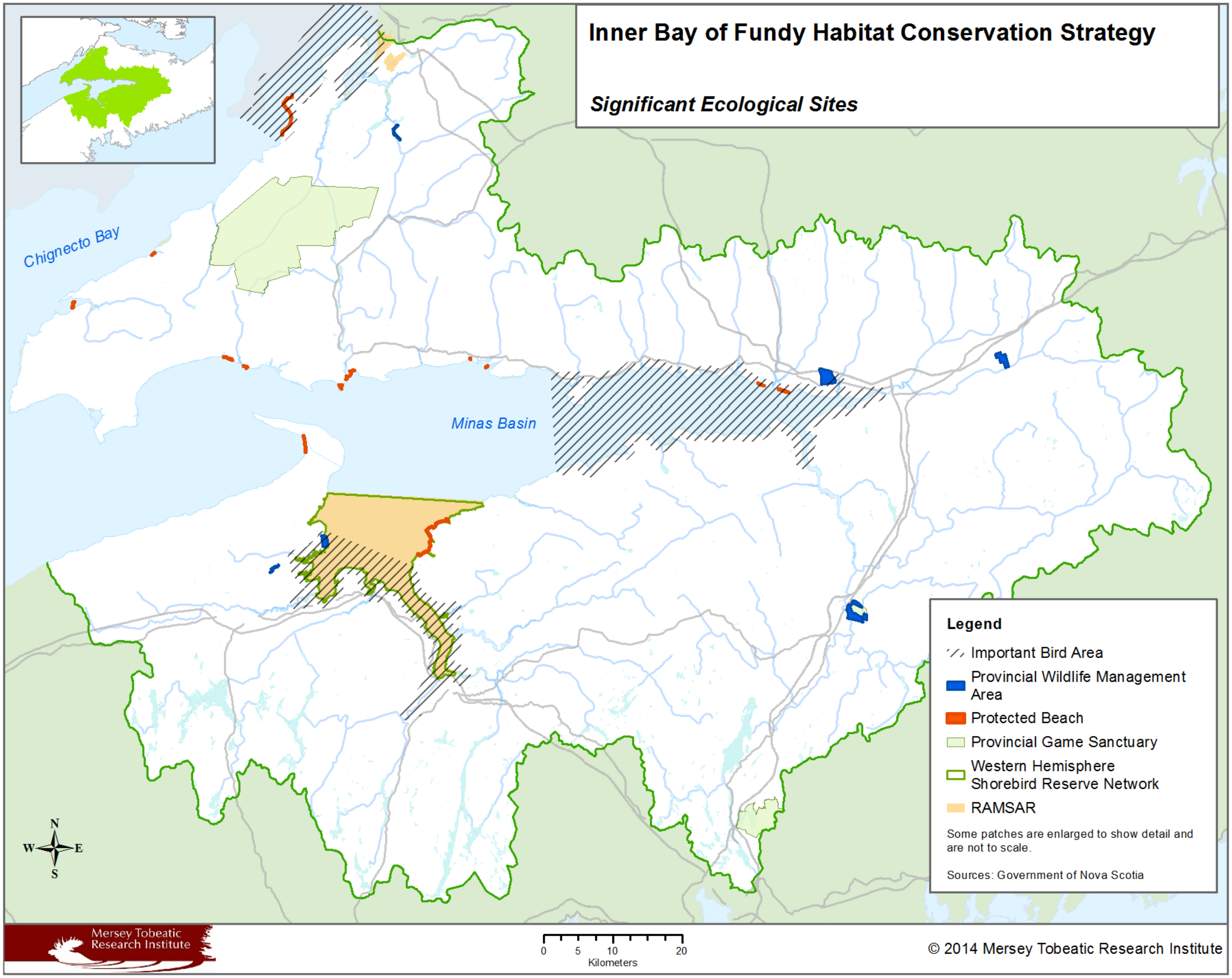


Figure 2. Significant ecological site designations in the Nova Scotia Inner Bay of Fundy bioregion.

iv. Protected areas and conservation lands

According to the International Union for Conservation of Nature (IUCN), a protected area is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature" (Dudley 2008). The Nova Scotia Environmental Goals and Sustainable Prosperity Act 2007 (EGSPA) commits the provincial government to legally protect 12% of the provincial land base by 2015. To count as 'contributing' towards the 12% target, sites must be dedicated and managed for the primary purpose of protecting biodiversity and natural processes, and be free of industrial uses. While other designated areas such as game sanctuaries, wildlife management areas, water supply areas, and some provincial parks managed for recreational or cultural purposes may offer some conservation value, they have been excluded as 'contributing properties' due to the level of disturbance or incompatible management objectives (e.g. industrial uses, development, and heavy recreation). For the purposes of this HCS, protected areas and conservation lands are defined as those determined by Nova Scotia Environment to be 'contributing properties' that count towards the 12% target (Figure 3; Table 6). These include:

- Government of Canada National Wildlife Areas and Migratory Bird Sanctuaries
- Government of Canada National Parks
- Province of Nova Scotia Wilderness Areas
- Province of Nova Scotia Nature Reserves
- Some Province of Nova Scotia Provincial Parks and Provincial Park Reserves (managed for nature conservation)
- Private conservation lands held by land trusts or with conservation easements

Currently just over 4% of the bioregion is considered protected, more than 93% of this by the province, 4% are federally protected and the remainder by private land trusts.

Federally-protected lands within the bioregion include two National Wildlife Areas and two Migratory Bird Sanctuaries, established under the authority of the *Canadian Wildlife Act* and the *Migratory Birds Convention Act* respectively, and managed by Environment Canada. These areas are managed to protect wildlife, migratory birds, and their habitats for the purposes of conservation, research and interpretation. Although access to most areas is not prohibited, restrictions are placed on activities that may cause damage or disturbance.

Provincially-protected contributing properties include six Wilderness Areas, three Provincial Parks, one Nature Reserve and various other sites designated under the *Special Places Protection Act*. Resource extraction and development are generally prohibited in all types of provincially-protected areas. Wilderness Areas are designated under the *Nova Scotia's Wilderness Areas Protection Act* (1998) and managed by Nova Scotia Environment. These areas provide protection for representative examples of Nova Scotia's natural landscapes, native biodiversity and outstanding natural features (NSE 2012a). Wilderness recreation, including hunting, trapping and fishing, are permitted. Nature Reserves offer the highest level of protection for nature in Nova Scotia. While there is currently only one designated Nature Reserve in the bioregion, a number have been slated for designation in the next few years. These areas, managed by Nova Scotia Environment, and protected under the *Special Places Protection Act* (1981), are areas selected to preserve and protect, in perpetuity, representative and special natural ecosystems, plant and animal species, features and natural processes (NSE 2012a). Scientific research and education are the primary uses of Nature Reserves and access for recreational activities is generally restricted.

Private conservation lands are held by the Nova Scotia Nature Trust (NSNT), the Nature Conservancy of Canada (NCC) and other partners in the Nova Scotia Eastern Habitat Joint Venture (NS EHJV). The NCC has secured approximately 262 ha of coastal and inland wilderness in the bioregion. The NSNT currently protects approximately 369 ha of coastal wilderness, critical freshwater habitats, karst topography, old-growth forests, and habitat for species at risk in the bioregion. Partners in the NS EHJV have secured and manage approximately 343 ha of prime coastal and inland wetlands in the bioregion through the North American Waterfowl Management Plan (1986), providing important nesting, staging, and wintering habitat for resident and migratory birds, and other wetland-dependent species.

Further gains in the area of provincially-protected lands in the bioregion are anticipated as a result of the 2013 Nova Scotia *Our Parks and Protected Areas: A Plan for Nova Scotia* (Government of Nova Scotia 2013). The plan identifies approximately 206,000 ha of land that the province commits to add to the existing parks and protected areas system as Wilderness Areas, Nature Reserves and Provincial Parks by 2015, with an additional 10,600 ha by 2020 (Government of Nova Scotia 2013). The areas were selected based on the following criteria:

- Remote: large areas in a mostly natural state with few human impacts
- Representative: examples of the full spectrum of Nova Scotia’s natural landscapes
- Rich: productive and diverse – where plant, lichen and animal life flourish
- Rare: unique or rare landscapes, plants, or animals
- Restoration: areas that fill important land gaps but need time to restore from past use
- Re-connection: areas that provide important natural connections for plants and animals

With these gains, protected lands will represent 13.04% and 13.9% of the provincial land base by 2015 and 2020, respectively (Government of Nova Scotia 2013). This exceeds the Government’s 12% commitment under the EGSPA, and will increase the size of the existing network of protected lands within the bioregion by 44% to 76,654 ha (7.4% of the bioregion; Figure 4).

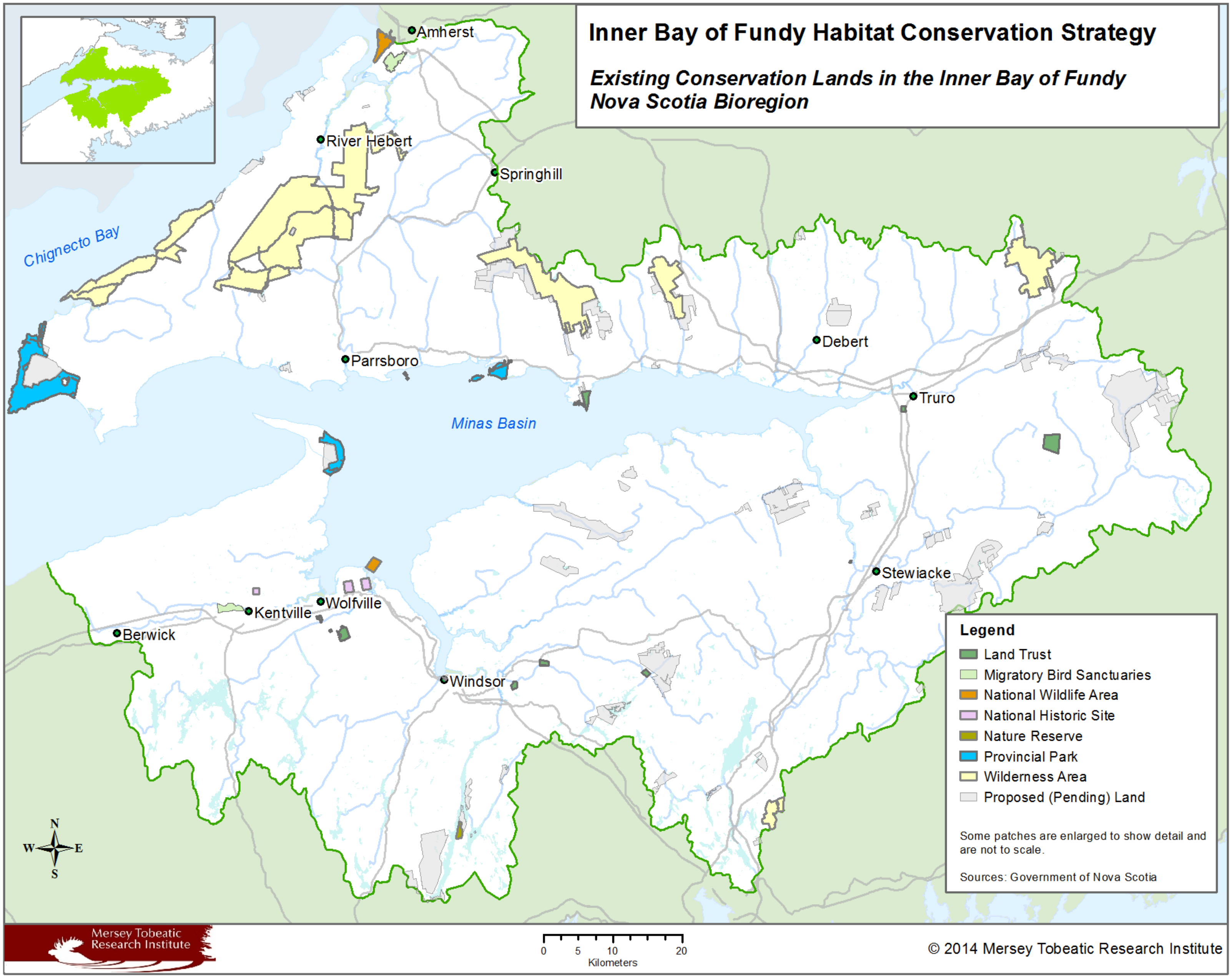


Figure 3. Existing conservation lands in the Nova Scotia Inner Bay of Fundy bioregion.

Table 6. Existing conservation lands in the Nova Scotia Inner Bay of Fundy bioregion.

Designation (Agency)	Site Name (Agency)	Area (ha)	% of Bioregion
National Parks & Historic Sites (Parks Canada)	Grand Pré	10	
	Other small sites	1.6	<0.01
National Wildlife Areas (Environment Canada)	Chignecto-John Lusby Marsh	999	
	Boot Island	107	0.11
Migratory Bird Sanctuaries (Environment Canada)	Amherst Point (largely overlaps with John Lusby Marsh NWA)	(427)	
	Kentville	336	0.03
Nature Reserves and Other Designated *Special Areas Protection Act* Lands (Nova Scotia Environment)	Joggins Fossil Cliff	4	
	Certain Lands at Debert	264	
	Panuke Lake Nature Reserve	121	
	Parrsboro Fossil Site	4	
	Fletcher Lake Lock	0.2	0.04
Wilderness Areas (Nova Scotia Environment)	Economy River	5,859	
	Gully Lake	3,273	
	Portapique River	2,057	
	Raven Head	1,044	
	Kelley River	20,926	
	Waverley - Salmon River Long Lake	737	3.2
Provincial Parks (Nova Scotia Department of Natural Resources)	Cape Chignecto	4,226	
	Five Islands	510	
	Blomidon	843	0.53
Nature Conservancy of Canada (262)	McLures Brook	7	
	Twin Lakes	164	
	Minas Basin	82	
	Spencer's Island	9	
Nova Scotia Nature Trust (369)	Brothers Islands	10	
	Rines Creek	1	
	Meander River	40	
	Wolfville Watershed	237	
	Wolfville Ridge	36	
	Gaspereau Mountain	8	
	Herbert River	28	
	Myrtha Stewart	9	
Eastern Habitat Joint Venture	Various	343	0.09
Total existing conservation lands in the bioregion (approximate)		**42,296**	**4.02**

Source: NS Environment Contributing Properties Data Layer as of January 2014.

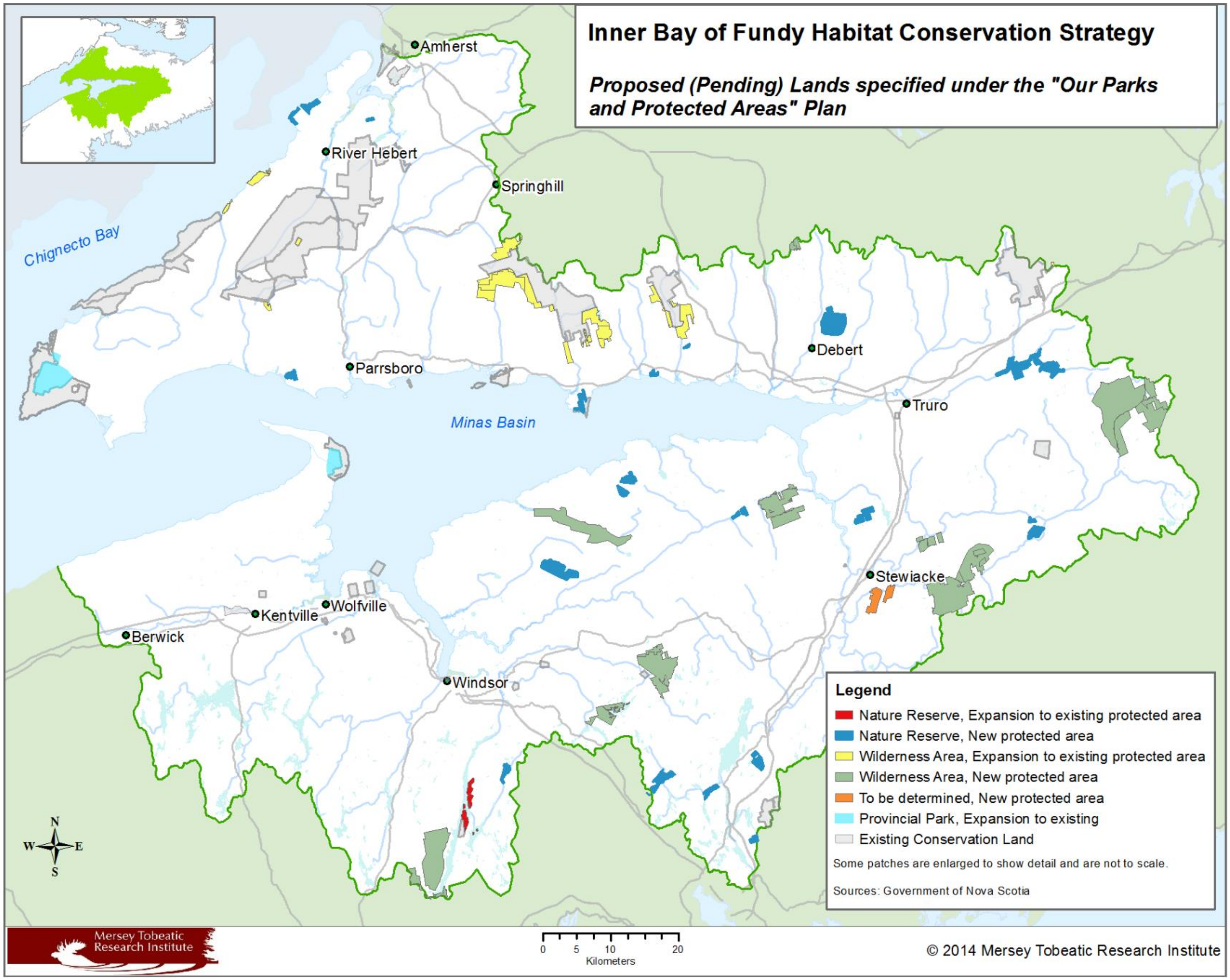


Figure 4. Network of conservation lands in the Nova Scotia Inner Bay of Fundy bioregion by 2015, including proposed (pending) lands specified under the Our Parks and Protected Areas Plan.

2. HABITAT, THREAT, AND SPECIES SPATIAL PRIORITIZATION

A. Conservation Priority Habitat Types

Central to the Habitat Conservation Strategy is the identification of priority habitat types that host conservation priority species within the bioregion. Conservation priority habitats are the native biological entities (i.e., ecological systems or communities[1]) that the HCS is aiming to conserve. Identifying conservation priority habitat types for the NS IBoF bioregion began with summarizing priorities identified in the Northern Appalachian-Acadian Ecoregional Plan (NAAP) for this area. Using best available ecological, biological, and geophysical data obtained from partners and expert local and regional knowledge, the NAAP is a comprehensive analysis of the ecology and conservation status of the Northern Appalachian-Acadian Ecoregion (Anderson *et al.* 2006). Guided by the priorities identified in the NAAP, the process used to identify conservation priority habitat types in the NS IBoF bioregion involved further literature review, consultation with experts, and iterative review with partners to identify habitat associations of priority species of conservation concern. The planning team strived to select priority habitat types at a coarse scale to encompass the most significant elements of conservation concern, including priority species (including BCR 14 and MBU 11 priority bird species, species at risk, S1, S2 and S3 (G1-G3) ranked species; Appendix C), and are representitive of the biodiversity of the bioregion.

The final suite of priority habitat types for the NS IBoF bioregion includes nine ecological systems:

1) Coastal beaches and cliffs
2) Tidal flats
3) Salt marshes
4) Coastal Islands
5) Barrens
6) Caves and calcareous sites
7) Riparian and aquatic systems
8) Freshwater wetlands
9) Late-successional Acadian forest mosaic

Descriptions and status assessments of each of the priority habitat types are presented in this section. For each of the priority habitat types, efforts were made to assess their ecological integrity using 'key ecological attributes' (KEA) and indicators within the framework of the Conservation Area Planning workbook (Low 2003), using background information collected from the NS IBoF bioregion, a review of literature, and expert opinion. For the purpose of this Habitat Conservation Strategy, the *Canada National Parks Act* (2000) definition of ecological integrity was adopted, which states that ecological integrity is "…a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes". Ecosystems with the greatest ecological integrity can better withstand or recover from natural and anthropogenic disturbances, and have the

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[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)

highest likelihood of retaining their integrity over time. These habitats may also serve as refuges for rare or at risk species which are absent or less abundant in 'lower quality' examples of the same ecosystem type. The KEAs are important for both assessing the current state of the priority habitat types, and monitoring changes in their ecological integrity over time. Identifying appropriate KEAs and determining the range of acceptable variation for their indicators of ecological integrity was designed to be adaptable as information changes and improves over time.

The ecological integrity of each of the priority habitat types was assessed based on their *landscape context*, *condition*, and *size* using criteria adapted from the NAAP to assess their ability to maintain regional biodiversity. Landscape context includes consideration of two factors: the ecological processes that maintain the priority habitat types and their landscape connectivity. Condition involves an assessment of the composition, structure, and biotic interactions that characterize the priority habitat, and size is a measure of the area or abundance of the priority habitat type. Priority habitat types were ranked for landscape context, condition, size, and overall as 'Poor', 'Fair', 'Good' or 'Very Good', as described in Table 7 (adapted from The Nature Conservancy; Low 2003). The locations of priority habitat types are mapped in Figure 5 to Figure 14.

Table 7. Description of the assessment ranks of ecological integrity of the conservation priority habitat types for the Nova Scotia Inner Bay of Fundy bioregion.

Rank	Description
Very Good	**Ecological Integrity Optimal**: The structure, species composition, and key ecological processes and functions of the conservation priority habitat 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 conservation priority habitat requires little or no management.
Good	**Ecological Integrity is Good**: The structure, species composition, and key ecological processes and functions of the conservation priority habitat 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 conservation priority habitat 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 conservation priority habitat will be vulnerable to serious degradation.
Poor	**Imminent Loss of Ecological Integrity**: The structure, species composition, and key ecological processes and functions of the conservation priority habitat 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 conservation priority habitat to remain in this condition for an extended period will make successful restoration highly improbable.
Unknown	**Research Need**: The conservation priority habitat 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 conservation priority habitat.

i. Priority Habitat: Coastal Beaches and Cliffs

Beaches are defined by Anderson *et al.* (2006) as "thick accumulations of unconsolidated waterborne, well-sorted sand and pebbles deposited on a shore, or in active transit along it" and cliffs are defined as "precipitous exposed faces which slough off rock fragments and shed water, while accumulating soil and nutrients at their bases", and include rocky crags, vertical cliffs, landslide scars, steep river bluffs, and precipitous talus slopes. The character of the NS IBoF bioregion coastline is primarily influenced by its extreme tidal range and currents. Compared to the Atlantic coast of Nova Scotia, the NS IBoF bioregion has few large inlets and higher relief cliffs. While limited in extent, one of the most characteristic features of the NS IBoF bioregion coastline is the steep-sided, often near vertical sandstone and basalt cliffs. Cliff faces and rocky outcrops bestow a unique characteristic in the region, with local bedrock type contributing significantly to biotic communities in a particular location (Anderson *et al.* 2006). Fronted by tidal flats, high basalt cliffs/bluffs and rocky islands are located intermittently along the northern shore of the Minas Basin, most prominently at Cape d'Or and Cape Chignecto (Sharp *et al.* 1998). High basaltic cliffs, fronted by coarse gravel-covered rock platforms, are also located on the southern shore, the most extensive being located at Cape Blomidon and Cape Split. The shore eastward of the Southern Bight consists of intermittent low cliffs of easily erodible soft sandstone, shale and glacial till. Beaches of firmly packed sand and mud, with coarse gravel and boulder fringes, are located in a few gently curving embayments along the northern shore, particularly around Advocate Harbour. A few sites with dunes - transient mounds of loose, windblown sand, sometimes stabilized by vegetation - are also located in the bioregion.

Both cliffs and gravel beaches are ecologically significant ecosystems as they support a high number of rare and at risk species (Parker *et al.* 2007). For example, certain vascular plants, lichens, and mosses thrive in cliff environments and Peregrine Falcons rely exclusively on these habitats for their breeding grounds. Cliffs also support a variety of swallow species, some of which are becoming increasingly rare. The exposed basalt cliffs and headlands at Cape d'Or, Cape Split and along the Parrsboro coast support vestiges of arctic (boreal) alpine flora (S. Basquill, pers. comm. 2014). The extensive rocky shorelines and cobble beaches in this bioregion support a high diversity of waterfowl and shorebirds. Beaches, especially Evangeline Beach, are particularly important for roosting shorebirds, such as the Semipalmated Sandpiper, which congregate in large numbers during high tide.

The total area of coastal beach and dune habitat is 832 ha in area and 44 km in length, comprising over 17% of the bioregion's coastline. Coastal cliffs comprise a total area of 889 ha covering 145 km (21%) of the coastline, with an additional 5 km of shoreline cliff along the Shubenacadie River. All provincially delineated beaches and cliffs are mapped in Figure 5. These habitats contribute to the health and conservation of at least 49 priority species.

Landscape context assessment of coastal beaches and cliffs: Fair

The average Landscape Context Index[1] (LCI) for Coastal Beaches and Cliffs is 34, which is considered moderate. Development within the bioregion is concentrated in the coastal zone; however, the rugged terrain along the coast where the majority of cliffs occur has limited development. Nevertheless,

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[1] *Landscape Context Index (LCI) is a measure that refers to the 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. An LCI below 20 (30 for coastal ecosystems) indicates that the habitat conservation priority is surrounded primarily by natural cover with higher LCIs indicating increasing amounts of development directly surrounding ecosystem occurrences. An LCI above 50 is considered to be high, with individual occurrences usually rejected as critical (Anderson et al. 2006).*

sometimes heavy agriculture and forestry occur in adjacent areas, particularly around Chignecto. A high percentage of the coastline is under private ownership so there is considerable potential for increased coastal development in adjacent areas. The sensitivity of the cliffs and beaches in the bioregion to sea-level rise and hence coastal erosion is low to moderate, but higher where tidal flats and salt marshes occur (Shaw *et al.* 1998). Large-scale tidal energy development may also affect the more sensitive coastal areas (See 2.B. Threats). Within the bioregion, only 7% of beaches and coastal cliffs are within the existing (including pending) network of protected areas; however, even these areas can still be threatened by fragmentation (lack of connectivity between core habitat patches) and impacts from adjacent land uses.

Condition assessment of coastal beaches and cliffs: Good
Coastal beaches and cliffs have experienced a comparatively low impact from human disturbance. This is most likely due to the inaccessibility of some of these areas along the rugged Fundy coast, limiting development and recreational use. Nevertheless, some areas experience moderate to heavy recreational use (foot traffic) (e.g. Cape Split, Cape Chignecto, Five Islands, Joggins, Evangeline Beach), where several species of rare flora and cliff birds are known to occur. Very few invasive species have been documented within these habitats.

Size assessment of coastal beaches and cliffs: Fair
The percentage of coastal beach and cliff habitat meeting the minimum critical patch size criteria is 40% (>8 ha) and 38% (>10 ha) respectively.

The primary current and emerging threats to coastal beaches and cliffs include:

Current

- Disturbance from heavy recreational use (specifically Coastal Beaches)
    - 6.1 Human intrusions & disturbance - Recreational activities

Emerging

- Coastal erosion, habitat shifting and alteration
    - 11.1 Climate change & severe weather - Habitat shifting & alteration

Overall assessment of coastal beach and cliff habitat in the NS IBoF bioregion: Fair

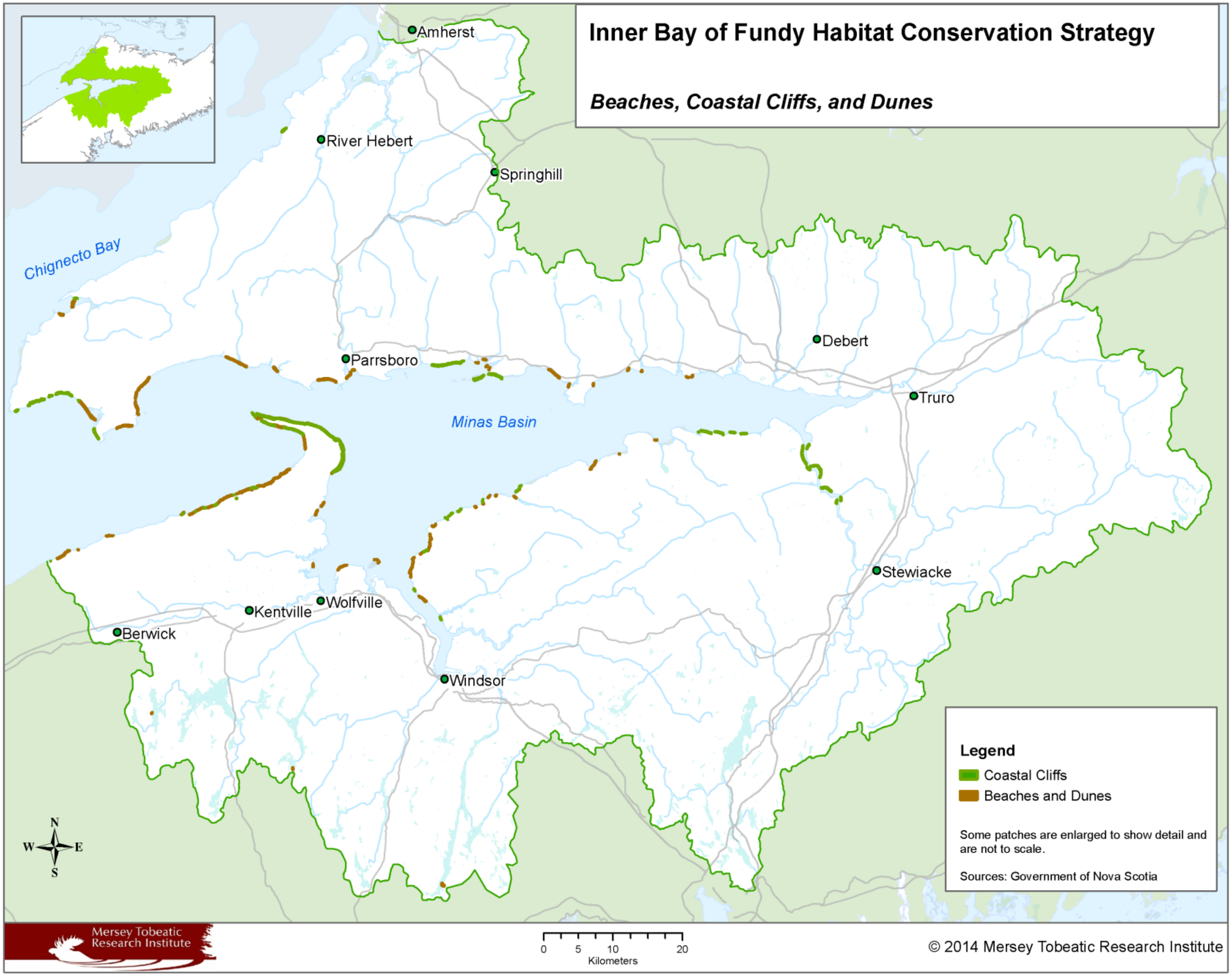

Figure 5. Coastal beaches and cliffs within the Nova Scotia Inner Bay of Fundy bioregion.

ii. Priority Habitat: Tidal Flats

Tidal flats are the most common coastal habitat in the bioregion. The IBoF tidal flats are extensive, horizontal tracts of unconsolidated clays, silts, sands and organic materials that are alternately covered and uncovered by the tide (Anderson *et al.* 2006). These sparsely vegetated, nutrient-rich flats provide habitat for a variety of invertebrate species, including amphipods (notably *Corophium volutator*), polychaete worms, molluscs and immense concentrations of unicellular organisms such as diatoms and dinoflagellates that form biofilm, which together form the basis of the food web in this habitat (Parker *et al.* 2007, Quinn and Hamilton 2012). From late July to mid-September, millions of shorebirds, representing as many as 42 migratory species, stage in the IBoF, feeding on the variety of invertebrate prey (WHSRN 2008). This includes species such as the federally endangered Red Knot and up to 95% of the global population of Semipalmated Sandpipers. Along with salt marshes, the productive tidal flats, particularly in the Southern Bight, Cobequid Bay and Chignecto Bay, are the main reason for IBoF tidal flats being identified as key components of Ecologically and Biologically Significant Areas (EBSA; Buzeta 2014) and for the identification and designation of a WHSRN Reserve, three IBA and two Ramsar sites. Overall, tidal flats contribute to the health and conservation of at least 22 priority species. Over 10,229 ha of provincially-delineated tidal flats occur within the NS IBoF bioregion, comprising 1% of the bioregion and 26% of all the tidal flats in Nova Scotia. All provincially delineated tidal flats are mapped in Figure 6.

Landscape context assessment of tidal flats: Poor

The average LCI for tidal flats is 45, which indicates a fairly high level of development adjacent to priority habitat sites. Extensive tracts of tidal flats in the bioregion, especially in the Southern Bight/Avon River estuary, are bordered by agricultural land, roads, industrial facilities and residential areas. The sensitivity of the bioregion to sea-level rise and hence coastal erosion is moderate where the majority of tidal flats occur (Shaw *et al.* 1998). While tidal flats themselves do not have a great deal of development potential, they may be severely impacted by adjacent onshore development and tidal barriers, which can cause changes to sedimentation patterns, introduce excessive nutrients and contaminants, or impact their ability to migrate inland in response to sea-level rise. Only 4% of tidal flats in the bioregion are currently within a designated or pending protected area.

Condition assessment of tidal flats: Good

The nature of tidal flats being inundated daily has limited the amount of direct anthropogenic disturbance, with the exception of recreational activities, clam and baitworm harvesting, and dredging for shipping. While impacts seem to have lessened in recent years, uncontrolled intensive clam and baitworm harvesting has occurred in the bioregion, with potential effects on tidal flat structure, the composition of invertebrate communities, and potentially the waterfowl and shorebirds which feed on them. Areas of tidal flats, particularly along the Avon River, have occasionally been dredged to permit access of shipping vessels to and from Hantsport Harbour. While the need for this has declined due to the closure of the gypsum quarry and pulp plant in the area, this practice could resume in the future. Indirect effects on tidal flats from coastal development and tidal barriers have been more notable. Tidal flats adjacent to the more highly developed areas in Cumberland, Colchester, and Kings Counties, particularly around the Southern Bight, have been particularly susceptible to accumulation of contaminants from agricultural, industrial and urban runoff (AECOM 2011). Moreover, the partial or complete obstruction of tidal flow due to tidal barriers has caused changes in sedimentation and erosion patterns, resulting in accretion of mud flats in some areas and erosion of flats in others (van Proosdij 2007; AECOM 2011). For example, the rate of mud accretion in the Avon River estuary has increased substantially following construction of the Windsor Causeway, leading to the gradual formation of a 'new' salt marsh system downstream (van Proosdij 2007). There are no recent reports of invasive species that could constitute a major concern within the Inner Bay of Fundy tidal flats.

Size assessment of tidal marshes: Very Good
The average patch size of tidal flats is 165 ha, with 97% of the habitat meeting the minimum critical patch size criteria identified in NAAP (>40 ha).

The primary current and future threats to tidal flats include:

Current

- Pollution from onshore development, including wastewater, agriculture and industrial effluents
    - 1.1 Residential & commercial development - Housing & urban areas
- Tidal barriers, which restrict the flow of tidal rivers, thus preventing the flushing and mixing of sediments into estuaries (esp. the Windsor Causeway along the Avon River)
    - 7.2 Dams & water management/use (dams & other aquatic barriers)

Emerging

- Future sea-level rise and coastal erosion
    - 11.1 Climate change & severe weather - Habitat shifting & alteration
    - 11.4 Climate change & severe weather - Storms & flooding
- Dredging of harbours for shipping, aggregate or mineral extraction (e.g. proposal to extract rare earth minerals from Shubenacadie River and Cobequid Bay)
    - 3.2 Energy production & mining - Mining & quarrying
- Development of tidal energy infrastructure
    - 3.3 Energy production & mining - Renewable energy

Overall assessment of tidal flats in the NS IBoF bioregion: Good

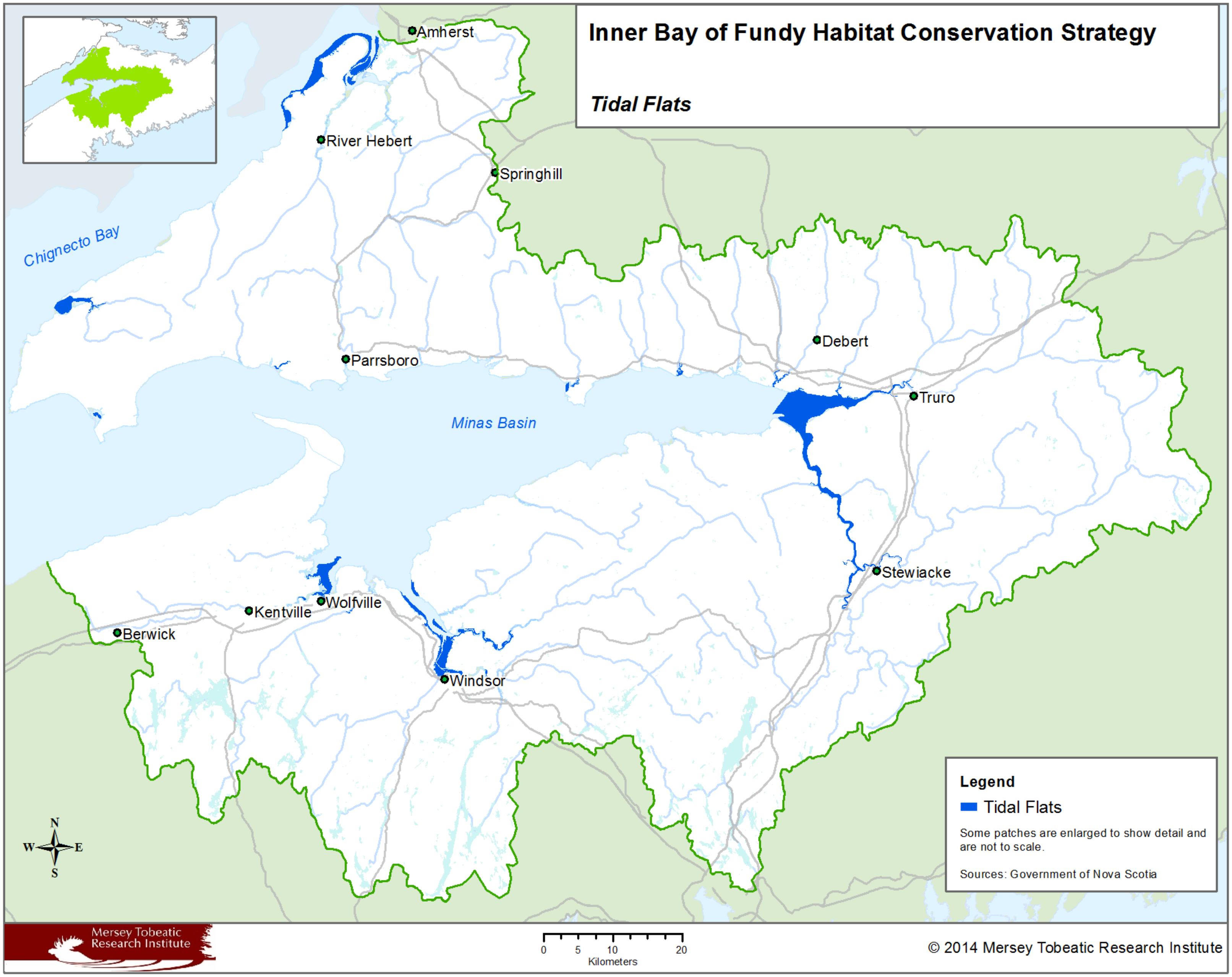

Figure 6. Tidal flats within the Nova Scotia Inner Bay of Fundy bioregion.

iii. Priority Habitat: 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 dominated by *Spartina* grasses (Anderson *et al.* 2006). Salt marshes form where sediment accumulates in sheltered areas in estuaries, at the mouth of and along tidal rivers (e.g., Avon River) and behind protective barriers, such as islands, spits and barrier beaches (Parker *et al.* 2007; AECOM 2011). Salt marshes in the IBoF are typically divided into two zones with different flooding regimes and vegetation communities. The high salt marsh, typically dominated by *Spartina patens* (marsh hay), occurs at the uppermost end of the intertidal zone and often only experiences flooding a few times a year when the tide is especially high (e.g., spring, storms). The low salt marsh, forming landward of tidal flats, experiences regular flooding during normal tidal cycle and is dominated by *Spartina alterniflora* (marsh cordgrass).

Salt marshes are among the most productive ecosystems along the coast and, along with tidal flats, provide critical breeding and feeding habitat for migratory and breeding waterfowl, shorebirds and seabirds, including rare and at risk species (e.g., Bobolink, Nelson's Sharp-tailed Sparrow, Short-eared Owl, and Willet), and serve as important nursery areas for fish, snails and shellfish. Tidal marshes also serve important functions in flood protection, erosion control, source of nutrients and organic matter for marine ecosystem, and filtering contaminants, nutrients and suspended sediments from the water column (AECOM 2011).

Although salt marshes occur in many areas along Nova Scotia coasts, they are most extensive in the IBoF, where they account for about 13% of the primary production (Parker *et al.* 2007; AECOM 2011). Extensive tidal marshes are found in the Southern Bight, Cobequid Bay, and Chignecto Bay (e.g., Tantramar Marshes). The conservation of this habitat contributes to the health and conservation of over 26 priority species within the bioregion. Provincially-delineated salt marshes total an area of over 4679 ha, which represents <0.01% of the NS IBoF bioregion, but 29.5% of all salt marshes within the province. All provincially delineated salt marshes are mapped in Figure 7.

Landscape context assessment of salt marshes: Poor
The average LCI for salt marshes is 45, which indicates a fairly high level of development adjacent to priority habitat sites. Extensive tracts of salt marsh, especially in the Southern Bight/Avon River estuary, are bordered by agricultural land, roads, industrial facilities and residential areas. These factors have led to contamination of salt marshes from wastewater and runoff, as well as coastline hardening from development of permanent structures. The sensitivity of the bioregion to sea-level rise and hence coastal erosion is moderate where the majority of salt marshes occur (Shaw *et al.* 1998). Shoreline hardening and associated loss of sediment supply may further compound the impacts of sea-level rise by limiting the landward migration of tidal marshes in response to natural and anthropogenic sea-level rise.

Within the bioregion, 27% of salt marshes are in designated or pending protected areas, and thus are less at risk from future development. Furthermore, salt marshes are offered additional protection under the 2011 *Nova Scotia Wetland Conservation Policy.* The policy outlines the government's goal to prevent the loss of *Wetlands of Special Significance,* which includes all salt marshes, by restricting activities that pose a substantial risk to these wetlands (Government of Nova Scotia 2011).

Condition assessment of salt marshes: Fair
Historically, extensive tidal marshes were located in Nova Scotia, especially in the Bay of Fundy. However, as much as 85% of the tidal marsh in the Bay of Fundy (65% provincially) has been lost since European settlement. It was primarily converted to agricultural land by dyking (CBCL Lt. 2009; AECOM

2011; Bowron *et al.* 2012). In the Avon River estuary alone, there was an 87% loss of salt marsh between 1858 and 1955, and an additional 14% between 1955 and 1964. Eighty-nine percent of this loss is believed to be due to dyking (van Proosdij & Baker 2007). Numerous tidal marshes within the bioregion have restricted tidal flow due to the installation of dykes and aboiteaux, undersized and poorly constructed culverts, causeways, and roadways. Tidal flow restrictions can result in decreased soil accretion and changes in vegetation, which can severely impact the health and integrity of tidal marsh habitat (Bowron *et al.* 2012). Over the past decade, efforts have been made to restore tidal marshes in several areas in the NS IBoF bioregion by removing dykes and tidal restrictions on lands no longer used for agriculture (Bowron *et al.* 2012). Examples include Cheverie Creek, Cogmugun River, and Walton River on the south shore of the Minas Basin. Moreover, due to restricted tidal flow and the resultant accumulation of sediments, a new marsh/tidal flat complex formed, unintentionally, in the Avon River following the construction of the Windsor Causeway in 1970. By 2006, almost all suitable mudflat surfaces had been colonized by salt marsh (van Proosdij & Baker 2007).

While development on salt marshes is currently restricted, runoff, effluents, shoreline hardening, erosion, and disturbance from human presence can impact these habitats (CBCL Ltd. 2009). Salt marshes adjacent to parts of the more highly developed areas in Cumberland, Colchester, and Kings Counties, have been particularly susceptible to accumulation of contaminants from agricultural, and industrial and urban runoff, particularly around the Southern Bight (AECOM 2011). At least three invasive plant species have been documented in tidal wetlands in eastern Canada. These are the Common Reed (*Phragmites australis* ssp. australis), Purple Loosestrife (*Lythrum salicaria*), and Reed Canary Grass (*Phalaris arundinacea*; T. Bowron & K. Porter, pers. comm. 2014). The Common Reed is an aggressive invasive species that inhabits freshwater or brackish shores and wetlands and is of particular concern in the bioregion. It spreads quickly to form large, dense stands that exclude native species and can alter the structure and function of native marsh ecosystems (Belliveau 2012).

Size assessment of salt marshes: Fair
While the average patch size is only 13 ha, 70% of salt marsh habitat meets the MCPS criterion identified in NAAP (>24 ha) indicating the presence of several large patches interspersed with many very small patches. The majority of salt marshes are associated with extensive tidal flats/salt marsh complexes (MCPS >40 ha), and thus the effective size of most of the habitat patches is considered good.

The primary current and emerging threats to salt marshes include:

Current

- Shoreline hardening and pollution from onshore development, including wastewater, agriculture and industrial effluents
    - 1.1 Residential & commercial development - Housing & urban areas
    - 2.1 Agriculture & aquaculture - Annual & perennial non-timber crops
- Dykes and other tidal barriers
    - 7.2 Dams & water management/use (dams & other aquatic barriers)

Emerging

- Future sea-level rise and coastal erosion
    - 11.1 Climate change & severe weather - Habitat shifting & alteration
    - 11.4 Climate change & severe weather - Storms & flooding

Overall assessment of salt marshes in the NS IBoF bioregion: Fair

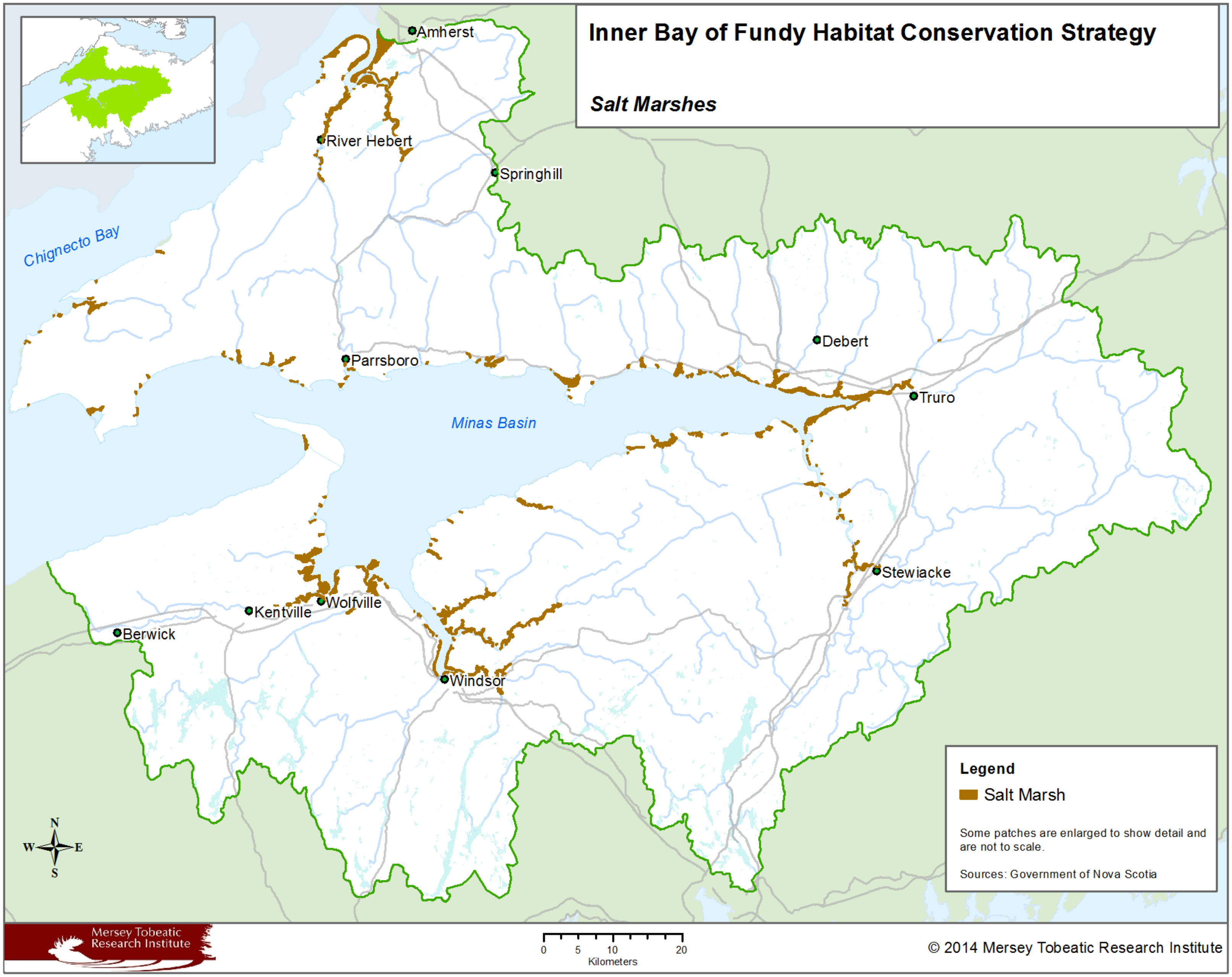

Figure 7. Salt marshes within the Nova Scotia Inner Bay of Fundy bioregion.

Priority Habitat: Coastal Islands

Coastal islands in Nova Scotia may be composed of bedrock, glacial till, or sand, though bedrock islands are most common in the IBoF, particularly in areas of resistant basalt (Davis & Browne 1996). For the purposes of this HCS, coastal islands include all provincially delineated islands larger than 0.1 ha that are located within 5 km of the coast (Figure 8). Compared to the Atlantic coast, coastal islands are rare in the IBoF. There are 30 coastal islands located within the NS IBoF bioregion, ranging in size from 0.1 ha to 113 ha (average 11.6 ha) and totalling an area of 347 ha. Clusters of small islands are located in the Southern Bight, off the mouth of the Gaspereau River, and in the coastal waters near Parrsboro and Five Islands.

The habitats and species of these islands vary depending on their location, geology, and size. Very little information is available on habitat and biodiversity as there have been few inventories of biota on most of Nova Scotia's islands (CBCL Ltd. 2009). However, at least 20 priority species are known to regularly occur on islands in the bioregion. For many species, especially sensitive plants and birds, islands can serve as sanctuaries from predators, as well as natural disturbances such as fire, disease, pests, and human disturbance. Islands in the IBoF are known as important breeding, nesting, and staging areas for waterfowl and shorebirds. The most well studied island is Boot Island National Wildlife Area. Boot Island consists of 91 ha of saltmarsh, 2 ha of forest/woodland habitat and approximately 14 ha of shrub and grassland habitat and is surrounded by open water and mudflats (Environment Canada 2012a). There are over 170 plant species recorded on the island and over 30 species of birds have been observed on or near the island, including breeding colonies of Herring Gull, Great Black-backed Gull, Great Blue Heron, and Double-crested Cormorant. This island also serves as a staging and migration area for other waterfowl and shorebirds. The floral and faunal communities on Boot Island are considered typical of islands in the bioregion (Environment Canada 2012a).

Isle Haute, while adjacent to the NS IBoF bioregion, lies more than 5 km from the coast, though it still deserves mentioning in this HCS. Its remoteness, physical and legal barriers to access and lack of infrastructure have limited most anthropogenic threats, and evidence stemming from ecological studies on the island suggests formal, long-term protection is warranted (Nova Scotia Museum 2000). The island is presently under the ownership of the Government of Canada.

Landscape context assessment of coastal islands: Good
Islands are isolated by nature, but may be subject to various levels of disturbance, based on their location and activities in surrounding waters. Disturbance along the coast of the mainland adjacent to the islands can affect their ecological processes and species. Development within the bioregion is concentrated along the mainland coastal zone and a high percentage of the coastline, including coastal islands, is under private ownership, so there remains a potential for further coastal development. Residential, agricultural, industrial, and recreational development is high along the mainland coastline in the Southern Bight where several islands are clustered near the mouth of the Gaspereau River. The sensitivity of coastal islands in the bioregion to sea-level rise and hence to coastal erosion is low to moderate, but higher where tidal flats and salt marshes occur (Shaw *et al.* 1998). Within the bioregion, 50% of coastal islands are within the network of existing or pending protected areas, and thus are less at risk from future development.

Condition assessment of coastal islands: Good
Information on the current condition of many of the islands in the bioregion is unavailable. Several islands, including at least three of the Five Islands, are known to have undergone historic and current anthropogenic disturbance from human habitation, agriculture and recreational use, which has led to

vegetation clearing and grazing, and possibly the disturbance of nesting birds and the introduction of invasive species. Boot Island and Brothers Island (owned by NSNT) remain fairly intact. The latter has remnants of old-growth hemlock and rare coastal flora such as Canada Yew and Purple Trillium.

Size assessment of coastal islands: Not Applicable
There is no minimum critical patch size for coastal islands.

The primary current and emerging threats to coastal islands include:

Current

- Sea level rise, especially for coastal islands in the southern Minas Basin
    - 11.1 Climate change & severe weather - Habitat shifting & alteration
    - 11.4 Climate change & severe weather - Storms & flooding

Emerging

- Mainland coastal development
    - 1.1 Residential & commercial development - Housing & urban areas
- Disturbance of wildlife from recreational use
    - 6.1 Human intrusions & disturbance - Recreational activities

Overall assessment of coastal islands in the NS IBoF bioregion: Good

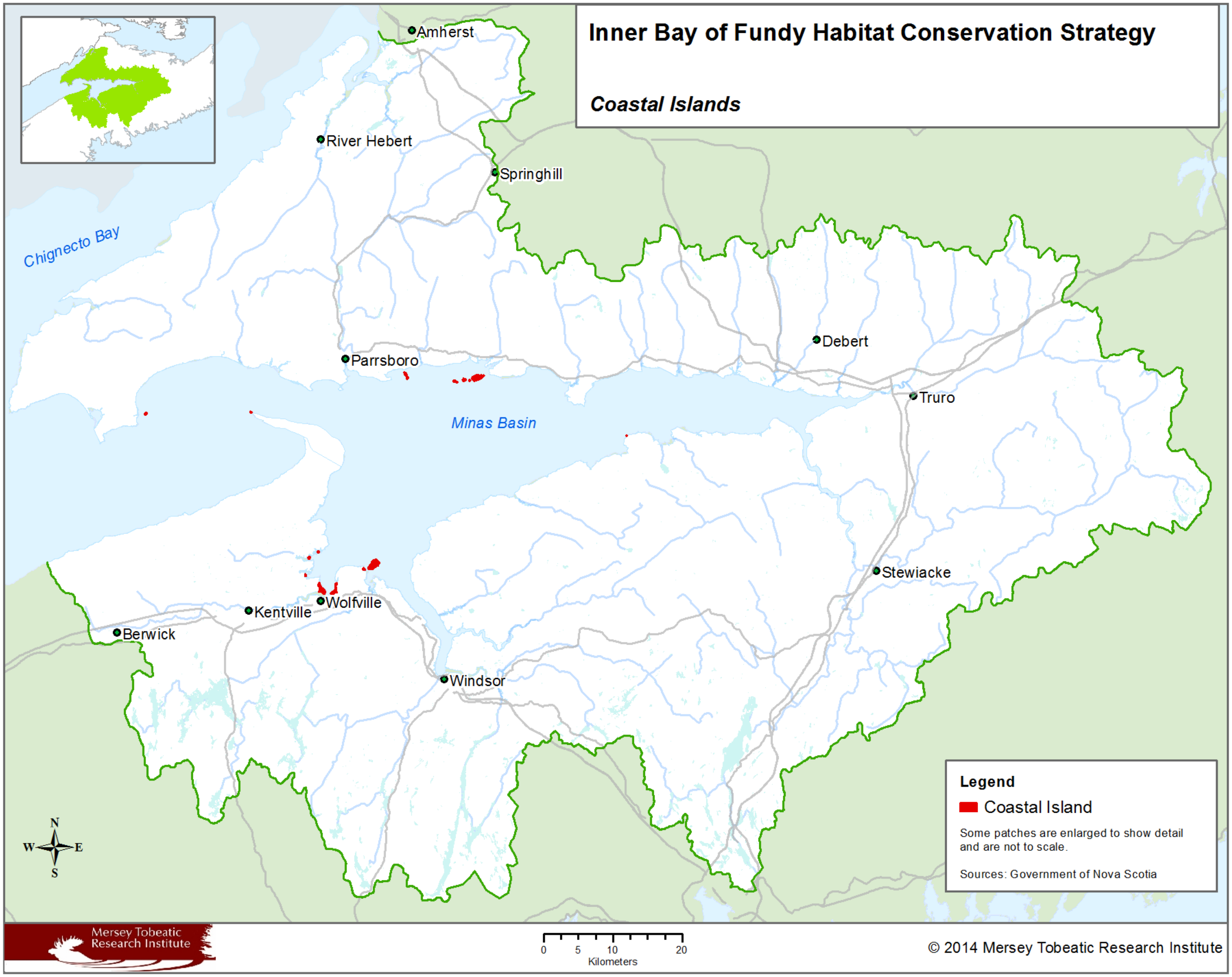

Figure 8. Coastal islands within the Nova Scotia Inner Bay of Fundy bioregion.

iv. Priority Habitat: Barrens

Barrens are acidic, nutrient-poor habitat types dominated by ericaceous (heath) vegetation and further characterized by sparse tree cover (Davis and Browne 1996; Carbyn *et al.* 2009). These shrub-dominated habitats often occur where prevailing conditions are too stressful for tree growth, and frequently found in association with bog wetlands (Carbyn *et al.* 2009). Many of the common shrub species, including blueberry, cranberry, crowberry, and huckleberry, are prolific berry producers, providing an abundant food source for foraging birds and mammals in the late summer and early fall.

Persistent barrens are thought to be regulated by climatic and edaphic conditions in exposed inland sites and near-coast exposed sites (Burley 2009). Four factors may be involved in the development of barren habitats: 1) the effects of ice action during glaciation scraping over hard rocks and leaving only a thin layer of coarse till; 2) the formation of a hardpan layer (ortstein) that is impenetrable to plant roots; 3) the effects of fire, stripping humus from the soils; and 4) harsh climatic conditions (Davis and Browne 1996). There are three categories of barrens recorded in the province, namely coastal, inland and sand barren, each with their own unique biotic communities.

Barrens are poorly inventoried in the bioregion and very little information is available on their current distribution and biota. All provincially-delineated occurrences of barrens, including those identified in published scientific literature and verified by experts, are mapped in Figure 9. These total 2896 ha with an average patch size of 4.7 ha. Of the mapped barrens, inland barrens make up the vast majority (>96%), and are primarily located in the headwaters of the Gaspereau, St. Croix, Shubenacadie and Salmon River watersheds, and in the Kelly/Maccan/Hebert Watershed. Less than 1% of the barrens are classified as sand barrens. Although sand barrens are mainly restricted to a small area of the Annapolis Valley east of the bioregion (Kingston sand barrens), a few small patches are believed to exist in the Annapolis Valley portion of the bioregion between Berwick and Kentville (eastern edge) (Carbyn *et al.* 2009; N. Hill, pers. comm. 2014), Debert (K. Porter & S. Basquill, pers. comm. 2014) and around Chignecto. Mostly found along the Atlantic coast of Nova Scotia, coastal barrens are also uncommon (3% of all barrens) in the bioregion, located on the cliffs and headlands along the Chignecto coast, including at Cape d'Or, Cape Chignecto, and at Blomidon/Cape Split.

In total, barrens comprise less than 0.3% of the bioregion. While uncommon, barrens were selected as a priority habitat for the bioregion due to the overall rarity of some types of barrens (e.g., sand barrens) in the province, their likelihood of supporting rare species, and their high level of historic loss. Conservation of barren habitats within the bioregion will contribute to the health and conservation of at least 25 priority species.

Landscape context assessment of barrens: Fair

The average LCI for barrens is 35, which is in the medium to high range. Most of the inland barrens, including the remnant sand barrens, are located in areas in or adjacent to agricultural, forestry or residential development, particularly around Chignecto, the Annapolis Valley, Truro/Debert and Shubenacadie River headwaters. The resulting fragmentation and isolation of habitat patches in some areas, especially in the Debert and Shubenacadie Rivers headwaters, places added stress on specialized barren species and increases the potential for local population extirpations by constraining their ability to move and disperse among suitable patches. In addition to direct habitat conversion, the presence of these activities introduces fire suppression, recreational use (off-highway vehicles, foot traffic), pesticides, and invasive species that may impact the integrity of remaining barrens. The rugged terrain along the coast where coastal barrens occur has limited the amount of development; however, sometimes heavy agriculture and forestry occur in adjacent areas. In total, 13% of barrens in the bioregion are currently within designated or pending protected areas; however, even these areas can still be threatened by fragmentation (lack of connectivity between core habitat patches) and impacts from adjacent land uses.

Condition assessment of barrens: Good
The historic distribution and characteristics of barrens in the bioregion are unknown. However, it is estimated that greater than 97% of the original open sand barrens occurring in the Annapolis Valley have been lost as a result of fire suppression, agricultural and residential development, sand quarrying, and invasive species (Catling *et al.* 2004). Loss and degradation of barrens in other areas is also likely to have occurred. The average human footprint score for barrens is 24, indicating a fairly low level of human development within existing barrens; however, agriculture, mining, forestry, road construction, and residential development continue in areas with known barrens and thus pose ongoing and, in some cases, imminent threats. Coastal erosion of exposed headlands also poses a threat to coastal barrens. Off highway vehicle use is one of the most well documented threats to barrens in some areas, where it has been shown to severely degrade habitat, damage sensitive vegetation, destroy soil characteristics, and alter hydrology (Oberndorfer & Lundholm 2009; Simon 2012; Porter 2013). At present, invasive species do not appear to pose a significant threat to coastal barren communities. However, Scots Pine has been shown to be an aggressive invader of the sand barrens of the Annapolis Valley, shading out native vascular plants (Hill & Blaney 2009).

Size assessment of barrens: Not Applicable
Size is not likely a limiting factor of the ecological value of this habitat type (K. Porter, pers. comm. 2013) and thus has not been used to assess the integrity of this habitat.

The primary current and emerging threats to this habitat (Barrens) include:

Current

- Agriculture, forestry, and residential development
    - 1.1 Residential & commercial development - Housing & urban areas
    - 4.1 Transportation & service corridors - Roads & railroads
    - 8.1 Invasive & other problematic species, genes & diseases - Invasive non-native/alien species/diseases
- Disturbance from recreational, particularly OHV use
    - 6.1 Human intrusions & disturbance - Recreational activities

Emerging

- Invasive species
    - 8.1 Invasive & other problematic species, genes & diseases - Invasive non-native/alien species/diseases

Overall assessment of barrens within the NS IBoF bioregion: Good

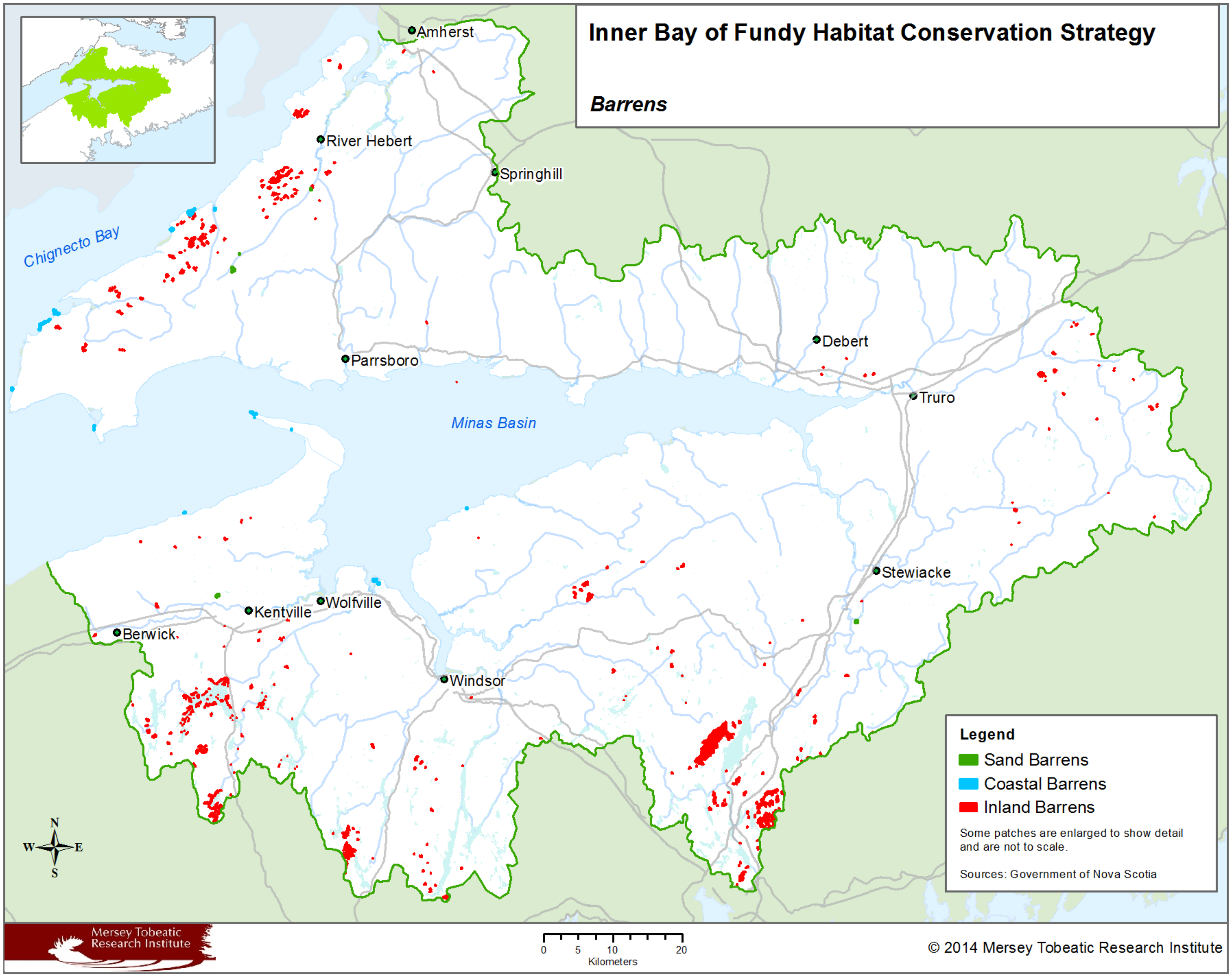

Figure 9. Barrens within the Nova Scotia Inner Bay of Fundy bioregion.

v. Priority Habitat: Caves and Calcareous Sites

Calcareous areas are lands underlain by gypsum, limestone, or dolomite bedrock or soil and are often characterized by surface or subsurface karst topographic features (NSDNR 2011). Karst landscapes in Nova Scotia most commonly form over gypsum deposits and are rugged and irregular with diverse surface expressions including cliffs, caves, fissures, talus, pinnacles, and steep sided funnel-shaped sinkholes. Karst is one of the most significant and characteristic features of the bioregion. All provincially-delineated calcareous and karst areas and any expert identified bat caves (by NSDNR, ACCDC, or Nova Scotia Museum) are mapped in Figure 10. The bioregion contains at least 10,163 ha of provincially-delineated calcareous habitat, 60% of which is recorded as karst or karst forest. Some of the calcareous areas include wetlands, such as bogs and fens. Calcareous and karst areas represent just under 1% of the total area of bioregion and 45% of all known karst formations in the province.

Karst landscapes contain a diverse mix of habitats ranging from dry hill crests and actively collapsing sinkholes to small alkaline ponds and wetlands (NSDNR 2011). The fertile wetlands and forest habitats that occur within calcareous areas in the bioregion support a unique suite of flora, much of which is found nowhere else. The calcareous floodplain forests and wetlands along the Meander, St. Croix, Herbert, Cogmugun, and Gays Rivers are known to be especially productive and important sites for rare plant species (S. Basquill, R. Newell, pers. comm. 2014). Temperate karst forests are rare within Canada (NSDNR 2011). Two unique karst Acadian Forest communities have been identified in the bioregion: a mature Eastern Hemlock/Red Spruce dominated softwood/mixedwood forest and a mature Sugar Maple dominated hardwood unit. Both are known to predominantly occur within the Hants and Colchester County portions of the bioregion (St. Croix, Kennetcook, and Shubenacadie). Several rare plants including Yellow Lady Slipper, Ram's Head Lady Slipper, Leatherwood, and Bulbet Bladder Fern are associated with karst and calcareous areas, many preferring gypsum cliffs and talus slopes. In fact, five of the six known sites of Ram’s Head Lady Slipper in Nova Scotia occur within the bioregion (in west Hants County; Blaney and Mazerolle 2007). The karst habitats within the bioregion also contain some of the rarest lichens and bryophytes in the province, some of which are not recorded anywhere else in the mainland (e.g., Olive Beard Moss and Pygmy Pocket Moss; Anderson and Neily 2010). Particular areas where rare lichens have been recorded include Walton, Tennycape, and White Head in Hants County. Calcareous soils also support the greatest diversity of land snails in the province (NSDNR 2011).

Another significant habitat feature of karst is its dissolution caves. Approximately 40 such caves have been documented in Nova Scotia, the majority of which occur within the bioregion. Caves and abandoned mines provide habitat for a number of obligate and facultative cave insects and other invertebrates, porcupines, deer mice, and occasionally amphibians and fishes (Moseley 1998). Three species of endangered forest bats depend on gypsum caves and abandoned mines for over-wintering, roosting, and swarming habitat (Moseley 2007; H. Broders, pers. comm. 2014). The majority of important bat hibernacula in the province are found in the bioregion, particularly on the south side of the Minas Basin, including the largest, Hayes Cave (Moseley 2007). Given the rapid decline of bat populations due to WNS (see Section 2.B Threats), protection of cave and karst forest habitats is especially important to reduce disturbance to already stressed populations and increase the chances of survival of those bats that may be resistant to the disease. Conservation of this priority habitat will contribute to the health of at least 42 significant facultative- or obligate-calcareous species.

Landscape context assessment of caves and calcareous sites: Fair
The average LCI for calcareous areas is 37, which is in the medium to high range. Landscape connectivity for calcareous areas is a concern given the high level of forestry, agriculture, roads and mining within the landscape. These activities continue to threaten the remaining intact areas. The resulting

fragmentation and isolation of habitat patches in some areas places added stress on specialized calcareous species (and potential for local population extirpations) by constraining their ability to disperse among suitable patches. In total, only 4% of calcareous habitats in the bioregion are currently within designated or pending protected areas; however, even these areas can still be threatened by fragmentation (lack of connectivity between core habitat patches) and impacts from adjacent land uses.

Condition assessment of caves and calcareous sites: Fair
The average human footprint score for calcareous areas is 36, indicating a medium to high level of human development. The long history of clearing of vegetation and large-scale mining of gypsum, limestone, and other deposits is likely to have resulted in the loss of suitable habitats and populations of specialized calcareous plants, such as Ram's Head Lady Slipper (Blaney & Mazerolle 2007). However, some abandoned quarries have since formed into ponds and some appear to now support rare species (Anderson & Neily 2010). Three large quarries are currently in operation and approximately 10% of the karst forest is currently managed for forestry. The current quarrying and forestry operations are occurring within the known distribution of habitat considered suitable for rare species in the bioregion (Blaney & Mazerolle 2007; Anderson & Neily 2010). Given their limited distribution and dispersal ability, the loss of further karst habitat may be significant for some species. The continual expansion of these activities, including associated road construction, continues to pose a threat to these areas (Blaney & Mazerolle 2007). The fertile calcareous forests and wetlands, particularly in floodplains, have been traditionally cleared for agriculture and expansion of agricultural lands continues to pose a threat.

The majority of natural bat caves and mines in the province are located in the bioregion, including some of the most significant, such as Hayes Cave. Due to WNS, there has been as much as a 99% decline in the population of bats in caves across the province, with 100% loss in some caves in the bioregion (H. Broders, pers. comm. 2014). Some historic bat caves and mines have been destroyed by quarrying (Moseley 2007).

Size assessment of caves and calcareous sites: Not Applicable
There is no minimum critical patch size for caves or karst.

The primary current and emerging threats to caves and calcareous sites include:

Current

- Agriculture, forestry, and mining
    - 2.1 Agriculture & aquaculture - Annual & perennial non-timber crops
    - 4.1 Transportation & service corridors - Roads & railroads
    - 5.3 Logging & wood harvesting
    - 3.2 Energy production & mining - Mining & quarrying
- Invasive species
    - 8.1 Invasive & other problematic species, genes & diseases - Invasive non-native/alien species/diseases

Overall assessment of caves and calcareous sites in the NS IBoF bioregion: Fair

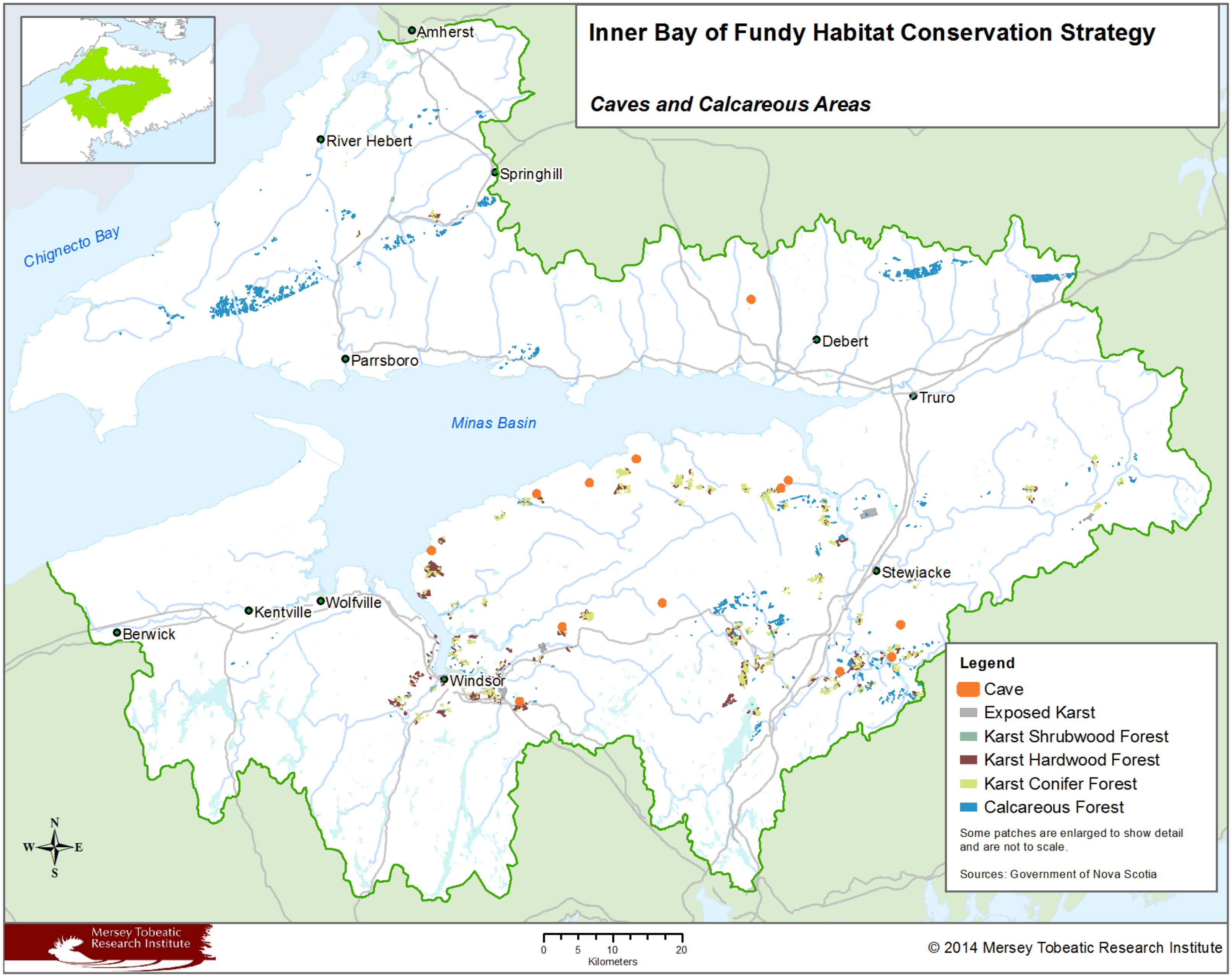

Figure 10. Caves and calcareous sites within the Nova Scotia Inner Bay of Fundy bioregion.

vi. Priority Habitat: Aquatic and Riparian Systems

This habitat priority type refers to freshwater aquatic ecosystems (e.g., rivers, streams, wetlands, and lakes), their adjacent terrestrial ecosystems, and the interface, or transition zone between them (Gregory *et al.* 1991). Riparian and aquatic systems within the bioregion host a diversity of species, including federally listed freshwater mussels, turtles, anadromous and catadromous fish, as well as a variety of riparian-dependent flora. Conservation of riparian and aquatic systems within the bioregion will contribute to the conservation of at least 123 priority species. All priority riparian and aquatic systems are mapped in Figure 11, including all major watercourses and lakes identified within the provincial water inventory, as well as all river systems classified as critical habitat for the IBoF Atlantic Salmon population. Riparian habitats have been delineated by applying a 275 m buffering around all identified priority waterbodies. The total area of riparian and aquatic system habitat is 145,772 ha, constituting 14% of the bioregion.

Rivers, streams and lakes

There are nine primary watersheds in the bioregion, including 33 major rivers which empty into the Minas Basin as well as numerous streams, brooks and lakes, with a total stream length of approximately 10,113 km, 80% of which is classified as priority habitat. The bioregion provides some of the most important tidal and freshwater habitats for fish, such as Striped Bass, Atlantic Salmon, shad, Atlantic Sturgeon, eels, gaspereau, sea-run trout, and smelt, in the province. Fifteen of the 19 rivers identified as important estuarine habitat and seven of the 10 rivers containing freshwater Critical Habitat for the IBoF Atlantic Salmon are located within the bioregion, the most important being the Gaspereau and Stewiacke Rivers (DFO 2010, 2013). The Shubenacadie /Stewiacke system also supports the only remaining spawning population of Striped Bass in the Bay of Fundy (COSEWIC 2012b). The bioregion contains some good quality trout streams; for example, according to MacMillan *et al.* (2008), 12 of 22 streams surveyed in the bioregion from 2002 to 2005 were characterized as cool-water. While not the only requirement, cold temperature is one of the most important determinants of suitable habitat for salmonids (e.g. Brook Trout and Atlantic Salmon) and other cool-water fish species (MacMillan *et al.* 2008). Of the cool-water streams, all contained Brook Trout and most with trout densities at or above the provincial mean.

There are approximately 3053 lakes and ponds (>0.1 ha) covering a total area of 20,007 ha in the bioregion, with the majority clustered in the headwaters of the Gaspereau, St. Croix and Shubenacadie River watersheds. These waterbodies comprise less than 2% of the bioregion and range from less than 0.5 ha to 1772 ha (Gaspereau Lake), with an average size of 6.6 ha. One of the larger lakes in the bioregion, the Shubenacadie Grand Lake, supports an important over-wintering population of Striped Bass. Other rare and at risk species found in the bioregion's aquatic ecosystems include the Wood Turtle, Brook Floater (a rare freshwater mussel recorded in a tributary of the Shubenacadie River, and historically in the Stewiacke River; COSEWIC 2009b), and Prototype Quillwort (a rare aquatic plant found in a few lakes in the Parrsboro/Five Islands area; COSEWIC 2005; Environment Canada 2012b).

Riparian systems

Generally, riparian habitats are recognized as the most biodiverse, complex and dynamic terrestrial systems on the planet, and 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 *et al.* 1993). Vegetated riparian areas are used by a broad range of terrestrial and semi-aquatic taxa, and typically support higher diversity and density of amphibians, reptiles, birds, and mammals than adjacent uplands (McEachern 2003). It has been estimated that 70 percent of terrestrial vertebrates use riparian areas during some part of their life (Naiman *et al.* 1993). Treed riparian areas are particularly important habitat for a number of breeding bird species, given the diversity and abundance of invertebrates available for food, diverse and complex vegetation, and favourable microclimates (Akerman 2007). They also serve as important pathways for dispersing and migrating organisms (Naiman *et al.* 1993).

In addition to terrestrial wildlife habitat, vegetated riparian areas play a vital role for aquatic habitats, including reducing and filtering chemical and sediment runoff from land, and for providing stream bank stability, complex habitat structure for aquatic wildlife, and shade for temperature control of cool/cold-water watercourses (East Coast Aquatics 2006). Rare plant communities and species are particularly notable along the wet mossy, steep-sided stream banks and gorges flowing down from the Cobequid Mountains into the Minas Basin (R. Newell, pers. comm. 2014), as well as the rich calcareous riparian floodplains of the Meander, St. Croix, Cogmugun, Gays and Salmon Rivers (S. Basquill, pers. comm. 2014). Integral to riparian and aquatic habitats are the river floodplains, the low-lying periodically flooded areas adjacent to rivers. The rich soils of the floodplains in the bioregion support a high diversity of species and habitat types, ranging from wetlands and seepage areas, to forests, grasslands and heathlands. Floodplain-associated habitats are discussed in greater detail in the Freshwater Wetlands and Acadia Forest Mosaic sections.

Landscape context assessment of aquatic and riparian systems: Fair
Riparian and aquatic ecosystems in the bioregion are particularly at risk from development. The average LCI for aquatic and riparian systems is 37, which is in the medium to high range. Forestry, agriculture and residential/cottage development are the primary threats to aquatic and riparian systems, as well as vehicle ford crossings (including OHVs), bridges, and dams and other aquatic barriers. Given the increasing demand for cottage and housing development along the bioregion's inland lakes and streams, the threat to these systems is likely to continue to increase.

Current forest harvesting regulations in Nova Scotia require that all forestry operations leave a minimum of 20 m as a forested buffer along watercourses, though some level of harvesting is permitted. However, agriculture and residential lands are not subject to any riparian buffer restrictions and clearing to the water's edge has been a common practice and continues to cause aquatic and riverside degradation. Nearly 10% of aquatic and riparian areas are currently located within designated or pending protected areas. In addition, all areas designated as critical habitat for Atlantic salmon are nominally protected under the SARA. However, even these areas can still be threatened by fragmentation (lack of connectivity between core habitat patches) and impacts from adjacent land uses.

Condition assessment of aquatic and riparian systems: Fair
The average human footprint score for riparian habitats is 32, which is considered a moderate level of human development. According to a study by East Coast Aquatics (2006), there are likely no truly intact/unaltered stream reaches in the IBoF. Even the most intact stream reaches, including those in protected areas, have some visible evidence of anthropogenic disturbance either in, or adjacent to, the stream channel. The smaller (third order) streams appear to be most impacted. Noted disturbances included selective harvest, clear cut logging, or agricultural land within or near the 20 m riparian buffer, vehicle crossings, bridge or culvert crossings, or recent bed load accumulations related to upstream impacts. Over 131 dams and other water control structures are present on watercourses in the bioregion (Fielding 2011; Garroway *et al.* 2012; see Section 2.B. Threats). Where they provide either a complete or partial obstruction to fish passage and/or stream flow, such as the Avon River, Gaspereau River, St. Croix and Parrsboro Rivers, these structures have resulted in significant changes in the physical and hydrological characteristics and biological communities of the river systems, and their adjacent

riparian and floodplain ecosystems. Many river systems have seen losses or declines of their historic native anadromous and freshwater fish populations due to water control structures.

Water quality is generally not a concern, but pollution from urban and industrial discharges and forestry, mining and agricultural runoff has been noted in the more heavily populated and farmed areas in Kings, Cumberland and Colchester Counties, most notably the Cornwallis River system, where water quality is considered poor (AECOM 2011). In terms of invasive species, Smallmouth Bass and Chain Pickerel have been gradually spreading throughout the lakes and streams in the bioregion (LeBlanc 2010). These species are voracious predators and both directly prey on and outcompete native fish species. In most lakes and streams in which they have become established, they have been found to devastate native fish populations, particularly Brook Trout. Although exotic species are present in most riparian zones in the bioregion, only a few are considered invasive (major threat), including Glossy Buckthorn, Common Reed and Garlic Mustard, all of which are rapidly spreading throughout the bioregion, especially in areas along roads (N. Hill, pers. comm. 2014).

While not pristine, many of the watercourses in the bioregion still maintain fair to good quality aquatic habitat and biodiversity. According to East Coast Aquatics (2006), Bass River (Five Islands), Grumbly Brook (Shubenacadie), Farrells River (Parrsboro), Shady Brook (St. Croix), Gleason Brook (Portapique), Elderkin River (Cornwallis) and Halfway River contained some of the best examples of low impacted stream reaches in the bioregion. Moreover, many watercourses on both public and private lands exhibit strong potential for habitat restoration, which can be made through basic aquatic and riparian habitat restoration activities.

Size assessment of aquatic and riparian systems: Not Applicable
There is no minimum critical patch size for aquatic habitats. Riparian habitats were delineated by assuming a 275m buffer surrounding all watercourses. Due to data and time limitations, quantitative assessment of the actual size of riparian buffers (width and length of stream reach) was not undertaken.

The primary current and emerging threats to aquatic and riparian systems include:

Current

- Removal of riparian vegetation, pollution and shoreline/channel alterations due to forestry, agriculture, recreation and urban and rural development
    - 1.1 Residential & commercial development - Housing & urban areas
    - 2.1 Agriculture & aquaculture - Annual & perennial non-timber crops
    - 4.1 Transportation & service corridors - Roads & railroads
    - 5.3 Logging & wood harvesting
    - 2.2 Wood & pulp plantations
- Stream crossings and water control structures
    - 7.2 Dams & water management/use (dams & other aquatic barriers)

Emerging

- Invasive species
    - 8.1 Invasive non-native/alien species/diseases

Overall assessment of aquatic and riparian systems in the NS IBoF bioregion: Fair

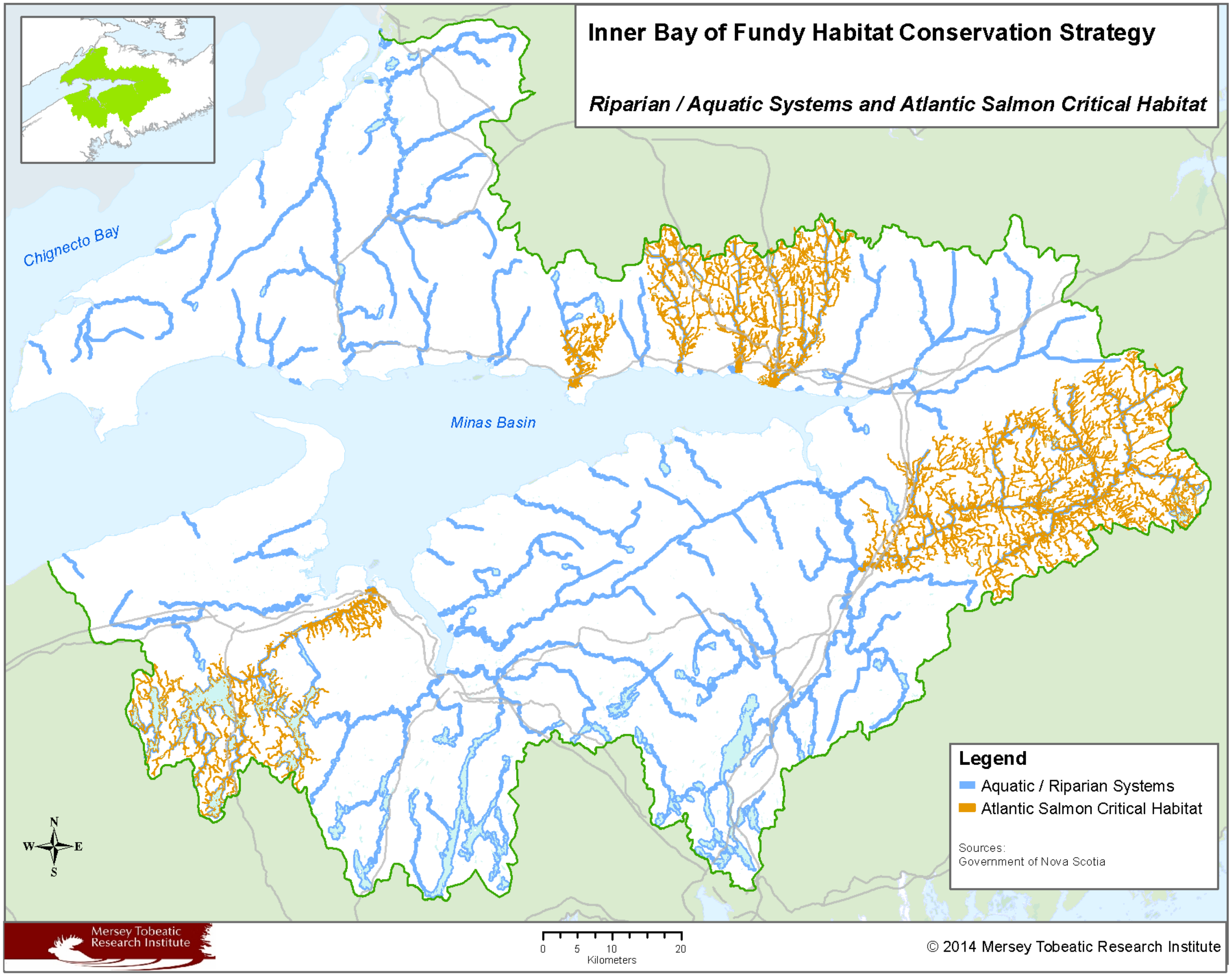

Figure 11. Aquatic and riparian systems within the Nova Scotia Inner Bay of Fundy bioregion.

vii. Priority Habitat: Freshwater Wetlands

Freshwater wetlands are areas where the water table is either permanently or periodically at, near or above the land's surface or that are saturated with water (Government of Nova Scotia 2011). These areas are characterized by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions. Among the most productive of all ecosystems, the ecological diversity of the bioregion's freshwater wetlands supports a diverse assemblage of wildlife and plants, including a number of Nova Scotia's rare and endangered species. At least 137 priority species have been identified in freshwater wetland habitat within the bioregion. Freshwater wetlands also perform vital ecological and social functions, including carbon storage, water quality improvement through natural filtration of pollutants, and the control or abatement of flooding, drought, and soil erosion (Government of Nova Scotia 2011).

There are approximately 49,930 ha of provincially-delineated freshwater wetlands within the bioregion, making up almost 5% of the bioregion. A variety of wetland types are found, each with different physical and biological characteristics, the most common being peatlands (bogs and fens)[1], marsh[2], and treed or shrub swamps[3]. The percent composition of each sub-habitat type in the bioregion is provided in Figure 12. All provincially-delineated freshwater wetlands in the bioregion are mapped in Figure 13. Many of the wetlands appear as small isolated patches; however, often individual patches are connected through above and below ground hydrological processes to form larger wetland complexes.

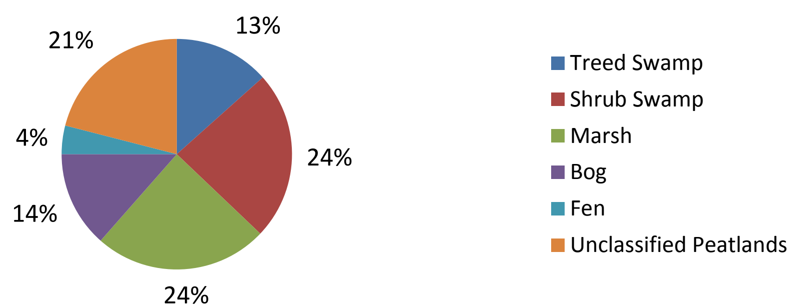

Figure 12. Percent composition of freshwater wetland sub-habitat types in the Nova Scotia Inner Bay of Fundy bioregion.

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[1] *Bogs develop on open terrain with restricted drainage and are dominated by Sphagnum mosses. The water supply of a bog comes almost exclusively from precipitation, resulting in a nutrient-poor, acidic environment (Government of Nova Scotia 2011). They may be treed (Black Spruce and Eastern Larch can be common), and they are usually covered with acid tolerant mosses (*Sphagnum *spp.) and ericaceous shrubs such as Leatherleaf, Huckleberry, Lambkill, and Labrador Tea, as well as carnivorous plants such as Pitcher Plants and Bladderwort. Fens are ground or surface water-fed peatlands saturated with water and typically dominated by sedges and brown mosses. The influence of ground and surface water, and thus more nutrient-rich environment, is what distinguishes them from bogs, and also supports a greater diversity of species, including shrubby trees (e.g., Black Spruce, Eastern Larch, willow).*

[2] *Freshwater marshes are frequently inundated with water levels that fluctuate daily, seasonally or annually, occasionally drying up or exposing sediments (Government of Nova Scotia 2011). These nutrient rich and highly productive habitats are characterized by emergent aquatic plants such as grasses, reeds and sedges, as well as aquatic macrophytes, mosses and macroscopic algae.*

[3] *Swamps are dominated by trees or shrubs with generally over 30% cover in woody species, wood-rich peat or mineral soils, and water tables typically at or below the surface (Government of Nova Scotia 2011). They may be seasonally or permanently flooded with as much as 30 cm of water.*

Peatlands, including bogs and fens, comprise the largest percentage of wetlands in the bioregion. Notably large peatlands in the bioregion include the Collins and McDonald bogs in the Kennetcook watershed, both of which exceed 400 ha (Neily *et al.* 2003). The next most numerous are swamps, which are most common along the drier portions of floodplains and riparian areas of rivers and streams. Almost a quarter of all freshwater wetlands in the bioregion are marshes. While most of the marshlands in the bioregion are small, a few large marsh complexes occur northwest of Upper Musquodoboit and in the Chignecto area. The marshlands at Amherst Point Migratory Bird Sanctuary are some of the most productive wetlands in the province, and derive this fertility from the gypsum-limestone bedrock and from marine silt deposits (CWS 2001a). Cattails and bur-reeds are the most common emergent plants. Over 200 species of waterfowl and other marsh birds have been recorded in the sanctuary, including some regionally rare species such as Gadwall, Redhead, Ruddy Duck, Virginia Rail, Common Moorhen, American Coot and Black Tern and the highest densities of Pied-billed Grebe on record.

Floodplain wetlands are nutrient-rich marsh or swamp wetlands that form on the banks of rivers and streams that seasonally flood. In summer, they appear mainly as grassland meadows that sometimes are interspersed with marshy areas. Some floodplains also may contain shrubs and trees. The combination of rich soil, adequate moisture and lush vegetation provides ideal conditions for a wide variety of animals and plants, including rare Canada Lily, Dog's Tooth Violet, Meadow Vole, Shrews, and Nodding Trillium. The rich floodplains of the Meander, St. Croix, Cogmugun and Salmon Rivers support patches of productive floodplain wetland, although much of this has been converted to agricultural land.

Vernal pools are small (typically less than 0.5 ha), isolated, and shallow wetlands that lack permanent inlet or outlet streams and often dry out in the summer (Government of Nova Scotia 2011). Despite their small size, they provide critical breeding habitat for a variety of amphibians, including the Wood Frog and various salamanders, which have adapted to living in these temporary, predator-free pools. They also provide foraging sites and refugia for a variety of wetland and non-wetland dependent amphibians, turtles, birds, and mammals. At least 985 seasonal vernal pools occur in the bioregion, with the majority occurring in the valley and North Mountain in the Gaspereau River watershed and along the St. Croix and Shubenacadie Rivers. This is most likely an underestimate as very little is known about the distribution and types of vernal pools present in Nova Scotia.

Landscape context assessment of freshwater wetlands: Fair

Freshwater wetlands occur throughout the bioregion and are often surrounded or fragmented by agriculture, forestry, mining and roads, as suggested by the medium to high average LCI score of 37. However, the 2011 *Nova Scotia Wetland Conservation Policy* outlines specific objectives to help prevent the further net loss of wetlands in Nova Scotia through both regulatory and stewardship approaches (Government of Nova Scotia 2011). The strongest protections are afforded to Wetlands of Special Significance, defined in the policy as wetlands that occur in protected areas or Ramsar sites, or contain known occurrences of species at risk. In total, 38% of freshwater wetlands in the bioregion are currently within a designated or pending protected area and thus covered under the policy. However, illegal infilling is still a threat, as well as indirect impacts from activities on adjacent lands and increased human access and disturbance. Moreover, small wetlands (<100 square meters), including vernal pools, not designated as a Wetland of Special Significance are not covered under the policy. Thus, with growing residential and cottage development, agriculture and forestry associated road construction, further degradation and fragmentation is a continued threat.

Condition assessment of freshwater wetlands: Good
Information on the extent of freshwater wetlands occurring in Nova Scotia pre-European settlement is limited; however historic losses appear to have been high in some areas. Losses of freshwater wetlands are thought to be highest in the most fertile regions, such as along the Cornwallis, Shubenacadie and Stewiacke Rivers, having been drained and converted to agriculture (Government of Nova Scotia 2011). The average human footprint score for the remaining freshwater wetlands is 29, indicating only a moderate level of human development within existing sites. Wetland fragmentation, particularly by roads, is a concern in areas with high levels of forestry, agriculture, and mining. This restricts hydrological and nutrient flows, and increases the risks to wildlife moving between wetland patches. A number of invasive species are emerging as threats but are generally not yet dominant in the bioregion. Glossy Buckthorn and Canary Reed Grass are of particular concern as they are aggressive wetland invasive species (Hill & Blaney 2009; N. Hill, pers. comm. 2014).

Size assessment of freshwater wetlands: Fair
Wetland complexes connected through above and below-ground water flow are not delineated in the provincial inventory and thus the integrity assessment is based on the size of individual patches. Based on individual patches, only 35% of freshwater wetland habitat meets the minimum critical patch size of 20 ha (Table 8). Vernal pools range in size from 0.001 ha to almost 0.8 ha; however, size is not considered a limited factor in the function or integrity of these habitats.

Table 8. Average size and percentage habitat meeting the minimum patch size of the dominant freshwater wetland types in the Nova Scotia Inner Bay of Fundy bioregion.

Wetland Type	Average Size (ha)	% Habitat Meeting MCPS
Treed Swamp	33.6	35
Shrub Swamp	34.1	26
Marsh	58.9	22
Bog	39.6	35
Fen	33.8	26
Unclassified Peatland	56.7	63

The primary current and emerging threats to freshwater wetlands include:

Current

- Degradation and fragmentation from agriculture, forestry, road construction, residential development and mining
    - 1.1 Residential & commercial development - Housing & urban areas
    - 2.1 Agriculture & aquaculture - Annual & perennial non-timber crops
    - 4.1 Transportation & service corridors - Roads & railroads
    - 5.3 Logging & wood harvesting
    - 7.2 Dams & water management/use (dams & other aquatic barriers)

Emerging

- Invasive species
    - 8.1 Invasive & other problematic species, genes & diseases - Invasive non-native/alien species/diseases

Overall assessment of freshwater wetlands in the NS IBoF bioregion: Fair

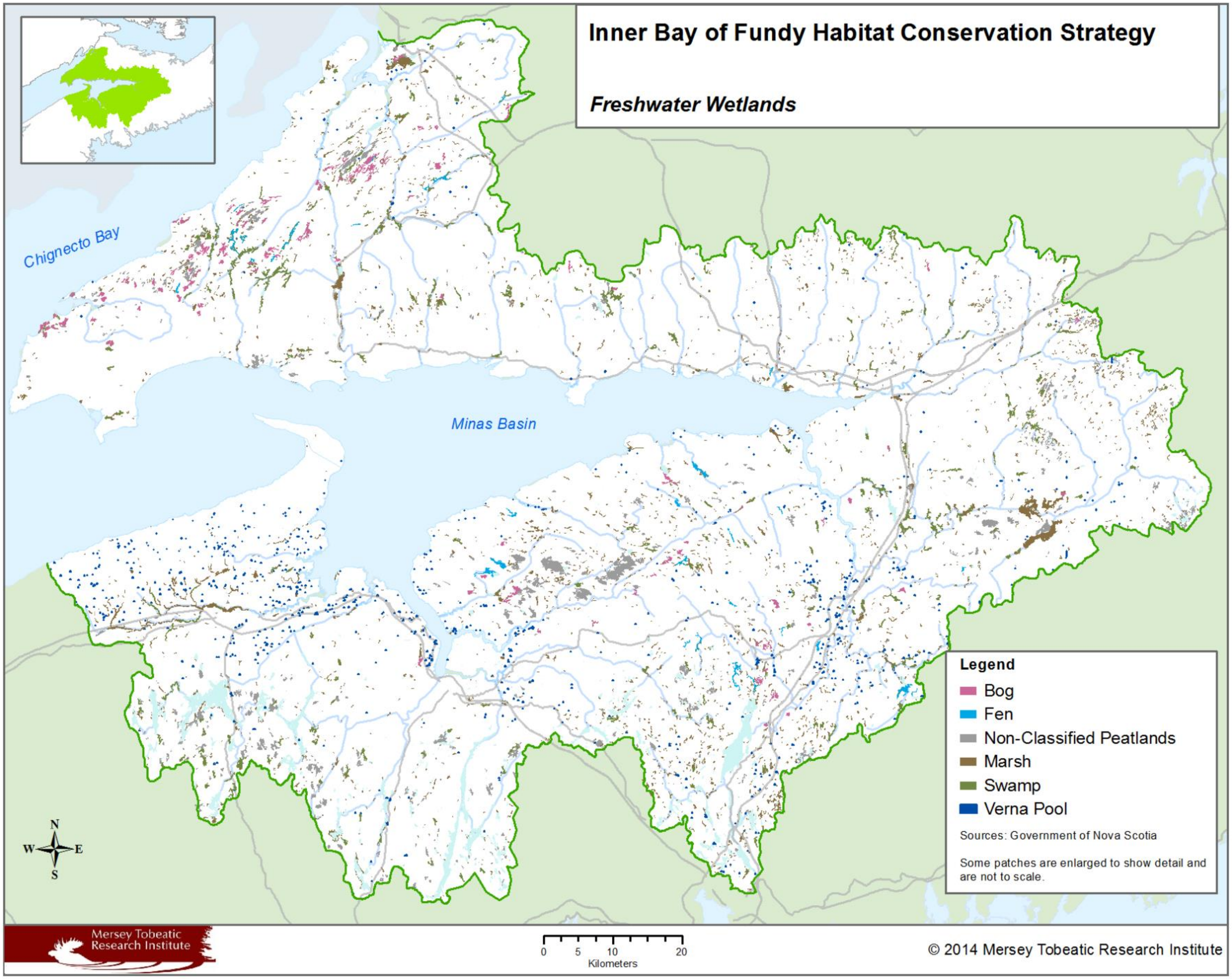

Figure 13. Freshwater wetlands within the Nova Scotia Inner Bay of Fundy bioregion.

viii. Priority Habitat: Late-Successional Acadian Forest Mosaic

Nova Scotia falls within the Acadian Forest Region, which encompasses the Maritime Provinces and limited parts of northern New England and southern Quebec. The Acadian Forest is a rich and diverse temperate forest with a unique mixture of boreal species from the north and deciduous species from the south, with Red Spruce often considered the defining species of this forest region (Mosseler *et al.* 2003). The World Wildlife Fund has designated the Acadian Forest as critically endangered due to the long history of settlement and land clearing that has occurred, with approximately 5% of the forest remaining in pre-settlement condition (Davis *et al.* 2013).

For the purposes of this HCS, priority habitat within the Acadian Forest mosaic includes all provincially delineated climax or late-successional forest communities. These are defined as those in Development Classes 'Mature Forest' or 'Multi-aged and Old Growth Forest' dominated by late-successional (seral)/climax species. Climax/late-successional forests are relatively stable and self-perpetuating communities dominated by mature long lived and shade tolerant species characteristic of the climatic and site conditions within an ecosystem (NSDNR 2012a). In the Acadian Forest, climax species include Eastern Hemlock, Red Spruce, White Pine, Sugar Maple, Yellow Birch, and American Beech; with Balsam Fir, Red Maple, and Black Spruce more likely to form the climax forest on edaphically limited sites (e.g. bogs, fens, highlands, coastal). Late-successional classed forests are considered a high priority forest habitat type since their species composition and gap dynamics most closely reflect native Acadian Forest conditions. Of the 847 036 ha of forested area in the bioregion, approximately 21% (180 888 ha) is classified as late-successional forest, making up over 17% of the total area of the bioregion. The distribution of late-successional forest stands is mapped in Figure 14. Thirty-three percent are sub-classified as tolerant hardwood (i.e., <20% softwood and > 60% tolerant species among hardwoods), 11% as mixedwood (i.e., 20-79% softwood and >50% tolerant species among hardwoods), and 56% as tolerant softwood (i.e., >80% softwood species).

The climax Acadian Forest supports a unique diversity of trees, flora, lichens, mosses, mammals, birds, amphibians, reptiles, and invertebrates. Over 130 significant forest-associated species are known to regularly occur in the various forest habitats in the bioregion. For example, once relatively common, the now rare swamp and floodplain-associated Black Ash and Eastern White Cedar are both located in limited sites within the bioregion (Newell 2007). Large areas of contiguous intact forest are especially important for large ranging mammals and forest interior birds (NSDNR 2012b). The large tract of fairly intact forest in the Chignecto region supports the largest remaining population of mainland moose in Nova Scotia (NSDNR 2007).

The bioregion also contains a number of unique, rare, and ecologically significant forest communities. The bioregion, particularly on the North Mountain and Cobequid Ridge, contains the best developed and richest tolerant hardwood stands left in the province (S. Basquill, R. Newell, pers. comm. 2014). Stands of Coastal Fog Forest, a humid Red Spruce/Balsam Fir/White Birch dominated late-successional forest type unique to the NS IBoF, are found primarily along the south shore of the Minas Basin and are home to a diversity of rare and endangered lichen and bryophyte species (NSDNR 2011), as well as the oldest known Red Spruce in the province (Cape Chignecto; S. Basquill, pers. comm. 2014). Temperate karst forests are rare within Canada, the majority of which occur within Nova Scotia (NSDNR 2011). Two unique karst forest communities have been identified in the bioregion: a mature Eastern Hemlock/Red Spruce dominated mixedwood forest and a mature Sugar Maple dominated hardwood unit. Both are known to predominantly occur within the Hants and Colchester county portions of the bioregion (St. Croix, Kennetcook, and Shubenacadie). Flooded hardwood forests are considered to have the highest landform, structural, and species diversity of any forest community in Nova Scotia (NSDNR 2011).

Regular flooding events and the associated deposition and erosion of stream sediment recharge nutrient and water reserves, producing extremely rich soils and inherently dynamic and productive forests. Rare communities of Wild Leek, Hepatica, Blue Cohosh, and other Appalachian deciduous herbs are found in the rich hardwood/mixed wood forested floodplains in Hants County (especially along the Meander, Herbert, Tom Cod, and Salmon Rivers; N. Hill, K. Porter, pers. comm. 2014).

Landscape context assessment of late-successional Acadian Forest Mosaic: Fair
In total, 20% of the bioregion's late-successional forest types are currently within the network of designated or pending protected areas. Moreover, the majority of forest stands that exhibit old growth characteristics are located primarily within protected areas, but small stands also exist on privately-owned and crown land. Outside of protected areas, widespread clearcut harvesting, plantations, and land clearance for agriculture has occurred (see Section 2.B Threats). In forests where clearcutting has not occurred, fire suppression, road construction, recreational activities, and other common forest management practices (i.e. high grading, biocides use, controlling growth of native non-commercially valuable species, and commercial plantations) are widespread and ongoing threats to habitat structure and native biodiversity. The average LCI for the late-successional forest habitat is 34.

Nevertheless, while significant temporary landscape conversion has occurred, there are a few sizable tracts of forest left in the bioregion with minimal permanent conversion to non-forest land-use, posing opportunity for ongoing and continued conservation efforts. The bioregion contains part or all of eight Tier 1 matrix forest blocks as identified in the bioregion in the NAAP (Anderson *et al.* 2006). These large blocks (minimum 10 000 ha) of contiguous forest contain few roads, relatively intact interior forest, and a variety of forest matrix communities, including at least some late-successional forest habitat (Anderson *et al.* 2006).

Moreover, the province is increasingly recognizing the importance of maintaining and restoring the natural range and structure of forest communities to benefit wildlife species. In 2012 the province introduced the *Old Forest Policy*, with the goal of protecting and restoring old-growth forest on a minimum of 8% of public forested land in each NSDNR Ecodistrict (NSDNR 2012a). Also in 2012, the province released a *Code of Forest Practice* for crown lands establishing principles and guidelines encouraging management practices that support late-successional, climax forest types, large intact forest patches and connectivity between patches (NSDNR 2012b). However, given the majority of forested land in the bioregion is privately-owned and thus not subject to these policies, it is uncertain what impact they will have on forest conservation.

Condition assessment of late-successional Acadian Forest Mosaic: Good
By definition, late-successional and old-growth forests should be fairly intact ecosystems with few signs of major permanent human disturbance. Nevertheless, the average HF score for late-successional forests is 28, indicating a moderate level of human development within at least some existing sites. As mentioned previously several of these sites are located within larger forested areas; this is important for maintaining climax forest conditions, including biodiversity and ecosystem processes. Since early European settlement the majority of Nova Scotia's forests have been logged extensively several times, simplifying the forest structure, composition, and age class (NSDNR 2012b). Recent industrial forestry practices, including widespread clearcut harvesting, combined with a long history of human habitation and forest use, have resulted in an increase in relatively young, even-aged, early-successional forest types, while the abundance and age of shade-tolerant, late-successional forest types has declined (Loo and Ives 2003; Mosseler *et al.* 2003). Forestry practices remain the dominant threat to the region's forested ecosystems, as well as invasive species such as Garlic Mustard and diseases such as Dutch Elm Disease and Beech Bark Disease.

Size assessment of late-successional Acadian Forest Mosaic: Fair

The MCPS for each of the identified late-successional forest community types were based on estimates found in the literature of the minimum habitat required to maintain viable populations of old forest dependent vertebrate species[1]. In total, approximately 36% of the late-successional forest habitat in the bioregion meets the MCPS.

Table 9. Average size and percentage habitat meeting the minimum patch size of late-successional forest types.

Late-Successional Forest Type	MCPS (ha)	% Habitat Meeting MCPS
Tolerant Hardwood	40	64
Mixedwood	60	3
Spruce-dominant	50	28
Pine-dominant	15	22
Other Softwood	50	5

The primary current and emerging threats to late-successional Acadian Forest Mosaic include:

Current

- Forest removal, conversion to agriculture, and mining
  - 1.1 Housing and urban areas
  - 2.1 Annual and perennial non-timber crops (conversion of forest lands to agricultural production; incompatible agricultural practices)
  - 3.2 Mining and quarrying
  - 3.3 Renewable energy
- Disturbance and fragmentation by roads, and incompatible forestry practices
  - 4.1 Roads and railroads
  - 5.3 Logging and wood harvesting
  - 2.2 Wood and pulp plantations

Emerging

- Invasive species
  - 8.1 Invasive non-native/alien species/diseases
- Climate change
  - 11 Climate change and severe weather

Overall assessment of late-successional Acadian Forest Mosaic in the NS IBoF bioregion: Good

[1] *Adapted from* Old Forest Community and Old-Forest Wildlife Habitat Definitions for New Brunswick *(NBDNR 2013) and* Maintaining the Integrity of Northern Goshawk Nesting and Post-fledging Areas in the Ecosystem Based Management Plan Area of Coastal British Columbia: Guidance for Forest Professionals *(Coast Forest Conservation Initiative 2012).*

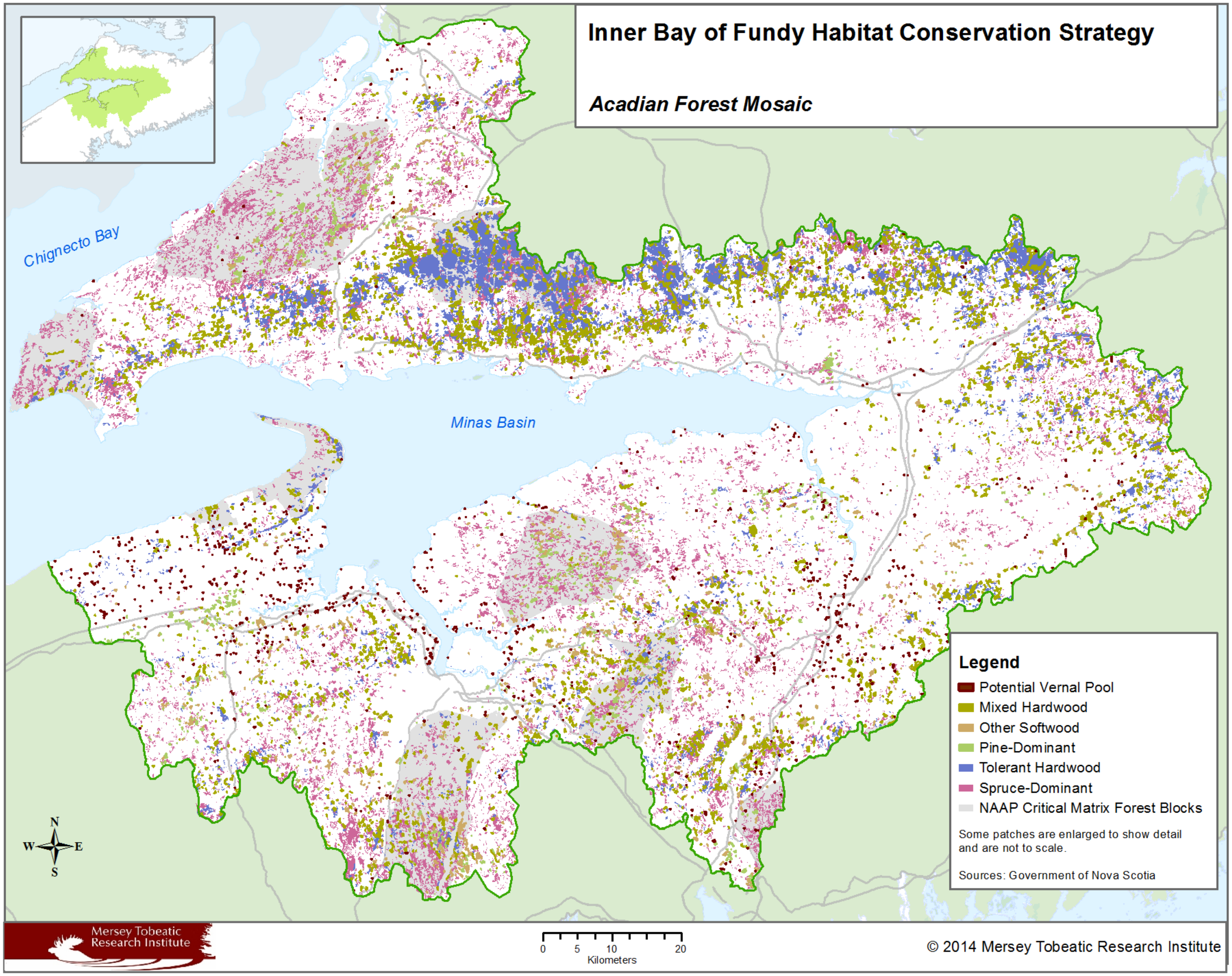

Figure 14. Late-successional Acadian Forest mosaic within the Nova Scotia Inner Bay of Fundy bioregion.

Summary status of priority habitats

A summary of the habitat integrity scores for the priority habitats is provided in Table 10. The number and type of priority species associated with each priority habitat type is provided in Table 11 (see Appendix C for a full list of priority species with approximate coarse-filter habitat associations). Habitat associations are based on literature, expert opinion and habitat notes in the ACCDC database.

The current overall priority habitat integrity rank for the NS IBoF bioregion is ‘Fair’. Three out of the nine priority habitats received overall ranks of ‘Good’, five received ‘Fair’ ranks and none received ‘Poor’ ranks. These results suggest that none of the priority habitats are degraded to the point of requiring significant management and/or restoration; however, many sites are threatened by human activities and will require a concerted conservation effort to reduce the risk of serious degradation in the future.

Table 10. Ecological integrity assessment for priority habitat types in the Nova Scotia Inner Bay of Fundy bioregion.

Priority Habitat	Ecological Integrity Assessment			
	Landscape Context	Condition	Size	Overall
Coastal beaches and cliffs	Fair	Good	Fair	**Fair**
Tidal flats	Poor	Good	Very Good	**Good**
Salt marshes	Poor	Fair	Fair	**Fair**
Coastal islands	Good	Unknown	N/A	**Good**
Barrens	Fair	Good	N/A	**Good**
Caves and calcareous sites	Fair	Fair	N/A	**Fair**
Aquatic and riparian systems	Fair	Fair	N/A	**Fair**
Freshwater wetlands	Fair	Good	Fair	**Fair**
Late-successional Acadian Forest Mosaic	Fair	Good	Fair	**Fair**
Overall assessment of priority habitats in the NS IBoF bioregion				**Fair**

Table 11. Number of priority species associated with each priority habitat type in the Nova Scotia Inner Bay of Fundy bioregion.

Habitat Type	Birds	Invertebrates	Reptiles	Mammals	Plants	Fish	Lichens	Mosses	Total	Species at Risk
Coastal beaches and cliffs	20				23		1	5	**49**	6
Tidal flats	22								**22**	2
Salt marshes	20				6				**26**	3
Coastal islands	17				3				**20**	3
Barrens	14	1			9			1	**25**	5
Caves and calcareous sites	1			3	27		5	6	**42**	7
Aquaticand riparian systems	29	14	2	2	70	4	2	2	**123**	19
Freshwater wetlands	39	13	2	3	76		1	3	**137**	18
Late-successional Acadian Forest	36	14	1	7	59		5	8	**130**	23

B. Threats

In the present context, 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 conservation priority habitat types.

Threats impact the habitat's ecological integrity and/or key ecological attributes, and were identified by the NS IBoF bioregion project team using past studies, local expert knowledge, and a review of the literature. Threats identified for BCR 14 and MBU 11 (Environment Canada 2013) were also examined for specific relevancy to the NS IBoF bioregion and are listed in Table 13 and Figure 15 and Figure 16. The threats identified within this Habitat Conservation Strategy are thought to be comprehensive for the bioregion's priority habitats, though other threats may be revealed through research or may emerge over time. Threats were ranked based on their scope, severity, and irreversibility of damage to priority habitats that can reasonably be expected within 10 years given the continuation of current circumstances and management, and were categorized according to established international taxonomy (Salafsky *et al.* 2008; IUCN-CMP 2012; Appendix G).

Table 12 provides a summary of the threats identified within the NS IBoF bioregion. The overall threat status for the NS IBoF bioregion is "high". The geographic extent of identified threats is mapped, where known, in Figure 17 to Figure 24.

Table 12. Summary of threats to the Nova Scotia Inner Bay of Fundy bioregion conservation priority habitats (continued on next page).

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*

Table 12 (continued). Summary of threats to the Nova Scotia Inner Bay of Fundy bioregion priority habitats.

Threats Across Habitats	Aquatic & Riparian Systems	Acadian Forest Mosaic	Caves & Calcareous Sites	Fresh-water Wetlands	Salt Marshes	Tidal Flats	Barrens	Coastal Beaches & Cliffs	Coastal Islands	Summary Threat Ranking
1.1 Housing & urban areas	High	High	Low	Medium	Medium	Medium	Medium	Low	Low	**High**
8.1 Invasive non-native/ alien species/diseases	High	Medium	High	Medium	Low	Low	Medium	Low	Low	**High**
2.1 Incompatible agricultural practices	High	Medium	Medium	High	Medium	Low	-	-	-	**High**
4.1 Roads & railroads	High	High	Medium	Medium	-	-	Medium	-	-	**High**
5.3 Incompatible forestry practices	Medium	High	Medium	Medium	-	-	-	-	-	**Medium**
7.2 Dams & other aquatic barriers	High	-	-	Medium	Medium	Medium	-	-	-	**Medium**
3.2 Mining & quarrying	Unk.	Low	High	Low	-	Unk.	Low	-	-	**Medium**
11.4 Climate change & severe weather - Storms & flooding	-	-	-	-	Medium	Medium	Low	Low	Medium	**Medium**
11.1 Climate-induced habitat shifting & alteration (coastal erosion)	Unk.	Unk.	Unk.	Unk.	Medium	Medium	Unk.	Medium	Low	**Medium**
2.2 Wood & pulp plantations	Medium	Medium	Medium	-	-	-	-	-	-	**Medium**
6.1 Recreational activities	Low	Low	Low	Low	-	-	Med.	Medium	Low	**Medium**
3.3 Renewable energy (e.g. wind, solar & tidal)	-	Low	Medium	-	Low	Low	Low	Low	Low	**Low**
5.4 Clam & baitworm harvesting	-	-	-	-	-	Low	-	-	-	**Low**
3.1 Oil & gas drilling	Unk.	Unk.	-	Unk.	Unk.	Unk.	-	-	-	**Low**
Overall threat assessment by priority habitat	**High**	**High**	**High**	**High**	**Medium**	**Medium**	**Medium**	**Medium**	**Low**	**High**

Table 13. Relative magnitude of identified threats to priority species within BCR 14 NB, and MBU 11 NS by threat category and broad habitat class. Overall ranks were generated through a roll-up procedure described in (Kennedy *et al.* 2012). L = Low magnitude threats; M = Medium; H = High. Blank cells indicate that no priority bird species had threats identified in the threat category / habitat combination. Reproduced with permission from Environment Canada 2013.

Threat Category	BCR 14 Habitat Classes													MBU 11 Habitat Classes			
	Coniferous forest	Deciduous forest	Mixedwood 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
Overall	**M**	**H**	**H**	**L**	**L**	**M**	**M**	**M**	**L**	**M**	**M**	**M**		**M**	**H**	**L**	
1. Residential & commercial development	L	L	L	L	L	L	H	M	L	M	M	L	**M**	L	L		**L**
2. Agriculture & aquaculture	M	M	M	L		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		**L**
5. Biological resource use	H	H	H		L			H	L	L	M		**H**	M	L		**L**
6. Human intrusions & disturbance					L		L	L	L	M	L		**L**	L	H		**M**
7. Natural system modifications	L	L	L	L		L		L		M	L		**L**		M		**L**
8. Invasive species & other problematic species & genes	L	L	L	L	L	L	L	L	L	M	L		**L**	L	M		**L**
9. Pollution	M	H	H	L	L	M	M	M	M	M	M		**H**	H	H		**H**
11. Climate change & severe weather												H				M	

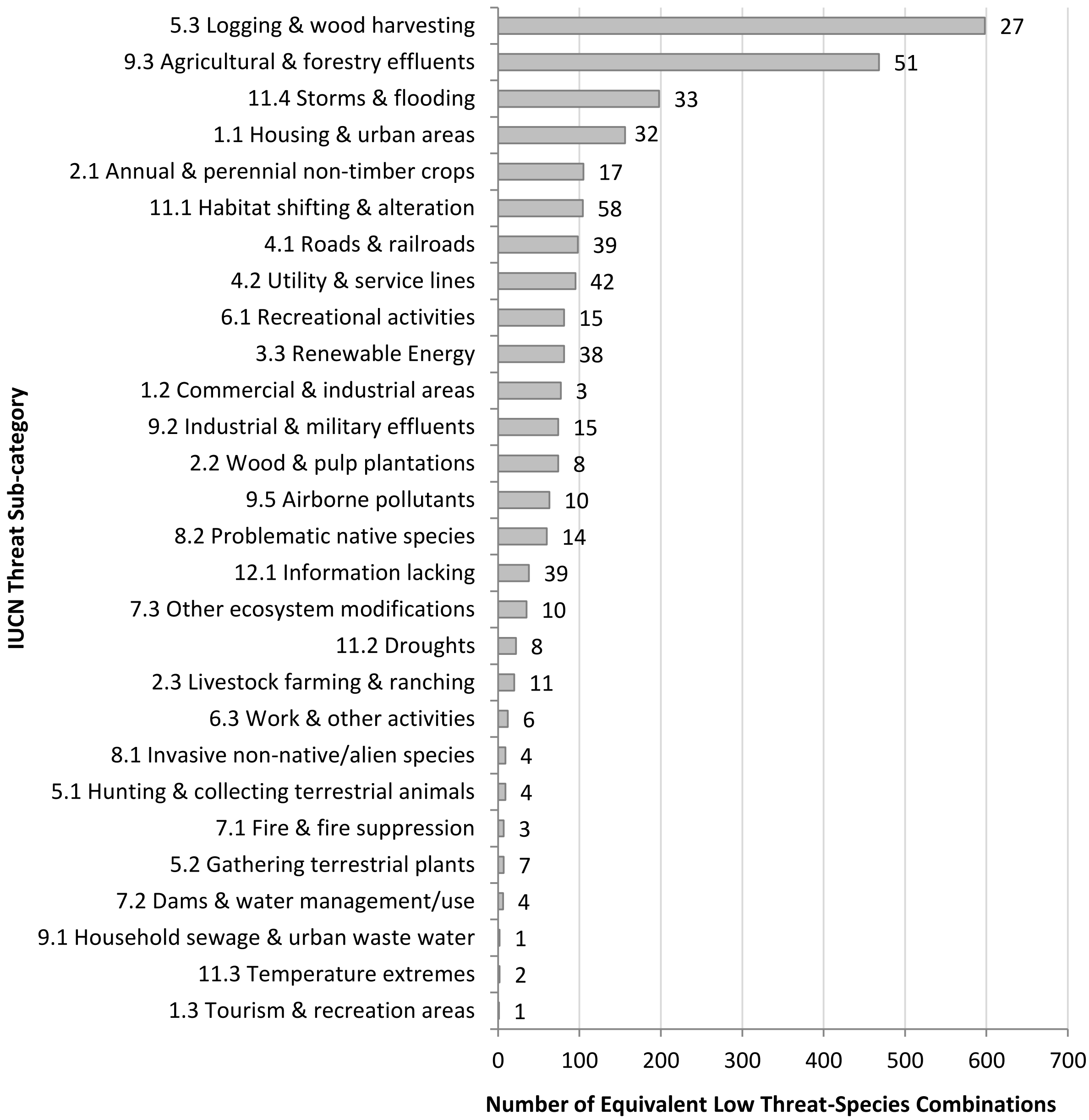

Figure 15. Ranked IUCN sub-categories of threats to priority bird species within BCR 14 NS based on the number of priority bird species affected and the magnitude of the threats (calculated using an inverse of the 3:5:7 rule; Salafsky 2003). The number of priority birds affected by threats within a particular IUCN threat sub-category is provided at the end of each bar. Modified from Environment Canada 2013 by A. R. Benoît.

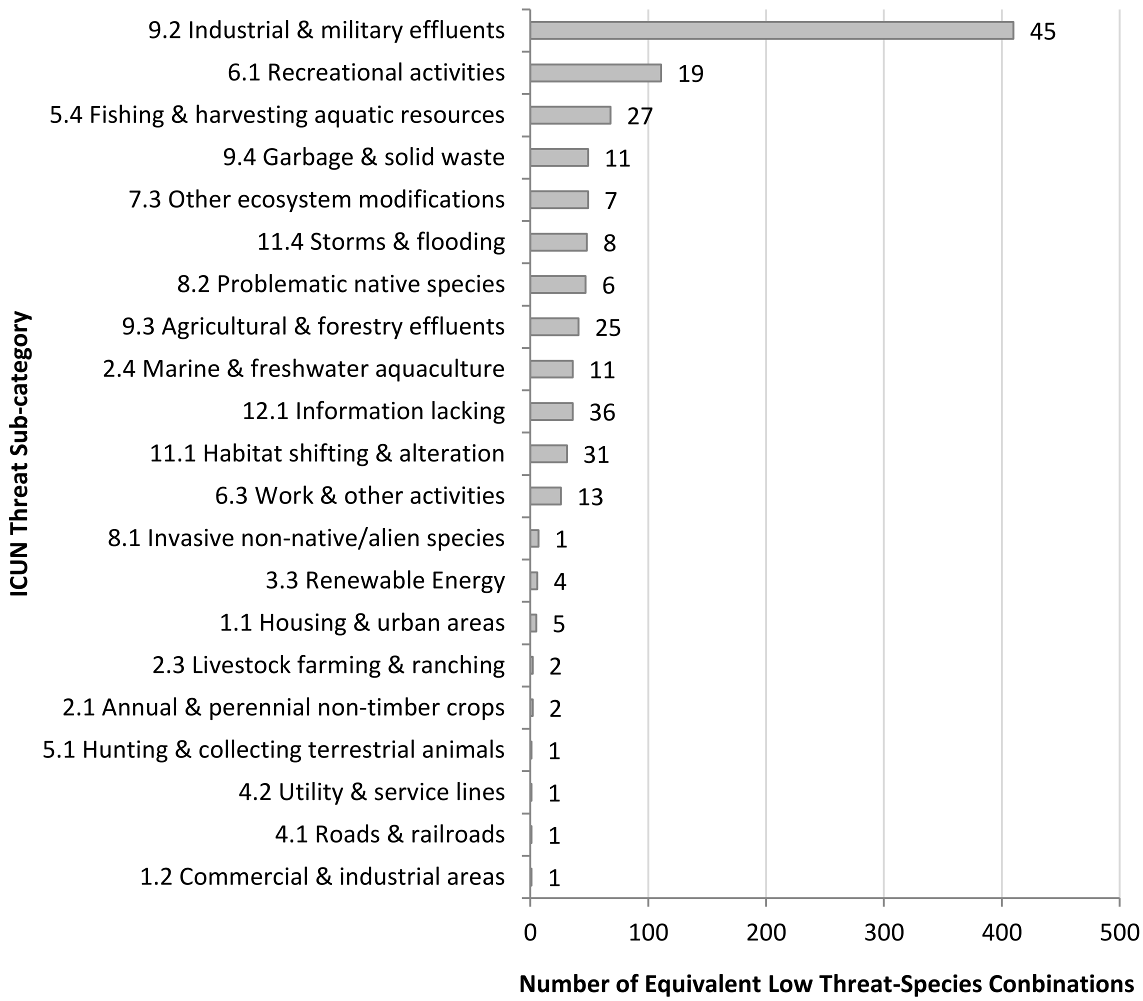

Figure 16. Ranked IUCN sub-categories of threats to priority bird species within MBU 11 NS based on the number of priority bird species affected and the magnitude of the threats (calculated using an inverse of the 3:5:7 rule; Salafsky 2003). The number of priority birds affected by threats within a particular IUCN threat sub-category is provided at the end of each bar. Modified from Environment Canada 2013 by A. R. Benoît.

i. Current Threats

1.1 Housing & urban areas
(Summary Threat Ranking: High)

The majority of the province's population lives in the coastal zone (CBCL Ltd. 2009). Despite this fact, about 80% of the land adjacent to the coast is classified as undeveloped, with the majority (66%) under natural forest cover (CBCL Ltd. 2009). This discrepancy probably reflects an uneven regional distribution with a few highly developed areas interspersed within expansive areas of rugged coastlines and cliffs that are less suitable for development. The bioregion is predominantly rural, with the highest densities of residential and commercial development in the more urbanized areas in the Annapolis Valley, along the shores of the Avon River estuary (Windsor area), and the town of Truro (Salmon River; Figure 18). Over the last 10 years, residential development in communities around Southern Bight and Cobequid Bay has been steadily growing due to urban sprawl out of Halifax and a growing commuter culture (CBCL Ltd. 2009). In contrast, the population has decreased around Chignecto Bay and the north shore of the Minas Basin. Residential development in inland areas is sparse; however, pressure from cottage development is growing along the shores of inland lakes and rivers. Historically, industrial and commercial facilities lined many of the harbours and rivers in the region. Currently, there are relatively few operational large-scale industrial or commercial facilities in the bioregion, with most situated along the Avon River, Truro, and Parrsboro. While the land area directly associated with industrial and commercial developments is usually limited in extent, their effects can be experienced over a greater area (CBCL Ltd. 2009).

Residential development is one of the most significant and pervasive threats to priority habitats and species in the NS IBoF bioregion. Given the increasing demand for cottage and housing development and a high percentage of privately owned land, this threat is likely to continue to increase. Coastal, riparian, and aquatic ecosystems in the bioregion are particularly at risk from some of the changes wrought by development, including factors such as the removal of natural vegetation cover, infilling, creation of lawns and gardens (e.g. invasive species, pesticide and fertilizer runoff), shorefront alterations (e.g., removal of riparian buffers, creation of artificial beaches, construction of docks, shoreline hardening, dredging), predation by domestic cats, increased human presence and traffic, transition to impervious surfaces (AGRG 2014), and habitat fragmentation from roads. Development in riparian and floodplain ecosystems also tends to interrupt the natural connections between aquatic and marine environments and their adjacent terrestrial uplands (CBCL Ltd. 2009).

With residential development also comes the risk of pollution to aquatic ecosystems from sewage and wastewater discharges, improperly functioning septic systems and runoff from paved (impermeable or impervious) surfaces and lawns (AGRG 2014). Historically, communities and industrial facilities discharged their sewage and effluent directly into tidal rivers and estuaries. Several communities in the bioregion still discharge their sewage and wastewater into the Minas Basin estuaries with minimal treatment. Inputs of nutrients from industrial and residential runoff and sewage sources can lead to algae blooms and eutrophication (GOMC 2010). Pollutants can accumulate in mudflats resulting in impacts on invertebrates, such as clams, bloodworms and amphipods (*Corophium sp.)*, and subsequently the fish and shorebirds which feed on them (GOMC 2010). Monitoring results show that coastal habitats adjacent to more highly developed areas in Cumberland, Colchester, and Kings Counties, are at a high risk of algal blooms from nutrient and industrial runoff, particularly those situated around the Southern Bight (AECOM 2011).

The Human Footprint index, developed by the Wildlife Conservation Society (Woolmer 2008), is a measure of the extent and relative intensity of human influence on terrestrial ecosystems at a resolution of 90 m using best available data sets on human settlement (i.e., population density, dwelling density, urban areas), access (e.g., roads, rail lines), landscape transformation (e.g., landuse/ landcover, dams, mines, watersheds), and electrical power infrastructure (i.e., utility corridors) (Figure 19). Each 90m grid cell is attributed with a Human Footprint score between 0 and 100, where 0 represents no human influence and 100 represents maximum human influence at that location. The map shows that while a few small, isolated areas are in a state relatively unaffected by anthropogenic activities (green), much of the bioregion has experienced only a moderate level of human impact to date (yellow to orange). The most heavily impacted areas appear in the population centres and along major roadways.

8.1 Invasive non-native/alien species/diseases
(Summary Threat Ranking: High)

There are a number of invasive plant species present within the bioregion. Two of the most pervasive are the Glossy Buckthorn and Common Reed. Glossy Buckthorn, found throughout the bioregion, is an introduced, ornamental shrub that can attain heights of 6 m and inhabits wet to moist fields, thickets, forest, shorelines, and open wetlands (Belliveau 2012). This species forms dense stands, replacing native wetland and shoreline plant communities, and dominating forest understories once established. It is tolerant of acidic conditions and is well adapted to invade a wide variety of natural habitats in the bioregion, potentially representing the greatest threat to native plant communities from an invasive plant in the province (Belliveau 2012). The Common Reed is an increasingly common aggressive invasive species that inhabits freshwater or brackish shores and wetlands in the bioregion (Hill & Blaney 2009; Belliveau 2012). It spreads quickly to form large, dense stands that exclude native species and can alter the structure and function of native marsh ecosystems.

Invasive insects and diseases have had significant impacts on the bioregion's forests. American Elm was once a significant floodplain forest species in Nova Scotia; however, it has been all but eliminated from natural habitats by Dutch elm disease, an introduced fungal pathogen that is spread by both a native and an introduced bark beetle (Belliveau 2012). Beech bark disease affects almost all beech trees in Nova Scotia (Belliveau 2012), and is the result of a fungus spread by an exotic insect introduced to North America from Europe. The disease causes severe craters or target-shaped scars in the bark, usually weakening and killing the tree. The disease has eliminated most large, mature American Beech and left a legacy of small, cankered trees in the region's forests (Davis and Browne 1996).

White-nose syndrome (WNS) is caused by a cold-loving fungus introduced from Europe that thrives in cave conditions and as such, impacts bat population directly during the winter hibernation period (Blehert 2012). WNS is hypothesized to cause starvation and dehydration by taxing bat energy reserves at a time when they would normally be inactive and hibernating (Cryan *et al.* 2010; Reeder *et al.* 2012), with mortality rates of >75% in infected hibernacula (Forbes 2012a,b,c). First documented in Nova Scotia in April 2011, WNS has decimated known hibernacula, with declines in the range of 80 to >99% (H. Broders, pers. comm. 2014). Researchers believe that WNS could lead to local extinctions of the Little Brown Myotis, as well as other species (Forbes 2012a,b,c).

The spread of two invasive fish species, Smallmouth Bass and Chain Pickerel, threatens native fish communities in lakes and rivers in Nova Scotia. Smallmouth Bass primarily inhabit lakes, but also riverine habitat, with rocky bottoms and plenty of shade (LeBlanc 2010; Belliveau 2012). Chain Pickerel inhabit shallow, vegetated ponds, lakes and streams (Belliveau 2012). Both species are voracious predators that have reduced or eliminated native Brook Trout and other fish populations in many lakes and rivers in the province through direct predation and competition for prey. Smallmouth Bass are rapidly spreading throughout the province (LeBlanc 2010). They are known to occur in at least 74 lakes in the five main counties (Hants, Kings, Cumberland, Colchester, and Halifax) that overlap with the boundaries of the bioregion, especially in the headwaters of the Shubenacadie River system (LeBlanc 2010). As of 2010, Chain Pickerel are known to occur in 95 lakes throughout the province, including Hants and Colchester Counties (Mitchell *et al.* 2010). Once established, they can decimate native Brook Trout and other populations in just a few years (Belliveau 2012). In the past Smallmouth Bass have been intentionally introduced for sport fishing purposes in some locations, but both species continue to spread due to natural dispersal and illegal transfers.

2.1 Annual & perennial non-timber crops (Incompatible agricultural practices)
(Summary Threat Ranking: High)

Approximately 9.5% (100 347 ha) of the land in the bioregion is classified as being under agricultural production (e.g., hayfields, pasture lands, croplands, livestock; Figure 20). The Gaspereau Watershed has one of the highest concentrations of agriculture in the province (Garroway *et al.* 2012). Threats from farming practices can include improper pesticide and fertilizer application, overuse of freshwater resources, soil erosion, invasive species, draining of wetlands, and degradation of riparian and aquatic habitat. Based on 2001 data from Agriculture and Agri-Food Canada (CBCL 2009), it is estimated that there are moderate to high risks of freshwater contamination from nitrogen in parts of every watershed in the bioregion, except the Kennetcook. Maintenance of a well vegetated riparian zone between agricultural lands and freshwater ecosystems provides an area where contaminants may be filtered from water runoff, thus improving water quality and reducing the impacts of pesticides and eutrophication on the region's freshwater resources and sensitive species at risk. Riparian buffers also contribute to water temperature control and stabilization of stream banks, thereby reducing flooding impact and stream bank erosion, and protecting the habitat of many aquatic communities. Many cultural practices, such as providing livestock direct access to streams for a water source and allowing livestock to cross through streams, have been widely used in Nova Scotia, and have been shown to be detrimental (Agouridis *et al.* 2005). There are currently no legislated requirements for stream protection or riparian buffers on land cleared for agriculture.

Nova Scotia has a long history of fragmentation and loss of wetland habitat as a result of conversion to agricultural land use by dyking, draining, and infilling. Large areas of salt marsh on the coasts of the bioregion have been dyked for agricultural purposes. It has been estimated that up to 80% of the salt marsh occurring here historically have suffered this fate since the European settlement began in the 17th century (Hynes *et al.* 2005a,b; CBCL Ltd. 2009). The 2011 *Nova Scotia Wetland Conservation Policy* offers some protective measures, particularly for Wetlands of Special Significance, to try to prevent the further net loss of wetlands (Government of Nova Scotia 2011). However, unsanctioned draining and infilling is still a threat, as well as indirect impacts from other farming practices.

Properly managed agricultural lands can be compatible with biodiversity conservation; for example, they presently serve as important habitat for some significant grassland-associated birds (Environment Canada 2013). A number of priority species within the bioregion are grassland dependant, such as Eastern Meadowlark, Common Nighthawk, Short-eared Owl, Barn Swallow, and Bobolink. A variety of non-grassland dependant species also use this habitat for foraging and nesting, such as waterfowl, Wood Turtle, Upland Sandpiper and Little Brown Myotis. Declines in grassland birds have been observed across North America and the rate of this decline exceeds that of any other bird guild (Environment Canada 2013). The greatest threat to grassland species is incompatible farming practices, such as mowing during the breeding season and pesticide application. Wood Turtle are further vulnerable to injury and mortality from farm machinery (COSEWIC 2007b). Studies in Nova Scotia have shown that delaying the timing of hay harvesting beyond the breeding season (June to early July) and raising the height of mowers in riparian fields may reduce farm machinery related mortality of Wood Turtles. In addition, Wood Turtle activity is usually restricted to within 300 m of the water's edge, thus maintaining a seasonal equipment free zone would significantly decrease mortality (Tingley *et al.* 2009).

4.1 Roads & railroads
(Summary Threat Rank: High)

There is a total of 10 896 km of roads in the bioregion (Figure 21), with a road density of 0.97 km/km^2. The areas with the highest densities of major roads are in the more heavily populated areas of the Annapolis Valley (Gaspereau Watershed), along the Avon River estuary and at Truro (Salmon/Debert watershed). The interior is criss-crossed by a network of less trafficked, predominantly unpaved roads used mainly for forestry, mining and by dispersed rural communities. These resource/recreational access roads comprise 38% of all roads in the bioregion, with a road density in excess of 0.40 km/km^2, which is higher than the provincial average of 0.31 km/km^2. There are still a few fairly sizable areas with few to no marked roads, particularly in the interior of the Kennetcook, St. Croix and Economy watersheds.

The ecological impacts of roads can be hard to quantify, but a growing body of research makes a compelling link between roads and ecological degradation in terrestrial and aquatic ecosystems (Trombulak & Frissell 2000). Roads fragment terrestrial landscapes and may act as physical barriers, which wildlife may need to cross to access critical habitats (Beazley *et al.* 2004). Direct effects of roads include mortality due to collisions with vehicles and exposure to predation and pollution. Indirect effects include avoidance of or inability to access important habitat areas, isolation of populations, reduction of interior habitat conditions and increased access for invasive species and human use (Trombulak & Frissell 2000). Road development has especially been a concern for wide-ranging mammals such as mainland moose, which are sensitive to human disturbance and require large tracts of intact habitat (NSDNR 2007). Moreover, some species of birds and turtles are attracted to paved roads and roadsides, increasing likelihood of being hit by vehicles (COSEWIC 2007b; Environment Canada 2013). Road construction can also have a negative impact on freshwater wetlands, tidal marshes, and estuaries as a result of changes to hydrology, construction of bridges, culverts and other stream crossing structures, and direct loss of habitat (Trombulak & Frissell 2000).

5.3 Logging & wood harvesting (Incompatible forestry practices)
(Summary Threat Rank: Medium)

This category of threat is the most important in terms of both the number of priority species affected and the total amount of habitat under threat in the NS IBoF bioregion. This is not surprising, as forest management activities are the main cause of change in the composition and structure of forests in Nova Scotia, and that healthy forests in general harbour a large diversity of species.

Within the Acadian Forest the dominant natural disturbance regime consists of gap dynamics, with stand-replacing disturbances (e.g., hurricane, fire) occurring only every several hundred to several thousand years (Mosseler *et al.* 2003), developing forest associations typical of the Acadian Forest including long-lived, shade-tolerant species such as Red Spruce, Eastern Hemlock, White Pine, Sugar Maple, American Beech, and Yellow Birch. In this disturbance mosaic, nearly constant canopy closure is maintained well beyond the life span of individual trees, providing habitat for a range of native species that depend on different forest stages. Following stand-replacing disturbances, forest succession typically begins with early-successional, shade-intolerant species, which require full light, establish themselves quickly, and exhibit rapid growth, though they have relatively short lifespans. In the absence of repeated disturbances, they tend to be replaced over time by more long-lived, shade-tolerant species (NBDNR 2013).

The majority of Nova Scotia's forests have been logged extensively several times, simplifying the forest structure, composition, and age class. The distribution of major forestry activities in the bioregion is mapped in Figure 22. Currently, more than 20% of the forested land base is managed for silviculture and clearcut accounts for over 40% of the managed forests (Figure 17). Pesticides and other biocides are commonly sprayed in the bioregion to control forestry pests and diseases, which can affect non-target species such as birds, amphibians, invertebrates and fish. Industrial forestry practices (i.e., extensive clear cutting and monoculture plantations) fail to mimic natural gap dynamics, and consequently the current conditions of Nova Scotia's forests no longer reflect the processes and structures produced by natural disturbance regimes (Neily *et al.* 2008). There has been a significant increase in relatively young, even-aged, early-successional forest types, while the abundance and age of shade-tolerant, late-successional forest types has declined (Loo & Ives 2003; Mosseler et al., 2003). Regenerating forest stands lack certain characteristics that are typical of old Acadian Forest stands, including large-diameter trees, large woody debris, and canopy openings with consequent understory regeneration, and fail to provide suitable habitat for some old forest dependent wildlife (NBDNR 2013). Clearcutting and heavy forest harvesting has also been suggested as one of the primary threats to mature calcareous forest habitats in the bioregion, which support remaining populations of the Ram's Head Lady Slipper and other rare calcareous plants (Blaney & Mazerolle 2007).

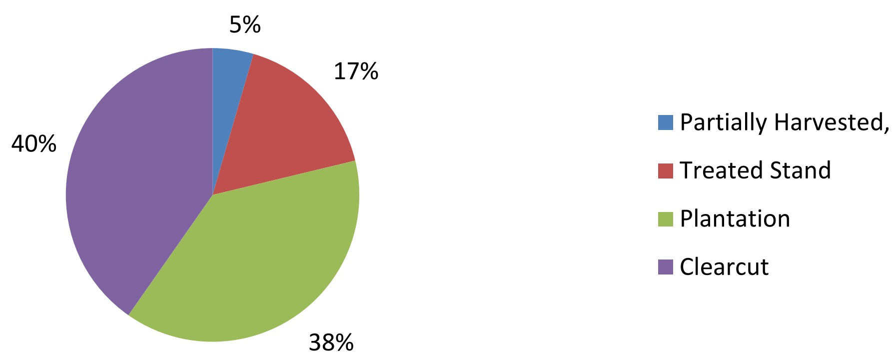

Figure 17. Major forestry activities in the Nova Scotia Inner Bay of Fundy bioregion.

Modern industrial forestry practices not only threaten the overall diversity and state of the bioregion's forests, but they can also have significant consequences for adjacent freshwater and coastal ecosystems. Clearcut areas often experience increased rates of soil erosion and water runoff, leading to reduced soil productivity, as well as siltation and flooding of adjacent waters. Water runoff from industrial forestry practices can also carry pesticides and other biocides, which can negatively impact water quality and associated aquatic communities and species. Removal of tree cover in close proximity to watercourses and wetlands reduces the ability of riparian areas to retain and filter water, which can lead to bank destabilization which increases erosion and siltation, and can reduce or eliminate tree shade; this in turn leads to increases in water temperatures (McEachern 2003). This can negatively impact aquatic communities and species, particularly salmonids, which require deep pockets of oxygen-rich, cold-water habitat which they use as summer refugia (Brylinsky 2002). Riparian area harvesting also reduces the input of organic material to waterbodies, such as litterfall and coarse woody debris, which constitute an important source of nutrients and structural complexity (McEachern 2003). Current forest harvesting regulations in Nova Scotia require that all forestry operations leave a minimum 20 m forested buffer along watercourses; this should help to alleviate some of these adverse impacts, however, the regulations permit some level of harvesting within these buffers.

7.2 Dams & other aquatic barriers

(Summary Threat Rank: Medium)

The effects of dam construction and operation can have both immediate and long term effects on long stretches of both upstream and downstream habitats. Within the bioregion, aquatic networks are critically important to the success of a number of aquatic species, including Atlantic Salmon, Brook Trout, Striped Bass, American Shad, Alewife, Rainbow Smelt, and American Eel. Barriers are thought to have contributed to the loss of historic fish populations in many of the bioregion's rivers and streams, and may be currently inhibiting their recovery (Wells 1999; DFO 2010; Fielding 2011; COSEWIC 2012a,b). Dams and other aquatic barriers can lead to a decrease in aquatic connectivity, the network created by freshwater streams, rivers and lakes as they flow into one another. Barriers along these aquatic networks can restrict or eliminate the movement of fish and other aquatic species up and down streams, and limit accessibility to suitable spawning, feeding, overwintering and summer habitats (DFO 2010; Fielding 2011; COSEWIC 2012a,b). Concerns around dam infrastructure itself are also present. Not only can physical harm come to fish that fall over spillways, but turbine mortality is also listed as a significant threat to species such as the American Eel, which migrate into the Bay of Fundy and beyond as part of their lifecycle (COSEWIC 2012a). In addition, dams impact ecosystems by altering the natural hydrology of river systems, including changes to flow regimes, water temperatures, sediment transport, and nutrient loads (Bednarek *et al.* 2001; Saunders *et al.* 2002). Changes to flooding regimes due to dykes and dams may also threaten Blue Cohosh and other rare deciduous forest plants that are limited to moist, fertile, regularly inundated floodplains and intervales (Hill & Garbary 2011).

According to the Nova Scotia Water Control Structure Database, there at least 131 dam/barrier structures[1] in the bioregion, 41% being recorded as either a partial or complete restriction (Figure 23). Fielding (2011) estimated these dams resulted in an upstream habitat loss of 1 299 km of stream length, equivalent to 7.1% of total stream length. Of the dams in the province, only 14% contain associated fish passage technology, many of which do not function effectively to allow fish passage (Fielding 2011). The Gaspereau Watershed contains the highest density of dams in the province, with the St. Croix River being one of the systems most affected by fish passage restrictions (Fielding 2011; Garroway *et al.* 2012).

At least 25 of the 44 major river systems in the Bay of Fundy are restricted by tidal barriers (Wells 1999). Tidal barriers are structures that restrict the natural movement of tidal waters and species into low lying coastal areas and waterways, including dykes, aboiteaux, causeways, bridges, culverts, dams and wharves (Hynes *et al.* 2005a). A 2003 tidal barrier audit found that 36% of the tidal crossings assessed in the Southern Bight, Minas Basin (Gaspereau, St. Croix, Kennetcook and Shubenacadie watersheds) (Hynes *et al.* 2005a) and 44% assessed on Cumberland County's Fundy shore (Hynes *et al.* 2005b) were either partial or complete restrictions to tidal flow and/or fish passage. The majority of these restrictions were caused by improperly sized and placed culverts affecting small to medium sized rivers and dyking for agricultural purposes.

[1] Only those with complete records, including GPS coordinates and attribute descriptions were included. There are many other non-recorded or poorly recorded restrictions in the bioregion (Garroway *et al.* 2012).

One of the major observed effects of tidal barriers in the bioregion is loss of salt marshes due to dyking or restricted tidal flow (Hynes *et al.* 2005a,b; CBCL Ltd. 2009). Moreover, in many locations, the partial or complete obstruction to tidal flow has caused changes in sedimentation and erosion patterns, affecting coastal habitats. For example, decreases in turbulent energy in the tidal system causing suspended particles to drop from suspension and accumulate forming mud, sand and silt deposits below the structure. The decrease in sediment moving out of the river can result in impacts on flats in other areas. In the NS IBoF, causeway-dam type barriers on the Avon, Great Village, and Parrsboro rivers are among the most substantial (DFO 2010) and are thought to have caused significant changes to the river systems (Wells 1999). For example, the causeway built across the Avon River estuary in 1970 has resulted in drastic changes in the river habitat and biological community, including the formation of a freshwater lake (in a previously tidal area) and the formation of an extensive tidal flat and salt marsh complex below the causeway due to sediment build-up.

3.2 Mining & quarrying

(Summary Threat Ranking: Medium)

Threats from mining and quarrying include the permanent destruction of habitat from the construction of roads and processing facilities. Threats also include erosion and sedimentation as a result of land clearing and disposal of debris, as well as soil and water contamination by chemical by-products that are used in processing. The number and size of active mining operations across the bioregion is low; however, the localized impacts on habitats where it does occur can be significant and irreversible. Moreover, numerous sites throughout the bioregion are under active mineral exploration activities for aggregates, gold, and base metals (McCulloch 2014).

There is a history of mining karst topography aggregate deposits in the bioregion, particularly gypsum and limestone, in the St. Croix, Kennetcook and Shubenacadie watersheds (NSDNR 2010; Whiteway 2013). In 2013, there were three active mining operations in the Shubenacadie watershed, for limestone, gypsum and silica sand (Whiteway 2013). Although several gypsum mines have recently closed in the Windsor area (St. Croix/Kennetcook watersheds), aggregate mining is still a major economic activity in the bioregion. Past and recent mining activities are believed to have resulted in the loss of populations of and suitable habitat for rare and sensitive calcareous/gypsum forest and floodplain habitat species, such as several rare and endangered orchids (Blaney & Mazerolle 2007; R. Newell, pers. comm. 2014). The gypsum and limestone caves and abandoned mines in the St. Croix, Kennetcook, and Shubenacadie watersheds are also considered significant habitat for bats, especially the three endangered species that depend on these areas for hibernating, summer roosting, and social behaviours (Moseley 2007). Proposals for new or expanded quarries will threaten the gypsum/calcareous cliff, forest, and floodplain habitats in which these activities take place and the remaining populations of rare species that depend on them (Blaney & Mazerolle 2007; R. Newell, pers. comm. 2014). There is only one active mine for salt on the north side of the Minas Basin in the Kelly/Maccan/Hebert watershed (NSDNR 2010; Whiteway 2013). While direct impacts of this operation on priority habitats and species is unknown, the site is located on land adjacent to the Chignecto National Wildlife Area and Ramsar site and thus is a possible stressor on significant wetlands, forests, and wildlife in the area (CWS 2001a).

Another potential threat in the bioregion is rare earth mining. A company has initiated an environmental assessment for a project to mine monazite, titanium, and zircon deposits from intertidal sandbars over an approximately 9 488 ha area in Cobequid Bay and the Shubenacadie River (REMSI 2014). The Shubenacadie River is an important habitat for diadromous fish species, supporting one of the few remaining spawning populations of the endangered IBoF Atlantic Salmon, the only spawning population, and an important overwintering population of Striped Bass in Atlantic Canada, as well as Atlantic Sturgeon, and American Eel. These species, and the invertebrates and microorganisms in the mudflats, support numerous shore and migratory bird species, including the Semipalmated Sandpiper. If this project goes forward, it could result in considerable disturbance to estuarine and tidal flat habitats (G. Daborn, pers. comm. 2014).

2.2 Wood & pulp plantations
(Summary Threat Ranking: Medium)

Conversion of natural forests to wood and pulp plantations is a common forestry practice in the bioregion (Figure 20 and Figure 22). According to the provincial forest inventory, over 65 765 ha of forest plantations are present, representing almost 8% of the forested land base. Forest plantations generally consist of even-aged monocultures of shade-intolerant, fast-growing softwood species for use in the pulp and paper industry. Native tree species used include Red Pine, Red, Black and White Spruce, as well as Balsam Fir for the Christmas tree industry. The use of non-native Norway Spruce is also widespread in Nova Scotia, primarily due to its exceptional growth, which can be superior to that of native spruce species on comparable sites. Forest plantations can severely reduce the species and structural diversity of forest stands, and can result in changes to the hydrology and soil characteristics of the site. They generally lack biodiversity, and have a reduced capacity to provide suitable habitat for native wildlife compared to natural forests. As monocultures, they are also far more vulnerable to damage by insects, diseases, and wind. As such, there is often an associated increase in the use of biocides, such as herbicides and pesticides.

6.1 Recreational activities
(Summary Threat Ranking: Medium)

With increased cottage and residential development along the coast and shorelines, there has been an associated increase in recreational activities, including hiking, camping, dog walking, mountain biking, and the use of OHVs. The threats associated with traditional recreational activities include trails, buildings, garbage, vegetation trampling, and general disturbance of wildlife and habitat. Use of OHVs is recognized as a particular threat to a number of the bioregion's priority habitats and priority species, including priority birds, rare plants, and wood turtles (Blaney & Mazerolle 2007; COSEWIC 2007b; Environment Canada 2013). OHV use can result in soil compaction, destruction of vegetation, noise, and changes to drainage patterns and hydrology. The Nova Scotia *Off-Highway Vehicles Act* (1989) prohibits the operation of an OHV in or on a wetland, watercourse, sand dune, or coastal or highland barren; however, it is difficult to enforce, particularly in remote areas.

5.4 Fishing & harvesting aquatic resources (clam & baitworm harvesting)
(Summary Threat Ranking: Low)

Recreational and commercial harvesting of clams and marine worms can have a substantial impact on intertidal flat habitat without proper regulation. Overharvesting can result in physical impacts to the habitat structure of tidal mudflats (GOMC 2010) and can result in negative impacts to benthic community structure by reducing the overall species richness and abundance of non-target infauna (GOMC 2010). In turn, the effects on mudflat infauna communities can affect food availability for fish and shorebird species which feed on them. Localized, and at times intensive, bloodworm and soft-shelled clam harvesting has taken place on some tidal mudflats within the bioregion, particularly in the Southern Bight area and north shore of the Minas Basin (clams) and overharvesting has historically been a concern (AECOM 2011).

ii. Emerging Threats

Climate Change and Severe Weather

11.1 Habitat shifting & alteration
(Summary Threat Ranking: Unknown)

The Earth's climate is warming as a result of anthropogenic emissions of greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, from the burning of fossil fuels and land-use change (i.e., climate change). The rate of global climate change observed over the last two decades is already having significant and wide ranging effects on the Earth's ecosystems and wildlife, and presents ever-increasing challenges for species' adaptation (Nicholls *et al.* 2007). In the Atlantic Provinces, mean temperature and summer rainfall are expected to increase by 3°C and up to 10%, respectively, by 2040 as a result of climate change (Bourque & Hassan 2008). Bourque and Hassan (2008) modeled anticipated tree species habitat redistribution in the Acadian Forest of eastern Canada as a result of climate change, and their preliminary projections suggest that boreal species such as Black Spruce and Balsam Fir will be limited to the cooler areas of the province and temperate hardwood species such as Yellow Birch and Red Oak, as well as White Pine, will benefit from climate change.

The resulting impacts of this anticipated habitat shifting on native wildlife is currently unknown. For wildlife species, anticipated range shifts to the north and from coastal to inland sites could lead to the introduction of new predators and increased competition with native wildlife (Environment Canada 2013). In freshwater lakes and rivers, climate change will likely lead to a further reduction in the availability of summer thermal refugia habitat for cold water fish species such as brook trout, and an increase in habitat availability for species more tolerant of temperature fluctuations, such as yellow perch and the invasive smallmouth bass and chain pickerel. In the coastal marine environment, climate change will result in changes in ocean temperatures and currents, with unknown impacts on marine productivity and food webs.

11.1 Global sea-level rise
(Summary Threat Ranking: Medium)

Global sea levels have risen approximately 120 m due to natural processes (post-glacial sea-level rise, regional subsidence) since the height of the most recent glacial period (i.e., the Wisconsin Glaciation) (Williams *et al.* 2009). More recently, the rate of sea-level rise has increased as a result of global climate change. As the oceans warm and expand, and polar ice caps melt, estimates of relative sea-level rise in the bioregion (Cobequid Bay) range from 0.41 m to 0.79 m by 2055, and 0.79 m to 1.40 m by 2100 (Greenburg *et al.* 2012). At these rates, van Proosdij *et al.* (2013) estimate that the majority of dykelands in the NS IBoF will be below sea-level by 2055. This will have profound effects on the bioregion's coastal ecosystems through increased coastal erosion, inundation, and frequency of flooding (Williams *et al.* 2009; van Proosdij and Page 2012).

Coastal ecosystems, such as beaches, tidal marshes, and tidal flats, respond to sea-level rise by growing vertically and migrating inland over time. Only those coastal features that accumulate sediment at a rate that maintains their elevation relative to sea-level will persist. Thus, having space available with a low gradient slope for inland migration is critical for the maintenance of coastal ecosystems in the face of increased sea-level rise as a result of climate change (Williams *et al.* 2009). Shoreline hardening effectively prevents the inland migration of coastal ecosystems and may result in their loss as global sea-levels rise. The potential alteration or loss of coastal habitats such as tidal marshes, beaches, and tidal estuaries will have negative impacts on many animal and plant species that depend on them.

11.4 Storm-induced coastal erosion
(Summary Threat Ranking: Medium)

Also associated with climate change is an anticipated increase in the frequency and intensity of storms and major cyclone activity, and consequently storm-related flooding and coastal erosion (Williams *et al.* 2009). Associated with increased intensity, projections also suggest that tropical storms in the Northern Hemisphere will track further north than before as a result of climate change (CBCL Ltd. 2009). Combined with the expected rise in global sea levels, the impact of storm surges on coastal ecosystems will be much greater than has been experienced previously, particularly on low-lying areas, such as the Acadian dykelands (CBCL Ltd. 2009).

3.3 Renewable energy
(Summary Threat Ranking: Low)

Wind
Wind turbines represent a potential conservation concern for both resident and migratory wildlife (NSDE 2011), through direct mortality, and loss of or disturbance to breeding and nesting habitat and migration corridors. Habitat loss due to land clearing and disturbance caused by increased human activity, roads, and noise may result in decreased breeding and nesting success or avoidance of wintering and feeding habitat in the area. While recent studies suggest that bird mortality from wind turbines is relatively low compared to other human impacts (NSDE 2011; Calvert *et al.* 2013), their cumulative impacts may be significant. In contrast, high rates of bat mortality are being reported at many wind energy facilities across North America (Johnson 2005). Bats may be killed by collisions or by air pressure changes associated with spinning turbine blades (NSDE 2011). However, short distance migrant species that are more common to Nova Scotia (e.g. Little Brown Myotis, Northern Myotis, Tri-coloured Bat), have comparatively low reported mortality from wind development than the less common long distance migratory species. Also potentially affected are wildlife species such as moose (NS mainland population), which are particularly sensitive to habitat fragmentation and human disturbance from land clearing, noise, and roads (NSDNR 2007).

The extent of wind energy development in the bioregion is currently limited to three small commercial wind farms. Two are located in the Cumberland uplands: a three turbine farm on Higgins Mountain in the Economy watershed and a site with two turbines near Springhill in the Kelly/Maccan/Hebert watershed (NSP 2014). The third, the Brookfield wind turbine, is in the Shubenacadie watershed (NSP 2014). While small, all are located in the vicinity of important bird areas and thus possible flight paths. Although wind speeds are highest in coastal areas and on mountain tops, future wind development in the bioregion is currently focused on the moderate and easily accessible inland wind resources closer to the transmission grid and demand (NSDE 2011). Several areas are being considered as potential sites for future development within the Shubenacadie and St. Croix watersheds, some of which have received regulatory approvals. Some sites are in the vicinity of known important bat hibernacula, roosting, and swarming sites (i.e., caves and mines), as well as the Southern Bight – Minas Basin IBA (Moseley 2007). In 2012, in response to public opposition, Kings County issued a moratorium on wind farm development in the municipality (Gaspereau Watershed). While the impact on priority habitats and species in the bioregion is currently considered low, careful siting and planning of future developments will be crucial to avoid impacts.

Tidal
With the growing demand for renewable energy, there has been exploration of the potential for harnessing the dynamic, high flow tidal energy resources of the Bay of Fundy. There is a long history of interest in harnessing tidal energy in the Bay of Fundy, with major proposals for tidal barrage style

systems put forth in the 1930s, 1960s, 1970s, and 1980s (Daborn 2013). Similar to hydroelectric power stations, these proposals involved building barrages (dams) across the entrances to bays or between islands. The Annapolis Tidal Generating Station, operating since 1985 in the Annapolis River, has had demonstrated impacts on water flow, sediment, and regional ecological resources, particularly fish populations in the area (e.g., sturgeon). Recently, a company has expressed interest in installing a tidal lagoon type facility for Scots Bay, which would involve a 1 100 MW tidal barrage or dam-like structure stretching 10 km from Cape Split to Baxter's Harbour (Bundale 2014). The environmental risks of such a scheme have yet to be assessed, but there is potential for major effects on the sensitive and important coastal and intertidal habitats and species throughout the Inner Bay of Fundy (Daborn 2013).

However, most of the present interest focuses on in-stream tidal energy devices which are designed to harness the kinetic energy from the flow of the tidal currents without the use of dams or impoundments (Daborn 2013). Current estimates suggest the Minas Passage may be able to support turbine arrays with an installed capacity of nearly 1 400 MW. While these devices are believed to have lower environmental risks than dam-style developments, in-stream development could still affect coastal habitats and species in the bioregion through construction-related disturbances, risk of release of contaminants, mortality and injury to migratory birds and fish from collisions, impacts of noise/vibrations, and physical alteration to coastal habitats (salt marshes, tidal flats, beaches) due to changes in water flow and sediment patterns (Isaacman & Daborn 2013).

In 2009, the Fundy Ocean Research Centre for Energy (FORCE) was established as a test centre for commercial-scale, in-stream tidal energy devices. FORCE's test site is in the Minas Passage near Black Rock, 10 km west and offshore from Parrsboro. FORCE consists of berth sites for up to four turbines or small arrays with a combined capacity of 5 MW maximum, power and data cables to shore, shore-based facilities, and an environmental monitoring and research program. One turbine was deployed in 2009-2010 with no observed impacts. More deployments are planned for 2015. While impacts at this current demonstration/developmental stage are likely to be negligible, commercial development in the Minas Passage could impact coastal environments in the future.

3.1 Oil & gas drilling

(Summary Threat Ranking: Low)

There are currently no oil or gas operations underway in the bioregion. However, there are conventional onshore oil and gas exploration agreements for areas in the St. Croix, Kennetcook, Shubenacadie, Salmon/Debert, Parrsboro, and Kelly/Maccan/Herbert watersheds (NSDE 2012). Threats from oil and gas operations depend on the method used, but relate to the destruction of habitat from the construction of roads and processing facilities, erosion and sedimentation as a result of land clearing and disposal of debris, as well as soil and water contamination from chemical and oil spills. The 2011 *Nova Scotia Wetland Conservation Policy* offers some protective measures for wetlands, particularly to prevent the net loss of Wetlands of Special Significance, including the Southern Bight and Chignecto Ramsar sites, both of which are within exploration agreement areas (Government of Nova Scotia 2011).

There is also the potential for shale gas exploration. The primary method contemplated for this extraction is by hydraulic fracturing or "hydrofracking", where liquid is forced into the ground under high pressure to release natural gas from shale deposits (Northrup 2010). Extracting hydrocarbons through the use of hydrofracking is controversial in Nova Scotia and elsewhere for various reasons. In other jurisdictions, it has been linked to small earthquakes. These tremors are apparently caused by injecting fracking waste water into deep underground injection wells (Horton 2012). However, to date, there is no indication that such injection wells are contemplated for this region. Nevertheless, shale gas drilling and extraction can also result in both ground- and surface-water contamination from the chemicals used in the fracking process, accidental spills during their removal and transport to waste facilities, leakage from holding ponds, as well as those released during the breakup of sub-surface shale (Entrekin *et al.* 2011). Moreover, and perhaps most importantly, there is the danger that the cement well casing of holding ponds will fail over time, which can lead to methane and fracking-fluid migration into aquifers. In addition, shale gas operations can release air pollutants and greenhouse gases (Howarth 2010; Howarth *et al.* 2011) and can result in extensive clearing of land for well-pads and infrastructure (Hein 2012). Potential additional, indirect impacts of shale gas mining include further fragmentation from road development, rapid road degradation through the increased use by industrial traffic, erosion, and sedimentation (Adams *et al.* 2011). Although there are currently few shale gas wells that have been drilled and hydraulically fractured in the Maritimes using the newer, unconventional, slick water, horizontally drilled, high volume technique that is the most controversial, the industry is in its very early stages here and there are no major known or reported incidents that have occurred as a result of this practice to date. Based on problems that have occurred using these same techniques elsewhere, this type of drilling has the potential to be highly damaging to the environment if the industry proceeds on a larger scale.

A more immediate concern, particularly for coastal and aquatic habitats, is the large amount of fracking wastewater being held in the bioregion. This wastewater contains a mixture of potentially harmful chemicals, including Naturally Occurring Radioactive Materials (NORMs). There are an estimated 27 million litres being stored at a facility in Debert, as well as in holding ponds in Kennetcook and Noel (CBC News 2014). In January 2014, leaks were detected in the Kennetcook holding ponds, potentially threatening ground and surface water. In 2010-11, seven million litres were discharged into the Avon River estuary, Minas Basin, after passing through the wastewater facility in Windsor, which was not equipped to treat the chemicals (CBC News 2012). The approval of the future releases of untreated wastewater appears unlikely. Colchester County rejected a proposal to dispose of the Debert facility water in the town sewer system (CBC News 2013). Moreover, the provincial government recently announced that it is requiring that the holding ponds be drained, the wastewater properly treated and disposed of, and the site remediated (Thompson 2013).

The only shale gas exploration in the bioregion to date took place in the Kennetcook Watershed in 2006 (CBC News 2014). The impact, if any, on habitats and biodiversity is unknown. In response to public concern related to the practice, in fall of 2014 the government of Nova Scotia announced the imposition of a ban on hydraulic fracking in shale oil and gas projects in the province.

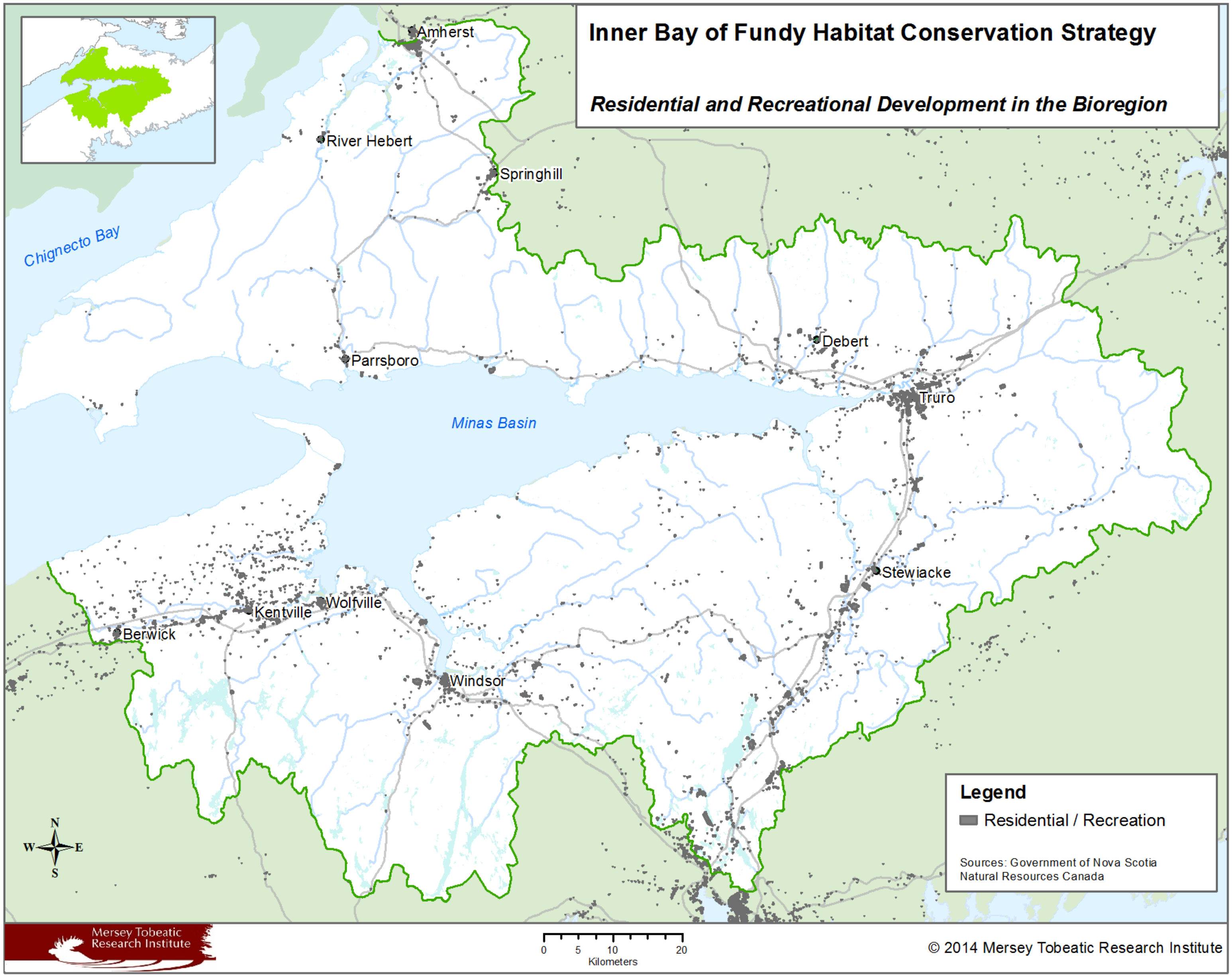

Figure 18. Residential & recreational development in the Nova Scotia Inner Bay of Fundy bioregion (1.1 Residential & commercial development - Housing & urban areas; Tourism and recreation areas).

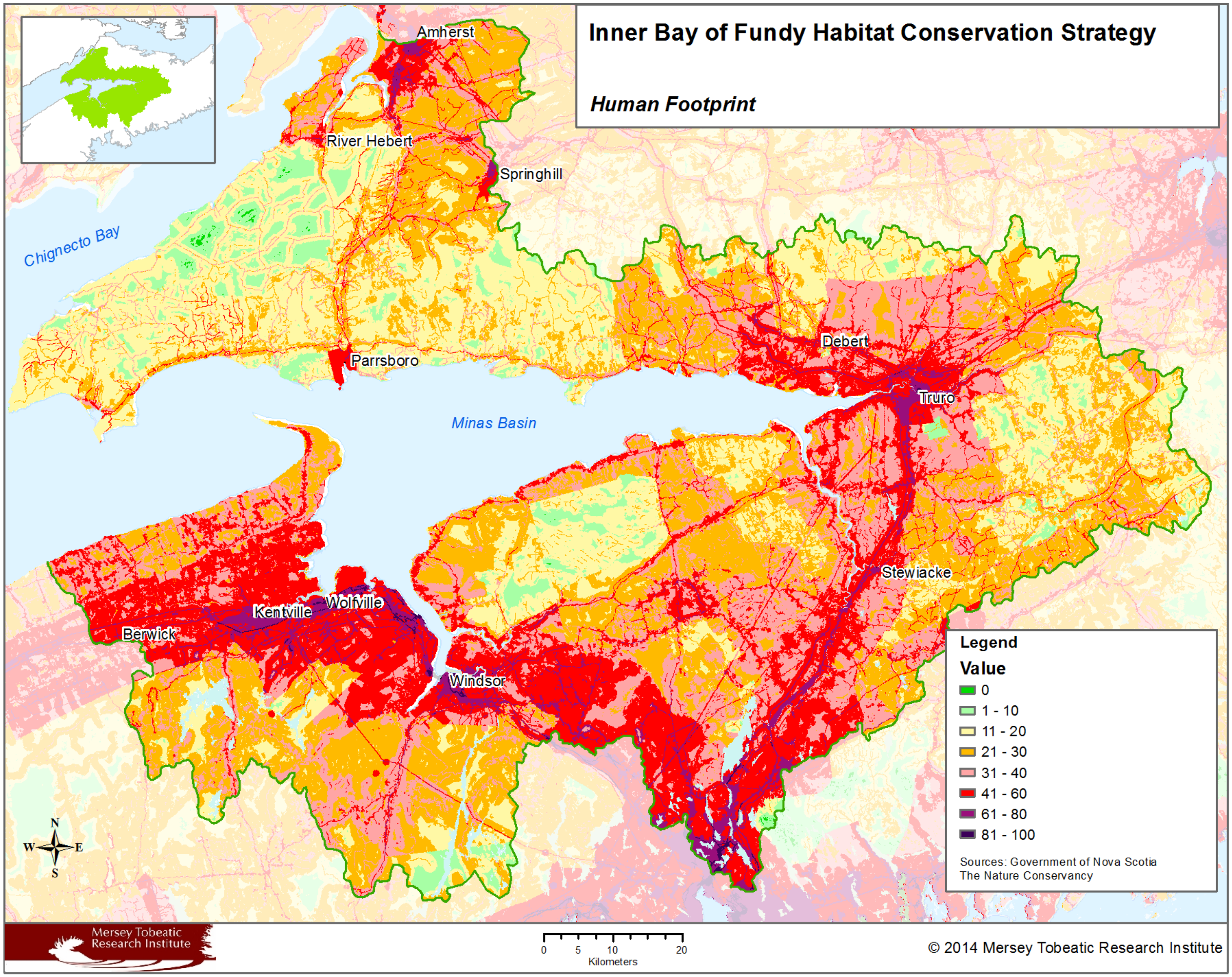

Figure 19. Human Footprint Index for the NS IBoF bioregion. The index considers human population (population density, dwelling density), human access (roads, rail), human landuses (urban, agriculture, forestry, mining, dams), and electrical power infrastructure (utility corridors).

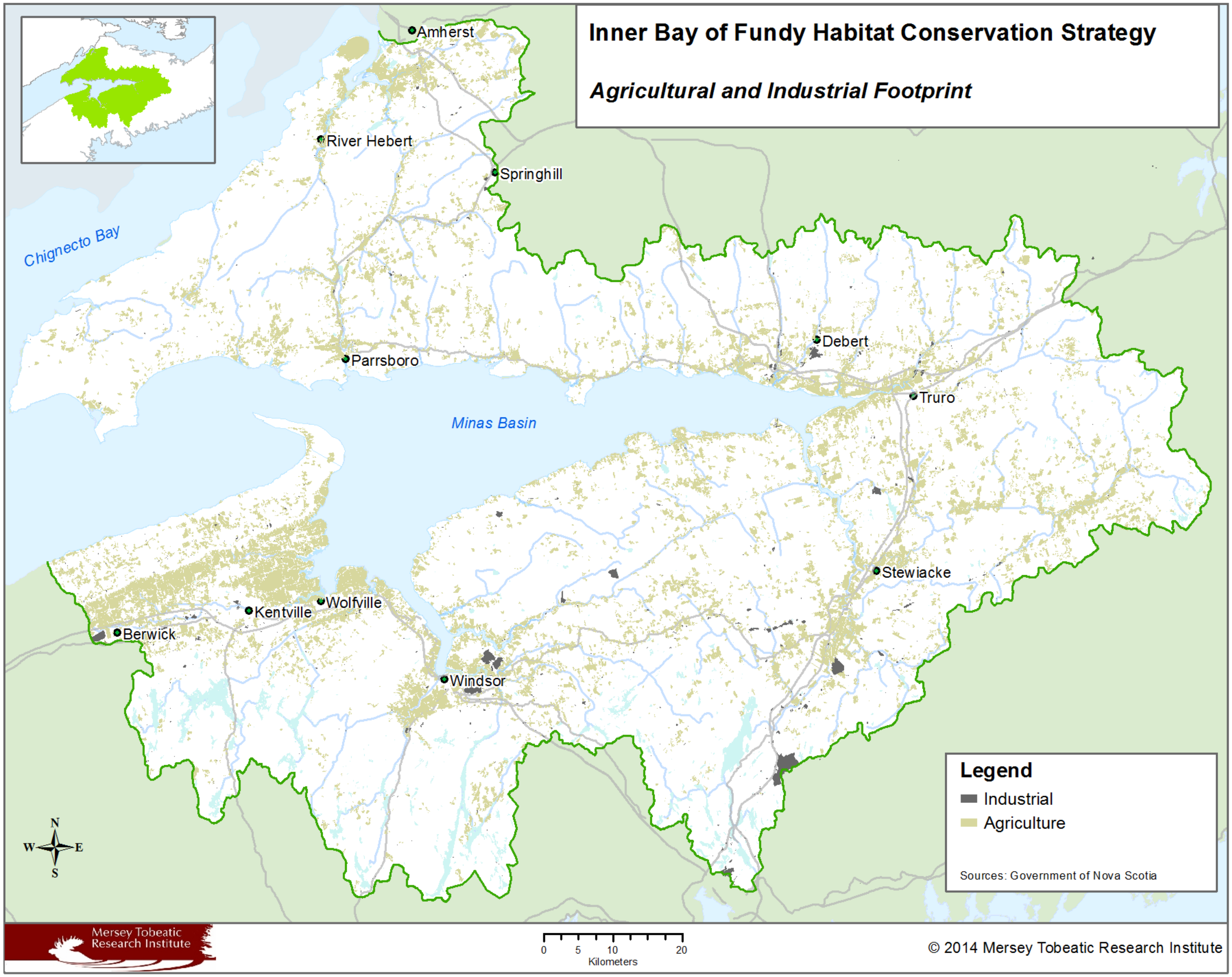

Figure 20. Agricultural & industrial development in the Nova Scotia Inner Bay of Fundy bioregion (2.1 Agriculture & aquaculture - Annual & perennial non-timber crops; 1.2 Residential & commercial development - Commercial & industrial areas).

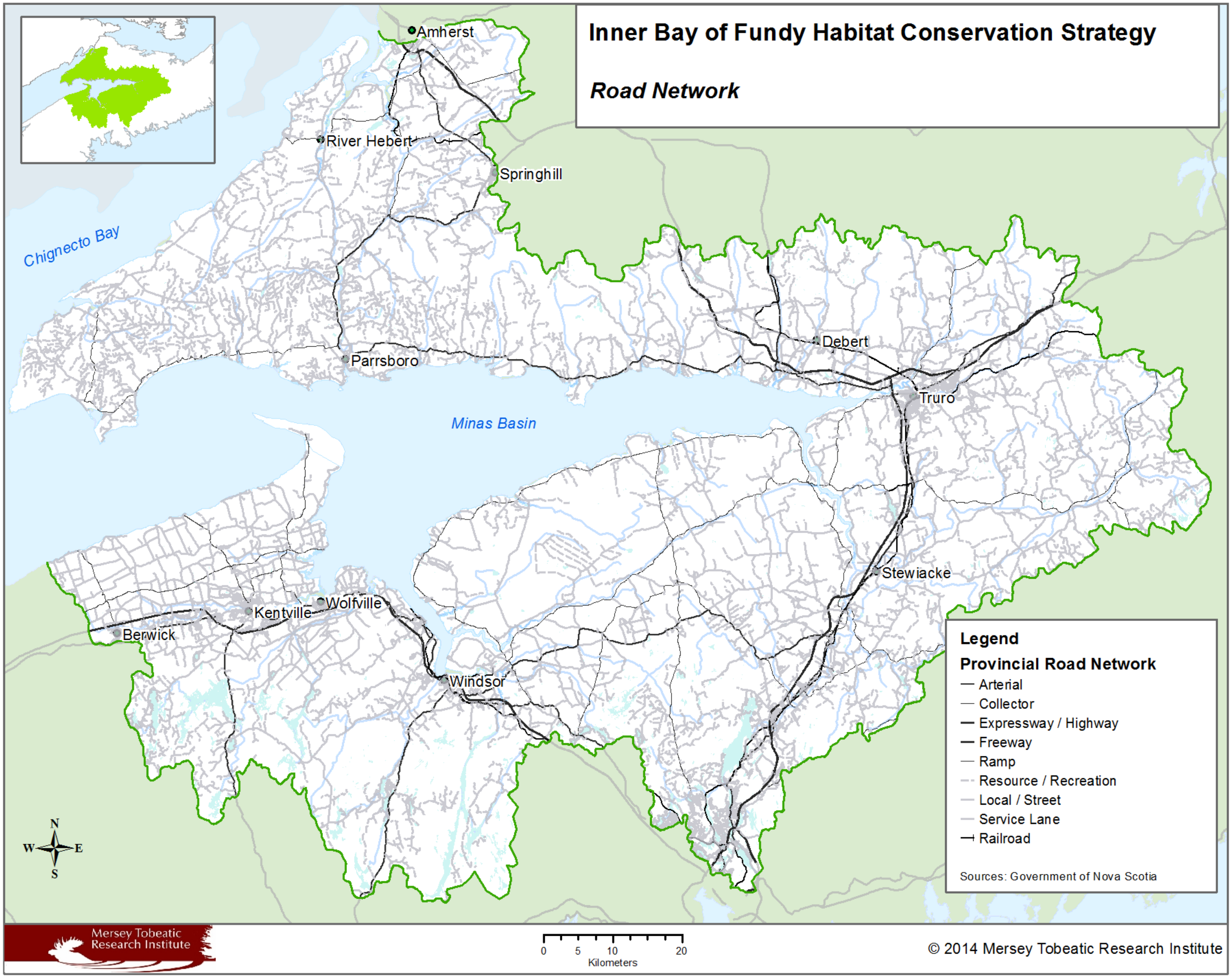

Figure 21. Road network in the Nova Scotia Inner Bay of Fundy bioregion (4.1 Roads & railroads).

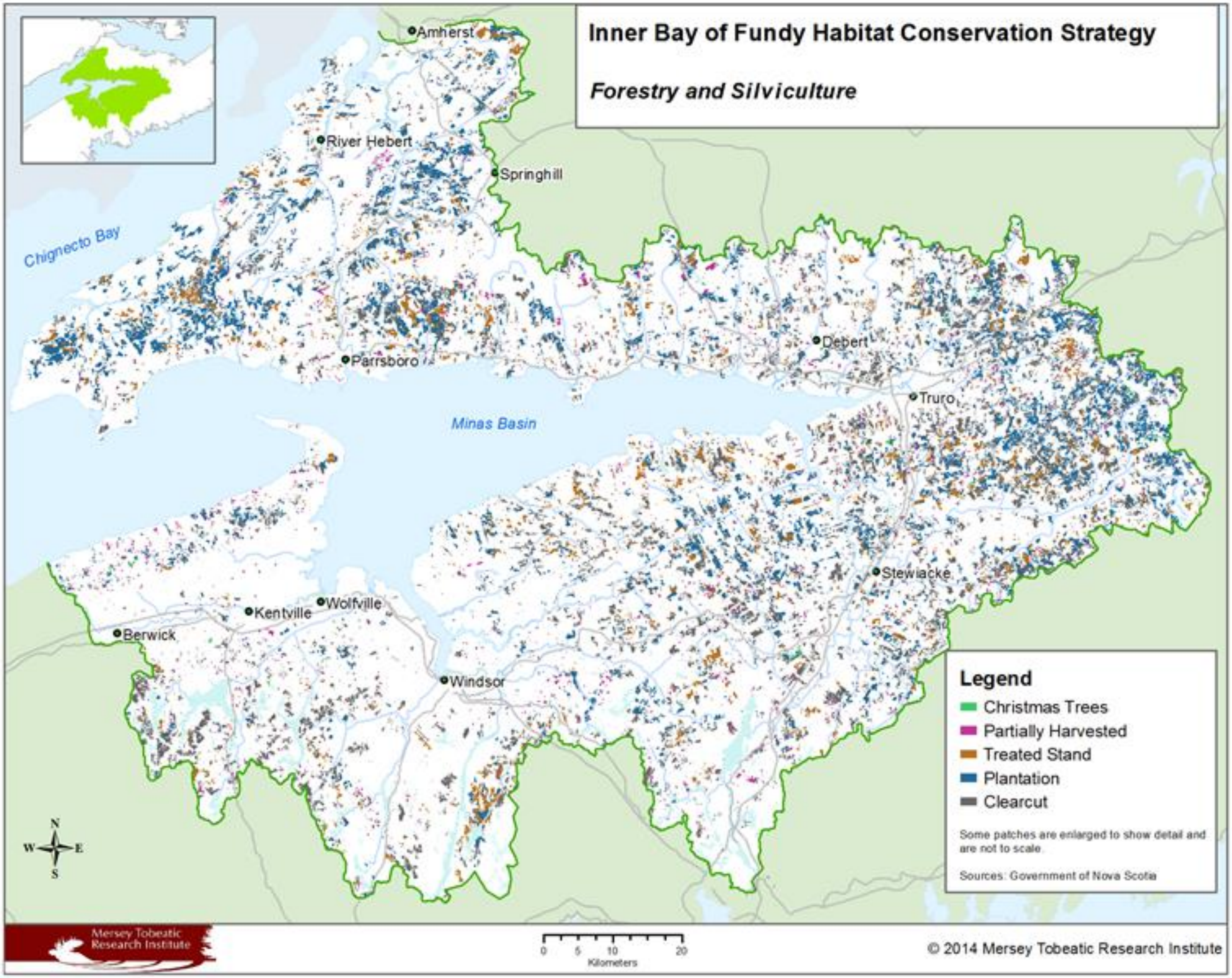

Figure 22. Forestry activity in the Nova Scotia Inner Bay of Fundy bioregion (5.3 Logging & wood harvesting; 2.2 Wood & pulp plantations).

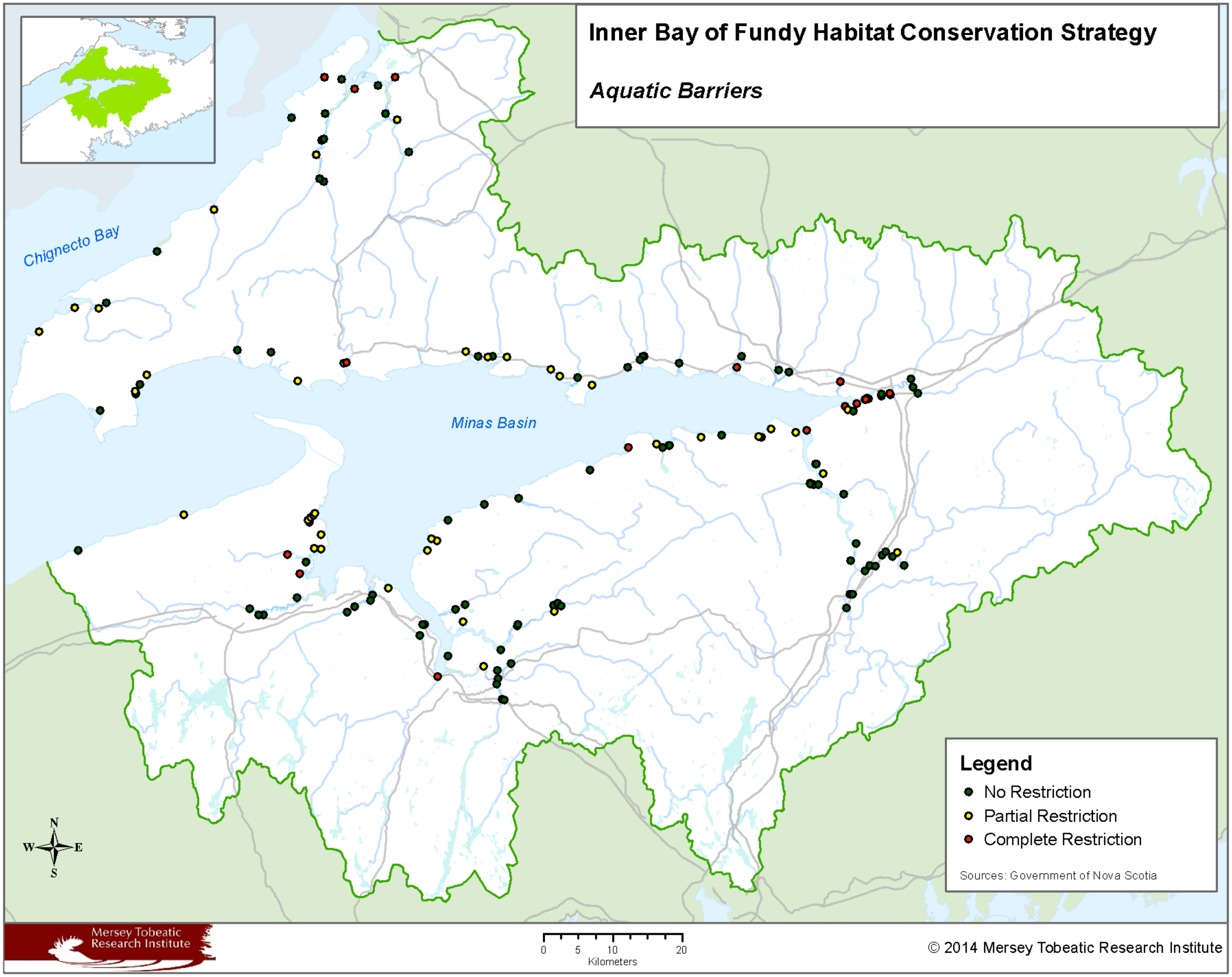

Figure 23. Dams & other aquatic barriers in the Nova Scotia Inner Bay of Fundy bioregion (7.2 Dams & water management/use).

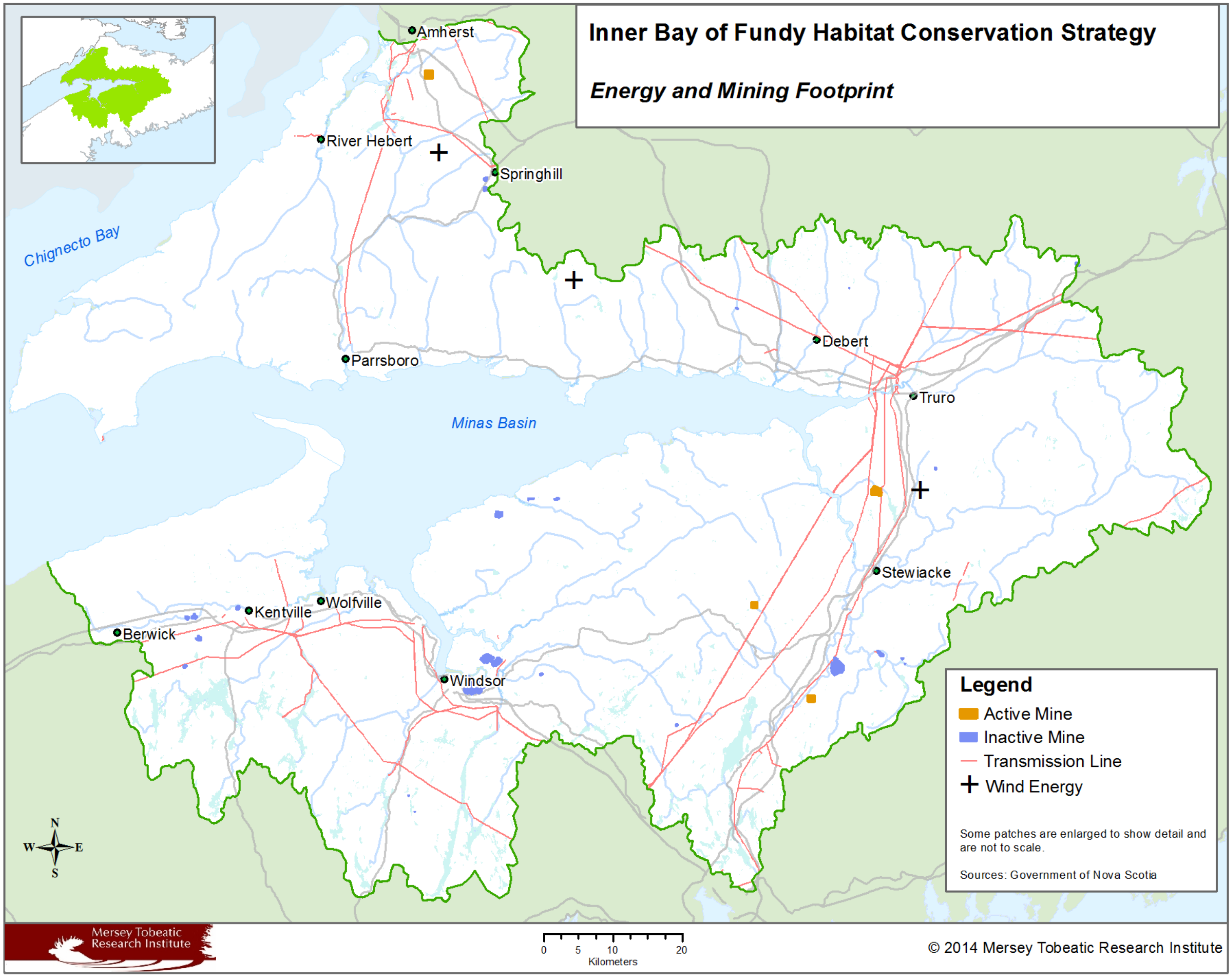

Figure 24. Energy & mining development in the Nova Scotia Inner Bay of Fundy bioregion (3.2 Mining & quarrying; 4.2 Utility & service lines; 3.3 Renewable energy).

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 NS IBoF 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 Appendix D.

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 D. 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 25 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 D.

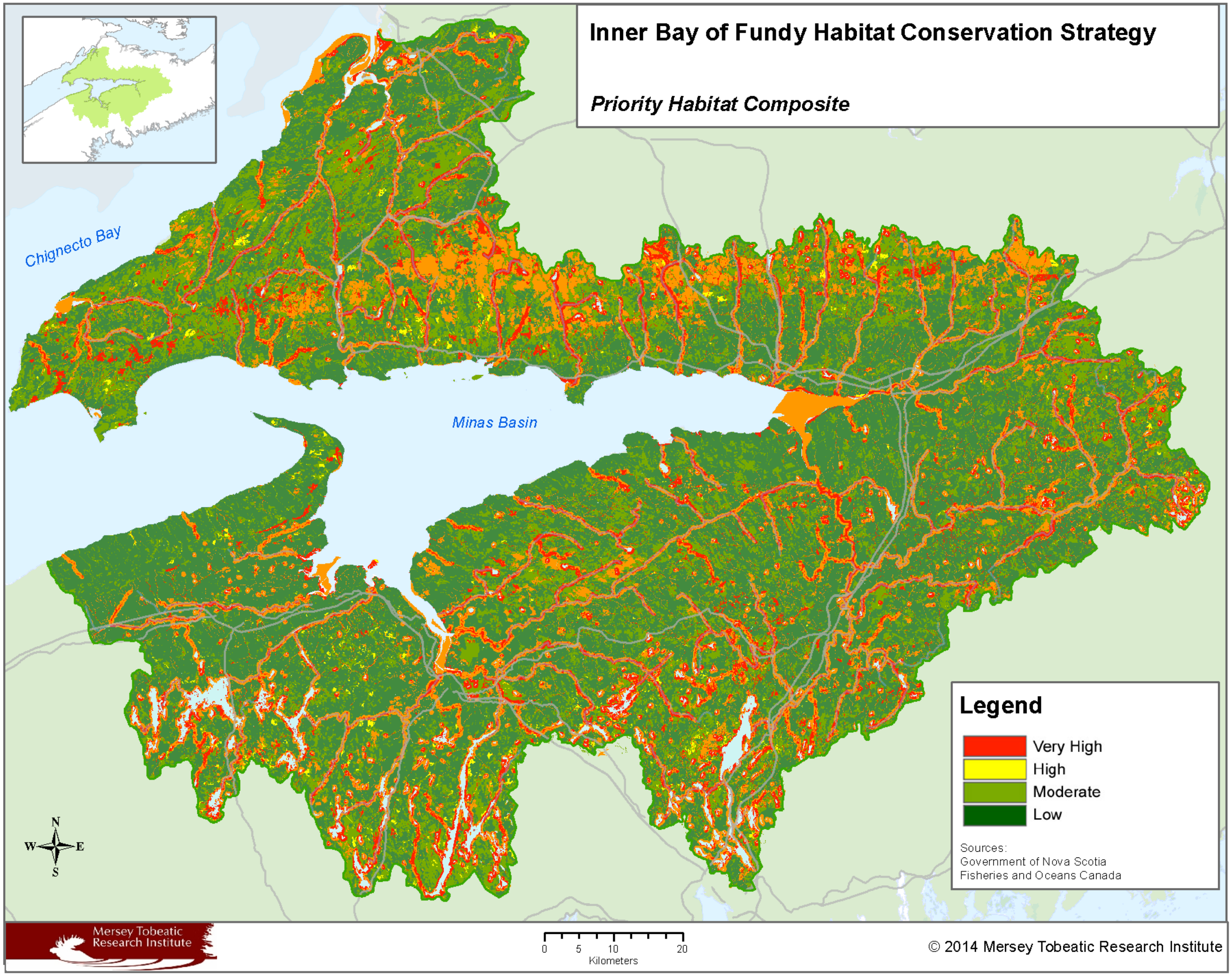

Figure 25. Priority habitat composite for the Nova Scotia Inner Bay of Fundy bioregion.

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 E. The reader is cautioned that species occurrence data are for the most part temporally and/or spatially incomplete; as such, maps that rely on species occurrence data 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 26). 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). Table 14 below provides a description of the various priority species composites that were generated, and the information they present in Figure 26 to Figure 33. 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.

Table 14. Priority species composites generated and spatial data sources used for the Nova Scotia Inner Bay of Fundy bioregion.

Fig.	Map Title	Description	Data Source(s)	Pp.
26	Species composite for all priority species	Likelihood of occurrence of all priority species	ACCDC Point Occurrence SAR Critical Habitat MBBA Relative Abundance MBBA Breeding Evidence	82
27	Species composite for all species at risk	Likelihood of occurrence of all species at risk	ACCDC Point Occurrence SAR Critical Habitat MBBA Relative Abundance MBBA Breeding Evidence	83
28	Species composite for priority terrestrial invertebrate species	Likelihood of occurrence of all priority terrestrial invertebrate species	ACCDC Point Occurrence	84
29	Species composite for priority fish and aquatic invertebrate species	Likelihood of occurrence of all priority fish and aquatic invertebrate species	ACCDC Point Occurrence	85
30	Species composite for priority reptile species	Likelihood of occurrence of all priority reptile species	ACCDC Point Occurrence	86
31	Species composite for priority mammal species	Likelihood of occurrence of all priority mammal species	ACCDC Point Occurrence	87
32	Species composite for priority[1] bird species	Likelihood of occurrence of priority bird species based on breeding evidence and relative abundance	MBBA Relative Abundance MBBA Breeding Evidence	88
33	Species composite for priority lichen and plant species composite	Likelihood of occurrence of all priority plant and lichen species	ACCDC Point Occurrence SAR Critical Habitat	89

[1] *BCR 14 NS and MBU 11 NS Priority Bird Species (Environment Canada 2013)*

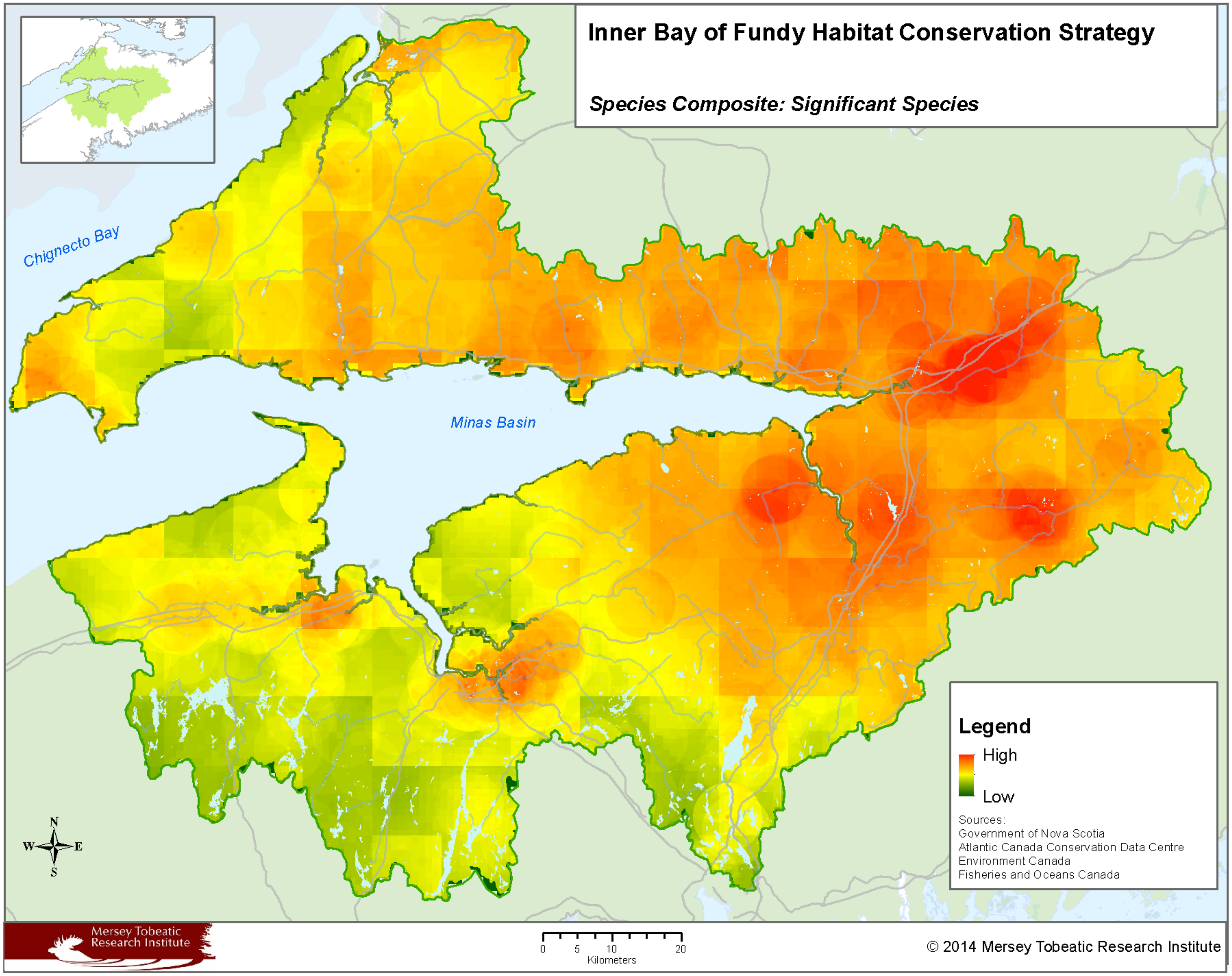

Figure 26. Species composite for all priority species in the Nova Scotia Inner Bay of Fundy bioregion.

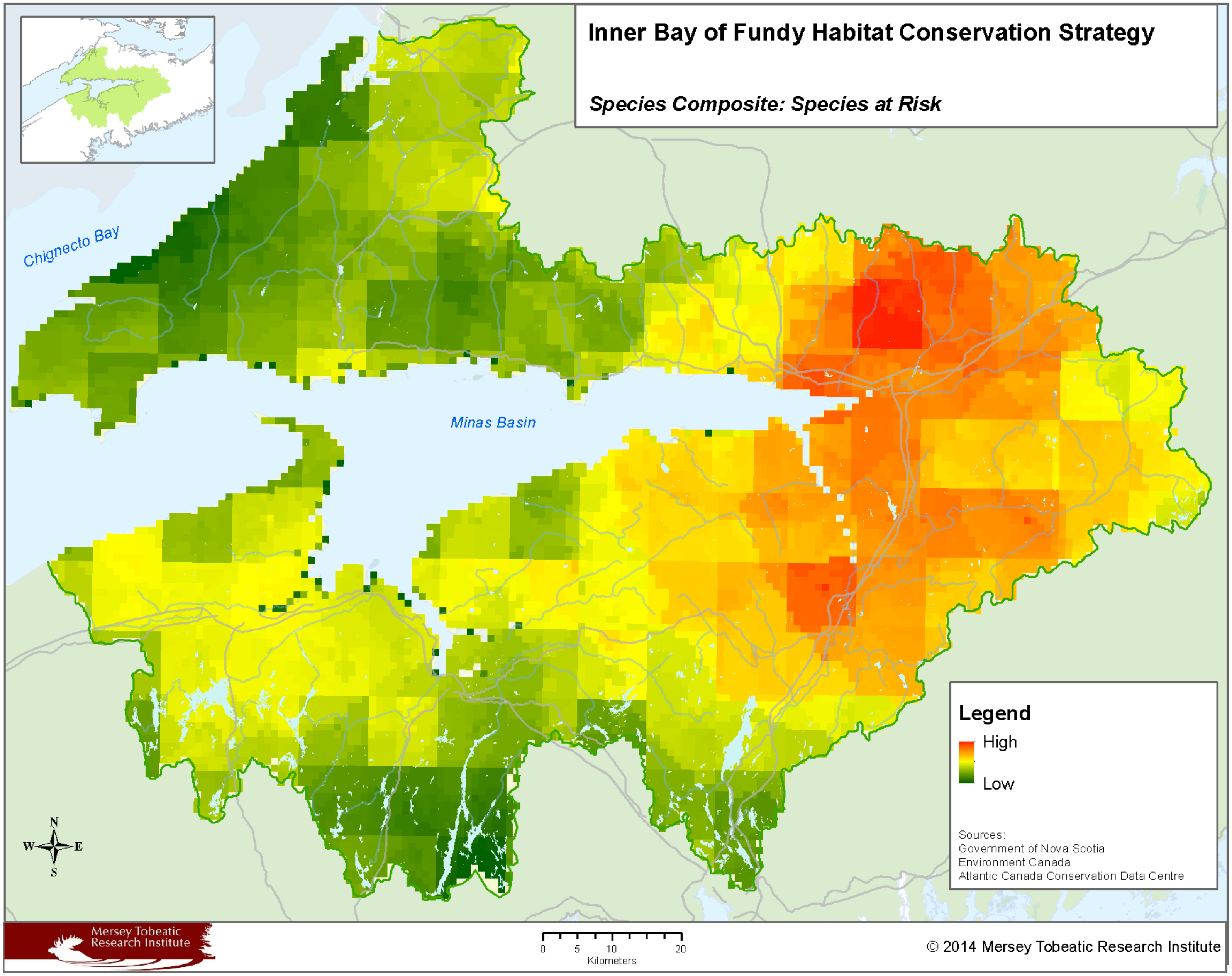

Figure 27. Species composite for all species at risk in the Nova Scotia Inner Bay of Fundy bioregion.

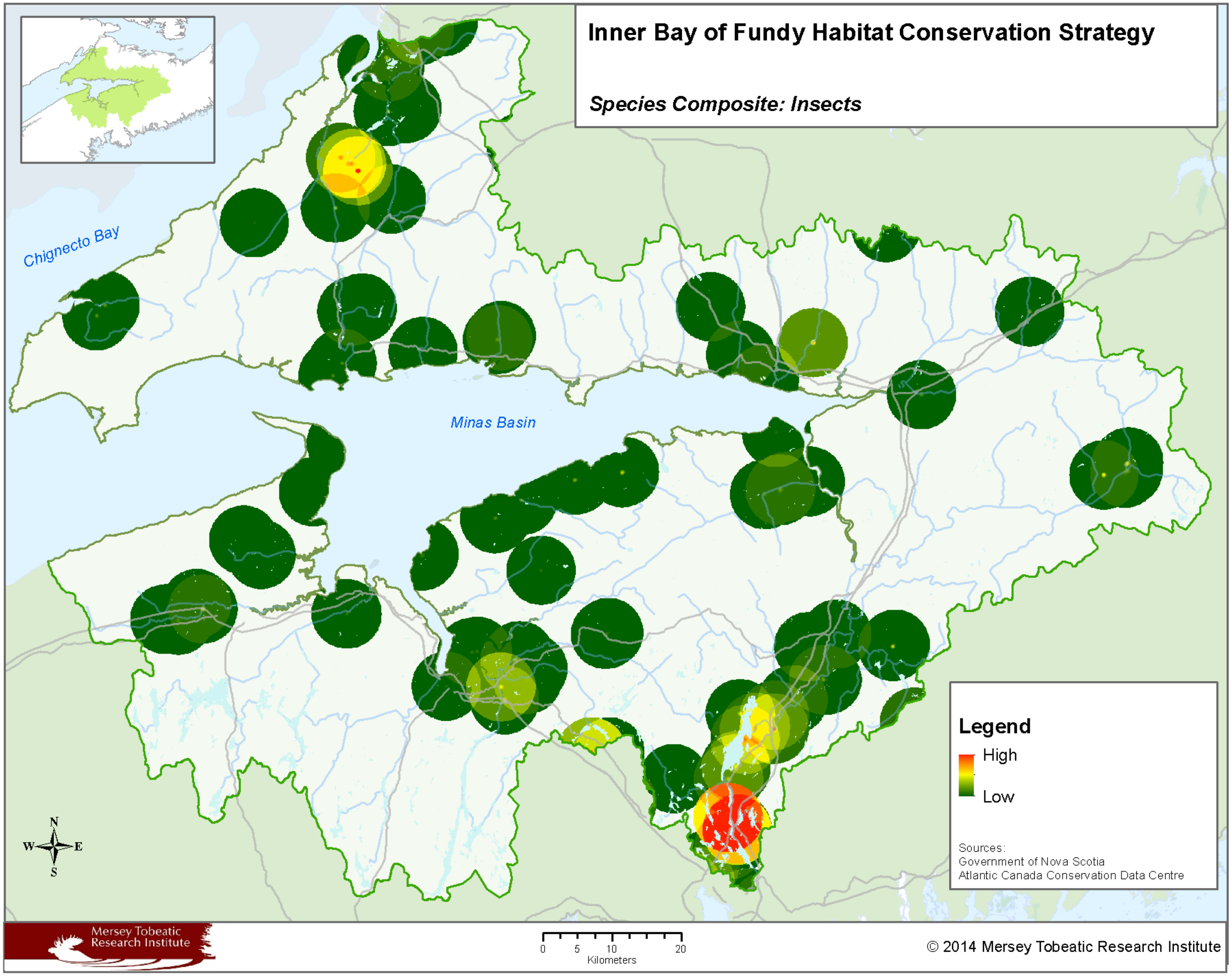

Figure 28. Species composite for priority terrestrial invertebrate species in the Nova Scotia Inner Bay of Fundy bioregion.

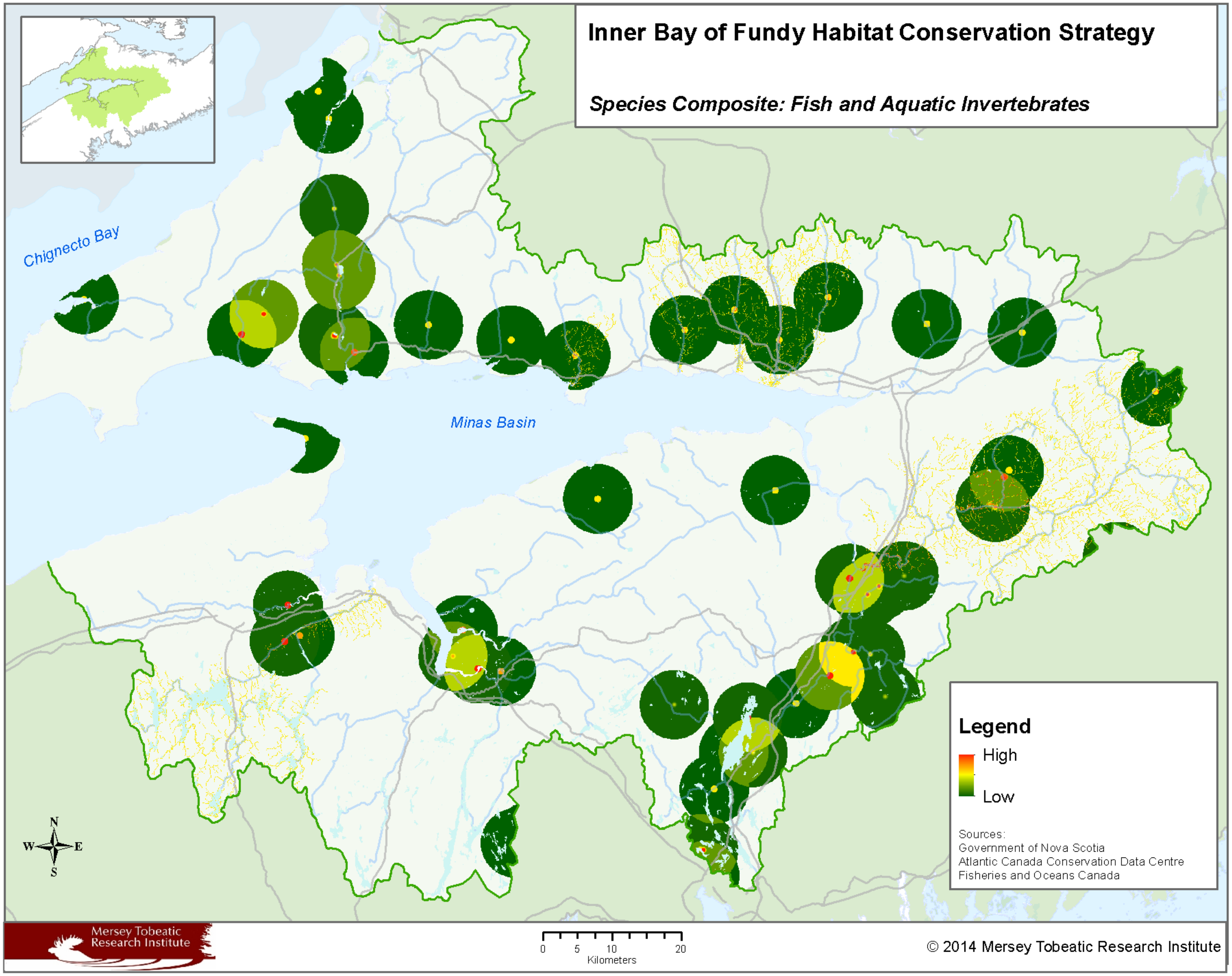

Figure 29. Species composite for priority fish and aquatic invertebrate species in the Nova Scotia Inner Bay of Fundy bioregion.

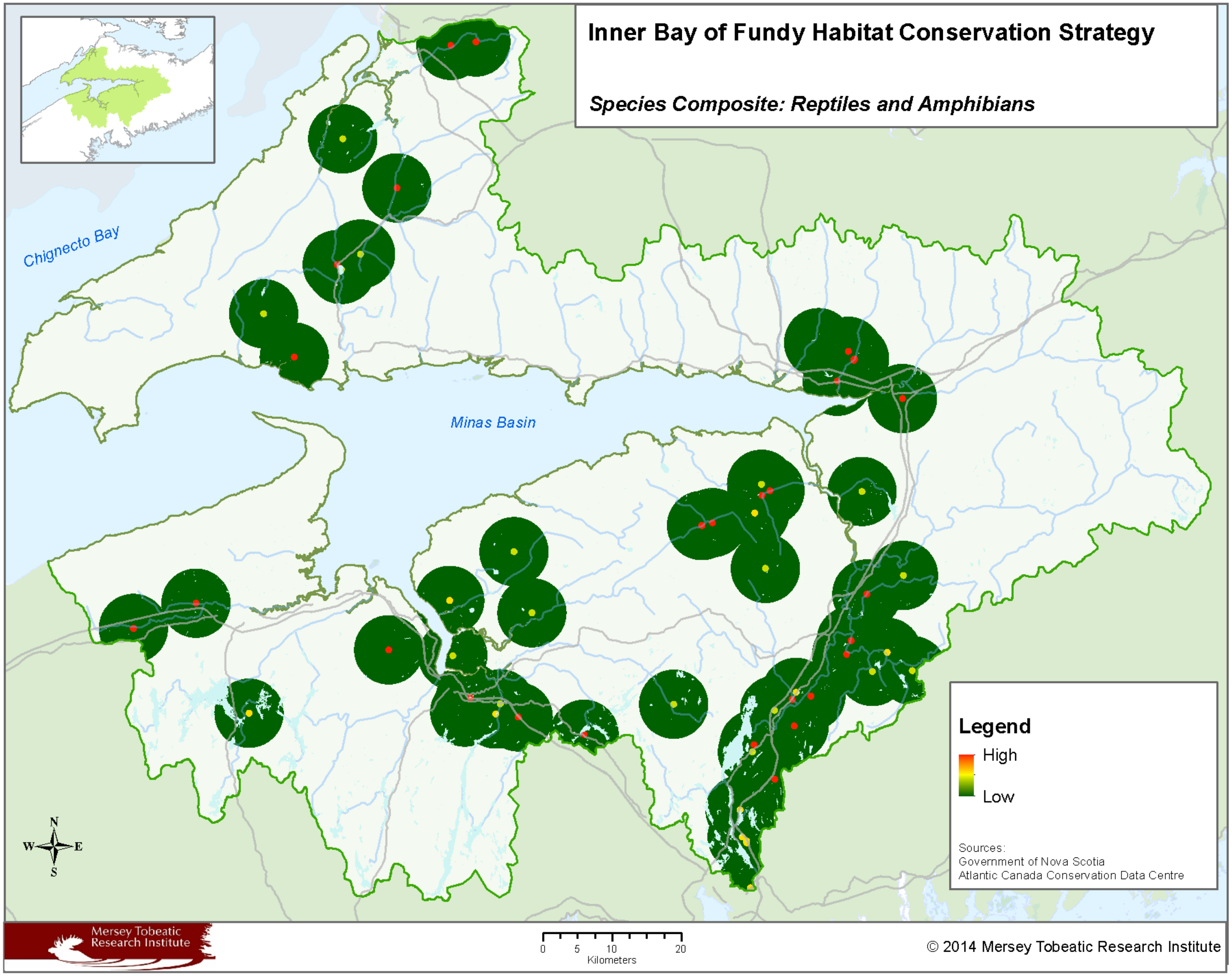

Figure 30. Species composite for priority reptile species in the Nova Scotia Inner Bay of Fundy bioregion.

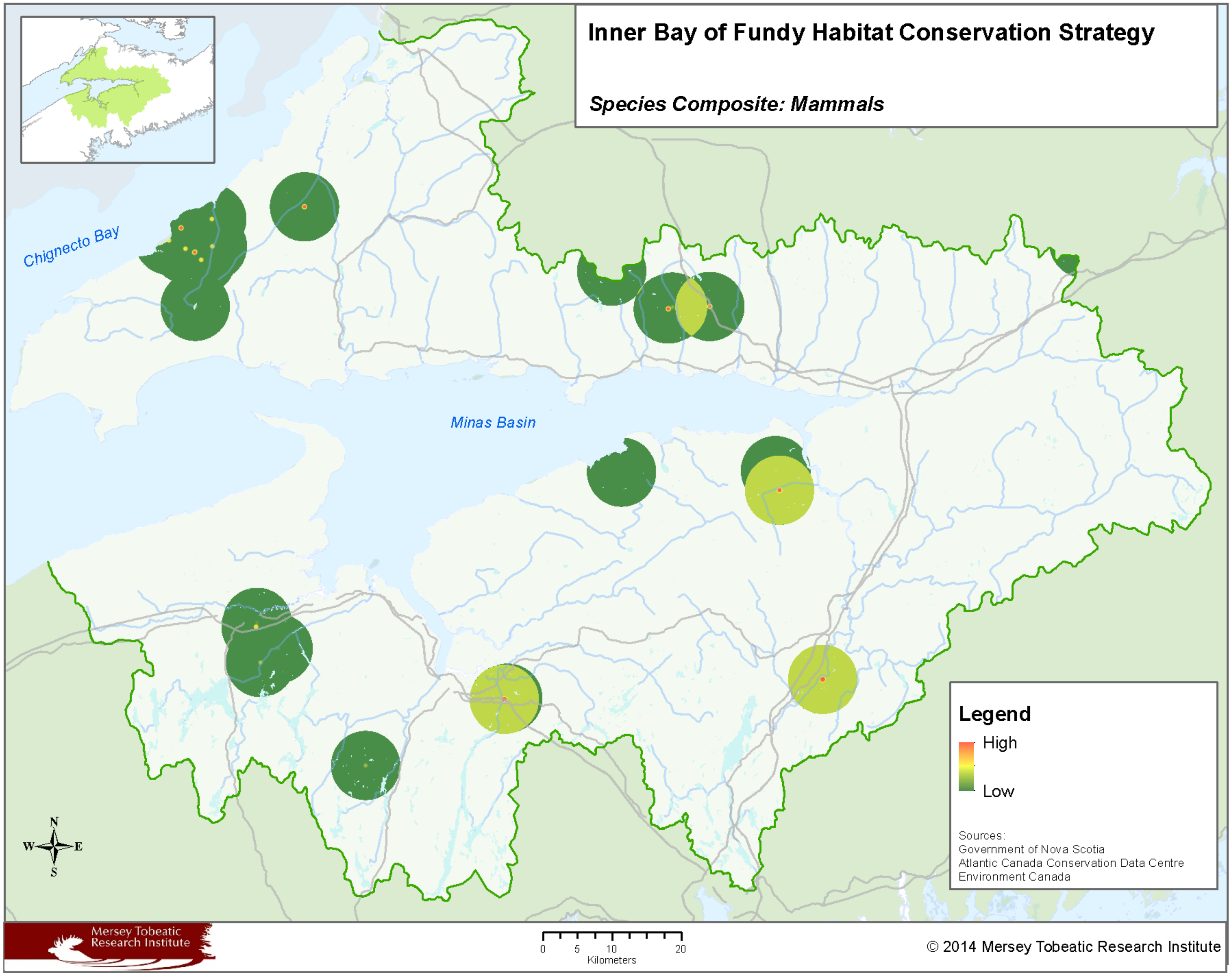

Figure 31. Species composite for priority mammal species in the Nova Scotia Inner Bay of Fundy bioregion.

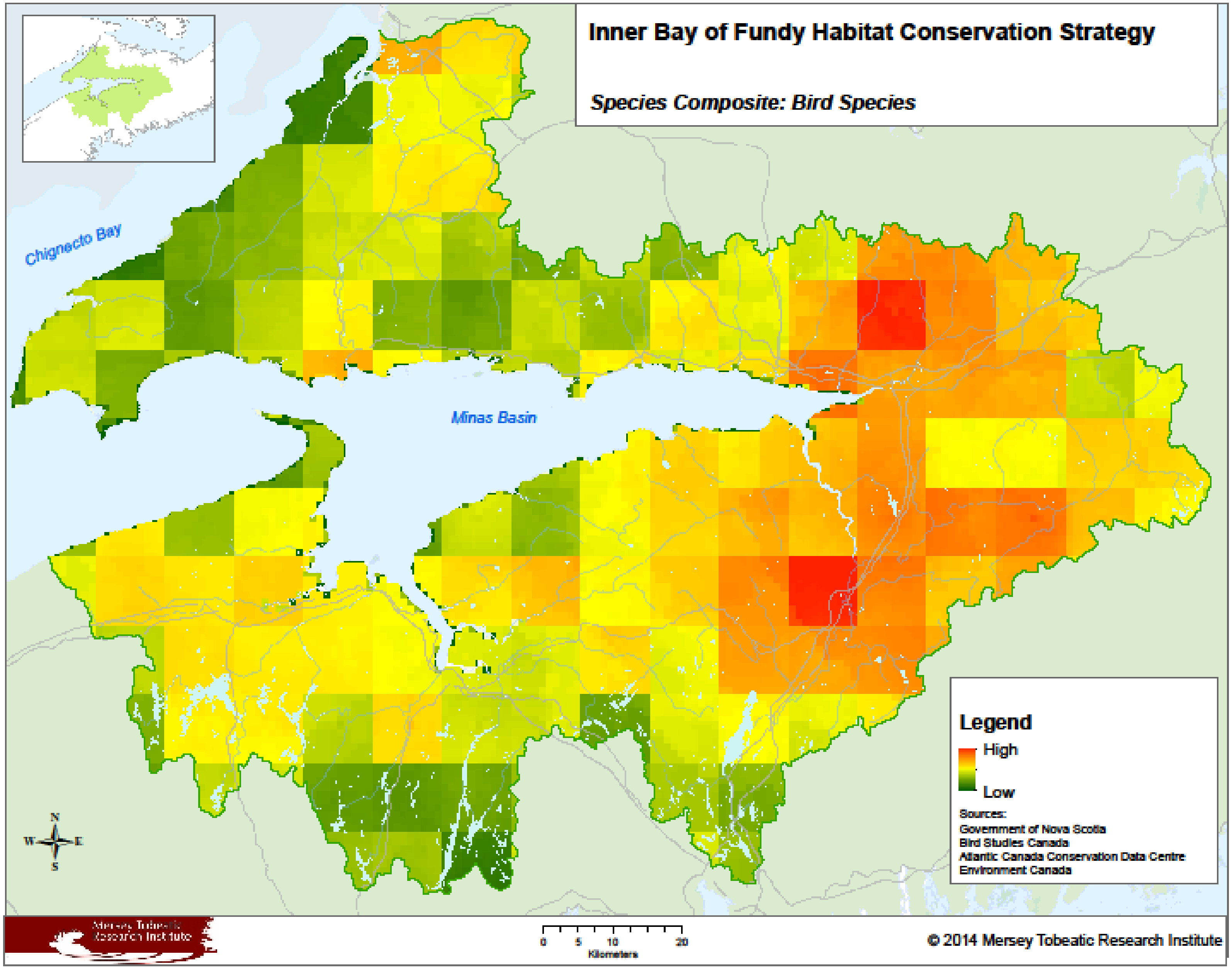

Figure 32. Species composite for priority bird species (breeding evidence and relative abundance) in the Nova Scotia IBoF bioregion.

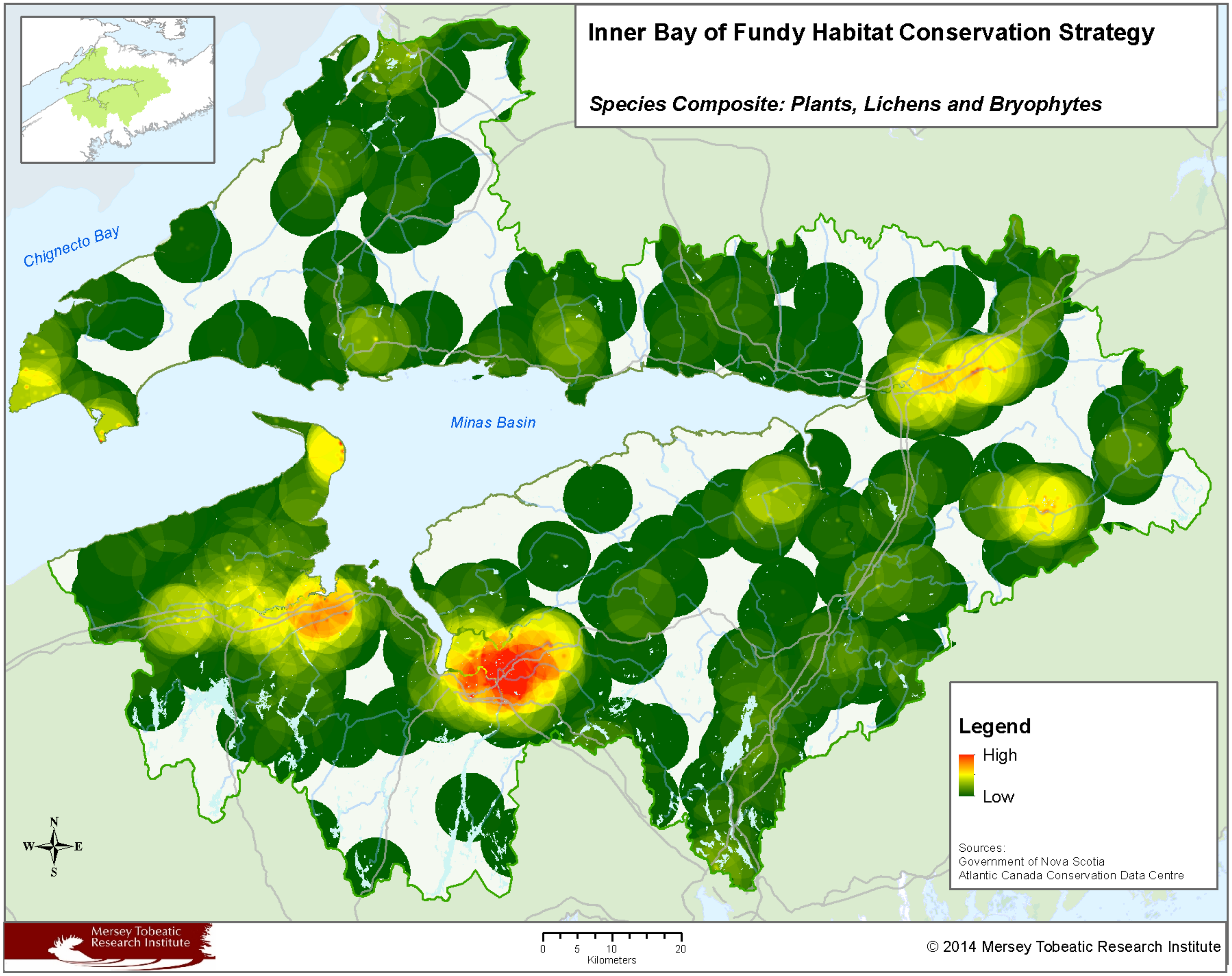

Figure 33. Species composite for priority plant, lichen and bryophyte species in the Nova Scotia Inner Bay of Fundy bioregion.

iii. Conservation Value Index

The scores generated through development of the priority habitat composite and the priority species composite (using the full list of priority species) were combined to yield a conservation value index for the Nova Scotia Inner Bay of Fundy bioregion, presented in Figure 34. Table 15 provides a summary of the results of the conservation value index analysis and a description of the methods used to develop the CVI is provided in Appendix F.

The results of the final prioritization seem to be consistent with firsthand knowledge of conditions across the NS IBoF bioregion, although the results of this analysis should be used in combination with field visits and local knowledge. Very discernible patterns emerge with respect to the Very High and High priority areas. These patterns should be regarded relative, and would be most appropriately used to compare the conservation priority for habitats of the same type to one another, but not the absolute ecological value or quality of a habitat. Low conservation value rank does not indicate that an area is of little conservation value; rather it is of lesser conservation value than Very High or High-ranked areas.

Table 15. Summary results of the conservation value index for the Nova Scotia Inner Bay of Fundy bioregion.

Priority Ranking	Value Interval	Area (hectares)	% of Bioregion
P1	>1	292,839	28
P2	0.8 - 1	105,620	10
P3	0.6 – 0.8	5,569	<1
Low Priority	0 – 0.6	647,972	62
Total	**N/A**	**1,052,000**	**100**

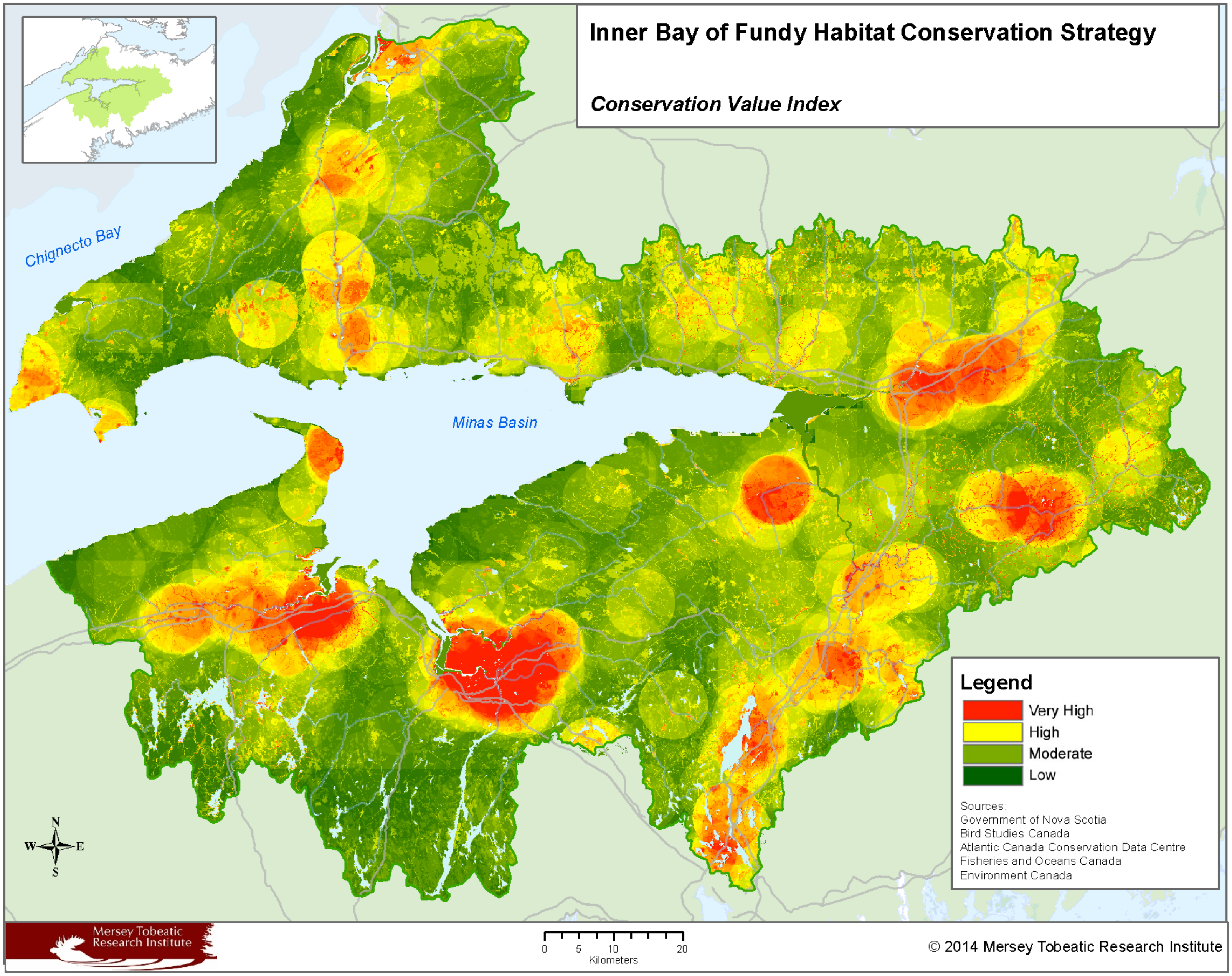

Figure 34. Conservation Value Index (CVI) for the Nova Scotia Inner Bay of Fundy bioregion.

3. CONSERVATION STRATEGY

This Habitat Conservation Strategy has been developed by partners and collaborators of the Eastern Habitat Joint Venture (EHJV) Nova Scotia Steering Committee. The purpose of this strategy is to identify the species and ecosystems of conservation priority for the Nova Scotia Inner Bay of Fundy bioregion, their spatial location, and the actions that conservation organizations plan to undertake to achieve their conservation and stewardship.

A. Goals

The conservation goals that have been identified to guide the development of the Nova Scotia Inner Bay of Fundy Habitat Conservation Strategy are:

1) Identify areas that are important for conservation priority habitats and species.
2) Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3) Maintain healthy, intact, and fully functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
4) Support the management of and protect 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, further informed by federal and provincial resources on species at risk.
6) Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7) Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

B. Conservation partners

Environment Canada – Canadian Wildlife Service
The Canadian Wildlife Service (CWS) has a mandate which focuses on migratory birds, species at risk, and their habitats, and is centered on the implementation of the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and the Federal Policy on Wetland Conservation. CWS identifies, designates and protects important habitats as National Wildlife Areas under the Canada Wildlife Act. In addition to managing National Wildlife Areas and Migratory Bird Sancuaries, CWS conducts migratory bird surveys and provides support for activities that benefit species at risk through its main funding programs, the Habitat Stewardship Program (HSP) and the Aboriginal Fund for Species at Risk (AFSAR). Additional funding resources include the HSP and AFSAR Prevention Stream (for species other than species at risk), and the National Conservation Plan – National Wetland Conservation Fund, the Gulf of Maine Initiative, and the Ecological Gifts Program. Environment Canada also funds the EcoAction Community Funding Program, the Atlantic Ecosystem Initiatives, and Environmental Damages Fund. CWS works closely with its partners in the development of recovery documents for species at risk and supports activities described within recovery documents for the completion of the schedule of studies for the identification of critical habitat. CWS supports the EHJV, and provides science guidance to conservation partners on conservation actions and priorities for migratory birds, species at risk, and their habitats, including involvement in the development, refinement, and implementation of HCSs, and the NS Bird Conservation Region 14 Strategy.

CWS shares its migratory bird survey data and expertise to inform biodiversity and habitat conservation initiatives that contribute to meeting not only the CWS mandate, but also the broader mandates and objectives of its conservation partners. CWS is supportive of the Habitat Conservation Strategy approach as it represents how species and habitat data can be compiled and assessed in ways that benefit a broader suite of conservation-oriented user-groups.

Bird Studies Canada
Bird Studies Canada (BSC) is Canada's national charitable organization dedicated to bird science, conservation, and education. Since 1967, the mission of BSC has been to advance the understanding, appreciation, and conservation of wild birds and their habitats in Canada and elsewhere, through studies that engage the skills, enthusiasm, and support of members, volunteers, and the interested public. In addition to engaging roughly 30,000 volunteer "Citizen Scientists" per year, BSC's work is facilitated and supported by federal, provincial, industry, and other NGO partnerships. In the Atlantic region, BSC's programs focus on bird population monitoring, species at risk, and their associated habitats. Of particular interest to the NS IBoF bioregion, BSC coordinates with citizens and other conservation organizations to monitor and promote stewardship of roost and nest sites of Chimney Swifts (Maritimes Swiftwatch, 2010-present).

The Nature Conservancy of Canada
The Nature Conservancy of Canada (NCC) is the nation's leading land conservation organization, working to protect our most important natural areas and the species they sustain. Since 1962 NCC and its partners have helped to protect more than 1 million ha across Canada. NCC has been protecting land in Nova Scotia since 1971 and has worked with individuals and communities to protect more than 13,142 ha in 43 projects across the province. The NCC has secured approximately 262 ha of coastal and inland wilderness in the NS IBoF bioregion.

Nova Scotia Nature Trust
The Nova Scotia Nature Trust (NSNT) is a conservation charity that works with private landowners to conserve ecologically significant habitat within Nova Scotia through securement and conservation easements. The NSNT's currently protects approximately 369 ha of coastal wilderness, critical freshwater habitats, karst topography, old-growth forests, and habitat for species at risk in the bioregion.

Mersey Tobeatic Research Institute (MTRI)
The Mersey Tobeatic Research Institute (MTRI) is a non-profit co-operative with a mandate to promote sustainable use of natural resources and biodiversity conservation in the Southwest Nova Biosphere Reserve and beyond through research, education, and the operation of a field station. MTRI has a diversity of projects in the bioregion from species at risk research to landscape and aquatic connectivity.

The Atlantic Canada Conservation Data Centre (AC CDC)
The ACCDC enhances data management and information on biodiversity in the region through the maintenance of the most comprehensive and current database on the distribution of biological diversity in Atlantic Canada. The ACCDC database includes more than 1,030,000 geo-located records of species occurrences, over 186,000 of which represent species of conservation concern, and reresents the single most comprehensive and current source of information regarding the distribution of Atlantic Canada's biodiversity. They also conduct biological surveys in areas of high biodiversity significance to further understanding of rare species' status and distribution.

Ducks Unlimited Canada (DUC)
Land protection is a critical tool by which Ducks Unlimited conserves waterfowl habitat throughout North America. DU protects land through several means including acquisitions, conservation easements and revolving lands strategy: 1) Land acquisition - In special cases, where intact waterfowl habitat is at imminent risk, DU may seek to acquire the property. Once purchased, the habitat is restored & conservation easements are placed on the land to perpetually protect its resource values; 2) Easements - Conservation easements can meet the needs of interested owners of working farms, ranches, timberlands, sporting properties and recreational lands, who wish to protect valuable natural resources while retaining ownership of the property; and 3) Revolving land - In locations where wildlife habitat has been degraded & the land is for sale, DU will seek to acquire it. Once purchased, the habitat will be restored and easements will be placed on land to perpetually protect resource values. DUC aims to develop initiatives to conserve existing coastal areas to protect molting, staging and wintering habitat; to maintain diverse habitat quality and quantity needed to sustain current breeding waterfowl numbers; to develop new initiatives that address problems of survival and recruitment of sea ducks; and to acquire wetland inventories and more complete waterfowl surveys to focus conservation programs.

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 NS IBoF 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 NS IBoF 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 NS IBoF 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 Nova Scotia Inner Bay of Fundy bioregion's conservation priority habitats and species. Table 16 identifies which organizations and government agencies are working to conserve priority habitats and species in the NS IBoF 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 16. Conservation actions and associated information for conservation partners in the Nova Scotia Inner Bay of Fundy bioregion.

Conservation Actions[1] **Description of related action (specific and measurable if possible)**	**Collaborators**	**Importance[2] /Associated Conservation Goals**	**Date for Completion**	**Priority Habitat(s)[3]**	**Primary Related Threat(s)**
1. Land/Water Protection					
1.1 Site/Area Protection Contribute to Marine Protected Area Network planning within the Scotian Shelf marine bioregion, and to the identification and description of Ecologically and Biologically Significant Areas and other habitat classification schemes that contribute towards the goal of protecting 10% of coastal and marine areas by 2020.	DFO EC PC	Necessary	2020	Beaches and Dunes, Tidal Marshes, Tidal Flats, Coastal Islands	

[1] *Categories based on IUCN – CMP Unified Classification of Conservation Actions Needed (Version 2.0). Actions and MOS are not listed in order of importance.*

[2] *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.*

[3] *Priority Habitats: Beaches and Dunes, Tidal Marshes, Tidal Flats, Coastal Islands, Freshwater Wetlands, Acadian Forest Mosaic, Riparian and Floodplain Systems, Grasslands/Agro-ecosystems, Barrens.*

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Associated Conservation Goals	Date for Completion	Priority Habitat(s)[3]	Primary Related Threat(s)
1.1 Site/Area Protection Province of Nova Scotia to designate 68 000 ha of new protected areas under the 14% Protected Areas Initiative.	Province of NS	Necessary	2025	Acadian Forest Mosaic	
1.1 Site/Area Protection Complete a gap analysis for the system of protected areas in the province.	Province of NS	Beneficial		All	
1.1 Site/Area Protection Continue to locate, map and assess potential old growth stands on private and public lands using adaptations of the NSDNR's old forest scoring methods to refine parcel prioritization, inform conservation efforts, and help maintain old forests and associated biodiversity for landscape connectivity according to Nova Scotia's Old Forest Policy.	MTRI NSDNR NCC	Necessary	Ongoing	Acadian Forest Mosaic	
2. Land/Water Management					
2.1 Site/Area Management Inform and implement the North American Waterfowl Management Plan (NAWMP) and conduct waterfowl surveys as required by the plan.	EC EHJV USFWS USGS	Necessary	Ongoing	Tidal Marshes, Tidal Flats, Freshwater Wetlands, Grasslands, Riparian and Floodplain Systems	
2.1 Site/Area Management Implement management plans for Chignecto-John Lusby Marsh and Boot Island National Wildlife Areas, and Amherst Point and Kentville Migratory Bird Sanctuaries.	EC	Necessary	Ongoing	Beaches and Dunes, Tidal Marshes, Tidal Flats, Coastal Islands, Acadian Forest Mosaic, Freshwater Wetlands, Riparian and Floodplain Systems, Barrens	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Associated Conservation Goals	Date for Completion	Priority Habitat(s)[3]	Primary Related Threat(s)
2.1 Site/Area Management Complete ecological risk assessments to assess threats to species and ecosystems within existing and proposed protected areas. Create a spatial layer of sensitive habitats and ecosystems to aid in planning and an action plan for protected area managers.	Province of NS	Beneficial		All	
2.1 Sire/Area Management Work collaboratively with partners and neighbours to manage NCC 625 acres of conservation lands in the region, including the development of management plans and baseline inventories, and undertake priority site management activities. Monitor key threats, and where possible, take direct action to mitigate threats posing an imminent impact to conservation priority habitats.	NCC	Necessary	Ongoing		
2.1 Site/Area Management Create baseline reports and management plans for all properties formally protected by NSNT in the bioregion. Manage protected sites for biodiversity conservation through regular monitoring and stewardship activities.	NSNT	Necessary	Ongoing	Beaches and Dunes, Tidal Marshes, Tidal Flats, Coastal Islands, Freshwater Wetlands, Riparian and Floodplain Systems	
2.1 Site/Area Management Conduct landscape connectivity analysis in the Chignecto Isthmus region with results to be communicated with relevant decision makers and planners.	NCC	Beneficial	2018	All	
2.1 Site/Area Management Assess air quality and climate change using lichens within permanent sample plots.	Province of NS	Beneficial	Ongoing	Acadian Forest Mosaic, Riparian and Floodplain Systems	9.5.1 Air pollution and acid

Conservation Actions[1] **Description of related action (specific and measurable if possible)**	**Collaborators**	**Importance**[2] **/Associated Conservation Goals**	**Date for Completion**	**Priority Habitat(s)**[3]	**Primary Related Threat(s)**
					precipitation 11 Climate Change
2.2 Invasive/Problematic Species Control Establish a structure to facilitate collaboration and strategic decision making regarding invasive species control techniques (e.g., Invasive Species Alliance).	NCC MTRI	Beneficial	2020	All	8.1 Invasive non-native/alien species/diseases
3. Species Management					
3.1 Species Management Continue to work together through the coordination of volunteers and partners in shorebird monitoring (including threat monitoring), staging habitat protection (e.g., addressing threats at roosting sites), and stewardship at sites adjacent tidal flats of NS IBoF, including joint monitoring collaborations, outreach, and volunteer celebration events.	BSC EC PC	Necessary	Ongoing	Beaches and Dunes	6.1.1 Recreational beach use
3.1 Species Management Engage with international partners in shorebird conservation to improve information sharing.	BSC	Beneficial	Ongoing		
3.1 Species Management Continue to systematically monitor population levels of Chimney Swift at known roost sites through a citizen-science monitoring and conservation program that brings together volunteers and community groups to act as stewards for Chimney Swift and their habitat, to advance knowledge of nesting ecology, and to increase awareness of this species at risk in the	MTRI BSC EC	Necessary	Ongoing		

Conservation Actions[1] **Description of related action (specific and measurable if possible)**	**Collaborators**	**Importance**[2] **/Associated Conservation Goals**	**Date for Completion**	**Priority Habitat(s)**[3]	**Primary Related Threat(s)**
Maritimes. Continue to solicit the public for sightings of Chimney Swift and Chimney Swift nest locations.					
3.2 Species Recovery Engage and consult with all partners in the development of SAR recovery documents, and support the activities described within recovery documents for the schedule of studies for SAR and the identification of their critical habitat within the NS IBoF bioregion.	EC, NSDNR, Academic Institutions, NSNT, NCC, MTRI	Necessary	Ongoing	All	
4. Education and Awareness					
4.3 Awareness and Communications Update EC website regarding NCP Connecting Canadians to Nature, SAR, EC protected areas. Partner in biodivcanada.ca website, and adhere to biodiversity goals and targets for 2020 within the Canadian Biodiversity Strategy.	EC Province of NS	Beneficial	Ongoing		
4.3 Awareness and Communications Address habitat threats through the education and engagement of stakeholders, landowners, and landusers.	NSNT	Beneficial	Ongoing		
4.3 Awareness and Communications Engage in partnerships with agricultural producers and practitioners to improve the conservation and restoration of wetland habitat in the agricultural landscape, primarily through the promotion and delivery of Agricultural Biodiversity Conservation (ABC) Plans, which allow farmers to clearly identify existing and potential Beneficial Management Practices (BMP's) that will promote the	EHJV	Necessary	Ongoing	Freshwater Wetlands, Grasslands	2.1.1 Incompatible agricultural practices

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Associated Conservation Goals	Date for Completion	Priority Habitat(s)[3]	Primary Related Threat(s)
maintenance or enhancement of biodiversity on farms.					
4.3 Awareness and Communications Continue to maintain the Nova Scotia Bat Conservation website www.batconservation.ca and engage the public on bat conservation issues. Increase public awareness of White Nose Syndrome in Nova Scotia bats and promote the proper use of bat houses through the Backyard Biodiversity project.	MTRI, NSDNR, Saint Mary's University, Canadian Cooperative Wildlife Health Centre	Necessary	Ongoing		
5. Law and Policy					
5.1.2 Legislation (National level) Implement the Migratory Bird Convention Act (MBCA), Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA), Species at Risk Act (SARA), Canadian Environmental Protection Act (CEPA), Canada Wildlife Act (CWA), Environmental Enforcement Act (EEA), Canadian Environmental Assessment Act (CEAA), Fisheries Act (water pollution).	EC DFO	Necessary	Ongoing		
5.1.3 Legislation (Sub-national level) Participate in the review and update of the *Nova Scotia Mineral Resources Act* and seek appropriate mechanisms for resolution of conflicts between private conservation lands and sub-surface rights.	NCC NSNT	Beneficial	2016		3.2.1 Mining and quarrying
5.2 Policies and Regulations Implement the federal policy on wetland conservation.	EC	Necessary	Ongoing	Tidal Marshes, Tidal Flats, Freshwater Wetlands, Riparian and	

Conservation Actions[1] **Description of related action (specific and measurable if possible)**	**Collaborators**	**Importance[2] /Associated Conservation Goals**	**Date for Completion**	**Priority Habitat(s)[3]**	**Primary Related Threat(s)**
				Floodplain Systems	
5.2 Policies and Regulations Collaborate with the Province of Nova Scotia and other stakeholders regarding changes to the *Code of Forest Practice for Crown Land*.	MTRI	Beneficial	Ongoing	Acadian Forest Mosaic	5.3.1 Forest harvesting practices
5.2 Policies and Regulations Share generated spatial data and mapping with landuse planning decision makers, and participate in landuse planning stakeholder consultations to influence planning that impacts the Acadian Forest and other priority habitats.	NCC MTRI other eNGOs	Beneficial	Ongoing	All	
5.4 Compliance and Enforcement Undertake wildlife and environmental enforcement activities (EC Wildlife Enforcement, Environmental Enforcement); address illegal hunting and disturbance, illegal activities and habitat destruction	EC Province of NS	Necessary	Ongoing	All	
6. Livelihood, Economic, and Other Incentives					
6.3 Market Forces Continue to assist small woodland owners in Nova Scotia IBoF to certify their woodlands under one collective Forest Stewardship Council (FSC) group certification and provide training and education opportunities as a tool for woodlot owner engagement and to support sustainable woodland management. Continue research to explore awareness and attitudes of forest product consumers, and to investigate marketing strategies to support locally produced forest products.	MTRI FNSWO	Beneficial	Ongoing	Acadian Forest Mosaic	5.3.1 Forest Harvesting Practices
6.4 Conservation Payments	EC	Necessary	Ongoing	All	

Conservation Actions[1] **Description of related action (specific and measurable if possible)**	**Collaborators**	**Importance[2] /Associated Conservation Goals**	**Date for Completion**	**Priority Habitat(s)[3]**	**Primary Related Threat(s)**
Implement and encourage the use of EC Ecological Gifts (Ecogifts) program.	NCC NSNT				
6.5 Non-monetary Values Explore the opportunity to develop an incentive program that provides recognition for woodlot owners that promotes sustainable harvesting and protection of biodiversity on woodlots.	NCC	Beneficial	2018	Acadian Forest Mosaic	5.3.1 Forest harvesting practices
7. External Capacity Building					
7.1 Institutional and Civil Society Development Provide EC-CWS support and input into the development of Habitat Conservation Strategies.	EC, NCC, MTRI, NSNT, DUC, Province of NS, BSC, ACCDC, watershed groups, municipalities	Necessary	Ongoing	All	
7.2 Alliance and Partnership Development Provide EC-CWS input into: Staying Connected Initiative, Western Hemispheric Shorebird Reserve Network, Important Bird Areas.	EC, NCC, MTRI, NSNT, DUC, Province of NS, BSC, ACCDC, International ENGOs, other government agencies, watershed groups, municipalities,	Beneficial	Ongoing	All	

Conservation Actions[1] Description of related action (specific and measurable if possible)	Collaborators	Importance[2] /Associated Conservation Goals	Date for Completion	Priority Habitat(s)[3]	Primary Related Threat(s)
7.2 Alliance and Partnership Development Assess the feasibility of establishing a consortium of conservation interests operating in Nova Scotia to provide a platform for collaboration and communication, information exchange, and high level strategy and planning on key issues.	EC Province of NS NCC MTRI NSNT	Beneficial	2016		
7.3 Conservation Finance Communicate, inform, and increase awareness related to funding opportunities for conservation: North American Wetland Conservation Act (NAWCA)/Eastern Habitat Joint Venture (EHJV), North Atlantic Landscape Conservation Cooperative (NALCC); National Conservation Plan (NCP): Atlantic Ecosystems Initiative (AEI), Habitat Stewardship Program (HSP), Aboriginal Fund for Species at Risk (AFSAR), National Wetland Conservation Fund (NWCF).	EC US Federal and State partners	Necessary	Ongoing	All	
7.3 Conservation Finance Implement and encourage the use of EC Ecological Gifts (Ecogifts) program.	EC NCC NSNT	Necessary	Ongoing	All	
7.3 Conservation Finance Continue to engage longstanding/key funding partners to support conservation work in the NS IBoF bioregion.	NCC MTRI NSNT ENGOs	Necessary	Ongoing	All	

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Appendices

Appendix A. List of Abbreviations

Acronyms	Title
ACCDC	Atlantic Canada Conservation Data Centre
BCR	Bird Conservation Region
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Department of Fisheries and Oceans (Fisheries and Oceans Canada)
EGSPA	Environmental Goals and Sustainable Prosperity Act
EHJV	Eastern Habitat Joint Venture
HCP	Habitat Conservation Strategy
HF	Human Footprint
IBA	Important Bird Area
IBoF	Inner Bay of Fundy
IUCN	International Union for Conservation of Nature
LCI	Landscape Context Index
MBBA	Maritime Breeding Bird Atlas
MBU	Marine Biogeographic Unit
MCPS	Minimum Critical Patch Size
NAAP	Northern Appalachian - Acadian Ecoregional Plan
NBDNR	New Brunswick Department of Natural Resources
NCC	Nature Conservancy of Canada
NS	Nova Scotia
NSDNR	Nova Scotia Department of Natural Resources
NS ESA	Nova Scotia Endangered Species Act
NSNT	Nova Scotia Nature Trust
NS PAP	Our Parks and Protected Areas: A Plan for Nova Scotia
OHV	Off-Highway Vehicle
Pers. comm.	Personal Communication
SARA	Species at Risk Act
WCSC	Wildlife Conservation Society Canada
WHSRN	Western Hemisphere Shorebird Reserve Network
WNS	White Nose Syndrome

Appendix B. Glossary of Biodiversity and Conservation Ranks

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

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

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

***Species at Risk Act* (SARA):** proclaimed in 2003, the federal legislation that is designed to prevent wildlife species, subspecies, and distinct populations from becoming extirpated or extinct, provide for the recovery of extirpated, endangered or threatened species, and ensure that species of special concern do not become endangered or threatened. Once a species is listed, the provisions under SARA apply to protect and recover the species.

***Nova Scotia Endangered Species Act* (NS ESA):** the provincial legislation that protects species in Nova Scotia that have been assessed and determined to be at risk of extinction. The Act was proclaimed in 1999 and was one of the first provincial endangered species acts in Canada. There are 59 species that are legally listed under the act. The NS ESA assigns the following status to species:

Status Category	Definition
Endangered (EN)	A species facing imminent extirpation or extinction.
Threatened (TH)	A species likely to become endangered if limiting factors are not reversed.
Vulnerable (VU)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Extirpated (EXP)	A species that no longer existing in the wild in the Province but exists in the wild outside of the Province.
Extinct (EXT)	A species that no longer exists.

Appendix B: Glossary of Biodiversity and Conservation Ranks

Rarity Ranks

Sub-national (Provincial) Rank (S-RANK): sub-national conservation status assessments are generally carried out by Canadian Data Centre (CDC) scientists with input from federal and provincial experts on particular taxonomic groups, and are based on a combination of quantitative and qualitative information. Provincial ranks are used by CDCs and Nature Serve programs to set conservation priorities for rare species and vegetation communities and are not legal designations. Comparison of global and provincial ranks gives an indication of the status and rarity of an element in that province in relation to its overall conservation status, therefore providing insight into the urgency of conservation action for it in the province.

Subnational 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# S#B S#N	**Range Rank**—A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4). **Breeding** (Migratory species) **Non-breeding** (Migratory species)

Appendix B: Glossary of Biodiversity and Conservation Ranks

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

Global Conservation Status Ranks

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.
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
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.

Appendix C. Priority Species—Conservation Ranks and Coarse Resolution Habitat Associations

This appendix provides a list of priority species for the Nova Scotia Inner Bay of Fundy bioregion. The basis of this list is primarily a subset of the Atlantic Canada Data Centre (ACCDC) database, Bird Studies Canada (BSC) rare and colonial birds database (2006-2010) and the Canada Wildlife Service colonial/migratory species dataset. Species occurrence records were refined to include only sightings recorded for species with a provincial rank of S1, S2, or S3 (with a global rank of G1, G2, or G3), or that are federally assessed (COSEWIC) or provincially listed (NS ESA) species at risk. Also included are the BCR 14 and MBU 12 priority bird species due to their importance to partners, which are not restricted to S1-S3 rankings. Appendix B provides a glossary of biodiversity and conservation ranks.

		Conservation Status Ranks						Coarse Resolution Habitat Associations									
Common Name	***Scientific Name***	**COSEWIC[1]**	**SARA[2]**	**NS ESA[3]**	**Global (G) Rank**	**Sub-national (S) Rank**	**CWS Priority Bird Species[4]**	**Coastal Beaches & Cliffs**	**Salt Marshes**	**Tidal Flats**	**Coastal Islands**	**Barrens**	**Caves & Calcareous Sites**	**Aquatic & Riparian Systems**	**Rock cliffs, outcrops & talus**	**Freshwater Wetlands**	**Acadian Forest Mosaic**
INVERTEBRATES		**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**14**	**-**	**13**	**14**
Arctic Fritillary	*Boloria chariclea*				G5	S2										X	X
Banded Hairstreak	*Satyrium calanus*				G5	S2											X
Bog Elfin	*Callophrys lanoraieensis*				G3G4	S1S2										X	
Bronze Copper	*Lycaena hyllus*				G4G5	S1										X	
Brook Floater	*Alasmidonta varicosa*	SC	SC	TH	G3	S1S2								X			
Brook Snaketail	*Ophiogomphus aspersus*				G4	S1								X			
Common Roadside Skipper	*Amblyscirtes vialis*				G5	S2								X			X
Compton Tortoiseshell	*Nymphalis vaualbum j-album*				G5T5	S1S2											X
Delicate Emerald	*Somatochlora franklini*				G5	S1										X	
Eastern Comma	*Polygonia comma*				G5	S2										X	X
Eastern Lampmussel	*Lampsilis radiata*				G5	S2								X			

		Conservation Status Ranks						Coarse Resolution Habitat Associations									
Common Name	***Scientific Name***	**COSEWIC[1]**	**SARA[2]**	**NS ESA[3]**	**Global (G) Rank**	**Sub-national (S) Rank**	**CWS Priority Bird Species[4]**	**Coastal Beaches & Cliffs**	**Salt Marshes**	**Tidal Flats**	**Coastal Islands**	**Barrens**	**Caves & Calcareous Sites**	**Aquatic & Riparian Systems**	**Rock cliffs, outcrops & talus**	**Freshwater Wetlands**	**Acadian Forest Mosaic**
Eastern Pine Elfin	*Callophrys niphon*				G5	S2											X
Ebony Boghaunter	*Williamsonia fletcheri*				G4	S1										X	
Henry's Elfin	*Callophrys henrici*				G5	S2						X				X	X
Hoary Comma	*Polygonia gracilis*				G5	S1											X
Jutta Arctic	*Oeneis jutta*				G5	S1										X	
Juvenal's Duskywing	*Erynnis juvenalis*				G5	S2S3										X	X
Kennedy's Emerald	*Somatochlora kennedyi*				G5	S1S2										X	
Maine Snaketail	*Ophiogomphus mainensis*				G4	S1								X			X
Milbert's Tortoiseshell	*Aglais milberti*				G5	S2								X		X	
Monarch	*Danaus plexippus*	SC	SC		G5	S2B											
Mustard White	*Pieris oleracea*				G4G5	S2										X	X
Northern Cloudywing	*Thorybes pylades*				G5	S2											
Orange Bluet	*Enallagma signatum*				G5	S1								X			
Pepper and Salt Skipper	*Amblyscirtes hegon*				G5	S2								X			X
Prince Baskettail	*Epitheca princeps*				G5	S2								X			
Quebec Emerald	*Somatochlora brevicincta*				G4	S1											X
Rusty Snaketail	*Ophiogomphus rupinsulensis*				G5	S1S2								X			
Skillet Clubtail	*Gomphus ventricosus*	EN	EN		G3	S1								X			
Spot-Winged Glider	*Pantala hymenaea*				G5	S2B											

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	CWS Priority Bird Species[4]	Coastal Beaches & Cliffs	Salt Marshes	Tidal Flats	Coastal Islands	Barrens	Caves & Calcareous Sites	Aquatic & Riparian Systems	Rock cliffs, outcrops & talus	Freshwater Wetlands	Acadian Forest Mosaic
Taiga Bluet	*Coenagrion resolutum*				G5	S1										X	
Tidewater Mucket	*Leptodea ochracea*				G3G4	S1								X			
Triangle Floater	*Alasmidonta undulata*				G4	S2S3								X			
Zebra Clubtail	*Stylurus scudderi*				G4	S1S2								X			X
FISHES		4	1	-	-	-	-	-	-	-	-	-	-	4	-	-	-
American Eel	*Anguilla rostrata*	TH			G4	S5								X			
Atlantic Salmon – Inner Bay of Fundy population	*Salmo salar*	EN	EN		G5TNR	S2								X			
Atlantic Sturgeon	*Acipenser oxyrinchus*	TH			G3	S1?								X			
Striped Bass – Bay of Fundy population	*Morone saxatilis*	EN			G5	S1								X			
BIRDS		**19**	**13**	**13**	**-**	**-**	**78**	**20**	**20**	**22**	**17**	**14**	**1**	**29**	**1**	**39**	**36**
American Bittern	*Botaurus lentiginosus*				G4	S3S4B	X		X							X	
American Black Duck	*Anas rubripes*				G5	S5	X		X					X		X	
American Coot	*Fulica americana*				G5	S1B				X				X		X	
American Golden-Plover	*Pluvialis dominica*				G5	S3M	X	X		X	X	X					
American Redstart	*Setophaga ruticilla*				G5	S5B	X					X		X		X	X
American Woodcock	*Scolopax minor*				G5	S4S5B	X					X					X
Bald Eagle	*Haliaeetus leucocephalus*				G5	S4	X	X	X		X			X			
Baltimore Oriole	*Icterus galbula*				G5	S2S3B								X			X

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	CWS Priority Bird Species[4]	Coastal Beaches & Cliffs	Salt Marshes	Tidal Flats	Coastal Islands	Barrens	Caves & Calcareous Sites	Aquatic & Riparian Systems	Rock cliffs, outcrops & talus	Freshwater Wetlands	Acadian Forest Mosaic
Bank Swallow	*Riparia riparia*	TH			G5	S3B	X	X			X		X	X	X		
Barn Swallow	*Hirundo rustica*	TH		EN	G5	S3B	X									X	
Bay-breasted Warbler	*Dendroica castanea*				G5	S3S4B	X							X			X
Belted Kingfisher	*Megaceryle alcyon*				G5	S5B	X	X						X			
Bicknell's Thrush	*Catharus bicknelli*	TH	SC	EN	G4	S1S2B	X										X
Black-bellied Plover	*Pluvialis squatarola*				G5	S4M	X			X							
Black Tern	*Chlidonias niger*				G4	S1B										X	
Black-and-white Warbler	*Mniotilta varia*													X			X
Black-billed Cuckoo	*Coccyzus erythropthalmus*				G5	S3?B	X										X
Blackburnian Warbler	*Setophaga fusca*				G5	S4B	X										X
Black-legged Kittiwake	*Rissa tridactyla*				G5	S2BS4 S5N	X				X						
Black-throated Green Warbler	*Setophaga virens*				G5	S4S5B	X									X	
Blue-headed Vireo	*Vireo solitarius*				G5	S5B	X									X	
Bobolink	*Dolichonyx oryzivorus*	TH		VU	G5	S3S4B	X		X			X				X	
Boreal Chickadee	*Poecile hudsonica*				G5	S3	X	X									X
Boreal Owl	*Aegolius funereus*				G5	S1B											
Brown Thrasher	*Toxostoma rufum*				G5	S1?B						X					X
Brown-headed Cowbird	*Molothrus ater*				G5	S2S3B											

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Canada Goose	*Branta canadensis*				G5	SNABS 4N	X		X	X				X		X	
Canada Warbler	*Cardellina canadensis*	TH	TH	EN	G5	S3B	X									X	X
Cape May Warbler	*Setophaga tigrina*				G5	S3?B	X										X
Chimney Swift	*Chaetura pelagica*	TH	TH	EN	G5	S2S3B	X									X	X
Common Eider	*Somateria mollissima*				G5	S4	X	X			X						
Common Goldeneye	*Bucephala clangula*				G5	S2BS5 N	X			X				X			
Common Loon	*Gavia immer*				G5	S3BS4 N	X			X				X			
Common Moorhen	*Gallinula chloropus*				G5	S1B								X		X	
Common Nighthawk	*Chordeiles minor*	TH	TH	TH	G5	S3B	X	X				X				X	X
Common Tern	*Sterna hirundo*				G5	S3B	X	X	X	X	X			X			
Cooper's Hawk	*Accipiter cooperii*				G5	S1?BS NAN											X
Dunlin	*Calidris alpina*				G5	S4M	X			X							
Eastern Kingbird	*Tyrannus tyrannus*				G5	S3S4B	X					X		X		X	
Eastern Meadowlark	*Sturnella magna*	TH			G5	S1B						X					
Eastern Whip-poor-will	*Caprimulgus vociferus*	TH	TH	TH	G5	S2?B	X										X
Eastern Wood-Pewee	*Contopus virens*	SC		VU	G5	S3S4B	X										X

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Evening Grosbeak	*Coccothraustes vespertinus*				G5	S4BS5 N	X										X
Gadwall	*Anas strepera*				G5	S2B								X		X	
Gray Catbird	*Dumetella carolinensis*				G5	S3B	X							X			
Gray Jay	*Perisoreus canadensis*				G5	S3S4	X									X	X
Great Cormorant	*Phalacrocorax carbo*				G5	S3	X	X			X						
Great Crested Flycatcher	*Myiarchus crinitus*				G5	S2B											X
Green-winged Teal	*Anas crecca*				G5	S4S5B	X							X		X	
Horned Lark	*Eremophila alpestris*				G5	S1S2B S4N											
Hudsonian Godwit	*Limosa haemastica*				G4	S3M	X		X	X	X						
Hudsonian Whimbrel	*Numenius phaeopus hudsonicus*				G5TNR	S3M	X	X	X	X	X	X					
Indigo Bunting	*Passerina cyanea*				G5	S1S2B						X					X
Killdeer	*Charadrius vociferus*				G5	S3S4B	X	X			X					X	
Least Bittern	*Ixobrychus exilis*	TH	TH		G5	SNRB			X							X	
Least Sandpiper	*Calidris minutilla*				G5	S1BS5 M	X		X	X	X						
Lesser Yellowlegs	*Tringa flavipes*				G5	S5M	X		X	X						X	
Long-eared Owl	*Asio otus*				G5	S2						X					X
Long-tailed Duck	*Clangula hyemalis*				G5	S4N	X										

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Magnolia Warbler	*Dendroica magnolia*				G5	S5B	X										X
Mallard	*Anas platyrhynchos*				G5	S5	X		X					X		X	
Marsh Wren	*Cistothorus palustris*				G5	S1B			X							X	
Mourning Warbler	*Geothlypis philadelphia*				G5	S4B	X										X
Nelson's Sparrow	*Ammodramus nelsoni*				G5	S4B	X		X							X	
Northern Parula	*Setophaga Americana*				G5	S5B	X							X		X	X
Northern Pintail	*Anas acuta*				G5	S2B			X							X	
Northern Shoveler	*Anas clypeata*				G5	S2B			X					X		X	
Olive-sided Flycatcher	*Contopus cooperi*	TH	TH	TH	G4	S3B	X									X	X
Peregrine Falcon (anatum/tundrius ssp.)	*Falco peregrinus anatum/tundrius*	SC	SC	VU	G4T4	S1B	X	X			X			X			
Philadelphia Vireo	*Vireo philadelphicus*				G5	S2?B											X
Pied-billed Grebe	*Podilymbus podiceps*				G5	S3B	X							X		X	
Pine Grosbeak	*Pinicola enucleator*				G5	S3?BS5N	X										X
Piping Plover (melodus ssp.)	*Charadrius melodus melodus*	EN	EN	EN	G3TNR	S1B	X	X		X							
Purple Finch	*Carpodacus purpureus*				G5	S4S5	X										X
Purple Martin	*Progne subis*				G5	S1B											
Purple Sandpiper	*Calidris maritima*				G5	S3N	X	X									
Red Knot (rufa ssp.)	*Calidris canutus rufa*	EN	EN	EN	G4T1	S2S3M	X		X	X	X						

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Red Phalarope	*Phalaropus fulicarius*				G5	S2S3M	X			X							
Red-necked Phalarope	*Phalaropus lobatus*				G4G5	S2S3M	X			X							
Red-throated Loon	*Gavia stellata*				G5	S4N	X			X							
Ring-billed Gull	*Larus delawarensis*				G5	S1?BS 5N											
Ring-necked Duck	*Aythya collaris*				G5	S5B	X							X		X	
Ruffed Grouse	*Bonasa umbellus*				G5	S4S5	X										X
Ruddy Duck	*Oxyura jamaicensis*				G5	S1B, S4N											
Rusty Blackbird	*Euphagus carolinus*	SC	SC	EN	G4	S2S3B	X							X		X	X
Sanderling	*Calidris alba*				G5	S4MS2 N	X			X							
Savannah Sparrow (princeps ssp.)	*Passerculus sandwichensis princeps*	SC	SC		G5T2	S1B	X	X				X					
Scarlet Tanager	*Piranga olivacea*				G5	S2B											X
Semipalmated Plover	*Charadrius semipalmatus*				G5	S1S2B S5M		X	X	X	X						
Semipalmated Sandpiper	*Calidris pusilla*				G5	S3M	X	X	X	X	X						
Short-eared Owl	*Asio flammeus*	SC	SC		G5	S1S2	X	X				X				X	
Solitary Sandpiper	*Tringa solitaria*				G5	S1?BS 4, S5M	X			X				X		X	

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Sora	*Porzana carolina*				G5	S4S5B	X	X								X	
Spotted Sandpiper	*Actitis macularius*				G5	S3S4B	X	X			X			X			
Spruce Grouse	*Falcipennis Canadensis*				G5	S5	X									X	X
Surf Scoter	*Melanitta perspicillata*				G5	S5N	X										
Tree Swallow	*Tachycineta bicolor*				G5	S4B	X					X		X		X	
Turkey Vulture	*Cathartes aura*				G5	S2S3B											
Veery	*Catharus fuscescens*				G5	S4B	X									X	X
Vesper Sparrow	*Pooecetes gramineus*				G5	S2S3B											
Virginia Rail	*Rallus limicola*				G5	S2B	X									X	
Warbling Vireo	*Vireo gilvus*				G5	S1?B											
White-throated Sparrow	*Zonotrichia albicollis*				G5	S5B	X										X
White-winged Scoter	*Melanitta fusca*				G5	S5N	X										
Willet	*Tringa semipalmata*				G5	S2S3B	X		X	X	X						
Willow Flycatcher	*Empidonax traillii*				G5	S2B											
Wilson's Snipe	*Gallinago delicata*				G5	S3S4B	X							X		X	
Wood Thrush	*Hylocichla mustelina*	TH			G5	S1B											X
REPTILES		**2**	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	-	**2**	**1**
Snapping Turtle	*Chelydra serpentina*	SC	SC	VU	G5	S5								X		X	
Wood Turtle	*Glyptemys insculpta*	TH	TH	TH	G3	S2								X		X	X

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MAMMALS		**3**	**2**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**3**	**7**
Fisher	*Martes pennanti*				G5	S2											X
Little Brown Myotis	*Myotis lucifugus*	EN		EN	G3	S1							X				X
Long-tailed Shrew	*Sorex dispar*		SC		G4	S1								X		X	X
Moose (Mainland)	*Alces americanus*			EN	G5	S1										X	X
Northern Myotis	*Myotis septentrionalis*	EN		EN	G1G3	S1							X				X
Southern Flying Squirrel	*Glaucomys volans*		SC		G5	S2S3											X
Tri-colored Bat	*Perimyotis subflavus*	EN		EN	G3	S1							X	X		X	X
LICHENS		**3**	**1**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**5**	**2**	**1**	**1**	**5**
Beaded Jellyskin Lichen	*Leptogium teretiusculum*				G4G5	S2S3											
Blistered Tarpaper Lichen	*Collema nigrescens*				G5?	S2S3											X
Blue Felt Lichen	*Degelia plumbea*	SC		VU	GNR	S2								X		X	X
Boreal Felt Lichen	*Erioderma pedicellatum*	EN	EN	EN	G1G2 Q	S1S2											X
Eastern Waterfan	*Peltigera hydrothyria*	TH			G4	S1S2								X			
Ghost Antler Lichen	*Pseudevernia cladonia*				G2G4	S2S3		X									X
Green Starburst Lichen	*Parmeliopsis ambigua*				G3G5	S2S3											
Naked Kidney Lichen	*Nephroma bellum*				G3G5	S3?											
Peppered Moon Lichen	*Sticta fuliginosa*				G3G5	S3?											
Petalled Rocktripe Lichen	*Umbilicaria polyphylla*					S2S3									X		

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Powdered Moon Lichen	*Sticta limbata*				G3G4	S1S2											
Scaly Pelt Lichen	*Peltigera lepidophora*				G4	S1S2							X				
Tattered Jellyskin Lichen	*Leptogium lichenoides*				G5	S1S2							X				
Tree Pelt Lichen	*Peltigera collina*				G3G4	S2S3							X				
Valley Oakmoss Lichen	*Evernia prunastri*					S2S3							X				X
Woodland Owl Lichen	*Solorina saccata*				G3G5	S1							X				
NON-VASCULAR PLANTS (MOSSES)		**1**	**-**	**-**	**-**	**-**	**-**	**5**	**-**	**-**	**-**	**1**	**6**	**2**	**1**	**3**	**8**
a Moss	*Sematophyllum marylandicum*				G5	S1S3		X									
a Moss	*Ephemerum serratum*				G4	S1S3		X									
a Moss	*Drummondia prorepens*				G5	S1											
a Moss	*Weissia muhlenbergiana*				G5	S2?											
Aloe-Like Rigid Screw Moss	*Aloina rigida*				G3G5	S2S3		X					X				X
Anomalous Bristle Moss	*Orthotrichum anomalum*				G4G5	S2S3										X	
Appalachian Fir-Clubmoss	*Huperzia appalachiana*				G5	S1		X					X				X
Drab Brook Moss	*Hygrohypnum luridum*				G5	S2?											X
Light Beaked Moss	*Eurhynchium hians*				G5	S2S3						X	X				X
Metropolitan Timmia Moss	*Timmia megapolitana*				G5	S2S3											X
Northern Firmoss	*Huperzia selago*				G5	S2?		X						X	X	X	X
Pygmy Pocket Moss	*Fissidens exilis*	SC			G3G4	S2S3							X	X			

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Rock Spikemoss	*Selaginella rupestris*				G5	S1							X				X
Tiny-leaved Haplocladium Moss	*Bryohaplocladium microphyllum*				G5	S2?											
Toothed-leaved Nitrogen Moss	*Tetraplodon angustatus*				G4	S2?											
Tufted Fen Moss	*Paludella squarrosa*				G3G5	S2?											
Wulf's Peat Moss	*Sphagnum wulfianum*				G5	S2S3										X	X
Yew-leaved Pocket Moss	*Fissidens taxifolius*				G5	S2?							X				
VASCULAR PLANTS		**3**	**3**	**5**	**-**	**-**	**-**	**23**	**6**	**-**	**3**	**9**	**27**	**70**	**9**	**76**	**59**
A Pussytoes	*Antennaria parlinii*				G5	S1							X				X
Acadian Quillwort	*Isoetes acadiensis*				G3Q	S3								X		X	
American Cancer-root	*Conopholis americana*				G5	S1S2											X
American False Pennyroyal	*Hedeoma pulegioides*				G5	S2S3		X									
Atlantic Sedge	*Carex atlantica ssp. capillacea*				G5T5?	S2										X	
Bearded Sedge	*Carex comosa*				G5	S2								X		X	
Bebb’s Sedge	*Carex bebbii*				G5	S1S2							X	X		X	
Big-leaved Marsh-elder	*Iva frutescens ssp. oraria*				G5T5	S2			X		X						
Black Ash	*Fraxinus nigra*			TH	G5	S2S3							X			X	X
Blood Milkwort	*Polygala sanguinea*				G5	S2S3						X				X	
Blue Cohosh	*Caulophyllum thalictroides*				G4G5	S2								X		X	X

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Blunt Sweet Cicely	*Osmorhiza depauperata*				G5	S1											X
Bog Birch	*Betula pumila var. pumila*				G5T5?	S2S3										X	
Bog Willow	*Salix pedicellaris*				G5	S2										X	
Boreal Aster	*Symphyotrichum boreale*				G5	S2?										X	
Branched Bartonia	*Bartonia paniculata ssp. paniculata*	TH	TH		G5T5	SNA										X	
Broad-Glumed Brome	*Bromus latiglumis*				G5	S1								X			
Butternut	*Juglans cinerea*	EN	EN		G4	SNA											X
Canada Anemone	*Anemone canadensis*				G5	S2								X			
Canada Lily	*Lilium canadense*				G5	S2S3								X		X	X
Canada Rice Grass	*Piptatherum canadense*				G5	S2						X					
Canada Tick-trefoil	*Desmodium canadense*				G5	S1								X		X	
Canada Violet	*Viola canadensis*				G5	S1											X
Carey's Smartweed	Polygonum careyi				G4	S1											
Case's Ladies'-Tresses	*Spiranthes casei var. casei*				G4T4	S1						X			X		
Chestnut Sedge	*Carex castanea*				G5	S2										X	X
Chinese Hemlock-parsley	*Conioselinum chinense*				G5	S2		X						X		X	
Clammy Hedge-Hyssop	*Gratiola neglecta*				G5	S1S2								X		X	
Clustered Sanicle	*Sanicula odorata*				G5	S1										X	X
Common Bedstraw	*Galium aparine*				G5	S1		X									X

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Cuckoo Flower	*Cardamine pratensis var. pratensis*				G5TU	S1										X	
Cursed Buttercup	*Ranunculus sceleratus*				G5	S1S2										X	
Cut-Leaved Coneflower	*Rudbeckia laciniata*				G5	S2							X	X			
Cut-Leaved Coneflower	*Rudbeckia laciniata var. gaspereauensis*				G5TNR	S2							X	X			
Disguised St John's-wort	*Hypericum dissimulatum*				G5	S2S3								X			
Downy Rattlesnake-Plantain	*Goodyera pubescens*				G5	S2							X				X
Drummond's Rockcress	*Arabis drummondii*				G5	S2		X									
Dudley's Rush	*Juncus dudleyi*				G5	S2?		X								X	
Dwarf Bilberry	*Vaccinium caespitosum*				G5	S2								X			X
Dwarf Clearweed	*Pilea pumila*				G5	S1								X		X	
Eastern Leatherwood	*Dirca palustris*				G4	S1							X	X			X
Eastern White Cedar	*Thuja occidentalis*			VU	G5	S1S2								X		X	X
False Mermaidweed	*Floerkea proserpinacoides*				G5	S2								X		X	X
Farwell's Water Milfoil	*Myriophyllum farwellii*				G5	S2								X		X	
Fernald's Serviceberry	*Amelanchier fernaldii*				G2G4 Q	S2?							X				
Field Locoweed	*Oxytropis campestris var. johannensis*				G5T4	S1		X									
Five-angled Dodder	*Cuscuta pentagona*				G5	S1											

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Flat-stemmed Pondweed	*Potamogeton zosteriformis*				G5	S2S3								X		X	
Fragrant Wood Fern	*Dryopteris fragrans var. remotiuscula*				G5T3T5	S2								X			
Fries' Pondweed	*Potamogeton friesii*				G4	S2								X		X	
Fringed Blue Aster	*Symphyotrichum ciliolatum*				G5	S2S3											X
Garber's Sedge	*Carex garberi*				G5	S1								X		X	
Gaspé Arrowgrass	*Triglochin gaspensis*				G3G4	S1?			X								
Glaucous Blue Grass	*Poa glauca*				G5	S2S3		X					X				
Golden Alexanders	*Zizia aurea*				G5	S1								X		X	
Green Spleenwort	*Asplenium trichomanes-ramosum*				G4	S2								X	X		
Greene's Rush	*Juncus greenei*				G5	S1S2						X					
Hairlike Sedge	*Carex capillaris*				G5	S2		X								X	
Hairy Lettuce	*Lactuca hirsuta var. sanguinea*				G5?T5?	S2											X
Halberd-leaved Tearthumb	*Polygonum arifolium*				G5	S2										X	
Hayden's Sedge	*Carex haydenii*				G5	S1										X	
Heart-leaved Foamflower	*Tiarella cordifolia*				G5	S2								X		X	X
Horned Sea-blite	*Suaeda calceoliformis*				G5	S2S3		X		X	X						
Houghton's Sedge	*Carex houghtoniana*				G5	S2?						X					X
Intermediate Mermaidweed	*Proserpinaca intermedia*				G4?Q	S1										X	

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	CWS Priority Bird Species[4]	Coastal Beaches & Cliffs	Salt Marshes	Tidal Flats	Coastal Islands	Barrens	Caves & Calcareous Sites	Aquatic & Riparian Systems	Rock cliffs, outcrops & talus	Freshwater Wetlands	Acadian Forest Mosaic
Inverted Bladderwort	*Utricularia resupinata*				G4	S1S2									X		
Kalm's Hawkweed	*Hieracium kalmii*				G5	S2?											
Labrador Bedstraw	*Galium labradoricum*				G5	S2										X	
Lance-leaf Grape Fern	*Botrychium lanceolatum var. angustisegmentum*				G5T4	S2S3											X
Large Round-Leaved Orchid	*Platanthera macrophylla*				G5T4	S2											X
Large Tick-Trefoil	*Desmodium glutinosum*				G5	S1							X	X	X	X	X
Large Toothwort	*Cardamine maxima*				G5	S1											X
Least Moonwort	*Botrychium simplex*				G5	S2S3											X
Lesser Brown Sedge	*Carex adusta*				G5	S2S3											X
Lesser Pyrola	*Pyrola minor*				G5	S2								X			X
Little Curlygrass Fern	*Schizaea pusilla*				G3G4	S3										X	
Livid Sedge	*Carex livida var. radicaulis*				G5T5	S1							X				
Long-bracted Frog Orchid	*Coeloglossum viride var. virescens*				G5T5	S2S3											X
Loose-flowered Sedge	*Carex laxiflora*				G5	S1											X
Maidenhair Spleenwort	*Asplenium trichomanes*				G5	S2		X					X	X	X		
Maritime Saltbush	*Atriplex acadiensis*				G4?	S1?			X								
Marsh Horsetail	*Equisetum palustre*				G5	S1										X	
Meadow Horsetail	*Equisetum pratense*				G5	S2								X			X
Michaux's Dwarf Birch	*Betula michauxii*				G4G5	S2										X	

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
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Mistassini Primrose	*Primula mistassinica*				G5	S2								X	X	X	
Nantucket Serviceberry	*Amelanchier nantucketensis*				G3Q	S1						X					
Narrow-leaved Evening Primrose	*Oenothera fruticosa ssp. glauca*				G5	S2											
Narrow-leaved Panic Grass	*Dichanthelium linearifolium*				G5	S2?								X			
Necklace Spike Sedge	*Carex ormostachya*				G4	S1											X
Nodding Fescue	*Festuca subverticillata*				G5	S1											X
Northern Adder's-tongue	*Ophioglossum pusillum*				G5	S2S3										X	
Northern Bedstraw	*Galium boreale*				G5	S2										X	X
Northern Blueberry	*Vaccinium boreale*				G4	S2										X	
Northern Bog Violet	*Viola nephrophylla*				G5	S2								X		X	X
Northern Dewberry	*Rubus flagellaris*				G5	S1?											
Northern Maidenhair Fern	*Adiantum pedatum*				G5	S1								X		X	X
Orange-fruited Tinker's Weed	*Triosteum aurantiacum*				G5	S2								X		X	X
Ovate Spikerush	*Eleocharis ovata*				G5	S2?							X	X		X	
Pale Green Orchid	*Platanthera flava var. herbiola*				G4?T4 Q	S1S2								X		X	X
Pale Jewelweed	*Impatiens pallida*				G5	S2		X									
Pale-Spiked Lobelia	*Lobelia spicata*				G5	S1											

Common Name	Scientific Name	Conservation Status Ranks						Coarse Resolution Habitat Associations									
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	CWS Priority Bird Species[4]	Coastal Beaches & Cliffs	Salt Marshes	Tidal Flats	Coastal Islands	Barrens	Caves & Calcareous Sites	Aquatic & Riparian Systems	Rock cliffs, outcrops & talus	Freshwater Wetlands	Acadian Forest Mosaic
Philadelphia Fleabane	*Erigeron philadelphicus*				G5	S2								X			
Pinebarren Golden Heather	*Hudsonia ericoides*				G4	S2						X					
Plantain-Leaved Sedge	*Carex plantaginea*				G5	S1											X
Porcupine Sedge	*Carex hystericina*				G5	S2										X	
Prairie Sedge	*Carex prairea*				G5?	S1										X	
Prickly Hornwort	*Ceratophyllum echinatum*				G4?	S2?								X			
Prototype Quillwort	*Isoetes prototypus*	SC	SC	VU	G2G3	S2								X			
Pubescent Sedge	*Carex hirtifolia*				G5	S2S3								X		X	X
Purple Clematis	*Clematis occidentalis*				G5	S1							X				X
Purple-veined Willowherb	*Epilobium coloratum*				G5	S2?										X	
Quebec Hawthorn	*Crataegus submollis*				G5	S1?										X	
Ram's-Head Lady's-Slipper	*Cypripedium arietinum*			EN	G3	S1							X				X
Red Ash	*Fraxinus pennsylvanica*				G5	S1										X	X
Richardson's Pondweed	*Potamogeton richardsonii*				G5	S2S3								X		X	
Robbins' Milkvetch	*Astragalus robbinsii var. minor*				G5T5	S1		X									
Robinson's Hawkweed	*Hieracium robinsonii*				G2G3	S2								X			
Robinson's Hawthorn	*Crataegus robinsonii*				G2G4 Q	S1?											
Rock Whitlow-Grass	*Draba glabella*				G5	S1		X									X
Rock Whitlow-Grass	*Draba arabisans*				G4	S2		X									X

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
		COSEWIC[1]	SARA[2]	NS ESA[3]	Global (G) Rank	Sub-national (S) Rank	CWS Priority Bird Species[4]	Coastal Beaches & Cliffs	Salt Marshes	Tidal Flats	Coastal Islands	Barrens	Caves & Calcareous Sites	Aquatic & Riparian Systems	Rock cliffs, outcrops & talus	Freshwater Wetlands	Acadian Forest Mosaic
Roland's Sea-Blite	*Suaeda rolandii*				G1G2	S1?			X								
Rosy Pussytoes	*Antennaria rosea ssp. arida*				G5T3T5	S1		X									
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*				G5T5	S1S2								X			X
Rugel's Plantain	*Plantago rugelii*				G5	S2								X			
Saltmarsh Alkali Grass	*Puccinellia fasciculata*				G3G5	S1			X								
Saltmarsh Starwort	*Stellaria humifusa*				G5?	S2			X								
Satiny Willow	*Salix pellita*				G5	S2S3								X		X	
Scabrous Black Sedge	*Carex atratiformis*				G5	S2							X				
Seabeach Ragwort	*Senecio pseudoarnica*				G5	S2		X									
Second Rush	*Juncus secundus*				G5?	S1						X					
Shining Ladies'-Tresses	*Spiranthes lucida*				G5	S2								X		X	
Short-awned Foxtail	*Alopecurus aequalis*				G5	S2S3							X	X			
Showy Lady's-Slipper	*Cypripedium reginae*				G4	S2							X			X	
Silky Willow	*Salix sericea*				G5	S2								X		X	
Silver Maple	*Acer saccharinum*				G5	S1											
Slender Blue Flag	*Iris prismatica*				G4G5	S1										X	
Slender Cottongrass	*Eriophorum gracile*				G5	S2										X	
Slim-stemmed Reed Grass	*Calamagrostis stricta ssp. stricta*				G5T5	S1S2										X	

Common Name	*Scientific Name*	Conservation Status Ranks						Coarse Resolution Habitat Associations									
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Small Yellow Lady's-Slipper	*Cypripedium parviflorum var. makasin*				G5T4T5	S2							X			X	X
Small-flowered Bittercress	*Cardamine parviflora var. arenicola*				G5T5	S2		X							X		
Small's Knotweed	*Polygonum buxiforme*				G5	S2S3								X			
Smooth Cliff Fern	*Woodsia glabella*				G5	S2								X	X	X	
Smooth Sweet Cicely	*Osmorhiza longistylis*				G5	S2								X		X	X
Soapberry	*Shepherdia canadensis*				G5	S2							X				
Southern Rein Orchid	*Platanthera flava*				G4?	S2								X		X	
Southern Twayblade	*Listera australis*				G4	S2										X	
Spotted Pondweed	*Potamogeton pulcher*			VU	G5	S1S2								X		X	
Spreading Wild Rye	*Elymus hystrix var. bigeloviana*				G5T5?	S1								X		X	X
Stalked Bulrush	*Scirpus pedicellatus*				G4	S1								X		X	
Steller's Rockbrake	*Cryptogramma stelleri*				G5	S1							X	X	X	X	
Swamp Milkweed	*Asclepias incarnata ssp. pulchra*				G5T5	S2S3								X		X	
Swan's Sedge	*Carex swanii*				G5	S2S3											X
Sweet Wood Reed Grass	*Cinna arundinacea*				G5	S1											
Tender Sedge	*Carex tenera*				G5	S1S2		X									X
Thread-Like Naiad	*Najas gracillima*				G5?	S1S2								X			

Common Name	***Scientific Name***	**Conservation Status Ranks**						**Coarse Resolution Habitat Associations**									
		COSEWIC[1]	**SARA[2]**	**NS ESA[3]**	**Global (G) Rank**	**Sub-national (S) Rank**	**CWS Priority Bird Species[4]**	**Coastal Beaches & Cliffs**	**Salt Marshes**	**Tidal Flats**	**Coastal Islands**	**Barrens**	**Caves & Calcareous Sites**	**Aquatic & Riparian Systems**	**Rock cliffs, outcrops & talus**	**Freshwater Wetlands**	**Acadian Forest Mosaic**
Triangular-valve Dock	*Rumex salicifolius var. mexicanus*				G5T5	S2								X			X
Tuckerman's Panic Grass	*Panicum tuckermanii*				G5	S2S3								X		X	
Tuckerman's Sedge	*Carex tuckermanii*				G4	S1											X
Vasey Rush	Juncus vaseyi				G5?	S1		X						X			
Virginia Anemone	*Anemone virginiana var. alba*				G5T4T5	S1S2							X	X			
Virginia Anemone	*Anemone virginiana*				G5	S2											
Virginia Anemone	*Anemone virginiana var. virginiana*				G5T5	S2											
Water Blinks	*Montia fontana*				G5	S1								X			
Wavy-leaved Aster	*Symphyotrichum undulatum*				G5	S2											
Western Hairy Rockcress	*Arabis hirsuta var. pycnocarpa*				G5T5	S1S2		X			X						
White Adder's-Mouth	*Malaxis brachypoda*				G4Q	S1		X									
White Mountain Saxifrage	*Saxifraga paniculata ssp. neogaea*				G5T5?	S2		X					X				
White Snakeroot	*Ageratina altissima*				G5	S1											X
White Trillium	*Trillium grandiflorum*				G5	S1											X
White-tinged Sedge	*Carex peckii*				G5	S2?											

Common Name	***Scientific Name***	**Conservation Status Ranks**						**Coarse Resolution Habitat Associations**									
		COSEWIC[1]	**SARA[2]**	**NS ESA[3]**	**Global (G) Rank**	**Sub-national (S) Rank**	**CWS Priority Bird Species[4]**	**Coastal Beaches & Cliffs**	**Salt Marshes**	**Tidal Flats**	**Coastal Islands**	**Barrens**	**Caves & Calcareous Sites**	**Aquatic & Riparian Systems**	**Rock cliffs, outcrops & talus**	**Freshwater Wetlands**	**Acadian Forest Mosaic**
Whorled Water Milfoil	*Myriophyllum verticillatum*				G5	S2							X	X			
Wiegand's Sedge	*Carex wiegandii*				G4	S1										X	
Wiegand's Wild Rye	Elymus wiegandii				G4G5	S1								X			
Wild Black Currant	Ribes americanum				G5	S1											
Wild Celery	Vallisneria americana				G5	S2								X			
Wild Chives	*Allium schoenoprasum var. sibiricum*				G5	S2								X			
Wild Comfrey	*Cynoglossum virginianum var. boreale*				G5T4T5	S1							X				X
Wild Leek	*Allium tricoccum*				G5	S1											X
Wood Anemone	*Anemone quinquefolia*				G5	S2											X
Woolly Panic Grass	*Dichanthelium acuminatum var. lindheimeri*				G5T5	S1?		X						X			
Yellow Ladies'-tresses	*Spiranthes ochroleuca*				G4	S2S3						X					
Yellow Lady's-slipper	*Cypripedium parviflorum*				G5	S2S3							X			X	X
Yellow Lady's-slipper	*Cypripedium parviflorum var. pubescens*				G5T5	S2							X			X	X
Yellow Marsh Marigold	*Caltha palustris*				G5	S2											
Yellow Spikerush	*Eleocharis olivacea*				G5	S2S3								X		X	

Appendix D. Priority habitat composite methodology

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. The methods used for the GIS analyses were established in a collaborative, iterative manner, through close communication with the Canadian Wildlife Services (CWS) and the Nature Conservancy of Canada (NCC), with input from and consultation with relevant experts from the ACCDC, Bird Studies Canada (BSC), and the New Brunswick provincial government.

The process for assigning priority habitat ranks involved weighting (scoring) certain characteristics of the conservation priority habitats higher than others. Wherever possible, weighting criteria included consideration of the uniqueness (rarity within each Natural Landscape and within the bioregion), representivity (by Natural Landscape), and size (compared to minimum patch size). The more high quality priority habitat that an area contained, the higher the priority habitat rank it received. Promoting small extents of multiple priority habitats was avoided by selecting minimum size criteria for habitat-based conservation priorities. In most cases, higher scores were given to areas with larger patches of ecosystems selected as priority habitat types.

For as much of the data as possible, the layers were gathered or generated for the full extent of Nova Scotia, and then clipped to the bioregion, in order to avoid repeating work for other bioregions in the province.

Priority species list

Determination of the priority habitat types to be considered began with the compilation of the list of priority species for the bioregion, established by consensus according to objective selection criteria. Initially, only species at risk were chosen as targets for the analyses, however concerns were raised early in the planning of the project by partners that this would result in a final product too limited in scope to be relevant to a wide group of stakeholders. Additionally, it was felt that focusing only on species at risk would mean that important species might be missed, resulting in a conservation plan that didn't capture the true diversity of habitats and species in the bioregion.

The ACCDC species database was used to compile the list of conservation priority species for the strategy. The list was limited to species that adhered to the following criteria:

- Ranked as S1 or S2, or as S3 with a G1, G2 or G3 ranking
- Identified as a BCR priority species (14 for Nova Scotia)
- Identified by COSEWIC as Endangered, Threatened or Special Concern

Aquatic species and species occurring accidentally were removed from the analyses.

Habitat associations for each priority species were determined (where possible) in either specific or general terms, based on information within existing species databases, literature review, and expert knowledge. Habitat associations were then summarized in to broad habitat types to identify priority habitat types for conservation that would encompass important habitat for the majority of the species making up the priority species list.

Based on habitat affinities of the priority species, but independent of their spatial patterns of occurrence, the following nine habitat types were determined to be conservation priority habitats for the NS IBoF bioregion:

1) Coastal beaches and cliffs
2) Tidal flats
3) Salt marshes
4) Coastal islands
5) Barrens
6) Caves and calcareous sites
7) Aquatic and riparian systems
8) Freshwater wetlands
9) Late-successional Acadian Forest Mosaic

Priority habitat data

Data pre-processing
All habitat priorities were directly included in the prioritization analysis. Whereas habitat priority data came from a number of sources, source layers were overlaid and the union and dissolve functions were used in ArcGIS to give the highest probability of actual habitat type occurrence without field verification.

Habitat data sources:

- **Beaches and dunes** - Beaches and dunes were selected from the Nova Scotia Provincial Forest Resource Inventory (FORNON = 94), the Department of Environment Small Patch Ecosystems layer (Feature1_ = beach/dune) and the Nova Scotia Wetlands Inventory (WTY1 = B and D)
- **Salt marshes** - Tidal marsh were selected from the updated Nova Scotia wetlands inventory (WETLAND = tidal marsh), the Department of Environment Small Patch Ecosystem layer (Feature1_ = tidal marsh) and the Nova Scotia Wetlands Inventory (WTY1 = S). A 275 metre buffer was applied to all of the polygons (Environment Canada 1998)
- **Freshwater Wetlands** - Six types of freshwater wetlands were selected as habitat targets within the bioregion. They were selected from the updated Nova Scotia Wetlands Inventory and included: bogs, fens, unclassified peatlands (bogs or fens), marsh, and swamp. Swamp polygons were further classified by vegetation type when overlaid with the Department of Natural Resources' wetland vegetation type layer into shrub or treed swamps. A 275 metre buffer was applied to all of the freshwater wetland polygons (Environment Canada 1998).
- **Tidal Flats** - Tidal flats were selected from the Nova Scotia Wetlands Inventory (WTY1= MF and EF) and the Small Patch Ecosystems (Feature1_ = estruine flat or tidal flat)
- **Barrens** - Barrens were selected from the Nova Scotia Forest Resource Inventory (FORNON = 84 and 85). Sand barrens were selected from the Small Patch Ecosystems layer (Feature1_ = sand barren). Sand barrens were erased from the FRI barrens to create a seamless layer for later scoring. A 500 metre buffer[1] was created around the coastline of the bioregion and all barrens (not including sand barrens) located within the buffer were re-classified as Coastal Barrens. All barrens found outside the coastal buffer (not including sand barrens) were re-classified as "inland barrens".
- **Coastal islands** - Coastal Islands were selected from the Nova Scotia Forest Resource Inventory (landclass = 97 - offshore islands).
- **Riparian areas** - Riparian areas were derived by adding a 275 metre buffer to the Nova Scotia Provincial Major Watercourses layer (FCODE =302). NAAP critical floodplains were also included. Riparian areas were used to increase the score of other habitat types that were found within them. It was not an independent target habitat for the purposes of this analysis.

[1]Coastal buffer size recommended when roughly identifying coastal barrens (Oberndorfer and Lundholm 2009).

- **Forest mosaic** - Forest data was first assembled and classified into the following forest community types by the Nova Scotia Department of Natural Resources office in Truro.
    - Tolerant hardwood (HTHw) - <= 20% softwood and >= 60% tolerant hardwood species in hardwood stands
    - Tolerant mixedwood (MTHw) - 21 - 79% softwood and >= 50% tolerant hardwood species in hardwood stands
    - Softwood - >=80% softwood species
        - Balsam fir dominant (SbFDom) - >= 60% balsam fir in softwood stands
        - Red/black spruce dominant (SrSbSDom) - >= 60% Spruce, >= 50% red/black/hybrid spruce
        - White spruce dominant (SwSDom) - >= 60% Spruce, < 50% red/black/hybrid spruce
        - Spruce/fir dominant (SSpbFDom) - >= 60% fir + spruce
        - Pine dominant (SpiDom) - >= 60% pine
        - Mixed spruce/pine/hemlock (SMHePiSp) - > 0% spruce + fir + pine + hemlock

  From all of these community types, only development class mature or multiaged and a seral score of 38 - 50 (late successional) were selected to be included in the analysis. The resulting selection was dissolved based on community type to ensure the largest patch size. All forest polygons located within any of the 5 coastal Natural Landscapes were sub-classified as coastal forest.

Cleaning the data

The first step prior to the habitat prioritization analysis was to clean the GIS data before assignment of weights 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. The area of each patch was recalculated using 'calculate geometry' and weights were then assigned based on the new area of the dissolved polygons.

Weighting the data

For each conservation habitat priority, final scores between 0 and 1 were assigned, the latter representing completely suitable habitat for nested species. All priority habitat occurrences (i.e., patches), with the exception of barrens, and riparian areas (see below), were scored using a three-tiered equation that equally divides the score by habitat uniqueness, representivity, and size:

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

Uniqueness

Conceptually, variations in enduring features across the landscape (e.g., geology, climate, topography, 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). Uniqueness is a measure of the rarity of a habitat type within each Natural Landscape and within the bioregion. The uniqueness calculation was created to take into account the potential differences of habitat types within each natural landscape present in the bioregion. To determine the uniqueness of each categorized habitat type across the bioregion (i.e., area of interest, AOI), two area based assessments were conducted (U_1 and U_2) as follows:

$$U_1 = 1 - \left(\frac{Habitat_{AOI-Natural\ Landscape}}{Habitat_{AOI-Total}} \right) \qquad U_2 = 1 - \left(\frac{Habitat_{AOI-Total}}{Ecosystem_{AOI-Total}} \right)$$

Habitat refers to the specific form of habitat (e.g., marsh) that is nested within a particular *Ecosystem* type (e.g., freshwater wetlands). U_1 calculates the area of a particular habitat type habitat within each Natural Landscape compared to the area of that habitat type within the AOI, or bioregion. U_2 calculates the area of the habitat type within the bioregion compared to the total parent ecosystem within the bioregion. The final uniqueness score is an average of the two:

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

Habitat types that are not nested (i.e., tidal marsh, tidal flats, beaches) did not require the use of the U_2 calculation and were scored for uniqueness based on U_1 alone.

Representivity

Based on the assumptions of Natural Landscapes mentioned above, representivity was calculated using two area based assessments (R_1 and R_2), as follows:

$$R_1 = \frac{Natural\ \text{Landscape}_{AOI}}{Natural\ Landscape_{Total}} \qquad R_2 = \frac{Habitat_{AOI-\text{ Natural Landscape}}}{Habitat_{Natural\ \text{Landscape}}}$$

R_1 is the proportion of each Natural Landscape within the bioregion. R_2 is the proportion of each priority habitat type within each Natural Landscape in the bioregion, regardless of the proportion that is within the bioregion. The final representivity score is as follows:

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

This method of calculating representivity accounts for the total area of each Natural Landscape represented within the AOI boundary (R_1) and is prorated by the percent of habitat that occurs within the portion of the Natural Landscape located within the AOI. Conceptually, if both R_1 and R_2 are equal, then the habitat type is equally represented across the Natural Landscape, both inside and outside the AOI boundary (*Representivity* = 0). If R_1 is smaller than R_2, than a higher proportion of habitat is located within the AOI portion of the Natural Landscape, 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 AOI portion of the Natural Landscape than outside of it. This results in a negative score (*Representivity* < 0), meaning that the habitat type is better represented outside the AOI portion of the Natural Landscape. All negative values are converted to 0.

Size

Size is a patch based metric. The area of each patch for each habitat type was divided by a critical minimum patch size[1] specific to each habitat type (see below for minimum patch sizes).

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

If a patch was the same size or larger than its respective minimum patch size, that patch was given a size score of 1. Other patches were scored on a scale from 0 to 0.99 based on their proportion of the critical minimum patch size. See table below for a summary of the minimum size criteria used within the analysis. Barrens and coastal islands did not receive a size score; upon consultation with field experts, it was communicated that size does not appear to be a limiting factor when determining the ecological value of these two habitat types (K. Porter, K. Allard, per. comm.).

Table 17. Minimum size criteria for each habitat type within the NS IBoF bioregion.

Habitat Conservation Priority	Minimum Size (Ha)
Beaches and Dunes	8.1
Rocky Shores	4.0
Tidal marsh	24.3
Tidal Flats	40.5
Freshwater Wetlands	20.2
Barrens	NA
Coastal Islands	NA
Acadian Forest Mosaic[2]	
Late Successional (LS) Hardwood	40
LS Mixedwood	60
LS Spruce, Fir, Spruce/Fir Mix	50
LS Pine	15
LS Spruce/Pine/Hemlock Mix[3]	50

Coastal islands, barrens, and riparian area scoring

- **Coastal islands** - Because coastal islands may not adhere to the enduring features which describe Natural Landscapes, a different scoring method was applied. Islands were scored based on 3 criteria: 1) Habitat (the number of habitat types present)[4]; 2) Development (presents

[1] Developed as part of The Nature Conservancy's NAAP report (2006).

[2] For forest communities, minimum patch sizes were adapted from the *NB Provincial Old Forest Community and Wildlife Definitions* (2005). With the exception of spruce, fir, and spruce fir mix at 375 ha, the largest patch size for each community was used to capture all species that were identified for the community type. Given the small number of contiguous spruce and fir patches 375 ha or greater, the second largest patch size (50 ha) was used.

[3] Based on minimum patch size for Northern Goshawk as reported in *Maintaining the Integrity of Northern Goshawk Nesting and Post-fledging Areas in the Ecosystem Based Management Plan Area of Coastal British Columbia: Guidance for Forest Professionals* (2012)

[4] Habitat types were identified from the Nova Scotia Forest Resource Inventory and included: natural forest stand, grass, brush, wetland, open bog, treed bog, cliff dune, rocky shore, rock barren, barren, beach. If 3 or more habitat types were found on an island, the habitat score was 0.4, otherwise it was 0.

of buildings)[1]; and 3) Colonial bird species presence (within 200 m of the island)[2]. Scores for the 3 individual criteria are summed for a maximum score of 1.

- **Barrens** - Barrens were scored based on a two tier equation by removing the size component from the 3 tiered equation.
- **Riparian areas** - A score of 0.2 was given to all riparian areas. If a priority habitat patch fell within a riparian area, the score for the overlapping priority habitat patch would increase by 0.2. NAAP critical floodplains were scored 0.4 so that overlapping habitat patches would have an increase in score of 0.4.

Buffer weighting
Tidal marsh and freshwater wetland habitat types were assigned buffers of 275 m. Buffers were assigned the score of their respective habitat occurrence. Where 2 buffers overlapped, priority was given to the higher score, both within the same layer as well as between layers.

Scoring Adjustments:

1. NAAP Critial Habitat - All priority habitat polygons that intersect with NAAP critical habitat polygons of the same type were automatically given the maximum score of 1.
2. Important Bird Areas - For all beach and dune, coastal island, tidal marsh, and tidal flat polygons that fell within an Important Bird Area, the score for the polygon was increased by 0.2.
3. Vernal Pools - The score of any forest mosaic polygon that contained a 30 metre (Semlitsch 2003) buffered vernal pool from the Small Patch Ecosystems Layer, was increased by 0.1; a marginal increase given the on-the-ground uncertainty of the vernal pool data.
4. The following data layers were converted to rasters and given additional scores to boost the values of forest patches that overlapped with them. This takes into account the repeated identification of particular forests as having high conservation value for different attributes, thus resulting in a higher final score.

PSOUF - This 2005 layer was created by the DOE and further updated with David Coleville's work on temporal landscape change in SW Nova Scotia. Satellite imagery was used to remove areas from the original PSOUF layer that had been disturbed. The remaining patches represent what was left undisturbed as of late 2012. These patches were given a score of 0.2. If a 30 m buffered vernal pool (described in number 3 above) was found inside a PSOUF patch, a score of 0.3 was given.

Calcareous forest - Identified for its rarity in the bioregion, these patches were queried from the Small Patch Ecosystems layer and given a score of 0.2 and 0.3 if a 30 m buffered vernal pool was found within them.

DNR A list - These patches of high conservation value forests were given a score of 0.2 or 0.3 if a vernal pool was found within them.

DNR old growth forest scores - These patches of suspected old growth forest were scored 0.2 and 0.3 if a vernal pool was found within them.

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[1] A buildings point layer was used such that if a building was found on an island, the score was 0, and if no building was found, the development score was 0.3.

[2] If there was a data point from Bird Studies Canada/CWS rare/colonial bird species data within 200 m of an island, the score was 0.3.

MTRI potential Medway old growth forest - These patches of field verified old growth forests were scored 0.2 and 0.3 if a vernal pool was found within them.

If a forest mosaic polygon contained any of the five layers listed above, the scores from these layers would be added to the score of the original polygons. For example: A LSTH polygon had an original score of 0.5. A PSOUF polygon with no vernal pool was also found to be within this polygon and a DNR old growth forest score polygon with a vernal pool was also present. The final score of the area of the LSTH that contained these additional two layers would be 0.5 + 0.2 + 0.3 = 1. This ensures that the repeated identification of this area as having a high conservation value for different attributes is considered in the final score.

Priority habitat composite

The resulting priority habitat composite map for the NS IBoF bioregion can be found in Figure 25.

Appendix E. Priority species composites methodology

Priority species occurrence data

As part of collaboration with the Canadian Wildlife Service, the Nature Conservancy of Canada, and other conservation organizations within the Maritimes region, GIS methods were developed to map the likelihood of occurrence of individual priority species within the bioregion using a kernel density estimation based on existing occurrence data. Suites of individual priority species layers were then combined to create the multispecies composite layers. The objective of the species composite was to determine "hotspots" for priority species within the bioregion, thus contributing to the identification of areas of high conservation value.

Multiple sources of species occurrence data were included in the analyses. The collation of data from such a large number of sources represents a new phase in collaboration and data availability, and means that other groups will avoid having to redo work already completed, and that all groups are working with all of the data available. Data used to generate the species composites are provided in Table 18. The priority species composite index was normalized between 0 and 1, 1 being the areas where the likelihood of presence of priority species was highest, based on the methodology of the Kernel analysis.

Table 18. Data layers, sources, and types used to describe priority species spatial distribution within the NS IBoF bioregion.

Data layers	Data source	Source data type
Point occurrence records of rare and at risk mammals, reptiles, amphibians, vascular plants, non-vascular plants, lichens, etc.	Atlantic Canada Conservation Data Centre (ACCDC)	Points with a precision of 5 km or less
Relative abundance of breeding bird species detected by point count, the preferred data source for bird species	MBBA[1] point count	Points, counts
Breeding evidence of bird species, consisting of breeding evidence categories within 10 km by 10 km survey squares, used for those species that were not adequately captured through the MBBA point count surveys	MBBA breeding evidence	Polygons (10 km X 10 km survey squares)
Occurrence and abundance of rare and colonial breeding bird species (specifically to map non-waterbird colonies)	MBBA rare/colonial species	Points, counts
Occurrence and abundance of shorebirds (non-breeding migratory flocks)	Atlantic Canada Shorebird Survey database	Points, counts
Occurrence and abundance of colonial waterbirds	Atlantic Region Colonial Waterbird database	Points, counts
Occurrence and abundance of coastal waterfowl (non-breeding and migratory flocks)	Atlantic Canada Coastal Waterfowl Survey database	Polygons (irregular blocks), counts
Occurrence of critical habitat[1] for species listed as threatened or endangered under the *Species at Risk Act*	CWS Atlantic Region Critical Habitat Mapping Database	Polygons (irregular)

[1] Maritime Breeding Bird Atlas II (MBBA)

Atlantic Canada Conservation Data Centre (ACCDC) species occurrence data

The ACCDC dataset contains point data records for a large number of species occurring in Atlantic Canada (mostly Maritimes). The goal of this analysis was to generate species-specific raster layers estimating the likelihood of occurrence. The methods used to prepare these data for inclusion in the final biodiversity composite are described below.

Occurrence points were buffered using a kernel density analysis based on their geographic precision such that points with a low geographic precision were given a large buffer with a low score. This method leads to artificially overweighting areas where two low precision buffers overlap; therefore, a two-layer buffering method was used.

A primary buffer was generated using a kernel density analysis based on the ACCDC precision codes of the point data (Table 19). The precision codes were recalculated so that they ranged from 0 to 0.8. Points with a higher geographic certainty were given a higher rank, recorded as a new field (titled Population; Figure 35). These points were then buffered using a kernel density analysis for each individual species, using a 500 m radius, a 100 m output cell size and the appropriate 'POPULATION' parameter value. This approach attributed higher value to pixels closest to the centroid with more precise observations, and resulted in raster layers for each of the species in the ACCDC database with pixel values ranging from 0 to 0.8.

A secondary buffer was also generated for each individual species. Each point was buffered to 5000 m, and the entire area of the buffer was given a rank of 0.2. These layers were converted into raster layers with a pixel size of 10 m. The primary and secondary buffer rasters were then combined to create a single layer for each species, with values ranging from 0 to 1 based on the likelihood of occurrence of the given species.

Table 19. Precision codes, definitions, spatial context, unit size, and range of values for species occurrence records within the ACCDC 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

[1] Critical habitat is defined in the SARA (S.C. 2002, c.29) as "…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" (s. 2(1)).

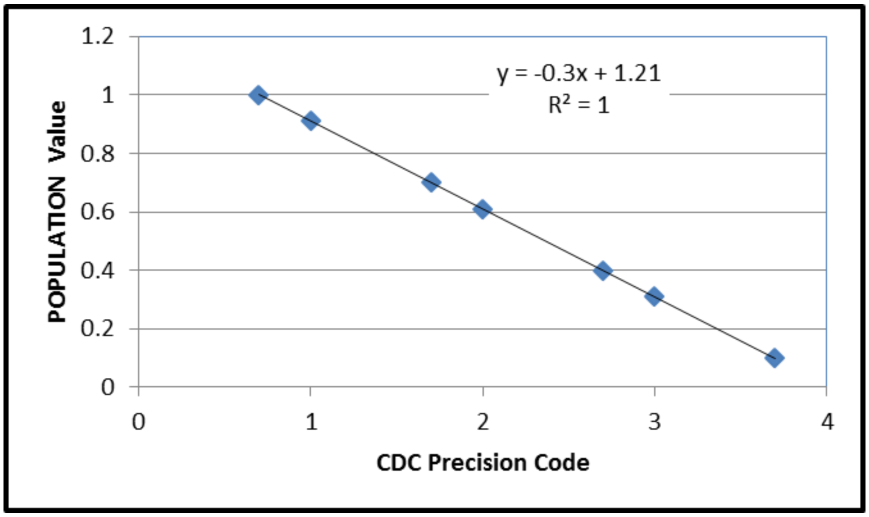

Figure 35. Population values derived for the purpose of informing the kernel density point process using precision code values found within the ACCDC dataset (linear equation can be used to populate a new attribute field with POPULATION value information).

ACCDC data steps

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 (Table 19).
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 38). This approach attributes more value to pixels closest to the centroid with more precise observations.
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 'species composites'.

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.

Maritimes Breeding Bird Atlas (MBBA) II 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.

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

MBBA point count data steps

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 data steps

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 adequately during the course of point count surveys.
2) The highest level of breeding evidence was determined, by species, for each square, for the Atlas period 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.
4) Raster Values were doubled such that values range between 0.2 and 1.

Atlantic Region Species at Risk Critical Habitat mapping

Mapping of Critical Habitat for Species at Risk in the Atlantic Region involves 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 has been identified for 13 species in the bioregion. 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.

AR SAR CH mapping data steps

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.

Priority species composites

Individual species raster layers were combined to create multispecies composites. In order to combine rasters from the 3 data sources, all species were represented by an equal range of values. The values for the MBBA Atlas 2 were doubled to increase the maximum value to 1. The relative abundance bird species rasters were run through a model which first replaced negative raster values with 0 and then normalized the remaining values between 0 and 1. The ACCDC non-bird kernel density rasters did not require additional normalization as they were previously calculated to be between 0 and 1. The species rasters were then input into the Cell Statistics Tool in Arc GIS 10.1 and a raster sum was calculated to create the multispecies composites. The output composite raster was normalized between 0 and 1 for display, so that all composites could be visualized at the same numerical scale.

The overall species composite is the sum of the un-normalized composites created for the MBBA 2 birds, the Relative Abundance birds as well as the All Rare-Non Bird Species. While combining these data sets may present some bias do to the differing methods in creating the individual species rasters, it can still present a general indication of areas with the highest concentrations of priority species. Species composites can also be adapted to illustrate biodiversity hotspots, hotspots for particular suites of species, hotspots for species associated with priority habitats (based on species-habitat matrices), etc.

Priority species composites

See Table 14 for a complete list of the priority species composites that were developed with descriptions and data sources, as well as figure numbers and page numbers where the respective priorty species composite map can be found.

Appendix F. Conservation value index methodology

The scores generated through development of the priority habitat composite (see Appendix D) and the priority species composite using the full list of priority species (see Appendix E) were combined to yield a conservation value index for the Nova Scotia Inner Bay of Fundy bioregion, presented in Figure 34, pg. 107. The goal was to identify areas within the bioregion that are the most critical for the defined priority habitats and species, where conservation efforts should be concentrated.

Combining the Data

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 priority habitat was weighted the same when the final score was calculated. Table 20 provides the list of all rasters that were combined for prioritization with their respective scoring.

Table 20. List of rasterized layers used in the conservation value analysis with their respective scoring range.

Prioritization Raster	Scoring Values
Beaches and Dunes	0.15 - 1
Tidal marsh	0.15 - 1
Tidal Flats	0.17- 1
Acadian Forest Mosaic	0.19 - 1
Freshwater wetlands	0.20 - 1
Buffers (tidal marsh and freshwater wetlands)	0.15 - 1
Coastal Islands	0 – 1
Riparian Areas	0.2[1] or 0.4[2]
Barrens	0.18 - 1
PSOUF	0.2 or 0.3
Calcareous Forest	0.2 or 0.3
NS DNR A-List Forests	0.2 or 0.3
NS DNR Old Growth Forest Scores	0.2 or 0.3
MTRI Medway Old Growth Forest	0.2 or 0.3
Species composite	0 - 1

[1] Major Watercourses FCODE 302 Rivers 275 Buffer
[2] NAAP Critical Floodplains

Appendix G. IUCN Threats Classification

World Conservation Union-Conservation Measures Partnership (IUCN-CMP) classification of direct threats to biodiversity (version 2.0).

Threats Classification	Definition
1 Residential and commercial development	**Human settlements of other non-agricultural land uses with a substantial footprint**
1.1 Housing and urban areas	Human cities, towns and settlements including nonhousing development typically integrated with housing
1.2 Commercial and industrial areas	Factories and other commercial centers
1.3 Tourism and recreation areas	Tourism and recreation sites with a substantial footprint
2 Agriculture and aquaculture	**Threats from farming and ranching as a result of agricultural expansion, intensification or practices; includes siviculture, mariculture and aquaculture**
2.1 Annual and perennial non-timber crops	Crops planted for food, fodder, fiber, fuel or other uses
2.2 Wood and pulp plantations	Stands of trees planted for timber or fiber outside of natural forests, often with non-native species
2.3 Livestock farming and ranching	Domestic terrestrial animals raised in one location on farmed or nonlocal resources (farming); also domestic or semidomesticated animals allowed to roam in the wild and supported by natural habitats (ranching)
2.4 Marine and freshwater aquaculture	Aquatic animals raised in one location on farmed or nonlocal resources; also hatchery fish allowed to roam in the wild
3 Energy production and mining	**Threats from production of non-biological resources**
3.1 Oil and gas drilling	Exploring for, developing, and producing petroleum and other liquid hydrocarbons
3.2 Mining and quarrying	Exploring for, developing, and producing minerals and rocks
3.3 Renewable energy	Exploring, developing and producing renewable energy
4 Transportation and service corridors	**Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality**
4.1 Roads and railroads	Surface transport on roadways and dedicated tracks
4.2 Utility and service lines	Transport of energy and resources
4.3 Shipping lanes	Transport on and in freshwater and ocean waterways
4.4 Flight paths	Air and space transport
5 Biological resource use	**Threats from consumptive use of “wild” biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species**
5.1 Hunting and collecting terrestrial animals	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsidence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch

Threats Classification	Definition
5.2 Gathering terrestrial plants	Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsidence, research or cultural purposes, or for control purposes
5.3 Logging and wood harvesting	Harvesting trees and other woody vegetation for timber, fiber, or fuel
5.4 Fishing and harvesting aquatic resources	Harvesting aquatic wild animals or plants for commercial, recreation, subsidence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch
6 Human intrusions and disturbance	**Threats from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources**
6.1 Recreational activities	People spending time in nature or travelling in vehicles outside of established transport corridors, usually for recreational reasons
6.2 War, civil unrest and military exercises	Actions by formal or paramilitary forces without a permanent footprint
6.3 Work and other activities	People spending time in or travelling in natural environments for reasons other than recreation or military activities
7 Natural system modifications	**Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare**
7.1 Fire and fire suppression	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation
7.2 Dams and water management/use	Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities
7.3 Other ecosystem modifications	Other actions that convert or degrade habitat in the service of “managing” natural systems to improve human welfare
7.4 Removing/reducing human maintenance	Absence or reduction of current or historical maintenance regimes important for key ecological attributes, including regimes historically maintained by protected area staff, farmers and ranchers, indigenous peoples, private landowners, or any other resource manager
8 Invasive and other problematic species, pathogens and genes	**Threats from non-native and native plants, animals, pathogens/microbes, or genetic material that have or are predicted to have harmful effects on biodiversity following their introduction, spread, and/or increase in abundance or virulence**
8.1 Invasive non-native/alien plants and animals	Harmful plants and animals not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities
8.2 Problematic native plants and animals	Harmful plants and animals that are originally found within the ecosystem(s) in question, but have become “out of balance” or “released” directly or indirectly due to human activities
8.3 Introduced genetic material	Human-altered or transported organisms or genes

Threats Classification	Definition
8.4 Pathogens and microbes	Harmful native and non-native agents that cause disease or illness to a host, including bacteria, viruses, prions, fungi, and other microorganisms
9 Pollution	**Threats from introduction of exotic and/or excess materials or energy from point and non-point sources**
9.1 Household sewage and urban waste water	Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments
9.2 Industrial and military effluents	Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments
9.3 Agricultural and forestry effluents	Water-borne pollutants from agricultural, sivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied
9.4 Garbage and solid waste	Rubbish and other solid materials including those that entangle wildlife
9.5 Air-borne pollutants	Atmospheric pollutants from point and non-point sources
9.6 Excess energy	Inputs of heat, sound or light that disturb wildlife or ecosystems
10 Geological events	**Threats from catastrophic geological events**
10.1 Volcanoes	Volcanic events
10.2 Earthquakes/tsunamis	Earthquakes and associated events
10.3 Avalanches/landslides	Avalanches or landslides
11 Climate change	**Change in climate patterns (e.g., those resulting from increased atmospheric greenhouse gases like CO_2) and/or events outside the natural range of variation that could wipe out a vulnerable species or ecosystem**
11.1 Ecosystem encroachment	Large-scale effects of ecoystems shifting and impinging on other species and ecosystems
11.2 Changes in geochemical regimes	Broad-scale changes in the geochemical conditions of ecosystems including ocean acidification
11.3 Changes in temperature regimes	Broad-scale changes in temperature mean, variability, seasonality, and extremes, including changes in temperature extremes, increased average summer temperature, and decreased minimum winter/spring temperature
11.4 Changes in precipitation and broad-scale hydrological regimes	Broad-scale changes in precipitation mean, variability, seasonality, and extremes, including decreased or increased precipitation, changes in timing of precipitation, changes in form of precipitation (e.g., snow vs rain; snowcover and snowpack where applicable), changes in evapotranspiration rates and hydrological cycles, and droughts and floods
11.5 Severe/extreme weather events	Changes in frequency, timing and/or intensity of storms as well as severe weather events that threaten targets that have lost resilience

Appendix H. IUCN Conservation Actions Classification

World Conservation Union-Conservation Measures Partnership (IUCN-CMP) classification of conservation actions (version 2.0).

Conservation Actions	Definitions
1. Land/water protection	**Actions to identify, establish or expand parks and other legally protected areas**
1.1 Site/area protection	Establishing or expanding public or private parks, reserves, and other protected areas roughly equivalent to IUCN Categories I-VI (includes marine protected areas)
1.2 Resource & habitat protection	Establishing protection or easements of some specific aspect of the resource on public or private lands outside of IUCN Categories I-VI
2. Land/water management	**Actions directed at conserving or restoring sites, habitats and the wider environment**
2.1 Site/area management	Management of protected areas and other resource lands for conservation
2.2 Invasive/problematic species control	Controlling and/or preventing invasive and/or other problematic plants, animals, and pathogens
2.3 Habitat & natural process restoration	Enhancing degraded or restoring missing habitats and ecosystem functions; dealing with pollution
3. Species management	**Actions directed at managing or restoring species, focused on the species of concern itself**
3.1 Species management	Managing specific plant and animal populations of concern
3.1.1 Harvest management	
3.1.2 Trade management	
3.1.3 Limiting population growth	
3.2 Species recovery	Manipulating, enhancing or restoring specific plant and animal populations, vaccination programs
3.3 Species re-introduction	Re-introducing species to places where they formally occurred or benign introductions
3.3.1 Reintroduction	
3.3.2 Benign introduction	
3.4 Ex-situ conservation	Protecting biodiversity out of its native habitats
3.4.1 Captive breeding/artificial propagation	
3.4.2 Genome resource bank	
4. Education & awareness	**Actions directed at people to improve understanding and skills, and influence behaviour**
4.1 Formal education	Enhancing knowledge and skills of students in a formal degree programme
4.2 Training	Enhancing knowledge, skills and information exchange for practitioners, stakeholders, and other relevant individuals in structured settings outside of degree programmes

Conservation Actions	Definitions
4.3 Awareness & communications	Raising environmental awareness and providing information through various media or through civil disobedience
5. Law & policy	**Actions to develop, change, influence, and help implement formal legislation, regulations, and voluntary standards**
5.1 Legislation	Making, implementing, changing, influencing, or providing input into *formal government sector legislation or policies* at all levels: internation, national, provincial, local, tribal
5.1.1 International level	
5.1.2 National level	
5.1.3 Sub-national level	
5.1.4 Scale unspecified	
5.2 Policies and regulations	Making, implementing, changing, influencing, or providing input into *policies and regulations affecting the implementation of laws* at all levels: internation, national, provincial, local, tribal
5.3 Private sector standards & codes	Setting, implementing, changing, influencing, or providing input into voluntary standards and professional codes that govern private sector practice
5.4 Compliance and enforcement	Monitoring and enforcing compliance with laws, policies and regulations, and standards and codes at all levels
5.4.1 International level	
5.4.2 National level	
5.4.3 Sub-national level	
5.4.4 Scale unspecified	
6. Livelihood, economic & other incentives	**Actions to use economic and other incentives to influence behaviour**
6.1 Linked enterprises & livelihood alternatives	Developing enterprises that directly depend on the maintenance of natural resources or provide substitute livelihoods as a means of changing behaviours and attitudes
6.2 Substitution	Promoting alternative products and services that subsitute for environmentally damaging ones
6.3 Market forces	Using market mechanisms to change behaviours and attitudes
6.4 Conservation payments	Using direct or indirect payments to change behaviours and attitudes
6.5 Non-monetary values	Using intangible values to change behaviours and attitudes
7. External capacity building	**Actions to build the infrastructure to do better conservation**
7.1 Institutional and civil society development	Creating or providing non-financial support and capacity building for non-profits, government agencies, communities, and for-profits
7.2 Alliance and partnership development	Forming and facilitating partnerships, alliances, and networks of organizations
7.3 Conservation finance	Raising and provinding funds for conservation work